2nd Edition

Energy-Efficiency Labels and Standards:

A Guidebook for Appliances, Equipment, and Lighting

Lead Authors: Stephen Wiel and James E. McMahon

CLASP

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Inside Front Cover

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Preface

Energy-performance improvements in consumer products are an essential element in any government's portfolio of energy-efficiency and climate change mitigation programs. Governments need to develop balanced programs, both voluntary and regulatory, that remove cost-ineffective, energy-wasting products from the marketplace and stimulate the development of cost-effective, energy-efficient technology. Energy-efficiency labels and standards for appliances, equipment, and lighting products deserve to be among the first policy tools considered by a country's energy policy makers. The U.S. Agency for International Development (USAID) and several other organizations identified on the cover of this guidebook recognize the need to support policy makers in their efforts to implement energy-efficiency standards and labeling programs and have developed this guidebook, together with the Collaborative Labeling and Appliance Standards Program (CLASP), as a primary reference.

This second edition of the guidebook was prepared over the course of the past year, four years after the preparation of the first edition, with a significant contribution from the authors and reviewers mentioned previously. Their diligent participation helps maintain this book as the international guidance tool it has become. The lead authors would like to thank the members of the Communications Office of the Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory for their support in the development, production, and distribution of the guidebook.

This guidebook is designed as a manual for government officials and others around the world responsible for developing, implementing, enforcing, monitoring, and maintaining labeling and standards-setting programs. It discusses the pros and cons of adopting energy-efficiency labels and standards and describes the data, facilities, and institutional and human resources needed for these programs. It provides guidance on the design, development, implementation, maintenance, and evaluation of the programs and on the design of the labels and standards themselves. In addition, it directs the reader to references and other resources likely to be useful in conducting the activities described and includes a chapter on energy policies and programs that complement appliance efficiency labels and standards.

This guidebook attempts to reflect the essential framework of labeling and standards programs. It is the intent of the authors and sponsor to distribute copies of this book worldwide, at no charge, for the general public benefit. The guidebook is also available on the web at www.clasponline.org and may be downloaded to be used intact or piecemeal for whatever beneficial purposes readers may conceive.

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1 Labels and Standards in Context

Nations traditionally classify their final energy consumption into three sectors—buildings, industry, and transportation. In residential and commercial buildings, energy is consumed by appliances, equipment, and lighting. In homes around the world, energy is consumed by everything from refrigerators and clothes-washing machines to garbage compactors and desktop computers, all in ever-increasing numbers. In office buildings, energy is consumed by everything from computers and copiers to water coolers and photosensor-controlled lighting, also in ever-increasing numbers. Heating and cooling equipment—often out of sight—is a collection of energy-consuming equipment as well. The energy-efficiency labeling and standards-setting programs described in this guidebook are intended to reduce the energy consumption of all of these products without diminishing the services they provide to consumers.

Worldwide, people consume 422 Exajoules (EJ) or 400 quadrillion British thermal units (Btus) of marketed energy. This energy consumption contributes about 25 to 30% of energy-related CO_2 emissions, accounting for 26% of all anthropogenic CO_2 emissions and 14% of our net contribution to climate change from all greenhouse gases (Wiel 1998). The use of energy in human activities related to buildings, including the use of appliances, equipment, and lighting, accounts for 42% of total energy consumption (including the use of biomass) and 36% of total energy-related CO_2 emissions. Industrialized countries consume half of this energy; the remainder is consumed by the rest of the world (Price et al. 2005).

The above numbers are a snapshot of today's energy use patterns; what's ahead? Recent (1995 to 2002) annual average growth rates in primary energy use in buildings range from around –0.3% in Eastern Europe and the former Soviet Union countries to over 6% in the commercial sector of the developing Pacific Asian nations. On average, energy use in buildings is growing by about 2% per year worldwide, and the rate of growth has increased since 1995 (Price et al. 2005). Such continued growth in energy use in buildings is likely to contribute to overstressing many already stressed economies and environments around the world.

Energy growth rates will vary among nations according to structural differences in their economies (demographics, industrial composition, economic growth) and differences in the energy services that each energy consumer chooses or desires to purchase. In the building sector, these differences in preferred energy services are affected by varying climates, construction methods, and cultural habits. Each country can accommodate its natural growth in the demand for energy services by some combination of supplying more energy and improving the efficiency of energy consumption. In all sectors, improving energy efficiency before increasing energy supply is generally the more economically efficient national strategy. A portfolio of energy policies is available to governments for this purpose, including strategic energy pricing, financing and incentive programs, regulatory programs, government purchasing directives, and consumer education.

Improving energy efficiency in the residential- and commercial-buildings sectors not only saves money and reduces pollution but also improves the indoor environment of homes and the productivity in commercial buildings. Energy-efficiency labels and standards for appliances, equipment, and lighting offer a huge opportunity to improve energy efficiency and are especially effective as an energy policy. Government labeling and standards-setting programs can affect most of the energy that will be used in buildings just two decades from now. As Figure 1-1 below indicates, most of the energy-consuming products that will account for building energy use 20 years from now have not yet been built.

Well-designed mandatory energy-efficiency standards transform markets by removing inefficient products, with the intent of increasing the overall economic welfare of most consumers without seriously limiting their choice of products. Energy labels empower consumers to make informed choices about the products they buy and to manage their energy bills. Perhaps the most dramatic example in the world of the effectiveness of energy-efficiency standards and labels is the transformation of the refrigerator market in the U.S. The average new refrigerator sold in the U.S. today uses, per year, only a quarter of the electricity that would have been used by a refrigerator sold 30 years ago when standards and labels were first introduced, despite the new product's increased size and added features. Such improvements in energy efficiency not only improve a nation's economic efficiency and foreign trade, they also enhance people's lives by lowering consumers' energy bills and making energy services more affordable, enhancing labor markets, and improving public and environmental health. Labels and standards are appropriate for most cultures and marketplaces; therefore, the authors believe that energy-efficiency labels and standards deserve to be the cornerstone of any country's balanced portfolio of energy policies

Most products that will use energy in buildings in 2020 have not yet been built.

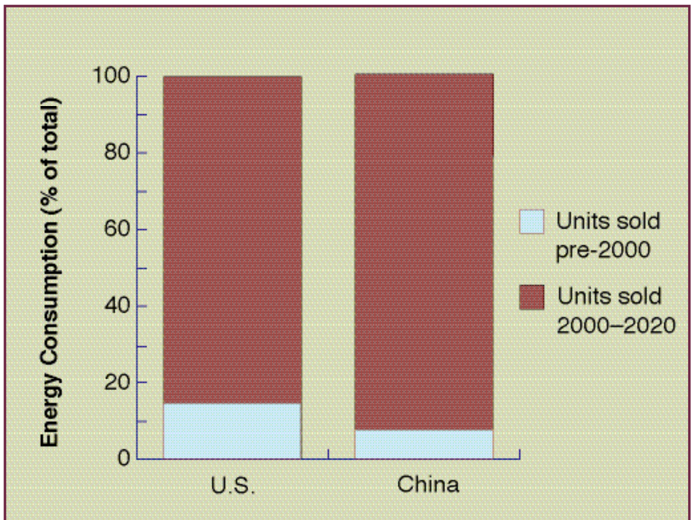


Figure 1-1 Source of energy consumption in buildings in 2020

and programs. Often, benefits similar to those from mandatory standards can be achieved by voluntary labels and other voluntary energy-efficiency programs, and opinions sometimes differ on which type of program should be considered first. The specific extent to which labels and standards should be applied and the balance of programs that will most effectively limit energy growth and at the same time stimulate economic growth will depend on individual national circumstances and other considerations discussed in this guidebook.

1.2 Purpose of This Guidebook

The authors have written this guidebook to assist policy makers and the institutions they represent in introducing energy-efficiency labeling and standards-setting programs for appliances, equipment, and lighting products and maintaining these programs effectively over time.

Policy makers will be faced with many difficult questions in the course of developing and maintaining labels and standards-setting programs. The guidebook is designed to assist policy makers in:

- determining whether a labeling or standards-setting program is right for their countries and, if it is, determining what combinations of programs and products are appropriate
- designing, developing, implementing, and maintaining labels and standards
- understanding the data; facilities; and cultural, political, and human resources necessary to reach their goals
- learning about existing field experience with energy-efficiency labeling and standards (through case examples and references)

One goal of this guidebook is to introduce the key steps in the standards-setting and labeling processes and to give a detailed explanation, based on collective experience, of the most direct and effective ways to undertake those steps. Many of the steps discussed can be harmonized with parallel activities of international organizations and other countries in the region and can be undertaken at relatively modest cost, resulting in significant economic and environmental benefits.

Except when discussing other government energy policies related to labeling and standards (Chapter 10), the guidebook does not address the building codes that are prevalent in most industrialized countries, throughout Southeast Asia, and elsewhere around the world, nor does it address energy-efficiency standards or labels for industrial processes or transport.

1.3 Modifications in the Second Edition

During the three years since the first edition of this guidebook was published, there has been increasing activity in standards-setting and labeling around the world. Labeling and standards in numerous countries have broadened their coverage to include new products such as electric motors, commercial lighting, and electric transformers. New standards have been introduced, and old standards have been updated to be more stringent. New labels have been introduced, and old labels have been redesigned to be more influential. The authors feel that the time is appropriate to share with the readers of the guidebook the news of shifting emphasis and progress in the field.

This second edition contains the same core material as the first edition, but the authors have updated examples and citations to dated material and clarified the text as needed. In addition, we have modified the book in four noteworthy ways. First, we have added a new Chapter 7 on public information campaigns (inserted just before the original Chapter 7) because an information campaign is an important element of standards-setting and labeling programs that was underemphasized in the first edition. Secondly, Chapter 5 on label design now crisply distinguishes between the development of comparison labels and the development of endorsement labels and overcomes a previous underemphasis on endorsement labeling. Thirdly, Chapter 8 has been retitled and significantly revised to address verification and compliance more broadly than in the first edition. Finally, throughout the book, the authors have described and given references to the dramatically increasing attention that nations around the world are paying to regional efforts to align and harmonize various elements of standards-setting and labeling programs, especially the adoption of testing protocols and mutual recognition of test results.

1.4 How to Use this Guidebook

The guidebook presents core concepts likely to be useful to people responsible for:

- considering whether or not to initiate an energy-efficiency labeling and/or standards-setting program
- designing the program
- implementing the program, and/or
- monitoring, enforcing, and maintaining the program

The remainder of the guidebook is organized as follows:

- **Chapter 2** is a stand-alone summary, similar to a Synopsis or an Executive Summary, of the entire volume.
- **Chapter 3** explores the many factors that are useful to consider when deciding whether to regulate the energy efficiency of any energy-consuming product or to require or encourage the provision of standardized and accurate information about its energy efficiency. Chapter 3 also discusses political, institutional, cultural, regional, technical, and economic factors that affect how successful or desirable such a program might be in various countries.
- **Chapters 4, 5, 6, and 7** describe the mechanics of labeling and standards programs, focusing on product testing (Chapter 4), label design (Chapter 5), standards analysis and determination of standards levels (Chapter 6), and communication campaigns (Chapter 7).

- **Chapters 8 and 9** address operation and maintenance of labeling and standards programs; Chapter 8 focuses on maintaining and enforcing labels and standards and Chapter 9 on evaluating their impacts.
- **Chapter 10** recognizes that the most effective national energy strategies are robust aggregations of many energy policies designed to transform markets and discusses how energy-efficiency labels and standards fit into a comprehensive national energy strategy.

Each chapter begins with "Prescriptions." These are the fundamental lessons that the more than 50 contributing authors and reviewers have learned from their many years of experience—the essential features of a successful energy-efficiency labeling and standards-setting program.

Chapters 2 through 9 each contain flow charts showing the basic steps in the relevant aspect of labeling or standards-setting that is addressed in that chapter. Together these flow charts make up a checklist of the many actions necessary to undertake a successful program of energy-efficiency labeling or standards.

Throughout the guidebook, the authors use the phrases "labels and standards" and "labeling and standards-setting" to refer broadly to programs that include any combination of mandatory or voluntary energy-efficiency labels, labeling, standards, and standards-setting. When our descriptions or prescriptions apply narrowly, we note which particular categories of programs we are addressing.

This guidebook and a comprehensive set of complementary support tools and resources are available on the Collaborative Labeling and Appliance Standards Program (CLASP) website: www.clasponline.org. Versions of the first edition of this guidebook in Spanish and Korean can be downloaded from the CLASP website. A version of the first edition in Chinese can be obtained by contacting CLASP at cegan@clasponline.org.

2. Energy-Efficiency Labels and Standards: An Overview

Guidebook Overview Prescriptions

1. Verify that efficiency labels and standards are appropriate as a basic element of your country's energy policy portfolio.
2. Apply your scarce resources to the products likely to provide the greatest public welfare.
3. Select/announce programs for specific products only when you've identified the necessary resources.
4. Allocate sufficient time and resources to adopt a common product-testing procedure for each major appliance. Focus first on certification of test laboratories and test facilities; if appropriate, leave actual testing to manufacturers and third-party testing organizations. Whenever possible, participate in regional or global harmonization of test procedures, and establish alliances with other nations working toward that goal.
5. Plan for involvement of manufacturers and all other interested stakeholders at appropriate stages in the processes of program design, label design, label specifications development, and standards-setting.
6. If you're new to standards-setting and labeling and have very limited resources, consider starting with a voluntary labeling program until you are comfortable and the stakeholders are ready for a more ambitious program.
7. Allocate sufficient time and resources to analyze the effects of any potential standards. The more the standards level remains grounded in a thorough, objective technical analysis, the greater the likelihood of political sustainability and subsequent compliance.
8. Be open to input from all stakeholders, and proceed in a transparent and responsive manner. Focus on what is best for the country in the long term. Be prepared to withstand strong political pressure.
9. Allocate sufficient resources to monitor, evaluate, and report the impacts of programs.

2.1 Definition of Energy-Efficiency Labels and Standards

Before discussing the many aspects of energy-efficiency labels and standards that follow, we define exactly what is meant by these two terms.

2.1.1 Labels

Energy-efficiency labels are informative labels affixed to manufactured products to describe the product's energy performance (usually in the form of energy use, efficiency, or energy cost); these labels give consumers the data necessary to make informed purchases. We distinguish in this guidebook between two types of labels:

- endorsement labels
- comparative labels

Endorsement labels are essentially "seals of approval" given according to specified criteria. Comparative labels allow consumers to compare performance among similar products using either discrete categories of performance or a continuous scale.

Energy labels can stand alone or complement energy standards. In addition to giving information that allows consumers who care to select efficient models, labels also provide a common energy-efficiency benchmark that makes it easier for utility companies and government energy-conservation agencies to offer consumers incentives to buy energy-efficient products. The effectiveness of energy labels is heavily dependent on how they present information to the consumer and on how they are supported by information campaigns, financial incentives, and other related programs.

2.1.2 Standards

Energy-efficiency standards are procedures and regulations that prescribe the energy performance of manufactured products, sometimes prohibiting the sale of products that are less efficient than a minimum level. The term "standards" commonly encompasses two possible meanings: 1) well-defined protocols (or laboratory test procedures) by which to obtain a sufficiently accurate estimate of the energy performance of a product in the way it is typically used, or at least a relative ranking of its energy performance compared to that of other models; and 2) target limits on energy performance (usually maximum use or minimum efficiency) based on a specified test protocol (McMahon and Turiel 1997). The term "norm" is sometimes used instead of "standard" in Europe and Latin America to refer to the target limit. In this guidebook, we use the term "test protocol" for specifications regarding testing and "standards" for target limits on energy performance that are formally established by a government.

There are three types of energy-efficiency standards:

- prescriptive standards
- minimum energy performance standards (MEPS)
- class-average standards

Prescriptive standards require that a particular feature or device be installed in all new products. Performance standards prescribe minimum efficiencies (or maximum energy consumption) that manufacturers must achieve in each and every product, specifying the energy performance but not the technology or design details of the product. Class-average standards specify the average efficiency of a manufactured product, allowing each manufacturer to select the level of efficiency for each model so that the overall average is achieved.

2.1.3 Mandatory vs. Voluntary Programs

Is it best to make labels or standards mandatory? What if manufacturers and importers are legally required to meet standards but generally do not adhere to them, as reportedly happened in Europe during the 1960s and 1970s (Waide et al. 1997)? Is the mere threat of mandatory standards enough to make a voluntary program effective? Switzerland successfully took this approach (Waide et al. 1997). Japanese manufacturers routinely meet "voluntary targets" even though Japanese regulations make no mention of enforcement or penalties for not meeting these targets. In Japan, the threat of public disclosure of non-compliance is sufficient deterrent to make voluntary targets effectively mandatory (Nakagami and Litt 1997, Murakoshi 1999).

Endorsement labeling programs are inherently voluntary. If the program includes a comparison label, the program can be either voluntary or mandatory or could start as voluntary and evolve to being mandatory later.

Deciding whether labels or standards should be legally binding is only one aspect of the process of designing a compliance mechanism. The goal is to affect the behavior of importers, manufacturers, salespeople, and consumers. Successful programs may combine any balance of legal, financial, and social considerations, depending on the structure, economics, and culture of the society.

2.1.4 Individual Products vs. Product Class

Is it better to set a standard that restricts the energy consumption of every individual product or to set a standard that controls the average energy efficiency for a class of products?

Most standards that have been set for refrigerators, freezers, clothes washers, clothes dryers, dishwashers, air conditioners, lighting products, and other household and office products have so far applied to each unit of every model manufactured. Manufacturers have the discretion to use any combination of technologies to meet a particular standard. For example, one refrigerator manufacturer may rely on an especially efficient compressor to meet a new standard while another may rely on a super-insulating door. Manufacturers test each model they offer and are expected to control production quality so that every unit meets the standard within a specified tolerance. Compliance can be checked relatively easily by testing any unit.

Switzerland, Japan and the European Union (E.U.) (through its negotiated agreements) are noted exceptions. These countries give manufacturers the discretion to achieve differing levels of energy efficiency in various models so long as the overall energy-savings target is achieved. This additional flexibility in the mix of products gives manufacturers the opportunity to find creative and economically efficient ways to achieve the desired overall efficiency improvement. However, it requires a more elaborate and sophisticated procedure for assessing and enforcing compliance and adds considerable complexity to manufacturer production and shipment schedules. Because the average is an aggregation of different efficiencies of different models, it depends heavily on the relative sales of the different models, which creates uncertainty about whether the class average will actually meet the target on the reporting date for compliance with the standards.

2.2 Rationale for Energy-Efficiency Labels and Standards

Energy-performance improvements in consumer products are an essential element in any government's portfolio of energy-efficiency policies and climate-change-mitigation programs. Governments should develop balanced programs, both voluntary and regulatory, that remove cost-ineffective, energy-wasting products from the marketplace and stimulate the development of cost-effective, energy-efficient technology, as shown in Figure 2-1. In some circumstances, mandatory requirements are effective. When designed and implemented well, their advantages are that:

- they can produce very large energy savings
- they can be very cost effective and helpful at limiting energy growth without limiting economic growth
- they require change in the behavior of a manageable number of manufacturers rather than the entire consuming public

Standards shift the distribution of energy-efficient models of products sold in the market upward by eliminating inefficient models and establishing a baseline for programs that provide incentives for "beating the standard." Labels shift the distribution of energy-efficient models upward by providing information that allows consumers to make rational decisions and by stimulating manufacturers to design products that achieve higher ratings than the minimum standard.

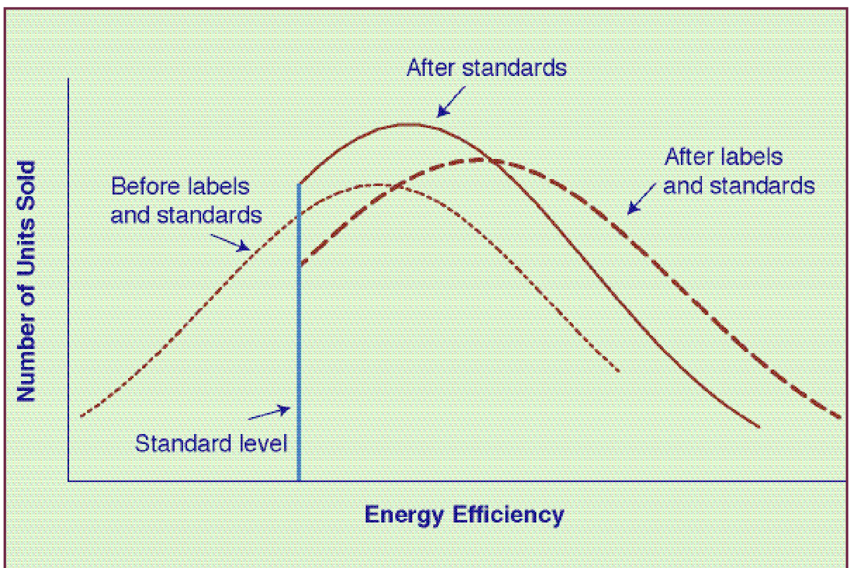


Figure 2-1 The impact of energy-efficiency labels and standards on the distribution of products in the marketplace: The Concept

- they treat all manufacturers, distributors, and retailers equally
- the resulting energy savings are generally assured, comparatively simple to quantify, and readily verified

The above benefits can easily be nullified if programs are not designed and implemented effectively.

The effect of well-designed energy-efficiency labels and standards is to reduce unnecessary electricity and fuel consumption by household and office equipment, e.g., refrigerators, air conditioners, water heaters, and electronic equipment. Reducing electricity use reduces fuel combustion in electric power plants. Cost-effective reduction in overall fuel combustion has several beneficial consequences. The six most significant of these benefits are:

- reducing capital investment in energy supply infrastructure
- enhancing national economic efficiency by reducing energy bills
- enhancing consumer welfare
- strengthening competitive markets
- meeting climate change goals
- averting urban/regional pollution

As individual nations around the world increasingly adopt and expand standards-setting and labeling programs, the harmonization of elements of these programs often brings additional benefits, primarily:

- reducing program costs by adopting program elements from trade partners
- avoiding or removing indirect barriers to trade
- avoiding the dumping of inefficient products on trading partners (see insert: *Dumping Inefficient Products on Trade Partners that Have Weak or No Standards*)

Dumping Inefficient Products on Trade Partners that Have Weak or No Standards

In an unusual twist, a recent study that benchmarked the performance of air conditioners among five Asian economies found that the "developing" countries (China, Korea, Malaysia, and Thailand) were "dumping" inefficient air conditioners on the more developed countries (Australia), which at the time did not have a minimum efficiency standard for air conditioners. In part as a response to the report, Australian manufacturers and distributors have agreed to speed the adoption of minimum standards for air conditioners, in order to keep the inefficient imported models off the market (Danish Energy Management 2004).

The benefits of standards and labeling programs are described in the following subsections.

2.2.1 Labels and Standards Reduce Capital Investment in Energy Supply Infrastructure

In industrialized countries, energy consumption by appliances, equipment, and lighting is already substantial. Energy use per capita has generally stabilized, and total energy use in buildings is growing roughly proportionally to population growth. In developing countries, by contrast, energy consumption in buildings is generally much lower than energy consumption in buildings in industrialized nations but is growing rapidly as more people use particular types of appliances and per-capita energy consumption increases. For example, Denmark, with a Gross Domestic Product (GDP) per capita of US$39,647, had total per-capita energy use of 154 megajoules in 2002, which had been growing at the rate of 0.02% per year during the previous 10 years. In the same year, Thailand with a per-capita GDP of US$3,000, had total per-capita energy use of 57 megajoules, with per-capita energy growth during the same 10-year period of 4.3% per year (IEA 2002). Most other countries (excluding the economies in transition of the former Soviet Union) have growth rates that fall between these two examples. Countries that expect rapid energy growth (which is most countries) face the uncomfortable need to invest hard currency in energy-consuming products and new power plants to supply the resulting energy needs.

Improvement in the energy efficiency of an electricity-, natural-gas-, or other fuel-consuming product reduces the amount of energy that the product uses. If the product consumes electricity and operates at times of peak power demand, the improved efficiency also reduces demand for new power plants. The investment that would be required for new power plants is vastly more expensive than the increased cost of designing and manufacturing energy-efficient components for the energy-consuming products that these power plants service. For example, an unpublished analysis by Ernest Orlando Lawrence Berkeley National Laboratory (LBNL) in the mid 1990s showed that if improvements in energy efficiency averted 20% of Pakistan's projected energy demand during the following 25 years, Pakistan would need US$10 billion less in hard currency for capital investments in power plants, transmission lines, and fuel. At the time, these efficiency improvements could have cost as little as $2.5 billion, with a portion of that in local currency. In other words, efficiency labels and standards are a highly cost-effective way to reduce future investments in expensive power plant construction, freeing capital for more economically advantageous investments in the energy sector, such as compact fluorescent lamp (CFL) manufacturing facilities or basic health and educational services.

2.2.2 Labels and Standards Enhance National Economic Efficiency by Reducing Energy Bills

The above rationale of reduced future investments applies equally to spending on fuel. Efficiency labels and standards reduce future investments in fuel acquisition, delivery, and use. The amount that is spent in the energy sector of any country in any year siphons money away from other sectors. Because much energy-sector spending directly supports production of other goods and services, a more efficient energy sector results in a more efficient economy.

Considering Pakistan as an example again, the 20% reduction in energy consumption discussed above would have reduced the country's electricity-to-GDP growth-rate ratio from the then-current range of 1.0 to 1.5, which was steadily increasing the relative energy cost in the economy, to a more desirable range of 0.8 to 1.2, which would have freed much hard currency for other important social and economic expenditures.

Perhaps the comparison of investment in energy-efficiency standards and labels to investment in power production shown in Figure 2-2 is the best way to demonstrate the economic benefits. The figure shows that, over its entire history, the U.S. energy-efficiency standards program has avoided the need for supplying additional electricity at a cost that is one-third that of actually having to supply it.

The cost of avoiding electricity use with energy-efficiency standards is far less than the cost of having to supply it.

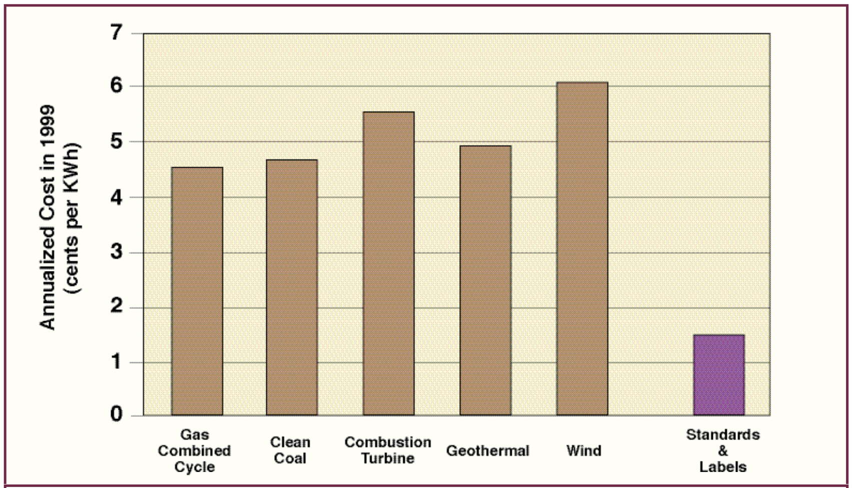


Figure 2-2 The cost of electricity in the U.S. from various new sources
Source: U.S. Energy Information Administration's National Energy Modeling System and (Meyers 2004)

2.2.3 Labels and Standards Enhance Consumer Welfare

When applied appropriately, labels and standards can boost energy efficiency and enhance consumer welfare. In the U.S., for example, the number of refrigerator models and features available to consumers has increased since efficiency standards have been put in place, and purchase prices have been even lower than those expected and justified by regulators (Greening et al. 1996). The average amount of electricity needed to operate a new refrigerator in the U.S. has dropped by 75% since standards we re first announced in the state of California almost 30 years ago even though new refrigerators have enhanced features and larger capacity. (It is important to note, however, that, if inappropriately and unnecessarily applied, standards can limit choice, add to product cost, and disrupt trade.)

2.2.4 Labels and Standards Strengthen Competitive Markets

If designed effectively, energy-efficiency standards and improved products can make local businesses more profitable in the long run; make local appliance, lighting, and motor manufacturers more competitive in the global marketplace; and make local markets more attractive for multinational commerce. By contrast, unnecessary and inappropriate standards can undermine burgeoning new local industries at a time when access to capital and other resources is limited. In addition, standards can have either a positive or negative effect on trade, by purposefully or inadvertently creating or removing indirect trade barriers.

There are many anecdotes and various views on the effects of standards on individual companies, and many manufacturers claim that they have been unsuccessful in maintaining margin on incremental product costs after the implementation of energy-performance standards. The desired outcome seen by some stakeholders is not always the actual outcome, as evidenced by consolidation of manufacturers in the U.S., and, in some cases, a shift of domestic manufacturing jobs offshore.

In sum, the application of new standards offers a government an opportunity to effect a change in its nation's business environment. The desired outcome is a strengthened competitive market in the long run although there is the risk that some manufacturers will be distressed in the short run.

2.2.5 Labels and Standards Meet Climate-Change Goals

Energy-efficiency labels and standards can help a country meet climate-change goals. Reducing electricity consumption decreases carbon emissions from fossil-fuel power plants. For example, appliance standards currently in effect in the U.S. are projected to reduce residential-sector carbon emissions by an amount equal to 9% of 1990 levels by the year 2020 (Meyers 2004).

2.2.6 Labels and Standards Avert Urban/Regional Pollution

Energy-efficiency labels and standards can help a country avert urban/regional pollution. Reducing energy consumption in buildings also decreases fossil-fuel power plant emissions of sulfur dioxide, nitrogen oxides, particulate matter, and other toxic gases and aerosols.

2.2.7 Harmonized Labels and Standards Reduce Program Costs and Foster Global Trade

As labeling and standards-setting programs proliferate, international cooperation is becoming increasingly advantageous in reducing the resources needed for developing these programs and in fostering global trade by avoiding or removing indirect trade barriers. The International Energy Agency (IEA) identifies several forms of cooperation, including: collaboration in the design of tests, labels, and standards; harmonization of the test procedures and the energy set points used in labels and standards; and coordination of program implementation and monitoring efforts. Such cooperation has five potential benefits (IEA 2000):

- greater market transparency
- reduced costs for product testing and design
- enhanced prospects for trade and technology transfer
- reduced costs for developing government and utility efficiency programs
- enhanced international procurement

Recently, more and more countries have been making a distinction between unilateral alignment of elements of standards-setting and labeling programs with those of trade partners and harmonization of these program elements in multilateral forums and compacts. The benefits from these two approaches to cooperation are basically the same.

Nations joining in regional harmonization activities have expressed differing reasons for their participation, including the desire to:

- improve energy efficiency
- improve economic efficiency (improve market efficiency)
- reduce capital investment in energy supply
- enhance economic development (enhance quality of life)
- avert urban/regional air pollution
- help meet goals to reduce climate change
- strengthen competitive markets (reduce trade barriers)
- reduce water consumption
- enhance energy security

This diversity of reasons for participating in regional harmonization activities has not diminished the commonality of interest in achieving harmonization. Delegations of countries and participants in various regional harmonization efforts have agreed, with little controversy, to seek one or more of the following:

- harmonized test facilities and protocols
- mutual recognition of test results
- common content for comparison energy labels
- harmonized endorsement energy labels
- harmonized MEPS for some markets
- shared learning about the labeling process
- shared learning about the standards-setting process

Furthermore, experience has shown that harmonization is aided by broad agreements on economics and trade, as evidenced, for example, by the harmonization activities of the North American Energy Working Group in support of the North American Free Trade Agreement and of the Expert Group on Energy Efficiency and Conservation within Asian-Pacific Economic Cooperation (APEC) (Wiel and Van Wie McGrory 2003).

The paragraphs above describe the benefits of well-designed and effectively implemented labels and standards. It is important, however, to remember that ill-advised or poorly designed or executed programs can actually harm consumers, manufacturers, and other stakeholders, as well as the overall economy and the environment. Some examples of negative effects of ineffective efforts are worth noting. With regional cooperation, formal harmonization of standards by treaty rather than voluntary unilateral alignment might result in adoption of a "least common denominator" that may restrain the more progressive countries. A regional harmonized approach might also add administrative complexity and delay the process. Perceptions that a country is surrendering sovereignty to other countries as part of a harmonization effort can create political impediments as well. In national programs, inattention to detail in the development and implementation of the program can have especially devastating impacts on poor consumers or small manufacturers. Standards that are too weak, endorsement labels placed on average-performing products, and comparison labels that communicate poorly offer little relief from high utility bills or from low-quality products. Standards that are too strong can cause overinvestment in energy efficiency, resulting in overly stressed manufacturers and in consumers paying, on average, more for a product than they will recover in utility-bill savings. This in turn decreases national economic efficiency. Careful attention to the issues raised in this guidebook can help countries avoid some of the pitfalls mentioned above.

2.3 History and Scope of Energy-Efficiency Labels and Standards

Conceptually, energy-efficiency labels and standards can be applied to any product that consumes energy, directly or indirectly, as it provides its services. The national benefits of labels and standards applied to the most prevalent and energy-intensive appliances, such as household refrigerators, air conditioners, water heaters and electronic equipment, are, initially, generally substantially higher than the cost of implementing the labels and standards programs and producing the efficient products. The stringency of initial standards is typically ratcheted up over time to accelerate the adoption of new technology in the marketplace, and the threshold criteria for endorsement labels are similarly raised over time. Likewise, the bandwidth or definition of categories for comparison labels is updated over the years. The need for periodic ratcheting and the cost effectiveness of any increases in standards levels will be uniquely determined for any product by the rate at which new technology is developed and the rate at which manufacturers voluntarily invest to incorporate this new technology into their product lines. The benefits from labels or standards for less common or less energy-intensive products, such as toasters, are often too small to justify the costs.

The first mandatory minimum energy-efficiency standards in modern times are widely believed to have been introduced as early as 1962 in Poland for a range of industrial appliances. The French government set standards for refrigerators in 1966 and for freezers in 1978. Other European governments and Russia introduced legislation mandating efficiency information labels and performance standards throughout the 1960s and 1970s. Much of this early legislation was weak, poorly implemented, had little impact on appliance energy consumption, and was repealed during the late 1970s and early 1980s under pressure to harmonize European trading conditions (Waide et al. 1997). The first energy-efficiency standards that dramatically affected manufacturers and significantly reduced the consumption of energy were mandated in the U.S. by the state of California in 1976. These standards became effective in 1977 and were followed by U.S. national standards that became effective starting in 1988. By the beginning of the year 2000, 43 governments around the world (including the 15 original members of the E.U.) had adopted at least one mandatory energy-efficiency standard. By 2004, the number had increased to 55 (including the addition of the seven E.U. accession countries that did not already have a program).

The beginning standards level set for each product has varied by country. For countries designing standards to have long-term impact, the intent is for standards to become increasingly stringent over time as part of the basic strategy, noted above, for coaxing newly emerging energy-efficient technology into the m a rketplace. De velopment of new technology is never ending although the ultimate efficiency of some p roduct components is limited by natural laws (for example, the vapor compression system used for refrigerators and room air conditioners is limited by the theoretical Carnot cycle). Nevertheless, humans are inherently innovative, and rates of efficiency improvement vary widely over the full range of appliances, equipment, and lighting products. Refrigerator standards in the U.S. are the most dramatic example of emerging technology and the ratcheting effect, which can be seen vividly in Figure 2-3.

Comparison labeling programs have developed in parallel with standards. In 1976, France introduced mandatory comparison labeling of heating appliances, boilers, water heaters, refrigerators, clothes washers, televisions, ranges, and dishwashers. Japan, Canada, and the U.S. soon followed suit with programs covering these and other products. U.S. labels enacted by law in 1975 took effect under the name EnergyGuide in 1980 for major household appliances. No new mandatory labeling programs we re undertaken until Australia adopted one in 1987. The Australian program, like the eight additional programs that were created around the world throughout the 1990s, also covers major household appliances (Duffy 1996).

Energy-efficiency standards are the primary reason that the average new refrigerator sold in the U.S. today uses one-quarter the electricity of the average new refrigerator manufactured 30 years ago.

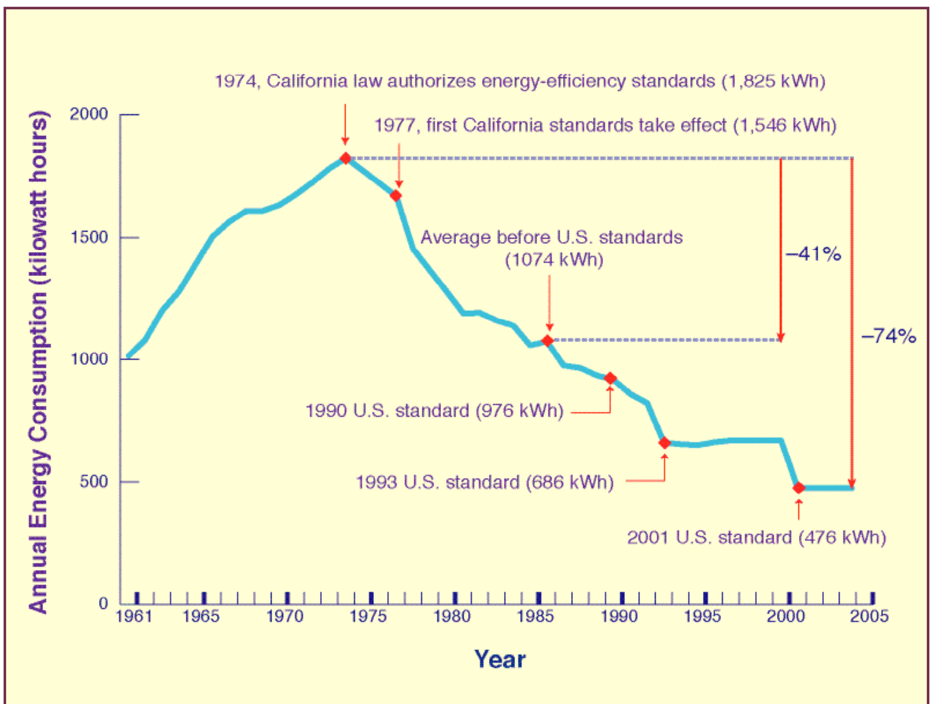


Figure 2-3 The power of ratcheting the stringency of standards: the example of U.S. refrigerator standards

Table 2-1 The Status of Energy-Efficiency Labels and Standards (as of September 2004)

Year: Date in which a country's first standard or label became effective

Fuel Type: B = building shell, D = diesel, E = electric, G = gasoline, N = natural gas, W = water, O = distillate oil

Fuel Type	Product	France	U.S.	Germany	Canada	Japan	Taipei China	[illegible]***	Russia	Brazil	Israel	Australia	New Zealand	India	China	Malaysia	Norway	EU****	Czech Republic	Singapore
	Year	1966	1975		1978	1979	1981	1983		1984	1985	1986		1987	1989			1992	1993	
E	Refrigerators	LS	LSL	L	LSL	LS	LS	LS	LS	LS	LS	LSL	LS	LSL	L'SL	L	LSL	LSSL	LSL	L
E	Freezers	S	LSL		LS	LS	L	LS	LS	LS	LS	LSL	LS		L	L	LSL	LSSL	LSL	L
E	Minibar Fridges																			
E	Clothes Washers	L	LSL	L	LSL		L			LS	LS	LS	L		LS		LSL	LSL	LSL	L
EN	Clothes Dryers		LS	L	LS		L			L		LS	L				L	L	L	L
EN	Washer-dryers				LS												L	L	L	
E	Dishwashers	L	LSL	L	LSL		L	S	S	L	LS	LS	L				LSL	LSL	LSL	
EN	Ranges/Ovens	L	L	L	LS	LS	LS	S	S	LS	LS			L			L	L	L	
E	Microwave Ovens			L			L			L					L					
E	Rice Cookers						S								LS					
E	Electric Kettles							S	S											
E	Vacuum Cleaners							S	S								L	L	L	
E	Irons							S	S						S					
E	Icemakers				S															
EN	Water Heaters	L	LS		S	LS	LS	S	S	LS	LS	LS	LS	L	L		S	S	S	L
	Solar Water Heaters					L	L			LS	LS	S								
W	Showerheads		LS							LS		L			L					
E	Showerheads									L										
E	Range Hoods						S			L										
W	Faucets		LS							LS		L			L					
W	Toilets		S									L			L					
E	Toilet Seats					LS														
W	Urinals		S									L								
E	Room Air Cleaners		L																	
E	Room AC		LSL		LSL	LS	LS	S	S	LS	LS	LSL	LS	S	L'SL		L	L	L	LS
E	Central AC		LSL		LS	LS				LS		LS	LS		S					
EN	Boilers	L	LSL		S		S			LS							S	S	LS	
O	Boilers		LSL		LS		S													
E	Chillers				S		S					S	S		S'					
E	Dehumidifiers		L		LS		L													
E	Fans		L		L		LS				LS				S					
N	Furnaces		LSL		LS					LS										
O	Furnaces		LSL																	
E	Heat Pumps		LSL		LS	S						L	L					L	L	
EN	Pool Heaters		S																	
E	Programmable Thermostats[a]		L		L															
EN	Space Heaters	L	L			LS				L	LS	LS								
E	Ballasts		LS		S	S				LS		LS	LS		LS	S	S	S	S	L
E	Lamps		LSL		LS	LS	LS			LS	LS	LS'	LS	L	LS		LL	LL	LL	L
E	Exit Signs		L		L															
E	Residential Lighting Fixtures		L																	
B	Skylights		L																	
E	Traffic Signals		L		L															
E	Wall packs																			
E	Televisions	L	L		L	LS	L	S	S	L		L	L	L	LS		LS	LS	LS	
E	Digital TV services											L						C		
E	VCRs		L		L	S						L	L		L		LS	LS	LS	
E	DVDs		L		L	S						L			L					
E	TV/VCR and TV/DVD Combination Units		L		L															
E	Set-top boxes		L		L							L			L		S	S	S	
E	Radio Tuner/Deck		L		L							L			S		S	S	S	
E	Portable Personal audio																			
E	Analogue Satellite Receivers																			
E	Home Audio[b]		L														S	S	S	
E	Answering Machines		L		L															
E	Cordless and mobile phones		L		L															
E	Battery chargers																			
E	Computers		L		L	LS	L	S	S			L	L		L		L	L	L	L
E	Monitors		L		L	L	L	S	S	L		L	L		L		L	LS	LS	L
E	Copiers		L		L	LS	L					L	L		L		L	L	L	
E	Printers		L		L	L	L	S	S			L	L		L			L	L	
E	Fax Machines		L		L		L					L	L		L		L	L	L	
E	Scanners		L		L	L	L					L	L							
E	Multifunction devices		L		L	L	L					L						L	L	
E	Mailing machines		L		L															
E	Hard-disk Drives					S														
E	Drinking Water Coolers (Hot&Cold)		L		L					L										
E	External Power Supplies		L															C		
E	Motors		S		S		S			LS		S	S	L	LS	S		LS	LS	L
E	Pumps									LS							L			
E	Transformers		L		LS	LS	L			LS		S'	S				S	S	S	
B	Building insulation		L																	
B	Doors		L		L															
B	Reflective Roof Products		L																	
B	Windows		L		L							L	L							
E	Commercial HVAC		L																	
GN	Commercial Fryers		L																	
E	Commercial Hot Food Holding Cabinets		L																	
E	Commercial Refrigerators		L									LS'	LS							
EN	Commercial Steam Cookers		L																	
E	Vending Machines		L			S														
G	Automobiles		L		L	S				LS		L						LS		

L = voluntary labels; L = mandatory labels; S = voluntary standards; S = mandatory standards; C = voluntary code of conduct

This table shows the chronological order in which countries first adopted an energy-efficiency label or standard. Since the indication dates shown for each country, many of the programs have been vastly expanded and updated (i.e., voluntary to mandatory, introduction of new product MEPS or labeling).

	1994		1995			1996			1998				1999	2000	2001				2002		2003			2004	
Philippines	Thailand	Switzerland	Hong Kong	Mexico	Poland	CIS countries	Costa Rica	Romania	Colombia	Hungary	Iran	Venezuela	Indonesia	South Africa	Argentina	Peru	Saudi Arabia	Slovenia	Uruguay	Turkey	Bulgaria	Egypt	Sri Lanka	Tunisia	EU Accession*****
L	L	LS	L	LSL	LS		LS	LS	LS	LS	LS	LS	L	L	L			L		L	L	LS		LS	LSSL
L		LS		LSL			LS	L	LS	LS	LS	LS			L					L	L	LS			LSSL
	L	LS	L	LSL	L			L		L	LS			L				L		L	L	LS			LSL
		LS	L		L			L		L										L	L				L
		L																			L				L
		LS			L			L		L										L	L				LSL
		S					LS	L													L				L
	L		L																						
																									L
											LS														
		S	L	LS			LS		LS		LS														S
									S																
					S																				
LS	LS[7]		L	LSL			LS		LS		LS	LS					S		S		L	LS			L
				LS																					
				S																					S
			L																						
		S																							
																									L
					S																				
LS	L			LS			LS		LS														L		S
LSL	L	L	L	LSL	L		LS	L	LS	LL				L	L	L		L		L	L		L		LL
						L																			
		S	L	L		L																			SL
																									C
		S				L																			SL
						L																			S
																									S
						L																			
						L																			
						L																			S
						L																			
						L																			
	L	LS				L																			L
	L	LS	L			L																			LS
	L	LS	L			L																			L
		LS	L			L																			L
		LS				L																			L
						L																			
			L			L																			L
						L																			
																									C
	L			LS	S		LS		LS		LS														LS
				LS							LS														
				S																					S
				LS																					
																									LS

Notes:

*Gas-fired water and space heaters only; Programmable Thermostats are categorized the same as EU Central Heating Controls

**Home Audio includes EU's Audio Systems & Audio Separates

***FSU (Former Soviet Union) identifies as a group the successor nations to the Soviet Union or USSR which collapsed in the early 1990s; this group of 15 countries consists of Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan

****EU (European Union): this table indicates the original 15 E.U. members countries with at least one standard or label in effect; Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom

*****EU Accession: The 10 accession members added to the E.U. in 2004 with at least one standard or label in effect; Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia

[1] effective from October 2004

[2] effective from October 2004

[3] effective from October 2004

[4] effective from March 2005

[5] effective from March 2005

[6] effective from March 2005

[7] effective on a voluntary basis from August 2003; become mandatory from March 2005

Sources: A wide range of sources were consulted in the formulation of this table, including correspondence with in-country experts. For a detailed list of sources, please consult the on-line version of the table at : www.claspononline.org/GB2ndEdition/Chapter2/Table2_1.xls

Recently, a number of countries have initiated programs of voluntary endorsement labeling for energy-efficient products. One of the most extensive and widely known programs is the U.S. ENERGY STAR program. Introduced in 1992 to recognize energy-efficient computers, the ENERGY STAR endorsement labeling program has grown to identify efficient products in more than 40 categories including household appliances, home electronics (televisions, audio systems, etc.), computers and other office equipment, residential heating and cooling equipment, and lighting. Many other countries including Australia, Canada, China, Brazil, and the United Kingdom (U.K.) have subsequently implemented national programs. The International Finance Corporation of the World Bank Group recently launched a multinational Efficient Lighting Initiative (ELI) that has so far supported endorsement labeling of efficient lighting products in seven developing and transition countries. By 2004, the number of countries labeling at least one product with a comparison label, endorsement label or energy-related ecolabels had grown to 51.

The history of initiation of labels and standards programs during the past three decades and the programs' current status is shown in Table 2-1 on previous pages and Figure 2-4 below. Readers are advised to check www.clasponline.org/GB2ndEdition/Chapter2/Table2_1.xls for updates to Table 2-1.

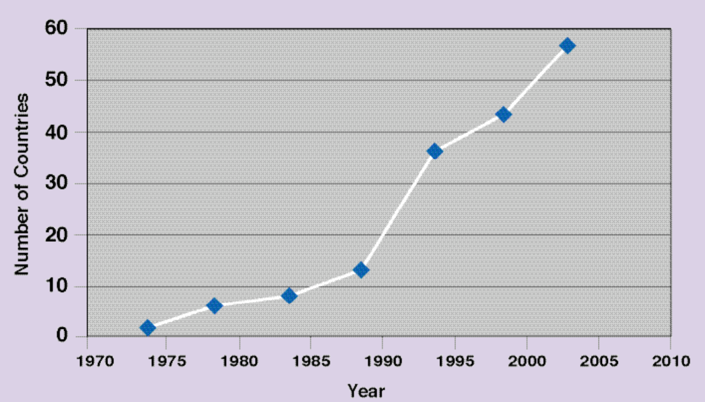


Figure 2-4 Growth in the number of countries that have adopted at least one standard or label

Since the mid-1970s when they were first introduced, the number of countries that have applied energy efficiency standards and/or labels has grown rapidly.

2.4 Resources Needed for Developing Energy-Efficiency Labels and Standards Programs

The development and implementation of energy-efficiency labels and standards require legal, financial, human, physical, and institutional resources. Each of these already exists to some degree in every country, and each is likely to need at least a little, if not major, bolstering to facilitate an effective labeling or standards program. The remaining chapters of this guidebook address the resources required for each step in the process. Below, we describe one anecdotal experience of the overall magnitude of government spending needed to develop and implement an energy-efficiency standards program.

The U.S. program of national, mandatory energy-efficiency standards began in 1978. By 2004, the program had developed (and, in 17 cases, updated) 39 residential and commercial product standards. During the first 19 years of program, the U.S. government spent US$104 million on developing and implementing these standards, with an average annual expenditure of US$5.5 million and never more than US$11.3 million or less than US$2.3 million in a single year. Annual spending per household was in the range of 2¢ to 12¢ per year for a total of $1.00 over 19 years ($2.00 in constant U.S. dollars). The payback on the increased manufacturer and consumer investments in efficient technology that have resulted from this endeavor has been enormous, as will be demonstrated in the next section.

Other countries that are developing standards and labeling programs can save some program costs by drawing on existing work in the U.S., E.U., Australia, and other countries. Still, undertaking a standards-setting and labeling program requires a serious commitment of resources by the implementing country.

2.5 Effectiveness of Energy-Efficiency Labels and Standards

The effectiveness of energy-efficiency labels and standards is generally reported in the form of: calculations of impacts prepared prior to implementation; anecdotal testimonials; or calculations of impacts based on monitoring of the response to labels and standards once they are in place.

Whether the calculations are made before implementation or after, they are generally based on solid market data. These data usually show the potential or actual impact in a dramatic way, as is the case for clothes-washer efficiency in the U.S. market. Figure 2-5 shows how the U.S.'s 1994 standards shifted the market toward washers that are substantially more efficient. The performance differences in an unregulated market typically range over a factor of three, even more than shown in Figure 2-5 (Adnot and Orphelin 1999). The impact of energy-efficiency labels has likewise been dramatic. The first evaluation of the impact of the recent E.U. labeling scheme showed that

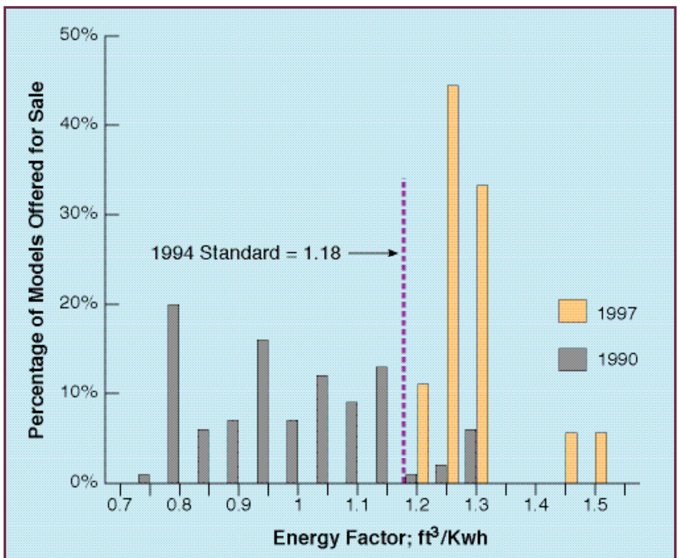


Figure 2-5 The impact of energy-efficiency standards on the distribution of products in the marketplace: clothes washers in the U.S.

An evaluation of the impact of 1994 clothes washer standards in the U.S. shows a dramatic upward shift in the energy efficiency of models offered for sale after the standards were implemented.

An evaluation of the impact of refrigerator labels and standards in the E.U. shows a dramatic upward shift in the energy efficiency of models offered for sale after the labels and standards were implemented.

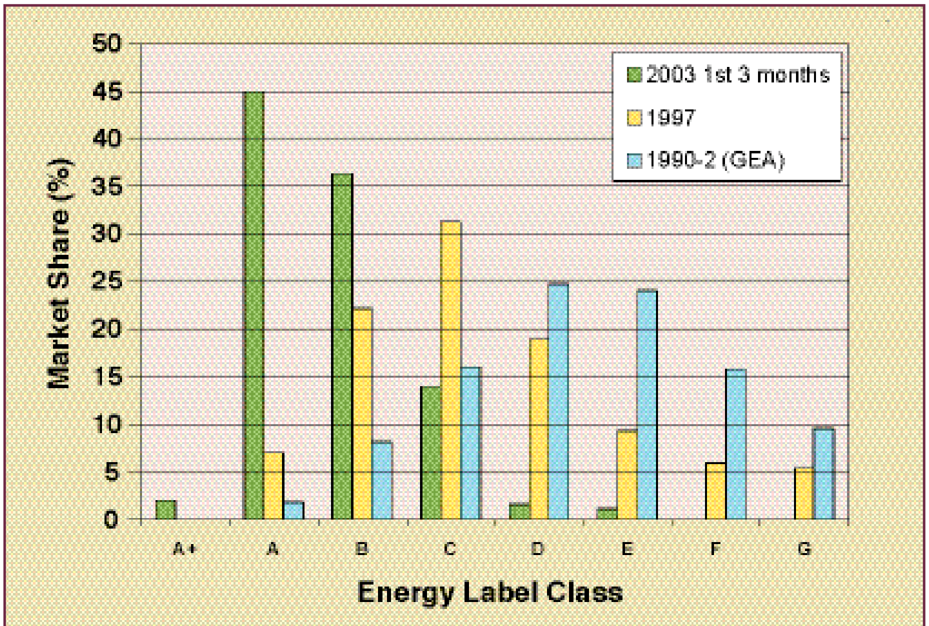


Figure 2-6 The Impact of energy-efficiency standards and labels on the distribution of products in the marketplace: refrigerators in the E.U

the sales-weighted average energy efficiency of refrigeration appliances improved by 26% between 1992 and late 1999, with over one-third of the impact attributable to labeling (Bertoldi 2000). The shift in the efficiency of refrigerators sold in the E.U. is displayed dramatically in Figure 2-6 (Waide 2004, GfK 2003). These assessments clearly imply a huge potential for reducing the energy use of a single product although they fall short of estimating the overall impact of this reduction (e.g., reduction in total energy use, net economic effect, or environmental contribution).

The best example of post-implementation calculations of overall impact is the U.S. claims that energy-efficiency standards adopted to date in the residential sector will result in $130 billion cumulative present-valued dollar savings from reduced energy use over the lifetimes of the products after subtraction of any additional cost for the more efficient equipment. Cumulative primary energy savings during this period are estimated to total 72 EJ. The result in 2020 is expected to be an 8% reduction in residential energy use relative to what would have been the case without the standards. Average benefit/cost ratios for these standards are estimated to be about 2.2 for the U.S. as a whole.

The total $2 per household federal expenditure for implementing the U.S. standards that have been adopted so far is estimated to have induced investment in energy-saving features equaling $1,000 per household, which results in $2,170 gross savings per household in fuel costs, and contributes $1,180 of net-present-value savings per household to the U.S. economy during the lifetimes of the products affected. Projected annual residential carbon reductions in 2020 are approximately 34 metric tons, an amount roughly equal to 9% of 1990 residential carbon emissions (Meyers 2004).

One impact of these mandatory standards is that manufacturers have invested heavily in redesigning full product lines to comply, spending hundreds of millions of dollars in the U.S. alone. This expenditure may have sometimes contributed to consolidation of manufacturers and relocation of production to other countries. For example, prior to the institution of standards for residential air conditioners in the U.S., almost all units sold in the country were made domestically. Now, there is only one company in the U.S. producing residential air conditioners. In developing countries, standards have in some cases protected local manufacturers from foreign competition, but the foreign competition has in other cases overwhelmed local manufacturers. Standards have had a variety of impacts on a country's manufacturing base.

The 2002 annual report on the savings from the labeling of the 34 products that were at that time covered by the U.S. ENERGY STAR program showed annual savings in 2001 of 560 trillion EJ and $4.1 billion. The peak demand reduction resulting from the ENERGY STAR labeling program was 5.7 gigawatts in 2001 and was expected to increase to 7.0 gigawatts in 2002. This report also includes a prospective analysis of the cumulative savings under target market penetrations for the periods 2002–2010 and 2002–2020, respectively, showing that all the products together were expected to save 11 quadrillion Btu (quads) by 2010, growing to 31 quads by 2020 (Weber et al. 2003).

Analyses from elsewhere around the world also report substantial impacts from standards and labeling. During the 1990s, the Demand-Side Management (DSM) Office of the Electricity Generating Authority of Thailand developed a portfolio of 19 DSM measures, including voluntary labeling programs for refrigerators and air conditioners. From 1994 to 2000, the total US$13.7 million that the government spent on these two programs (22¢ per capita) induced spending by consumers on energy-enhancing features of US$80 million ($2.44 per capita) and resulted in a 168-megawatt (MW) reduction in peak power, 1,200-gigawatt hour (GWh) reduction in annual electricity use, and an 860 kiloton reduction in CO_2 emissions. This saved Thai consumers a net $56 million (91¢ per capita) (Singh and Mulholland 2000).

An unpublished study of China's energy-efficiency standards was conducted by the China Center for the Certification of Energy Conservation Products (CECP), the China National Institute of Standardization (CNIS), and LBNL for the U.S. Energy Foundation. This study estimated savings from eight new minimum energy-performance standards and nine energy-efficiency endorsement labels that were implemented from 1999 through 2004 for appliances, office equipment, and consumer electronics. The study concluded that during the first 10 years of implementation, these measures will have saved 200 terawatt hours (TWh) (equivalent to all of China's residential electricity consumption in 2002) and 250 megatonnes of CO_2 (almost 70 megatonnes of carbon) (Fridley and Lin 2004).

Korea shows similar evidence of the impact of labeling, as does the E.U. Figure 2-7 on the next page displays the same type of market shift for refrigerators in Korea that is shown for the E.U. in Figure 2-6 (KEMCO 2003).

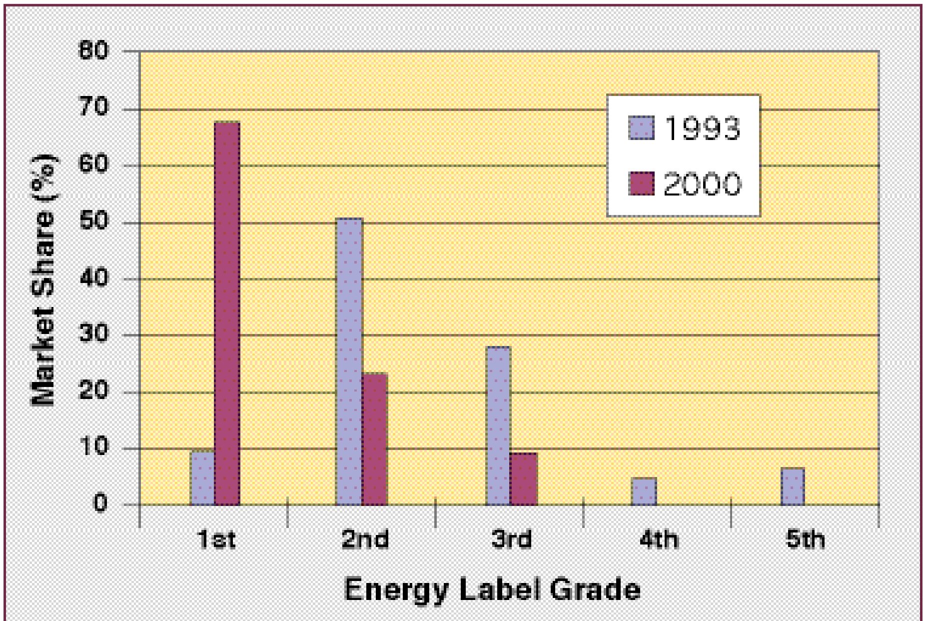


Figure 2-7 The impact of energy-efficiency labels on the distribution of products in the marketplace: refrigerators in Korea

The impact of labels and standards is similar worldwide.

A recent IEA report concludes that if it had not been for the implementation of existing policy measures such as energy labeling, voluntary agreements, and MEPS, electricity consumption in OECD countries in 2020 would be about 12% (393 TWh) higher than is now predicted. The report further concludes that the current policies are on course to produce cumulative net cost savings of 137 billion in OECD-Europe by 2020. Large as these benefits are, the report found that much greater benefits could be attained if existing policies were strengthened (IEA 2003).

An example of a testimonial is the remark of a representative of Bosch-Siemens, a European appliance manufacturer, who was quoted in 1995 as saying "This labelling is having a major effect on our sales ...We see market share decline or rise within even as short as 3 months after labelling commences" (Ginthum 1995). The reader will have no trouble finding such quotes ranging from euphoria (from a Chief Executive Officer whose company dramatically increased market share after labels and standards went into effect) to neutral observations like the example above to despair (from a plant manager whose facility was shut down because of the introduction of new efficient technology). In addition to individual anecdotes, policy shifts are sometimes described, as in this excerpt from the United Nations Foundation (UNF 1999):

> Within the broad area of the changes required in the energy systems of both developing and developed countries, UNF has chosen two specific programmatic areas which would have a highly leveraged impact on the future development patterns of the developing world: energy-efficiency labeling and standards, and community-based rural electrification using sustainable energy technologies.

and this excerpt from a 2004 speech by Ambassador William C. Ramsay, Deputy Executive Director of the IEA (Ramsay 2004):

> Moreover, these regulations (appliance efficiency standards) save far more than could be saved by any other efficiency policy at low costs to consumers and society. Energy labels are also a critical element of an energy efficiency policy strategy as they provide the otherwise missing information on equipment energy use that is needed to allow demand and supply side options to compete in a level marketplace.

Examples of actual monitoring and verification of the added cost that consumers pay as a result of standards are hard to find. The most rigorous example that we have found is a retrospective evaluation of the features and energy consumption of refrigerators in the U.S. prior to 1990 standards and after imposition of 1990 and 1993 standards. The assessment concluded that “consumers appear to have received higher levels of cold food storage service at lower operating costs, without significant increases in purchase, or ‘first,’ costs” (Greening et al. 1996). Because structural changes in the appliance market accompanied the introduction of U.S. refrigerator labels and standards, a rigorous researcher cannot conclusively attribute the benefits to the standards. However, researchers are generally confident that a valid evaluation of the exact impact of U.S. refrigerator standards, if that were possible, would show lower costs and similar benefits accruing from the labels and standards than those reported above.

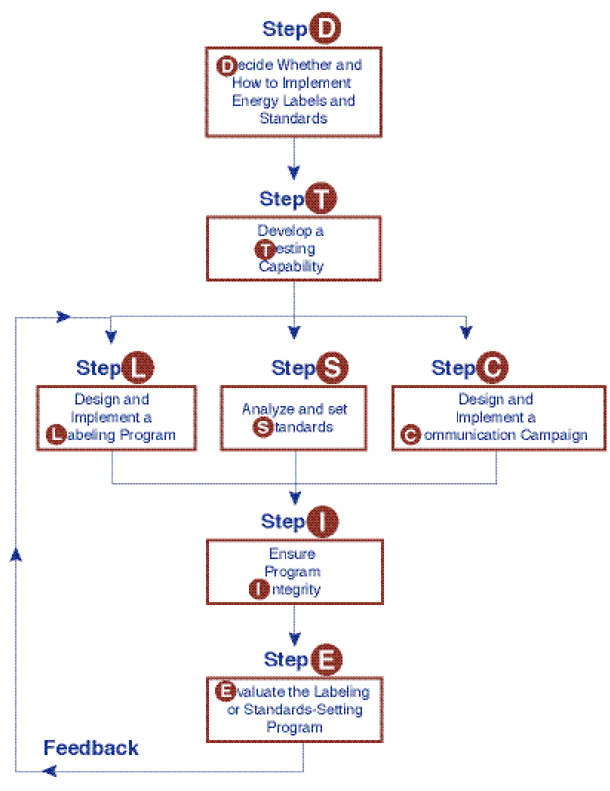


Figure 2-8 Typical steps in the process of developing consumer product energy-efficiency labels and standards

2.6 Steps in Developing Energy-Efficiency Labels and Standards Programs

Typical steps in the process of developing energy-efficiency labels and standards for consumer products are defined below. These steps are shown schematically in Figure 2-8, described briefly in the following paragraphs, and discussed in depth in subsequent chapters.

2.6.1 First Step D: Decide Whether and How to Implement Energy Efficient Labels and Standards

A government's decision on whether or not to develop an energy-efficiency labeling or standards-setting program is complex and difficult. Many actors and factors determine whether such a program is beneficial in any particular country. Chances for success are best if the process of making the decision and preparing to establish a labeling or standards program includes:

- assessing how local cultural, institutional, and political factors are likely to influence the adoption and effectiveness of the program
- establishing strong and clear political legitimacy for standards
- deciding the extent to which to rely on existing test facilities, test procedures, label design, and standards already established by international organizations or neighboring countries
- assessing the data needs of the program and the capability of the government to acquire and manage the data
- screening and selecting which types of products are the highest priorities

These basic elements in the preparation for a labeling or standards-setting program are described in Chapter 3. Some key aspects of the process are described below.

Assessing the Capacity to Develop and Implement a Program

Appropriate constitutional, legislative, and administrative authority must exist or be established for conducting each of the steps of the standards-setting process. Sometimes the decisions to implement energy-efficiency labels and standards and to cover particular products are made by legislation. Otherwise, these decisions must be formally made by the implementing agency. It is best if the steps and schedule for establishing energy-efficiency comparison labels and standards are clearly prescribed in enabling legislation or rule making. Endorsement and other voluntary labeling programs may not require regulatory formality but should still be set up as transparent processes with clear and logical steps and procedures. In all cases, trained, competent personnel must be available and institutions must exist to effect change. A testing capability must exist or be established. Resources must be allocated. The potential impact on local manufacturers must be understood and be acceptable. And the appropriate political will must exist or be reasonably achievable.

Once the decision has been made to adopt energy-efficiency labeling requirements and standards, the implementing agency must establish rules for all the subsequent steps in the process, that is, for analysis, public input, compliance testing, certification, marketing and promotion, enforcement, monitoring, and revision. This is a time-consuming venture that evolves over the years as the initial strategy is refined.

Serious consideration should be given to aligning or harmonizing elements of the labeling or standards-setting program to match those of a country's trading partners. Alignment or harmonization allows countries, companies, and consumers to avoid the costs of duplicative testing and non-comparable performance information while also benefiting from a reduction in non-tariff trade barriers and access to a wider market of goods. As mentioned previously, appropriate harmonization can avoid the "least common denominator" approach that holds all of the participating countries to the levels that are acceptable to the least progressive country. It can also avoid undue complexity and delays in the process of establishing standards and labels. Australia has used this approach as described in insert: *Australia Aligns With the World's Best Practice*. Recognizing the potential benefits, many countries are participating in regional activities directed at harmonizing energy-efficiency standards and labels and especially the testing that underlies both these measures.

Australia Aligns With the World's Best Practice

Initially, the Australian scheme, copied from North America and Europe, focused on domestic debates between Australian-based stakeholders about labeling options. Through the 1990s, the program stalled (with mandatory labels applied to only six major appliance types). The lower-than-expected impact of the scheme was attributed to continuing market failures though this focus on domestic solutions was also eventually identified as an impediment.

In 1999, the Australian scheme shifted focus to match the most stringent energy performance requirements mandated by Australia's trading partners. This move to expand the focus to "world best regulatory practice" was a direct response to program experience and overcame many of the problems of a domestically focused program. The "best regulatory practice" policy authorizes Australian government officials to regularly review energy-efficiency standards in force around the world to benchmark energy performance of appliances and equipment. It also systematically expands the products covered by regulated standards in Australia. By relying on standards developed by trading partners, the Australian government and local manufacturers avoid the significant costs of conducting technical and feasibility analyses to justify efficiency regulation of appliances and equipment and avert the arguments about trade barriers and technical feasibility of the proposed standards that so often delay standards in other countries.

The change proved to be successful in releasing cost-effective energy efficiency benefits in the Australian economy. The program is now a partnership between government and industry examining cost effective options to improve end-use product energy efficiency rather than divisive debates about what is or is not possible. It regulates 16 product types and has announced plans to cover up to 50 product types by 2010. The Australian approach benefits local consumers because, if a major trading partner has banned the sale of products on inefficiency grounds, those same products cannot be "dumped" in Australia. Australian manufacturers support the scheme because, if a product is made in Australia meeting this policy, it can be exported to any market throughout the world. The Australian environment benefits from cost-effective energy conservation and greenhouse gas emissions abatement.

Assessing Data Needs and Screening/Selecting Products

Before deciding to implement energy standards in a country, it is important to estimate the potential impact of the standards by quantifying their predicted environmental and monetary benefits. Much information on this process is available from existing label and standards programs around the world. Some information is provided in this guidebook, and much more is available from the referenced resources. Ideally, assessment of the technical potential of labels and standards will be based on data collected on the use of consumer products that describe:

- current levels and forecasted trends for efficiency of products in the marketplace
- specific new technology that has recently or will soon become available in the marketplace
- existence and characteristics of domestically manufactured products
- existence and characteristics of imported products
- existence and levels of standards in other countries

This assessment will usually involve collecting and interpreting new local data. This process and the evaluation of how much of the technical potential can be achieved and how much it will cost are described in Chapter 3.

Deciding which products should be covered by standards depends on a number of factors. Implementing labels or standards for different consumer products, such as refrigerators, freezers, room air conditioners, lamps, and fluorescent lamp ballasts, will involve different costs and yield different benefits. The opportunity also exists for addressing one specific energy use in most or all appliances with a single regulation, as in the case of limiting standby power losses (IEA 2002). In addition to analyzing the impact of and resources needed to implement a given standard, choosing a standard also may require assessing the reality and the politics of the manufacturers' market, the government's ability to enforce the standards, and other factors. It is important for program credibility and success that energy-efficiency labeling and standards programs be established and applied to a product only when the necessary resources are likely to be available.

2.6.2 Second Step T : Develop a Testing Capability

A uniform product-testing procedure for each major appliance is a vital precursor to the development of a label or standard for that product. All manufacturers' products must be evaluated in the same way. This requires, for each type of product, a standard metric [e.g., kilowatt-hours (kWh) per year, coefficient of performance (COP), seasonal energy-efficiency rating (SEER), efficacy factor], a standard test facility, a standard test procedure, and a process for assuring compliance with testing requirements, as described in Chapter 4.

Testing capabilities can be created in a testing center within the country, shared among several countries, or purchased from outside the country. In some countries where most or all of the units of a particular appliance are imported from foreign manufacturers, it may be cost effective to rely on existing test facilities from the country of origin. Assistance is often available to help plan and design the necessary test facility (see Section 2.8).

Testing by manufacturers and private laboratories must be accredited and recognized. Generally, government costs are reduced and product marketing delays are avoided if governments rely mainly on private testing and only conduct audits themselves.

Adoption of existing test protocols for assessing product energy efficiency is strongly preferable to creation of a new protocol. Existing protocols have the advantage of being known quantities. Repeatability and reproducibility are established, and the facility needs and benefits and issues associated with existing protocols are already well defined, whereas new protocols pose the risk of new, unforeseen issues. In addition, there is great benefit to manufacturers and all affected parties if a test protocol is harmonized at the highest possible level—preferably globally, or at least among regional areas of trade. Harmonization allows for consistent decision criteria and standardization among all models, which, in turn, allows for economy of scale in manufacturing. Investments in energy-testing facilities and test resources are also minimized. Interest and participation in alignment with trading partners, regional harmonization collaborations, and international standards organization specifications have been expanding rapidly in recent years.

2.6.3 Third L and Fourth S Steps: Design and Implement a Labeling Program and Analyze and Set Standards

Label Design

The goal of an energy-labeling program should be to encourage consumer awareness and choice in the purchase of an energy-using product or appliance and thus shift the market toward greater energy efficiency. From a consumer's perspective, the energy label is the most important and obvious element of the program. However, the label that appears on a product is only a small part of an elaborate infrastructure. The design of a labeling program involves several key choices:

- What products should be covered?
- Should a program start with endorsement or comparative labeling?
- How, and to what degree, should endorsement and comparative labels be linked?
- If a comparative labeling program is chosen, should it be mandatory or voluntary?
- Should comparative labels be continuous or categorical?

After these choices are made, label requirements can be established in a variety of ways, usually involving consumer research (e.g., use of focus groups) as an important element. Label designers typically face the choice of whether to focus on accommodating current consumer response to achieve short-term impact or striving for long-term changes in consumer understanding and behavior. This choice is addressed in more detail in Chapter 7, and all aspects of designing labels are addressed in Chapter 5 where examples of several types of labels are described.

After a labeling program has been designed, coordination with the testing program is required to ensure that the information presented on the label is accurate. Then the label design can be finalized and the program implemented.

Consideration should be given to regional labeling if the marketplace, particularly for imported products, is more regional than national. Even slightly different labeling requirements among nations can be disruptive to trade, limit choices, and add to consumer costs. Harmonization of labels needs to be considered in two parts: harmonization of the technical foundation (i.e., shared metrics and technical categorization) and harmonization of label format and presentation. There are good reasons for harmonizing the former as broadly as possible as long as this doesn't significantly restrain the more progressive participants in the collaboration or bog down the process in bureaucratic red tape. Harmonizing label design can be beneficial but may have limitations if cultural differences among participating countries would render a single label design ineffective. In such situations, customized label designs may be preferable.

Standards-Setting

A standard can be set to:

- eliminate inefficient models currently on the market
- avoid import of inefficient products
- encourage importers and local manufacturers to develop more economically efficient products

Several types of analyses should be conducted to ensure that a standard achieves its purpose. Following is a listing of the types of analyses that have been used and are based on existing methodologies for determining the level at which to set a standard. These methods are described in detail in Chapter 6. The resources that any country devotes to these analyses should be carefully tailored to the country's specific situation. Sometimes simplified analyses can be conducted or analytical results adapted from other countries. Each country needs to customize existing data and analytical models to fit its own needs, train government staff or others to perform the analysis, and review the analysis to verify results.

Engineering Analysis—An Engineering Analysis assesses the energy performance of products currently being purchased in the country and establishes the technical feasibility and cost of each technology option that might improve a product's energy efficiency as well as evaluating each option's impact on overall product performance.

Market Analysis—A Market Analysis is an alternative to an engineering analysis. It looks at the existing efficiency or energy consumption choices for a product of a given size available in the regional or national market and compares the difference in cost for each choice with the difference in energy use. This method may be used when it is difficult to perform engineering analysis or when it would be helpful to corroborate the results of the engineering analysis. This method generally (but not always) produces less ambitious energy-efficiency targets than an engineering analysis will because some cost-effective technologies may not yet be incorporated into existing products.

National Impact Analysis—A National Impact Analysis assesses:

- the societal costs and benefits of any proposed standard
- the impacts on gas and electric utilities and future gas and electricity prices that would result from reduced energy consumption
- the environmental effects—e.g., changes of emissions of pollutants such as carbon dioxide, sulfur oxides, and nitrogen oxides – that would result in residential and commercial buildings and power plants because of the reduced energy consumption

Consumer Analysis—Consumer Analysis determines the economic impacts on individual consumers of a standard, including effects on purchase and operating costs.

Manufacturing Analysis—A Manufacturing Analysis predicts the impact of a standard on international and domestic manufacturers and their suppliers and importers. This analysis assesses effects on profitability, growth, and competitiveness of the industry and predicts changes in employment. Depending on the local situation, this analysis may be expanded to include distributors and retailers.

The earlier recommendation to standardize test protocols does not necessarily extend to energy standards levels. Standards levels should be assessed based on specific national situations and should integrate factors such as user habits, the use environment (including power distribution characteristics), the technological and financial situations of affected manufacturers, the approaches adopted by trading partners, and the estimated impact on the national economy. An example of a reason to differentiate standards based on country-specific conditions is evident in the higher-efficiency motor designs typically applied in developed countries, which may not be appropriate with the higher-variability power distribution networks typically found in developing countries.

Stakeholder and Consumer Involvement

The initial recommendation of a label design or standard for any consumer product should begin a process of public review and revision. The need for standards is based on the premise that an improvement in the energy efficiency of products will serve the overall public good. Manufacturers want to ensure that standards will not require large, unjustified capital investments and do not limit product utility or features or consumer choice. Energy-efficiency and environmental advocates generally want manufacturers to make products that are as efficient as technically possible. The government's role is to determine the optimum public good using information that is often incomplete and claims that are sometimes contradictory. The more input the government collects from all involved stakeholders, the more informed its decisions will be.

A beginning standards level is best set based on a compilation and examination of the results of various analyses, tempered by technical and political judgment, which leads to a recommendation that maximizes the long-term public good. In the early stages of the process, there should be as much reliance on the results of the analysis and as little political judgment as possible (no matter which interested stakeholders apply pressure). The analysis keeps the ultimate political recommendation within realistic bounds. The more the level of a standard remains grounded in a thorough, objective technical and economic analysis, the greater its political sustainability and the degree of compliance with it. Thorough, objective analysis requires an equitable balance of input from the various interest groups.

Legislators or government officials responsible for establishing labels and standards programs in a country must specify what level of public involvement is most appropriate for that country. Experience to date shows that the more manufacturers, consumer organizations, and other interested stakeholders are involved early in the label-design or standards-setting process, the more effective the resulting labels and standards (i.e., they lead to greater economic efficiency, more product model options, and more appropriate applications of technology) and the greater the rate of compliance by affected manufacturers. Whether the goal is to refine the design of an energy-efficiency label or the level mandated by an energy-efficiency standard, testing the response of the users of the labels and stakeholders affected by the standards early in the process is extremely useful to enhance the quality of the outcome. In many developing countries, there is little experience with providing public notice, conducting focus groups and public hearings, interpreting public comments and reviewing and weighing their relevance, and making appropriate changes to balance the expressed interests of many stakeholders. The experience of other countries that are practiced in collecting, acknowledging, and seriously considering public input is sometimes transferable, depending on the democratic tradition and governance style of each country. Assistance is often available for these efforts.

Promulgation

The steps and schedule for establishing energy-efficiency labels and standards are most often clearly prescribed and straightforward in enabling legislation or rule making. Specifying the information requirements and format for labels, the level for standards, and the schedule for both can be politically sensitive, however, and politically induced delays are common. Often, manufacturers and their suppliers and distributors practically or philosophically oppose this type of government regulation. Manufacturers must have time to create labels, retool, make and distribute new models, and dispose of old inventory. They will often want a longer transition period than government regulators would choose. The interests of other stakeholders may bring pressure for additional analysis and greater efficiency levels.

Government officials responsible for promulgating labeling requirements and standards must find an appropriate balance between consensus-building and unilateral government action. They should be open, transparent, and flexible in balancing the variety of considerations entailed in deciding whether and what labeling and standard regime to adopt and how rapidly the regime should be implemented. No matter how much they rely on consensus-building, they must be prepared to withstand strong political pressure and maintain a regulatory posture with focus on what is best for the country in the long term. More information on this subject is provided in Chapter 5 for labeling and Chapter 6 for standards-setting.

2.6.4 Fifth Step C : Design and Implement a Communication Campaign

Effective standards-setting and labeling programs require a communication campaign to support acceptance and use of the new standards and/or labels. Consumers and retailers need encouragement and stimulation to change their behavior. Experience shows that programs will be more effective if they adopt targeted messages and communications mechanisms. Execution of an information campaign is a significant undertaking that involves designing information channels, creating evaluation tools, pretesting all the elements of the campaign, and continuously evaluating and refining the campaign based on consumer response.

2.6.5 Sixth Step I : Ensure Program Integrity

After the label design process is mandated or a standard is set, those responsible for the labeling and standards-setting programs must monitor and enforce compliance based on a foundation of accurate and reliable information. Both a well-thought-out and well-implemented verification regime (to determine whether the declared energy performance of equipment available on the market is accurate) and compliance regime (to ensure that market actors abide by the requirements of the program) are needed to ensure the program's integrity. Accrediting testing facilities and certifying test results are important components of verification.

The government officials responsible for labels or standards must be prepared to assess the potential effectiveness of self-certification and other certification processes; establish certification and compliance monitoring procedures; and train personnel in certification procedures, compliance monitoring, and enforcement programs. Officials must also be ready to defend their actions if challenged in courts as has happened in some countries.

Aside from legal issues of compliance and enforcement, there is the practical issue of helping people acclimate to a marketplace that requires manufacturers to provide information labels on products and to manufacture and market products that meet or exceed a specified efficiency level and/or encourages them to participate in endorsement labeling programs. This takes time, and providing information and training at various points in the product chain can significantly shorten the length of time. In fact, the viability of a labels or standards program can be jeopardized without appropriate public education and training. In some countries, the involvement of environmental advocacy organizations is also important. A well-designed labels and standards program includes training programs in product engineering or regulatory compliance for manufacturers, label interpretation for product salespersons and consumers, label and standards design for implementing agency officials, and public involvement for stakeholders. Likewise, a public education campaign to educate consumers and retail staff about what labels mean and how to use them, as described in Chapter 7, can be crucial to the success of a program.

All these elements of verification and compliance for labeling and standards-setting programs are addressed in Chapter 8.

2.6.6 Seventh Step E: Evaluate the Labeling or Standards-Setting Program

If a government is to maintain an energy-efficiency labels and standards program over the long run, it will have to monitor the program's performance to gather information to guide adaptations to changing circumstances and to clearly demonstrate to funding agencies and the public that the expected benefits are actually being achieved. Good test procedures, labels, and standards require periodic review and update. Periodic review allows the government to adjust test procedures, redesign labels, and adjust or "ratchet" the stringency of standards upward as new technology emerges and use patterns change. Review cycles in countries with labels and standards programs typically range from three to 12 years, depending on the product and national priorities.

As described in Chapter 9, establishing a monitoring program includes planning the evaluation and setting objectives, collecting data, analyzing the data, and applying the evaluation results, where appropriate, to meet several goals. These goals include refining the design, implementation, and evaluation of the labeling and standards-setting programs; supporting other energy programs and policies; and supporting accurate forecasting of energy demand for strategic planning. The analysis will normally include assessments of the actual energy consumption of the regulated products, the level of consumer satisfaction with new energy-efficient models, and the impact of the program on individual manufacturers and their industry. It is important for the labeling and standards-setting program to allocate resources and perform this task in a systematic and meaningful way.

In addition, labeling and standards-setting agencies are usually obligated to report the results of their activities. Generally, this merely entails compilation of the results of all the activity described above. Only if the monitoring program is underfunded is there likely to be any difficulty in achieving this task.

2.7 Relationship to Other Energy Programs and Policies

Energy-efficiency labels and standards work best in conjunction with other policy instruments designed to shift the market toward greater energy efficiency. Standards typically eliminate the least efficient models from the market. Other energy policies and programs, including energy-efficiency labeling, help to further shift the market toward higher energy efficiency. No one government policy makes an energy-efficient economy. Together, an array of policy instruments can influence manufacturing, supply, distribution, product purchases, and the installation, operation and maintenance of energy-consuming products. When working effectively, these policy instruments accelerate the penetration of energy-efficient technology throughout the market. A rich portfolio of policies is necessary to achieve the stated economic and environmental goals of most of the world's nations.

Although energy-efficiency labels and standards are considered by many to be the backbone of a country's program for efficient residential and office energy consumption, the overall energy-efficiency package should also include complementary programs, such as:

- research and development
- energy pricing and metering
- incentives and financing
- regulation, in addition to information labels and standards
- voluntary activities, including quality marks, targets, and promotion campaigns
- energy-efficient government purchasing
- energy auditing and retrofitting
- consumer education

An important trend in some countries is to combine policy instruments in ways that selectively support "market transformation"; this results in specific interventions for a limited period that lead to a permanent shift toward greater energy efficiency in the market. Chapter 10 discusses how labels and standards fit within a larger portfolio of energy-efficiency policies and programs and how best to combine and sequence policies to create an effective, sustainable market-transformation process

2.8 Availability of Technical Assistance

Need help? Whether you're looking for technical expertise or financial assistance, help is often available through bilateral and multilateral grants and loans for such activities as:

- assessing the potential benefits and costs of labels and standards
- establishing appropriate legal frameworks for labels and standards
- adopting test procedures, laboratory services, and labeling schemes
- setting cost-effective standards based on various analytical methodologies
- monitoring and reporting on labels and standards
- evaluating the impact of labels and standards

- participating in regional forums on harmonization of elements of labeling and standards-setting programs
- training government officials; utility company employees; product manufacturers, distributors, and salespeople; architects/designers; environmental activists; and/or consumers in any aspect of the design, development, implementation, and use of energy-efficiency labels and standards

Several organizations have grant programs that offer technical expertise to developing countries specifically for creating energy-efficiency labeling and standards programs. The most prominent of these are listed below; there are many more, however, especially in European countries:

- The United States Agency for International Development (U.S. AID), which offers training and technical assistance for energy-efficiency labeling and standards programs for most countries (U.S. AID funded much of the preparation of this guidebook).
- The United Nations Department of Economic and Social Affairs (UN/DESA), which has been helping six Arab countries with energy standards, implementing a refrigerator efficiency project in China, and offering assistance through a grant from the United Nations Foundation (UNF) to assist all aspects of energy-efficiency labeling and standards programs worldwide.
- The United Nations Economic Commission for Latin America and the Caribbean (UN/ECLAC), which is working with several Latin American countries using a parliamentary approach to enact legal and regulatory reform for energy standards.
- The United Nations Economic and Social Commission for Asia and the Pacific (UN/ESCAP), which has organized workshops in numerous Asian countries to promote energy standards.
- The United Nations Economic Commission for Europe (UN/ECE), which promotes standards under its Energy Efficiency 2000 program and manages some European Commission programs in Eastern Europe.
- The Global Environmental Facility (GEF), administered through the World Bank, the United Nations Development Program (UNDP), and the United Nations Environmental Program (UNEP), which provides grants for greenhouse gas mitigation. For example, GEF has contributed $9.8 million to a $40-million program to improve the efficiency of refrigerators in China, including the development of stringent energy-efficiency standards.
- UNDP—See GEF entry above.
- UNEP—See GEF entry above.
- The European Commission's Directorate General for Transport and Energy (DG TREN), which sponsors projects to promote energy-efficiency programs, including labeling and transformation of the appliance market in European countries outside the E.U. It also has programs to foster collaboration on energy efficiency with Latin America and Asia.
- The International Energy Agency (IEA), which conducts regional workshops and prepares publications to promote energy-efficiency standards and labels in non-IEA countries.

- The Energy Foundation, whose mission includes assisting China's transition to a sustainable energy future by promoting energy efficiency and renewable energy.
- UNF, which has an environmental component in its charter and has provided direct grants for the development of standards-setting and labeling programs globally, most recently targeting China, India, and Brazil.

In addition to grant programs, multilateral banks are increasingly recognizing that energy-efficiency labels and standards are cost effective for governments and as a result have been providing loans to fund elements of the development of these programs. At this point, we are aware of loans of this type given by the Asian Development Bank (ADB), the Interamerican Development Bank (IDB), and the International Bank for Reconstruction and Development (World Bank).

Many other organizations worldwide are involved in the various aspects of developing labeling and standards-setting programs. These organizations include manufacturers' associations, standards-setting organizations, testing laboratories, government agencies, lending institutions, consultants, universities, and public-interest advocacy groups. More information is given about these organizations in the specific chapters that follow.

CLASP, a global partnership formed in 1999 with the sole mission of fostering energy efficiency labels and standards worldwide, provides technical assistance on request and extensive information about labeling and standards-setting programs, including current information about resources available for supporting such programs, at its website (www.clasponline.org).

3. Deciding Whether and How to Implement Energy-Efficiency Labels and Standards

Guidebook Prescriptions for Deciding About Labels and Standards

1. **Review existing legislation and establish framework legislation to develop a legal basis for and political commitment to labels and standards.**
2. **Assess existing institutional capacity for developing, implementing, and maintaining a labeling and standards-setting program.**
3. **Develop an overall label and standards-setting plan, and assign one government agency primary responsibility for driving each element of the program. Consider starting with a voluntary program.**
4. **Harmonize energy-performance test procedures with international protocols to facilitate testing and reduce barriers to trade.**
5. **Establish minimum data needs, and develop a plan for collecting the data necessary to conduct analysis to support the program. It is better to rely on simple forecasts based on limited but reliable data than on detailed forecasts from end-use models that are based on unreliable proxy data. If you need more data to decide whether or not to proceed, take the time to collect it.**
6. **Use cost-effectiveness analysis to screen the products to be included in the program and establish the order of priority.**
7. **Plan to periodically review and update the labels and standards every few years.**

This chapter introduces the complexities of deciding whether or not to develop an energy-efficiency labeling or standards-setting program. **Figure 3-1** illustrates a five-step process for deciding whether and how to implement a labeling and standards-setting program. The following sections address each of these steps.

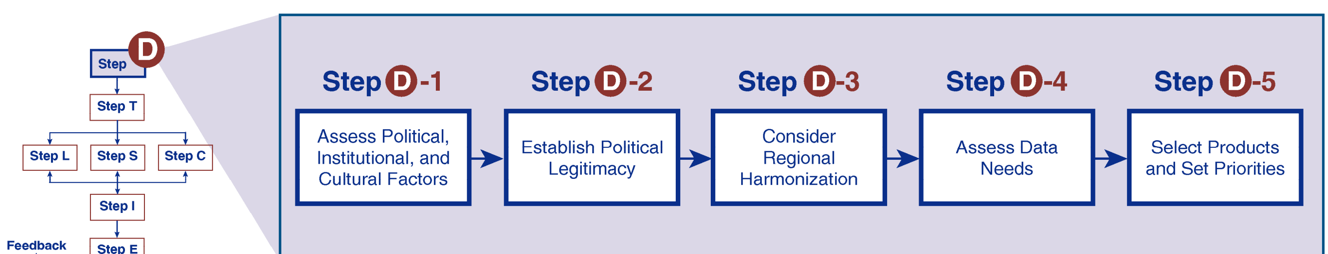


Figure 3-1 Major steps in deciding whether and how to implement an energy-labeling or standards-setting program

3.1 Step D-1: Assess Political, Institutional, and Cultural Factors

The first step in deciding whether or not to develop an energy-efficiency labeling or a standards-setting program is to assess how local political, institutional, and cultural factors are likely to influence the adoption and effectiveness of the program. For example, in countries that have a tradition of strong central government, it may be relatively easy to reach political consensus that a sweeping set of minimum standards will provide consumer benefits that are not being captured by the private market. In countries with a less centralized political structure, there may be greater resistance from influential stakeholders (i.e., manufacturers and distributors) to mandatory regulations, and time and education may be required to convince concerned parties to accept the benefits claimed for energy-efficiency standards. A substantial amount of education and persuasion may also be required to convince key stakeholders that standards are economically beneficial to consumers, do not decrease consumers' choice of products, and do not reduce the number of consumers who can afford quality-of-life improvements such as air conditioners.

International experience to date has shown that, in the case of energy labeling, cultural differences are often not as important as cultural similarities, and much of what works in one region is often transferable to another (as described in Chapter 5). In all cases where a country decides to proceed with labels or standards, it is important to develop support for labeling and standards-setting programs—not only within the government but in the private and non-governmental organization (NGO) sectors as well. In addition, impartial and credible labeling and standards-setting institutions need to be in place to ensure effective results. These institutions need to have a mandate, an adequate budget, and enough staff to effectively oversee the development and implementation of the programs.

Potential implementers of standards and labeling programs can consider that these programs require both legal authority and institutional resources. These requirements are addressed in the following two subsections.

3.1.1 Assessing Existing Energy Regulatory Frameworks

It is *always* important to begin assessing a labeling and standards program by examining the existing regulatory framework to determine what authority the government has to establish such a program. It is true that legislation may not be a prerequisite for the development of labeling and standards-setting programs and that a voluntary program may be less politically risky to undertake without a legislative mandate than a mandatory program would be. Nonetheless, direct legislative support or some form of legally mandated authority for the implementing agency greatly enhances the likelihood that a labeling or standards-setting program will be adopted and have a significant and sustained impact over time. The stronger the implementing agency's claim to legal jurisdiction, the more likely the program will survive adversarial challenges.

The first questions to ask are:

- Is there legislation that affects the energy performance of products?
- Is any agency empowered to establish minimum energy-efficiency standards or a mandatory energy-labeling program?
- Is there a standards agency that regulates the quality and performance of products, including products that consume energy?
- Is any agency empowered to develop energy-performance test procedures for energy-consuming products?
- Is there any existing legislation to protect consumers against false product-performance claims?

These questions must be answered early because legislation forms the basis of an effective mandatory program. Even when voluntary agreements are reached with industry, these agreements are often only achieved when industry perceives that government negotiators may enforce a mandatory scheme instead. This has been the case in negotiations to develop voluntary appliance energy-efficiency targets in Switzerland, Japan, and the E.U. Legislation should provide a clear, legal mandate for a government agency to require manufacturers (or retailers) to test products in a uniform way and place labels on all affected products. The passage of legislation also signals strong political support for the program. For voluntary programs, especially those aimed at stimulating voluntary actions by consumers, legislation may be less important.

The most widely practiced approach for developing legal authority for labels or standards has two stages. First, general "framework" *legislation* is introduced. This legislation may authorize an agency to implement standards and/or labels; it may mandate such programs; it may prescribe what products are to be addressed in the programs; and/or it may even prescribe initial standards. The establishment of this legislation is followed by promulgation, by an implementing agency, of *regulations* tailored to specific product types (e.g., lamps, refrigerators). (See discussion of framework legislation in Section 3.2.2.)

3.1.2 Assessing Existing Institutional Capacity

Early in the process of assessing local cultural and political factors, it is important to evaluate the existing resources and institutional capacity for developing, implementing, and maintaining labeling and standards-setting programs. In particular, these programs require financial resources, personnel, and physical facilities.

Financial Resources

A regular and consistent source of funding for an operational budget is required, from one source or a combination of sources. Typically, annual government budget allocations are the most reliable although they can be difficult to justify and obtain at the outset of a program. Some countries supplement governmental resources with fees collected from manufacturers for testing, certification, and/or the label itself. For example, China's endorsement label is supported in part through a certification fee collected from manufacturers on a voluntary basis in exchange for use of the endorsement. India is considering a fee for information labeling to support its program, which will pilot as a voluntary program and switch to a mandatory initiative within five years. Many developing countries rely, at least initially, on donor funding to support the launch and/or implementation of programs. These funds can be an essential source of revenue, but, over the mid to long term, a self-sustaining alternative must be developed to ensure program continuity in the face of diminishing donor assistance.

Personnel

Qualified staff are needed for testing, technical analysis, administration, monitoring, enforcement, evaluation, and information campaigns. Some outsourcing is possible and even desirable but, in general, base program management will require a dedicated staff that develops niche expertise in standards-setting and labeling programs.

Energy-performance testing is the first staff capability that must be in place. As described in Chapter 4, this requires specialized expertise. Technically specialized staff are also required to analyze energy efficiency, set standards, and design labels, as described in Chapters 5 and 6. Conducting the communication campaigns described in Chapter 7 takes a different kind of talent. The same is true for the monitoring of certification and compliance described in Chapter 8. The evaluators described in Chapter 9 should also be trained experts capable of objective program review and are, ideally, independent of the implementing agency. This specialized work can be done in house or contracted out to trained independent experts. The enforcing institution must have an adequate budget to hire staff or engage consultants to carry out its task. One possible problem in developing countries is that civil service regulations and pay scales may make it difficult for government testing and enforcement agencies to attract and maintain high-quality staff.

The institutional review that precedes the establishment of a program should evaluate whether the agency responsible for enforcement has the personnel and resources to operate effectively. The review should also specify roles for appropriate institutions, identify areas that need strengthening, and evaluate the tasks that must be carried out to build the necessary capacity in all key institutions. The review will help to establish the existence of any major practical constraints that might limit program development. The review should also give an early indication of the program's viability, taking into account the likely resources and depth of political support.

Especially in smaller countries, it may be an inefficient use of limited financial, technical, and human resources for each nation to develop separate institutional capacity for labeling and standards. Consideration should be given to regional approaches or to relying on programs in other geographical areas that affect the local appliance market.

Facilities

The type and location of facilities will vary depending on the particular program but will include some combination of central offices for dedicated staff, field facilities for monitoring/enforcement, and/or laboratories for testing. The establishment of fully equipped, staffed, and accredited test laboratories, the subject of Chapter 4, can be the most resource-intensive and time-consuming aspect of developing a labeling and standards-setting program. Test laboratories are expensive to construct and operate, and it is not generally practical for them to be sustained solely for the purpose of supporting an energy-labeling and standards-setting program.

The lack of availability of testing laboratories or of funds for their development has often been a serious barrier to the development of standards-setting or labeling programs, especially in the least economically developed countries because many sources of foreign aid preclude the use of assistance funds for laboratory construction and because these countries often suffer from limited foreign exchange. If no suitable test laboratories are already in place within a country, it may be necessary to consider establishing energy-efficiency testing as part of wider government programs covering product safety, quality, and environmental acceptability. Alternatively, policy makers may consider pooling resources with neighboring countries to establish a regionally funded and managed test laboratory. Another option may be to rely on existing private-sector test laboratories. Care must be taken, however, to avoid potential conflicts of interest. For example, it may not be appropriate for test laboratories that are doing research for regulated companies on a contract basis to also act as program-designated test centers.

A country should assure itself that it has adequate resources—including an ongoing budget for operation and maintenance—for the facilities it needs before undertaking a major standards and labeling program.

3.2 Step D-2: Establish Political Legitimacy

Mandatory labels and standards can have an inherently adversarial aspect because they force manufacturers to take action that they might not otherwise take. Minimum energy-efficiency standards, for example, compel the appliance and equipment industry to make capital investments to design, manufacture, and market more efficient products than they otherwise might. If such potential conflicts are not dealt with early in a program's design, they may prove detrimental to its operation. It is, therefore, important to establish strong, clear political legitimacy for standards as early as possible. This is the second step in deciding whether or not to develop labeling and standards-setting programs.

Political legitimacy can take various forms, depending on the nature of the government or other agencies involved. Legitimacy is strongest when a program is widely recognized as reflecting a social consensus that is supported by top political leaders and articulated in binding legislation or decrees. Whatever the form of expression, political authorities should establish a clear sense of the:

- strength of their political resolve
- objectives of the program
- lines of program authority

- boundaries for program intervention
- need for an open and transparent process for program design
- relationships with other relevant energy and non-energy policies

3.2.1 Determining Boundaries of Authority and Responsibility

For the sake of program effectiveness and economies of scale, governments may wish to enact labels or standards in as large a market as possible. However, product markets often do not match political boundaries. This issue can be especially complex in federated states as the federal government may or may not have sufficient authority to regulate all types of commerce within its states or provinces. Below we briefly summarize the process of legislating labeling and standards-setting in countries that are federations of states or provinces: Canada, Australia, the E.U., and the U.S.

In Canada, federal jurisdiction over energy is limited to international and inter-provincial commerce. Thus, federal standards apply only to products imported into Canada and/or shipped between provinces but not to products manufactured and sold within a single province. Given the nature of the Canadian appliance and equipment market, federal jurisdiction is sufficient for an effective standards program; standards apply to the vast majority of products sold in Canada.

In Australia, individual states and territories are responsible for legislation, regulation, and associated administration. State-based legislation is necessary because the Australian constitution gives the states clear responsibility for managing resources, including energy. Thus, the federal government has taken on the job of coordination. Federal authorities assist in writing "model" legislation that the states and territories then "mirror."

In the E.U., each national government is obliged to coordinate with the union to prevent the creation of non-tariff trade barriers when developing a policy. This situation may soon be repeated in other trade blocks as provisions about minimizing barriers to trade are becoming increasingly common.

In the U.S., national regulations have, for most products, superseded those enacted by individual states. In the mid-to-late 1980s, U.S. manufacturers pushed for uniform regulation throughout the country so that they would not be forced to offer different product lines in different states. Some economists have suggested that federal regulations are more economically efficient.

3.2.2 Enacting Framework Legislation or Decrees

Political authority for mandatory standards and labels should be built on a strong but flexible foundation. In most countries, this means enacting a framework law or issuing a decree that mandates standards and/or labels for certain products, with provisions for expanding and revising the program later (European Community 1992). Framework legislation should be generic and comprehensive rather than piecemeal, creating a legal basis and authority for developing labels and/or standards without specifying technical details related to specific products. In occasional cases, for example where there is a solid but possibly fleeting political consensus in support of standards, it may be advisable to act quickly and out-line only the very basic framework of the program in the law itself, leaving all the technical details to a capable regulatory body. This approach was used in Mexico in 1991 and more recently in China and India. In other cases, for example where the political consensus is weak, it may be advisable to write technical details into the law to make the regulation more powerful and enduring. This was the approach used in the U.S., where general regulatory authority for the U.S. Department of Energy (U.S. DOE) was augmented by initial standards levels and effective dates that were specified by the U.S. Congress for some products; this is an example of the legislative branch driving a less-committed executive branch. Generally, the preferable strategy is to develop a generic framework that empowers a capable agency to develop the technical details.

By empowering an implementing agency to develop product-specific regulations at a later date, framework legislation avoids the need to return to the legislative assembly to seek approval for each new regulation. This approach passes responsibility for developing product-specific legislation to a body with technical competence and removes a potentially significant cause of delays that could greatly reduce program effectiveness. Framework legislation should identify the main stakeholders and define their roles, responsibilities, and obligations related to the law. It should also designate a government agency as the "implementing agency" and give this agency the authority to issue product-specific minimum efficiency standards (see insert: *Examples of Framework Legislation*).

Optimal framework legislation or decrees describes:

- defined program objectives
- authorized types of intervention (mandatory standards and/or voluntary targets)
- criteria for determining which products are covered
- criteria for the level of technical intervention (based on consumer payback time, life-cycle costing criteria, or harmonization with trading partners)
- an implementation time frame
- process rules and deadlines
- a requirement for an evaluation report on the program's impact, including effects on manufacturers, consumers, and the nation

In practice, the amount of technical detail (e.g., product categories, standards levels, implementation dates, revision schedule) specified in a law or decree is likely to be a matter of political strategy. Provisions such as the U.S. prohibition on standards that significantly impair product selection, product function, or national commerce may be necessary to reassure concerned stakeholders and develop a political coalition in support of the legislation.

Examples of Framework Legislation

Two good examples of framework legislation are the E.U. Directive establishing a framework on energy labeling (92/75/EC) and the U.S. National Appliance Energy Conservation Act (NAECA) of 1987, updated in 1988. The E.U. Directive gives authority to the European Commission to issue product-specific energy labels following approval from a committee of nationally appointed civil servants. The NAECA legislation empowers and obligates U.S. DOE to issue minimum energy-efficiency standards for energy-intensive tradable equipment when a specific set of criteria is met. For a fuller discussion of framework legislation see Waide (1998).

3.2.3 Assigning Authority and Responsibility for Implementation

Ideally, it is easiest if one governmental agency has overall responsibility for developing, issuing, and maintaining both labels and standards, to ensure that they are enacted and upgraded in a consistent manner. Frequently, however, there are conflicting institutional claims for control of the programs. For example, in some countries, a division of resources has meant that different agencies or institutions are responsible for separate energy/environment endorsement labels, comparative energy labels, "ecolabels," or minimum efficiency standards. In several countries, this type of split responsibility has been effective. In situations where several agencies are or may be involved, conflicting claims must sometimes be addressed and resolved to avoid a damaging division of resources that will reduce program impacts. When authority for various elements of standards-setting and labeling programs is spread among more than one agency, coordination among the agencies must be designed into the programs. Even if one agency has the lead for the entire program, effective implementation requires close coordination with a number of other agencies to enlist their support. A single agency rarely has all the skills necessary to develop labels and standards in house. Depending on the skills and procedures of the agency or agencies in charge, it may be wise to hire outside experts to assist in program management, including program oversight, data collection, product registration, and coordination with other agencies.

3.2.4 Maintaining Political Support for Program Development and Operation

Standards must evolve with products and their markets, and a coalition of manufacturers and other interested parties must be maintained to support effective implementation and operation of a program over time. Without such political support, opportunities could be missed for substantial energy savings and carbon emissions reductions. In addition, a standard that is too stringent or overly prescriptive can evoke a manufacturer backlash and create an unintended obstacle to development of efficient products.

Standards should be regularly revised and updated. In many cases, this requires a substantial analysis of their viability and cost effectiveness. The revision process can itself be a source of controversy. For example, in the U.S., the process of standards development was delayed for more than a year during 1995-96 because of stakeholders' discontent with both their limited involvement and typically long delays. It is necessary to establish a revision process that minimizes non-substantive issues of disagreement and allows full consideration of substantive issues. In the U.S. case, the program mentioned above got back on track only after an extensive reform of the standards-setting process gave stakeholders more say in each step—from priority-setting to final rule-making (Turiel and Hakim 1996).

It is also important for policy makers to keep in mind that ongoing resources are needed over many years for the development, maintenance, operation, and evaluation of a labeling or standards-setting program. Substantive negotiations on the technical details of standards cannot take place without high-quality technical data and analysis as well as periodic program evaluation, both of which must be funded. Well-designed framework laws/decrees and procedural rules cannot be followed if they are not accompanied by adequate funding.

3.3 Step D-3: Consider Regional Harmonization

The third step in deciding whether or how to develop a labeling or standards-setting program is for policy makers to determine the extent to which they can rely on elements of standards-setting and labeling programs that are already established by international organizations or in neighboring countries. Harmonizing may involve adopting existing test procedures, agreeing to mutual recognition of test results, and/or aligning performance standards levels and energy-labeling criteria for particular appliances.

The term "harmonization" is commonly used in international trade negotiations (particularly in the World Trade Organization) to refer to the use of common standards, test procedures, import tariffs, etc. for the purpose of liberalizing or facilitating international trade. In some regional organizations, e.g. the Asia-Pacific Economic Cooperation forum (APEC), the preferred term is "alignment," which refers to unilateral action by any member economy. In this edition of this guidebook, we use the term "harmonization" to refer to multilateral cooperation to establish uniformity in any aspect of standards-setting or labeling. We use "alignment" to mean the unilateral adoption of previously established test procedures, standards methodology or levels, or label criteria or design from outside the country.

3.3.1 Rationale for Alignment and Harmonization

Alignment and harmonization allow countries, companies, and consumers to avoid the costs of duplicative testing and non-comparable performance information, thus benefiting from a reduction in these non-tariff trade barriers and from access to a widened market of goods. Most electrical products and appliances are subject to national standards that specify minimum safety and performance requirements. Because countries have different industrial or product standards, it is difficult and time consuming for a manufacturer or exporter to carry out the necessary tests and get customs approval to import a product into many different countries. Costly and time-consuming customs procedures amount to a non-tariff trade barrier.

The major goal of harmonization is to reduce non-tariff trade barriers by (IIEC 1999):

- simplifying and harmonizing customs procedures among countries
- harmonizing test procedures, labels, and standards
- implementing mutual recognition agreements (MRAs)

Recognizing the benefits of harmonization, many countries are participating in regional activities directed at harmonizing energy-efficiency standards and labels and the testing that underlies these measures. Such activities are being undertaken by APEC, the South Asia Regional Initiative for Energy Cooperation and Development (SARI/E), the Pan American Standards Commission (COPANT), the Association of Southeast Asian Nations (ASEAN), and the North American Energy Working Group (NAEWG). The E.U. has a rich history of regional coordination as a result of the conversion from individual country standards and labels to a unified E.U.-wide program. These harmonization efforts address the shared interests of the participants in mutually agreeable test facilities and protocols; mutual recognition of test results; common comparative energy label content; consistent endorsement energy labels; consistent minimum energy-performance standards for some markets; and shared learning about the labeling and standards-setting processes (Wiel et. al. 2003).

By design, government standards-setting and labeling programs are intended to influence the ways in which manufacturers of energy-consuming products produce and distribute their products. Harmonization not only facilitates the globalization of appliance, equipment, and lighting-product markets, it also offers governments the opportunity to make energy efficiency standards-setting and labeling programs more stringent and more effective than they might otherwise be. For example, Mexico's participation in NAEWG appears to have accelerated the harmonization of its minimum energy-performance standard for refrigerators with those of the U.S. and Canada. Harmonization discussions can be complex and slow because standards, harmonization, and trade regulations are negotiated based on strategic advantages for participants. Reduction of trade barriers is not necessarily "beneficial" to all concerned, especially when either importers or local manufacturers might have significant competitive advantages in particular countries.

Below, we discuss the relative pros and cons of aligning or harmonizing test procedures, labeling, and minimum energy-efficiency standards.

3.3.2 Aligning or Harmonizing Test Procedures

Many countries already have a government-backed institution to oversee the development of testing and certification procedures for industrial and consumer products. Typically, the mandate of these standards agencies is to certify the safety and performance of designated products. Safety and performance standards are usually adopted by a local technical committee and are aligned with international standards such as those developed by the International Organization for Standardization (ISO) or the International Electrotechnical Commission (IEC). For most products, safety and performance standards specify protocols for testing performance and mandate some minimum levels of safety and quality. Only occasionally do national standards include energy efficiency as a criterion. Each country must decide how to design a minimum energy standards program, drawing on the resources and expertise of the existing standards agency, the national energy agency, and other qualified bodies.

In general, it is beneficial for national test procedures to be harmonized as closely as possible with international test procedures in order to reduce non-tariff trade barriers. However, there are other pragmatic reasons for adopting international test procedures including:

- avoiding "reinventing the wheel" (developing product energy-performance test standards is a complex and time-consuming activity)
- simplifying test laboratory accreditation; relying on shared procedures makes it possible to establish the proficiency of a country's designated test lab(s) through cross-testing with an international laboratory using the established standard (see Chapter 8)

- facilitating energy-performance benchmarking of local products against international levels

In practice, there are varying degrees of harmonization, depending on the extent to which a country allows for changes or exceptions to the international test procedure. The best international testing protocols cover many climate conditions and a broad range of operating conditions, and test results from harmonized protocols readily allow for product comparisons. However, in some cases, a country may adopt modified test conditions to reflect the local operating environment for a product. In addition, some countries may require testing of product characteristics that are unrelated to energy use (e.g., noise level) to ensure that energy-efficiency gains are not achieved at the expense of other elements of product performance. Energy testing of appliances and equipment is discussed in more detail in Chapter 4.

3.3.3 Aligning or Harmonizing Labels

Consensus on the benefits of aligning or harmonizing labels is much less strong than consensus on aligning or harmonizing test procedures and accreditation. Non-uniformity of test procedures and accreditation poses a much bigger barrier to trade than does the lack of harmonized labeling schemes for appliances and equipment. There is little justification for harmonizing labels unless there is evidence that a label used in one country or region would also be effective in other countries or regions (Harrington 1997). In fact, an effort to harmonize all information on energy labels among several countries could reduce the impact of the label in each country because the optimal design elements of an effective label may be different in different cultures; symbols or graphic elements that work in one country may not necessarily transfer to another. The best way for policy makers to design effective labels is to carry out consumer research in their country to determine which label design can be most readily understood and is most likely to influence consumers to purchase an energy-efficient product.

When considering harmonization of any aspect of a country's labeling program, separate consideration should be given to metrics and category definition for the comparative label, appearance of the comparative label, criteria for the endorsement label, and appearance of the endorsement label. The benefits of harmonization and the approach used to achieve it will vary among the four options. Any of the four elements may be pursued, singly or in combination.

Despite the above warning against an excessive focus on harmonization of labels, the successful "harmonization" of the energy label among 15 countries and 10 languages of the E.U. shows that it is possible to devise a functional unified label that works across borders. Even slightly different labeling requirements among nations can be disruptive to trade and can ultimately limit choices and add to consumer costs. A regional labeling approach is appropriate if the marketplace, particularly for imported products, is more regional than national.

For smaller, developing countries with little or no manufacturing capacity for a particular product, harmonization could strengthen the national economy by fostering trade in a common regional market. An example of such a regional label is the ASEAN endorsement label that is being developed for high-efficiency fluorescent lamp ballasts and other products. The ASEAN program would make an endorsement label available for any products in the region that meet an agreed-upon threshold for "high efficiency" and allow smaller or less-developed countries in ASEAN to jump-start a labeling program for certain products by adopting the new regional label (see insert: *The ASEAN Energy Labeling Scheme* on page 113 in Chapter 5).

3.3.4 Aligning or Harmonizing Energy-Efficiency Standards

If standards are to be adopted, careful consideration should be given to whether to harmonize the standards regionally or internationally. A series of different standards applied in the same trading region can have a significantly disruptive effect on commerce for both native and importing industries. The benefits of aligning or harmonizing minimum energy-efficiency standards are important, but they may be secondary to the primary benefits of the standards themselves. Harmonization should not become the excuse for avoiding or delaying implementation of a labeling or standards-setting program. However, the process of adopting standards may be shortened if the proposed standard is aligned with standards that exist elsewhere, which can help justify the standards level. In some cases, it may be expedient to take a longer-term approach to alignment by first adopting an earlier, less stringent version of a trade partner's standard, with a commitment or intent to upgrade it to the current level in the near future.

Harmonization of mandatory rules limiting the sale of inefficient products may require significant tact and diplomacy, both within one's own country and among trading partners. A developing country that is struggling economically may not find it practical to establish minimum energy-efficiency standards that are aligned with the energy-efficiency standards of large developed nations such as Japan or the U.S. There are a number of reasons for this, including:

- there is likely to be a lack of energy-efficient products available in the developing country
- any incremental cost of energy-efficient products is likely to be high relative to average income in the developing country
- tough energy-efficiency standards may hurt local industry and benefit importers of foreign products

Still, harmonization of standards has often been found to be useful, and more and more countries are discussing regional cooperation.

3.3.5 Using Mutual Recognition Agreements

MRAs are "multilateral arrangements between two or more economies to mutually recognize or accept some or all aspects of another's conformity test procedures (e.g., test results and certification)" (IIEC 1999, Motoomull 1999, Rath 1999). MRAs simplify cross-border trade in products that must be tested and inspected. Broadly speaking, there are two types of MRAs: intergovernmental and technical.

Intergovernmental MRAs

Intergovernmental MRAs are, as their name indicates, established between governments; they cover products that are regulated by the government sector, such as electrical appliances, telecommunications, or food products. These agreements can be bilateral or multilateral. The recent trend has been toward multilateral MRAs, such as the APEC Electrical MRA, because forging agreements of this kind is much less time consuming than establishing separate, bilateral MRAs with a number of different countries (see insert: *APEC Mutual Recognition Agreement*).

Technical MRAs

Technical MRAs establish technical equivalency among bodies in different countries. These types of agreements can cover laboratory-accreditation, inspection-accreditation, and testing-certification. The key usefulness of technical MRAs for electrical products is that they eliminate the need for retesting a product in a foreign country. For example, technical MRAs between European and U.S. laboratories allow the results from a European test laboratory that tests a product according to a U.S. test procedure to be accepted in the U.S. without requiring retesting.

3.4 Step D-4: Assess Data Needs

To optimize the design of a labeling and standards-setting program, it is necessary to gather, organize, and analyze a large number of diverse data. The fourth step in deciding whether and how to develop labeling and standards-setting programs is to assess the program's data needs and the capability of the government to acquire and manage those data.

Many more data and much more analysis are required to justify a sound, mandatory energy-performance standard than are needed to justify a voluntary standard, a comparison label, or an endorsement label. This is one reason that consideration might be given to a voluntary program when a government is in the initial stages of developing a standards-setting program; this is also a reason for considering adoption of standards levels from another country.

APEC Mutual Recognition Agreement

The APEC Electrical Mutual Recognition Agreement (MRA) is an example of an intergovernmental MRA that was established to facilitate trade in electrical products within the APEC region, which includes 22 countries in the Asia-Pacific basin. The MRA has three main components:

Part 1: information exchange agreement

Part 2: mutual recognition of test results

Part 3: mutual recognition of certification

These are separate parts of the MRA, and a country can choose to sign onto just one (e.g., information exchange) or all three. The MRA covers most electrical products except telecommunications equipment, which will be covered under a separate APEC MRA. The Electrical MRA was completed in 1999. The current draft of the Electrical MRA covers safety and performance requirements but not energy-efficiency requirements.

The MRA will reduce the barriers to trade in energy-using products by reducing the need to test a product several times to import it into multiple countries. This MRA will facilitate trade in electrical products with other signatory countries because test results certified by an accredited laboratory in that country will be recognized by other signatory countries.

If a country chooses to proceed with mandatory standards, far less analysis and expense are required to justify, for example, a simple standard that eliminates the 10 or 20% or even 50% of products that are least energy efficient, compared to what would be needed to support a stringent standard that would require most or all products to be upgraded. The stringent energy-standards regimes of the U.S. and E.U., for example, are based on life-cycle cost and technological feasibility and thus require relatively expensive iterations of data collection and analysis for each product regulated. An exception to this model is the Australian approach to developing minimum energy-performance standards, which is based on matching "world's best regulatory practice" (see insert: *Australia Aligns With the World's Best Practice* on page 27 in Chapter 2). Although the Australian approach uses international benchmarks as a basis for setting energy-performance requirements, many other variations are possible.

3.4.1 Evaluating the Types of Data Needed for Analysis

The data needed for labels and standards development can be put into five broad categories: market, engineering, usage, behavioral, and ancillary. These categories are described in the following paragraphs, but, first, a word of caution: although it would be ideal to have complete data for all the items listed in each category below, all countries manage to get by with incomplete data. Administrators should avoid being overwhelmed—scared off—by the volume of data required. No country in the world has managed to collect complete data on all listed items; countries use the best estimates that can be collected from available resources.

Market Data

General and specific market data are needed to assess potential program impacts and to optimize program design whether the program addresses comparison labels, endorsement labels, standards, or all three. The data needed include:

- equipment annual sales volumes
- sales prices
- production volumes
- import and export volumes

as well as information on:

- equipment distribution channels, including
  - how equipment is distributed from manufacturers and importers to retail outlets and final consumers
- retail-sector characteristics, including
  - market shares by retail type and sector, e.g., electrical specialists /retailers, furniture or kitchen specialists, department stores
  - retail marketing strategies and niches
  - geographical spread
  - typical profit margins
- manufacturing-sector characteristics, including information on
  - competition

- market shares
- brands
- parent groups and trade alliances
- share of production
- exports and imports
- type of production—e.g., full production, final assembly only
- type and quality of products produced
- production capacities
- component suppliers
- distribution of production
- costs of marketing, transportation, and vending
- costs driven by regulatory policy
- typical profit margins
- research, design, and development investments
- technical capabilities
- access to high technology
- flexibility of production process

Most of the types of data listed above should, ideally, be disaggregated into sales by equipment subcategories and efficiency levels. For example, room air conditioners can be further divided into subcategories of: single packaged (through-the-window or wall units), split-packaged (units with separate condenser and evaporator units linked by a refrigerant line), multi-splits (split, packaged units with a single condenser unit and more than one evaporator unit), and single-ducts (integrated portable air conditioners where exhaust heat from the condenser is discharged to the outside via a tube or duct). The subcategories should also be grouped by size (e.g., cooling capacity), if possible. Historical time series data are the most useful and should continue to be gathered after a program is under way, for use in program evaluation.

Engineering Data

The goal of gathering engineering data should be to assemble a comprehensive database of summary technical and energy characteristics for individual product models available on the market. Engineering data should include:

- comprehensive technical descriptions of typical (baseline) products for energy-engineering simulations used in developing standards. For example, for some pre-selected, average-efficiency room air conditioners, this might include data on the compressor, accumulator geometry, evaporator coil, evaporator blower, refrigerant line, flow-control device, condenser coil, condenser fan, and operating temperatures and pressures

- component and material cost information for use in estimating life-cycle product costs associated with incremental design improvements to increase efficiency

Usage Data

Usage data include:

- historical, annual, time-series data on equipment ownership levels and energy use or energy efficiency, ideally broken down by equipment subcategories
- demographic statistics such as the number of households, number and size of office buildings, distribution of occupants per building, socioeconomic characteristics of occupants, information about occupants by income level and region, typical occupancy patterns
- existing equipment stock, including the rate of replacement and rate of acquisition (needed for forecasts of the equipment market and of energy consumption)
- end-use measurements of how the equipment is used in practice, both nationally and in different climate regions (for climate-sensitive appliances), including energy consumption, power demand, and time and frequency of use (Sidler 1997)

Behavioral Data

Behavioral data include:

- desired product utility and features
- attitudes of consumers and equipment users toward energy savings, purchasing decisions, label designs, environmental concerns, and product service
- retailer attitudes toward and knowledge of energy efficiency in general, labeling, selling priorities, and consumer preferences
- manufacturer attitudes concerning energy efficiency in general, energy labeling, specific label designs, product energy performance, and marketing priorities
- socioeconomic segmentation of equipment purchasers and users

Ancillary Data

Ancillary information includes:

- data and forecasts for energy prices and tariffs
- data on utility generation, transmission, and distribution, including capacities, demand, costs (peak and off peak), and the fuel mix
- national energy statistics

- national trade, economic, and employment statistics
- data on direct and indirect environmental emissions
- data on any additional environmental impacts of equipment production and usage
- comparative data on the effectiveness of alternative and complementary energy-efficiency programs

Of course, it is not always possible to gather all of the data listed above in a thorough and systematic manner. Prior to designing a program, officials should establish minimum data needs and prioritize the need for the remaining data. The intended use of the data must be clearly defined, and proxy data or reasonable assumptions should be used whenever specific data are not available.

3.4.2 Specifying the Data-Gathering Process

It can be very difficult to gather detailed, product-specific engineering and cost data from manufacturers and suppliers unless a high level of trust has been established between manufacturers and government. Manufacturers should be brought into the labeling or standards-setting process from the outset through the formation of a stakeholder committee. The committee structure allows manufacturers to present their views and concerns and to "buy in" to the process. In addition, the committee can facilitate the process of collecting data to analyze the impact of the labeling and standards-setting program.

There are a number of sources for the necessary data:

- Stakeholders, i.e., parties who may have an interest in the required data, should be the first point of contact. They can be helpful in identifying a range of data sources including existing literature, reports, or market surveys when available.
- Industry organizations, such as trade, manufacturer, or retailer associations, will often have valuable market and product data that they may be prepared to share.
- Market research companies may be prepared to sell market data (older or aggregated data may be available at a discounted price).
- Manufacturer catalogs can be good sources of model-specific technical data for statistical analyses.
- Long-established test laboratories often have model-specific data on product performance.
- Direct contact with manufacturers is the best way to gather detailed engineering data and data on production processes and manufacturing costs.
- Surveys and questionnaires can be used to gather behavioral data. These data may already be available from local market-research firms.
- Government ministries and information agencies and their publications are the best source of ancillary and demographic data. These agencies include census bureaus, national statistics bureaus, ministries of industry or energy, information centers, customs departments, housing authorities, and electric utilities.

- International reports and databases can provide useful benchmarking and proxy data that can be used to carry out a reality check of local data and can also be used as a starting point in program design.

3.4.3 Finding a Home for the Data

Policy makers should designate an institutional home for the data generated throughout the course of the labeling or standards program. In both industrialized and developing countries, outside consultants are often contracted to collect and analyze the data. Both governments and funding agencies must recognize the need for skill transfer so that, when consultants complete their task, the local institution can maintain the database. The local institution should not only store the data, but should also be capable of updating the database, providing useful and consistent analysis based on it, and making it available to third parties such as academics who may wish to use it for research and analysis. A publicly available data set can have significant benefits for the country as government officials, consultants, academic researchers, and others can then design companion programs or test alternative standard or label designs based on common information and assumptions. Over time, this developing database should allow for a powerful understanding of the trends and potential for energy efficiency in end-use appliances and equipment.

3.5 Step D-5: Select Products and Set Priorities

The fifth step in the process of deciding whether and how to develop labeling or standards-setting programs, as shown in Figure 3-1, is to screen and select which combinations of program type and product class are the highest priorities. All energy-consuming products—and some non-energy-using ones, such as windows—are candidates for labels and standards. In theory, there are no limitations on which products can be addressed by energy-efficiency regulations. However, these regulations require considerable financial and managerial resources, so it is only possible and practical to develop labels and standards for a limited number of products at a time. It is therefore necessary to establish priorities among a government's market-transformation policy options and among the products within the labels and standards option based on which regulations are likely to have the most impact and are easiest and most practical to design and implement from a market perspective. In practice, for reasons that will be explored below, both regulatory and non-regulatory energy-efficiency policies have focused on only a few products.

3.5.1 Selecting the Program Approach

Should we start with labels or standards? Should we start with comparative labels, endorsement labels, or both? Should we start with a mandatory or a voluntary program? These are the first decisions that officials typically face when beginning a new labeling and/or standards-setting program. There is no single right answer to these questions, or perhaps a better way to put it is to emphasize that there are no wrong answers. The best path for any given government at any given time will depend on a complex array of political, social, economic and technical factors, including which appliances, equipment, or lighting products will be addressed by the program that is being designed.

For example, the decision of whether to start with a voluntary or mandatory label may appear difficult. Many practitioners feel passionately that comparative labels must be mandatory to be effective. However, voluntary energy labeling programs may require little or no formal regulation. Voluntary comparative labeling schemes have been implemented in countries as diverse as Thailand, Hong Kong, India, and Brazil, with varying success. In these voluntary regimes, only appliances in the higher-efficiency classes tend to carry labels because manufacturers and retailers of lower-efficiency products have no incentive to advertise that their products are inefficient (see insert: *The Voluntary Labeling Program in Thailand*). When only the most efficient products have a label, the comparative label becomes an endorsement label indicating the top-rated models.

As a general rule, governments find it easier to start by creating an energy labeling program rather than a program that sets minimum efficiency standards. This is true because labels provide consumers with information and can encourage a shift toward higher-efficiency products, but labels do not require the phase-out of existing low-efficiency products. It is harder to build support for minimum standards, which impose more significant and immediate market changes.

The Voluntary Labeling Program in Thailand

The Thai voluntary labeling program has worked well for refrigerators but has been less effective for air conditioners. After two years of the program, 85% of single-door refrigerators in the market had achieved an energy label ranking of 4 or 5 (5 is the highest ranking), and, after four years, 92% had achieved label rankings of 4 or 5, with more than 95% of these labels being the top-rated 5 ranking. Because the label levels were initially set with 4 being 10% more efficient than the market average and 5 being 25% more efficient than the market average, this indicates that the labeling program resulted in a roughly 25% increase in the average efficiency of single-door refrigerators (Agra-Monenco International 1999). Since the initial program evaluation was completed in 1999, the label has been made mandatory for single-door refrigerators, and all models in the market are now labeled. It is worth noting that the voluntary label was supported by an extensive promotional campaign and budget, which played a large role in both getting the manufacturers to join the program and in raising awareness among Thai consumers.

The voluntary labeling program for air conditioners has been less effective than the refrigerator labeling program because of the uneven distribution of air-conditioner efficiencies. In the air-conditioner market, high-end domestic and imported units have higher energy efficiencies but cost twice as much as the lower-priced domestic units that dominate the market. The lower-priced units often have very low efficiencies, and a substantial number are not properly registered for sale to avoid the excise tax on air conditioners. Manufacturers or importers of the more efficient models attain a high label ranking (i.e., a 4 or 5) on their products, and the labels are only applied to models with the top 5 ranking. The remaining models—with lower efficiencies—are unlabeled (Danish Energy Management 2004). After three years of the program, fewer than 40% of models in the market were labeled (Agra-Monenco International 1999). Five years later, that percentage had increased only slightly, to approximately 50% of products.

3.5.2 Setting Screening Criteria

What are the main criteria for selecting products? The arguments for establishing product priorities are numerous; some of the most well known are described below.

Impact on total energy demand

For each product considered, the total energy demand of the current and/or future stock should be significant compared to the energy demand of the sector. Assessing the energy demand of a given end use may require a combination of market analysis, specific surveys, end-use metering, laboratory testing, and educated guesses. One problem may be deciding when the energy demand for a given end use qualifies as significant. To start with, any product whose stock represents more than 1% of total energy demand should be considered. Although it may seem counterintuitive to many policy makers, many new miscellaneous end uses can actually be quite significant. A study recently commissioned by the Australian government found that standby power use aggregated over an array of miscellaneous household, commercial, and industrial end uses represented the single largest source of potential energy savings for planned activities in Australia's National Appliance and Equipment Energy Efficiency Program (NAEEEP) (Australian Greenhouse Office 2003). In addition, given the increasing importance of mitigating greenhouse gas emissions and the availability of credits for carbon emissions reductions, the CO_2 emissions reductions that result from reducing energy demand should also be considered.

Level of ownership and turnover

Energy-efficiency policy should focus on products that have a high level of market penetration or for which market penetration is rapidly increasing. The penetration of a given appliance is measured by the level of ownership, that is, the percentage of households that own and use the equipment in question. The rate of increase in ownership is most important in choosing products to address through labels or standards.

In the current global market, the penetration of many new types of energy-consuming equipment, especially electronic and information technology products, is growing much faster than the penetration of traditional major appliances. Even though these electronic devices use less energy per unit than traditional household appliances do, their proliferation has a significant impact on energy demand. However, for the new generation of electronic equipment, such as personal computers, the short useful life of the products makes it difficult for regulators to introduce minimum performance standards in a timely and meaningful way. If we take personal computers as an example, we can see that it is difficult to assess the energy consumption of the next generation of processors when the technology is likely to change drastically within only one or two years. For these types of products, regulators may choose to establish minimum performance standards for some key aspects such as the power supply, display energy management, or standby losses. Endorsement labeling has been widely and effectively adopted for these types of products and has had a significant impact.

Potential for energy- efficiency improvement

A specific research study may be required to determine the potential for energy-efficiency improvements in a product. In particular, it is necessary to understand the importance of both the design of the technology itself and the impact of user behavior on final energy consumption of an appliance. For instance, refrigeration appliances are excellent candidates for an energy-efficiency standard because they run constantly, there are numerous technical options to improve their efficiency, and the impact of user behavior on final energy consumption is smaller than for many other products. At the opposite extreme, the energy consumed by an electric iron is primarily dependent on individual user behavior, and the technology is simple, so irons are less promising candidates for energy-efficiency regulation. Research studies have been carried out on most products, and these studies usually provide an adequate basis for any country that is taking its first steps in standard-setting or labeling; using these existing studies rather than starting from scratch reduces the time and resources a country is obliged to devote to this task.

Anticipated stakeholder impact

The adoption of mandatory energy-efficiency labels and standards creates winners and losers. Some manufacturers and distributors will benefit, and some will be worse off. Some consumers will profit, and some will never recover their added investments in energy-efficiency features. For both manufacturers and consumers, there will be a range of profitability and loss. (An example of the magnitude and extent of benefits and losses can be seen in Chapter 6). When choosing products for standards or labels, it is useful to anticipate the extent to which some manufacturers or consumers might be significantly disadvantaged despite the program's overall societal benefits.

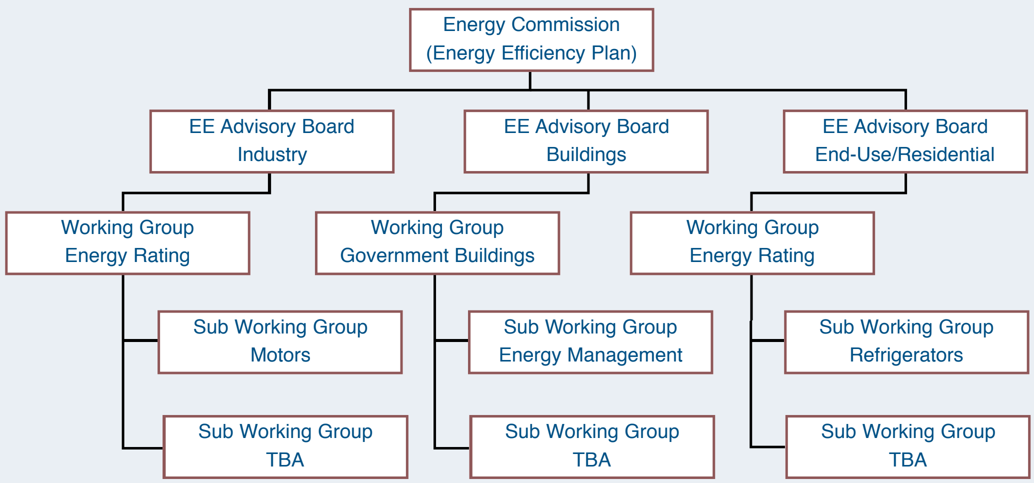
If especially stringent standards levels are anticipated for any product, consideration should be given to the possibility that some manufacturers or consumers of that product will be unhappy. In general, the range of gain or loss for consumers depends on the normal purchase and operating costs for the appliance, and well-designed standards explicitly consider the tradeoffs between costs and benefits. Regulators need to consider whether the regulations might cause any manufacturer to close a production plant, which could result in the loss of local jobs. Conversely, tougher standards can also be a stimulus for employment in that they can drive industrial renovation and boost local competitiveness. In addition, jobs may be created as consumers spend the savings from reduced energy bills.

As will be discussed in detail in Chapters 5 and 6, it is extremely important for regulators to design a process for stakeholder input into the design of standards; experience around the world shows that stakeholders are not shy about expressing their preferences and concerns, which offers program implementers ample opportunity to learn what those specifically impacted by any proposed regulation have to gain or lose. Such input can be used to inform the program design and develop a broad-based consensus. Malaysia, for example, has developed a stakeholder advisory process as part of its overall demand side management (DSM) programs. This process has been used to particular effect in the initial selection of voluntary labeling programs for refrigerators and electric motors (see insert: *Malaysian Stakeholder Input Process* on next page).

In some situations, it may be appropriate to consider measures that mitigate negative impacts of standards. For example, it is possible to provide a rebate at the point of sale to minimize any anticipated increase in product price resulting from the standards. Tax relief might be in order as an interim measure to mitigate the impact on manufacturers who are adversely affected by a particular standard.

Malaysian Stakeholder Input Process

The Malaysian Energy Commission wishes to ensure that the country's energy-efficiency (EE) programs maximize the needs and interests of the stakeholders and end users. In order to encourage stakeholder participation in the design, planning, and implementation of new activities in the Malaysian EE programs, the Energy Commission has involved a number of boards and working groups to look into energy-efficiency activities in three key areas: industry, buildings, and end-use/residential, as shown in the following diagram.



The working groups are made up of representatives from government, industry associations, and individual companies, and experts from universities and the consulting industry. The working groups have been effective mechanisms for setting priorities—for example, advising that energy-labeling efforts begin with refrigerators and electric motors. The sub working groups have subsequently been closely involved in the design of voluntary labeling programs for these two product types. Industry representation in the working groups has aided the Energy Commission in developing its market surveys and assessment, and the working group was the forum in which memoranda of understanding (MoUs) were developed that laid the basis for the programs.

The administration and management of the groups are handled by the Energy Commission where task managers for each sector (i.e., industry, end use, and buildings) have been appointed. The Energy Commission is not obliged to follow the recommendations of the work groups, but, in practice, the work group recommendations are generally used as the basis for the final program design.

Coverage by test procedures

A test procedure that establishes the performance, including energy consumption, of a given product must exist before energy labels or minimum performance standards are implemented. It is always preferable to reference international standards and test protocols when developing minimum energy-performance standards; these could be the widely used IEC and ISO test procedures or they could be regionally accepted ones such as U.S. DOE test procedures.

For some products—e.g., new products and products that are used only in some regions—international test protocols may not exist. This is the case for rice cookers, for example, which have a high market penetration in some cultures where rice is a staple food. In cases like these, a test protocol must be designed with the goal of sound energy performance not only when the product is in use but also when it is not performing its primary function, for example while in standby mode.

Existence of energy-efficiency regulations in other parts of the world

Many energy-consuming products are traded internationally. It is a good idea when proposing a new standard to at least consider adopting (or adapting) the applicable regulations from the exporting country. For example, minimum energy-efficiency standards for household refrigerators are in place in several parts of the world, including North America, Europe, Japan, and Australia. As a result, refrigerators are priority candidates for energy-efficiency regulation elsewhere. Policy makers can save time and resources and avoid having inefficient products dumped in their countries by examining existing regulations in other markets and adapting those regulations to their own national markets. However, policy makers must exercise caution when adapting existing regulations from other markets and consider and account for local user habits, power distribution infrastructure, and other influential factors.

Existence of an energy-labeling scheme

Energy labeling, perhaps in the form of an initial voluntary program, may be the best way to begin a labeling and standards program that will lead to eventual introduction of minimum performance standards. Manufacturers of appliances covered by an existing energy-labeling program are made aware of the need to conserve energy and are thus in a better position than most manufacturers to recognize the impact of marketing products that consume less. They may also be better prepared to participate in negotiations to set minimum performance standards.

In Europe, negotiated energy-performance targets have been established for both domestic clothes washers and dishwashers, among other appliances. These targets were based directly on the energy-efficiency rankings in the energy-labeling scheme and may eventually become mandatory minimum performance standards. In Thailand, voluntary labeling programs initiated during the late 1990s paved the way for mandatory labeling for single-door refrigerators in 2001 and for minimum performance standards taking effect in 2005 for several other products.

A starting point for prioritization

Table 3-1 classifies appliances into two tiers based on the priority for establishing minimum energy-performance standards for these products. This list is meant to illustrate the screening approach described in the preceding subsections. Of course, the specific results in any one country will vary according to the prevalence and use of each appliance or product.

3.5.3 Addressing Standby Power Requirements as a Crosscutting Issue

One dilemma facing the energy-performance standards community is how to address unnecessary electricity consumed by electrical equipment when it is switched off or not performing its main function. These low-power-mode losses (often called "standby losses") are estimated to account for about 3 to 15% of home and office electricity use (www.energy.ca.gov/reports/reports_500.html#500). Standby losses are mostly attributable to audiovisual equipment (e.g., televisions and video equipment with remote controls), electrical equipment with external low-voltage power supplies (e.g., cordless telephones), information technology (e.g., computers and office equipment), and devices with continuous digital displays (e.g., microwave ovens).

Standby losses raise a number of very difficult questions for policymakers and regulators. How can test procedures account for the various ways that products operate when not being used for their primary function? Should standards be developed or modified product by product to address these losses? Should there be a single standard that restricts low-power-mode operation and power use on a collection of products? Should standards officials leave this issue to their colleagues who are developing endorsement labels?

In 2002, the International Energy Agency (IEA) launched a worldwide initiative to reduce standby power consumption, and there is general agreement that action is urgently needed to avoid large increases in standby power use. A number of Organization for Economic Cooperation and Development (OECD) countries and regions have policies to address low-power-mode use; other regions have launched similar initiatives. Several policy instruments can be used to tackle the international problem of standby power consumption, including voluntary or mandatory labeling and/or minimum performance standards.

The E.U. strategy for reducing standby power use has been primarily based on negotiated agreements and voluntary E.U. Codes of Conduct that set maximum standby power consumption levels as alternatives to mandatory efficiency requirements. Australia, in a joint initiative of Commonwealth, State, and Territory Governments, has adopted a one-watt target for standby energy consumption of all manufactured or imported products and is developing a national strategy to achieve this goal. Two policies address standby power in Japan: one is the ENERGY STAR program under an agreement with the U.S. government and the other is the Law Concerning Rational Use of Energy, which requires manufacturers and importers of designated appliances to make efforts to improve the energy efficiency of their products. China has approached the issue by adopting a voluntary ENERGY-STAR-type labeling scheme for several products (Bertoldi et. al. 2002) and is considering minimum energy-performance standards as well. The U.S. is addressing the issue through its government procurement policy, its voluntary ENERGY STAR labeling program and individual product performance standards. In 2003, the U.S. amended the test procedure for dishwashers to require that manufacturers or private labelers include measurement

Table 3-1 **A Sample Priority List of Appliances to be Covered by Minimum Energy-Efficiency Standards**

Because most countries have the capacity to implement labels or standards for only a few products at a time, it is important to pick those that will have the greatest impact first.

Top Candidates for Minimum Energy-Efficiency Standards
Household refrigerators, freezers, and combined refrigerator-freezer units
Air conditioners
Fluorescent lamp ballasts
Fluorescent tube lamps
Electric motors
Washing machines, tumble dryers, and combined washer-dryer units
Boilers
Storage water heaters
Heat pumps
Pumps
Fans
Public Illumination and lighting systems
Standby power
Second-Tier Candidates for Minimum Energy-Efficiency Standards
Cooking products (including stoves, rice cookers, and hot plates)
Dishwashers
Chillers
Commercial refrigeration appliances
Electricity distribution transformers
Photocopiers
Other lamps (compact fluorescent, incandescent, high-intensity discharge) and illumination and lighting systems for buildings
Computers
Office equipment and new information technologies
Peripheral equipment for television sets [videocassette recorders (VCRs), satellite antennae, decoders, set-top boxes]
Personal computers
Peripheral equipment for personal computers (printers, modems) (standby power)
Radio sets, stereo equipment (standby power)
Telephone apparatus, fax machines (standby power)
Television sets
Lifts/elevators

This table classifies appliances into two tiers that indicate the priority for establishing minimum energy-performance standards for these products. The classification is based on the international experience of the authors and reviewers of this guidebook. Actual priorities in any country will depend on local conditions (e.g., dishwashers may not be a priority in some developing countries because of very low market penetration).

of standby power consumption in the estimated annual operating cost and estimated annual energy use calculations for all dishwasher models (www.eere.energy.gov/buildings/appliance_standards/residential/dishwashers.html). California has been developing and testing procedures for measuring power levels of various residential equipment operating in low-power modes.

As this guidebook goes to press, there is considerable momentum developing to address standby power use on an international basis. So far, the collaboration includes the U.S. Environmental Protection Agency (U.S. EPA), Australia's National Appliance and Equipment Energy Efficiency Committee, Eletrobras and Procel in Brazil, Natural Resources Canada, China Certification Center for Energy Conservation Products (CECP), and the California Energy Commission.

3.5.4 Assessing Potential Costs and Impacts

During the process of screening products, analysts evaluate the likely energy savings, cost savings, and associated environmental benefits from developing standards and/or labeling. Products to be included in the program are ranked in terms of cost effectiveness and potential for savings. If a country has national goals for total energy savings, these goals help guide the screening process.

The basic steps in assessing the potential cost and impact of a standards or labeling program are listed below. Generally, studies that have been conducted by other countries can be readily adapted or at least can provide an appropriate methodology for a country newly considering labeling or standards.

1. Develop a baseline model for the candidate product—The baseline represents the energy performance of a typical model of a given product (e.g., refrigerators) and is the starting point for an engineering analysis. Baseline characteristics determine what type of design modifications can be made to the product to improve its energy efficiency.

2. Identify potential energy-efficiency improvements—This step involves assessing the technical options available for improving the energy efficiency of each product.

3. Estimate the cost of energy-efficiency improvements—Based on market research, the energy-efficiency improvements and extra manufacturing costs associated with each of the options can be calculated, and analysts can evaluate any associated increased manufacturing costs likely to be passed on to the customer through the supply chain (see insert: *Use of a Cost-Efficiency Table*). Alternatively, analysts can collect data on the cost and performance of existing units on the market, to determine a cost-efficiency relationship.

4. Calculate the potential savings from energy-efficiency improvements—This step involves estimating the energy savings from the energy-efficient design options for each product.

5. Calculate cost effectiveness—This step involves estimating the life-cycle costs and payback periods for different levels of minimum energy-efficiency standards or from a labeling program (see Table 3-2).

Use of a Cost-Efficiency Table

A cost-efficiency table can be used when deciding how to establish a level for minimum energy-efficiency standards. Table 3-2 is a real example from a recent analysis that was performed to establish minimum energy-performance standards for Thailand. The table begins with a row showing the annual electricity use of a baseline ("base case") Thai refrigerator: 255 kWh/year. It then shows the cost and energy-efficiency improvements associated with additional technical measures that can be adopted to improve the refrigerator energy efficiency. Note that the first few measures are the most cost effective, with the highest benefit-cost ratios. Subsequent steps are still cost effective but have slightly lower benefit-cost ratios. Although methodologies for more sophisticated analyses that account for variability among consumers and uncertainty in the data are available and can prove very useful when designing advanced policies, they are usually not needed for initial ventures into standards-setting.

A cost-efficiency table is a useful tool for establishing the appropriate level for a minimum energy-efficiency standard.

Table 3-2 Cost-Efficiency of a Thai Refrigerator

	Description	Annual kWh	Energy Saving (%)	Manufacturer Cost (Baht)	Retail Cost (%)	Benefit/Cost Ratio (see notes) This Step	Benefit/Cost Ratio (see notes) All Steps
	Base case	255	N/A	N/A	N/A	N/A	N/A
1	Add 1 cm insulation to side walls	234	8.4	47	1.5	2.9	2.9
2	Add 1 additional cm to side walls (add 2 cm total, including Step 1)	227	11.1	94	3.0	1.1	2.3
3	Add 2 cm insulation to back walls (2 cm were added to side walls in Step 2)	216	15.3	137	4.4	1.9	2.1
4	Small "Good" compressor: 52.9 kCal/hr, 0.92 COP* (replacing 58 kCal/hr, 0.89 COP compressor)	201	21.1	237	7.6	1.1	1.7
5	Add run capacitor to small compressor: COP=1.01	183	28.5	362	11.6	1.1	1.5
6	Improve door gasket design (reduce gasket heat loss by 25%)	171	32.9	442	14.2	1.1	1.4

Notes:
- Baseline model is a 176-liter, 1-door, manual defrost refrigerator freezer.
- Each of the steps listed in this table is incremental to the previous step.
- The benefit/cost ratio is the ratio of the discounted net present values of the societal benefits to the societal costs.

* COP = Coefficient of Performance

Source: ERM-Siam 1999, p. 2-19

When discussing the results of such an assessment, it is often useful to distinguish among the following:

- technical potential: the maximum technically achievable energy savings
- economic potential: the economically optimum energy savings from a product-user's (consumer's) perspective
- achievable potential: the practical, sustainable energy-savings potential, given market barriers and competing policies

It is much easier to measure the savings potential for minimum energy-efficiency standards than for labeling because minimum energy-efficiency standards remove all products with a lower-than-mandated energy-efficiency level from the market, which makes the savings calculation comparatively straightforward. Comparative labeling, however, affects all models on the market, so any net energy-efficiency changes associated with labeling are difficult to separate from ongoing market trends and forecast.

Once cost and energy-efficiency data have been collected, baseline energy-efficiency information is used to estimate how much energy will be saved if the average energy efficiency of all models is increased by a certain amount. End-use forecasting models that accurately predict energy demand can be used for projecting policy impacts. In reality, however, detailed end-use data may not be readily available. In the absence of these data, simplified methods can be used to forecast the energy savings achievable from energy-efficiency standards. It is better to rely on simple forecasts based on limited but reliable data than on detailed forecasts from end-use models that are based on unreliable proxy data. An equipment stock model can organize product ownership and retirement data and use key demand drivers such as forecasts of the number of households and of household income. Such a model or spreadsheet can generate forecasts of equipment sales. In practice, crude sales forecasts are often made during the screening stage using simple spreadsheets that result in an acceptable estimate of the program impact.

Technical potential

An assessment of the technical potential for energy savings can be focused on the best theoretically conceivable design, the best design using conventional technologies, or the best design currently on the (national or international) market. These three reference points for measuring technical potential offer different levels of possibility for the "maximum" savings potential and the time horizon in which this potential could be achieved. Typically a national and/or international statistical analysis can be used to compare the difference in energy-efficiency levels between currently available products and the reference energy-efficiency level. The magnitude of that difference can be translated into savings potentials by assuming that all new equipment sales are at the higher energy-efficiency level in the energy-forecast model or spreadsheet.

Economic potential

The economic potential can be estimated in one of two ways. One method is to assume that labels and/or standards will achieve the greatest economic efficiency from the consumer perspective. This entails calculating the estimated incremental increase in product price against the expected reduction in the cost of operating the product for any given increase in the energy-efficiency level. In the absence of a thorough analysis, a rough estimate can be made using market data on the correlation (if any) between product price and energy efficiency. Another method is to assume that the labels and/or standards will achieve the greatest economic efficiency from a societal perspective. This will be the case when the initial costs of the energy-efficiency improvements are less than the net present value (NPV) of the utility's cost of supplying energy over the life of a product.

Achievable potential

Achievable potential is the analyst's best estimate of how much of the economic potential can be achieved in practice for a given product or program, based on experience with a similar program or product in another location or country. Achievable potential is less than economic potential because of the presence of market and non-market barriers that will reduce the actual savings achieved. The most commonly cited barriers are listed in Table 3-3. The shortfall is generally less for mandatory programs than for voluntary ones.

3.5.5 Planning for Phase-In, Evaluation, and Update

Minimum energy-efficiency standards need to be periodically reviewed and increased as the overall energy efficiency of products on the market improves and new technical options become available. The method and amount by which any minimum energy-efficiency standard is increased will vary depending on the product.

Table 3-3 **Possible Barriers to the Purchase of Efficient Products**

What appear to be cost-effective investments in energy-efficiency are often not made because of the presence of market and non-market barriers.

Market and Non-Market Barriers
Lack of awareness of energy efficiency
Lack of information about which products are more efficient (when there aren't effective energy labels)
Higher first cost
Low energy price
Low priority for consumers
Low priority for manufacturers/retailers
Equipment purchased by third party
Lack of available technology
Lack of government programs/support

Establishing a procedure for revisions will require input from the various stakeholder committees. It will also require a discussion of methods for setting and adjusting minimum energy-efficiency standards levels as well as for accommodating industry feedback on time frames that can be reasonably accommodated given other external pressures on manufacturers (see insert: *Malaysian Stakeholder Input Process* on page 60).

International experience has shown that the most effective minimum energy-efficiency standards regimes involve industry input in the establishment and periodic review/increase of minimum levels.

This chapter of the guidebook has discussed considerations that are useful in deciding whether and how to develop an energy-efficiency labeling or standards-setting program. Once the decision has been made to proceed, the next step is to establish test procedures and arrange for testing of appliances and equipment. These subjects are addressed in Chapters 4 and 8.

4. Energy Testing for Appliances

Guidebook Prescriptions for Energy Testing

1. Begin adopting or establishing test procedures and facilities before standards and label regulations are enacted. Include a significant budget for meetings, testing, and foreign travel.
2. Don't even think about developing a labels or standards program without an independent test facility for ensuring compliance.
3. Ensure that test facilities are certified and will provide credible results.
4. Adopt internationally recognized test and capacity-measurement procedures whenever possible. If this is not possible, consider simplified versions of internationally recognized tests to lower the costs and technological obstacles to testing.
5. Make the procedures for reporting test results, preparing forms, and establishing a database of compliant units as simple and easy to access as possible.
6. Make the mechanism to request waivers, exceptions, or deviations from the test procedure when the test is not appropriate as simple and easy to access as possible.
7. Implement self-certification by manufacturers, if possible, to minimize the cost of a compliance program.

4.1 Energy Testing Infrastructure

The process of creating an energy testing capability must begin long before a labeling or standards-setting program is launched. The major steps in this process are shown in Figure 4-1.

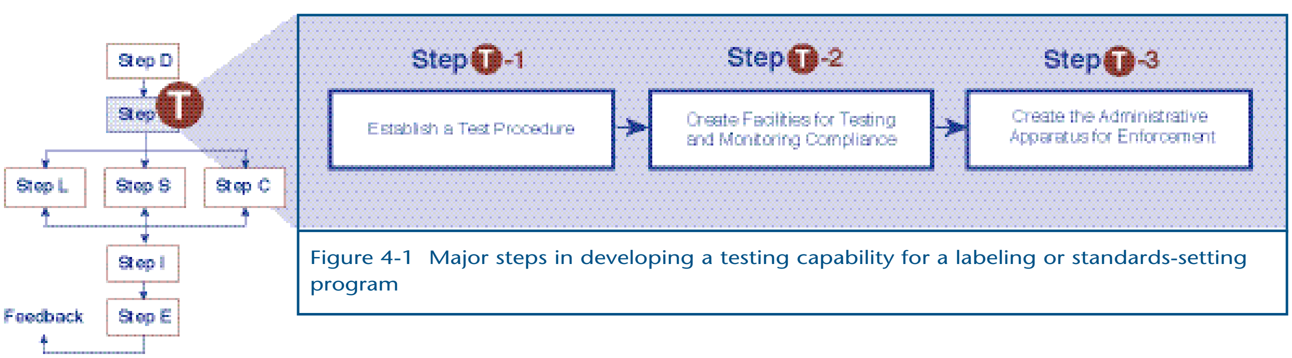


Figure 4-1 Major steps in developing a testing capability for a labeling or standards-setting program

This chapter explains what energy testing is and then describes the infrastructure needed to establish test procedures, test facilities, and testing compliance to support an energy-efficiency labeling or standards-setting program.

4.1.1 Definition of an Energy Test Procedure

An energy test procedure is an agreed-upon method of measuring the energy performance of an appliance. The results of an energy test procedure may be expressed as an efficiency, efficacy (for lighting products), annual energy use, or energy consumption for a specified cycle, depending on the appliance being tested. Worldwide, there are energy test procedures for all major energy-consuming household appliances.

The test procedure and the regulatory standard for an appliance are often lumped together, but they are very different. A regulatory standard establishes a level of minimum energy efficiency; the test procedure describes the method used to measure the energy performance of the product. A regulatory standard typically references the appropriate test procedures.

4.1.2 Importance of Test Procedures

The test procedure (sometimes referred to as "test standard") is the foundation for energy-efficiency standards, labels, and other related programs (Meier and Hill 1997). It gives manufacturers, regulatory authorities, and consumers a way of consistently comparing energy use and savings among different appliance models. A well-designed test procedure meets the needs of its users economically and with an acceptable level of accuracy and correspondence to typical conditions. By contrast, a poorly designed energy test procedure can undermine the effectiveness of everything built upon it. The adoption of established test procedures, especially those of internationally recognized testing organizations, makes it easy to compare the efficiency of different models.

4.1.3 Elements of a Good Test Procedure

The ideal energy test procedure will:

- reflect typical usage conditions
- yield repeatable, accurate results
- reflect the relative performance of different design options for a given appliance
- cover a wide range of models within a category
- produce results that can be easily compared with results from other test procedures
- be inexpensive to perform

Unfortunately, these goals usually conflict with each other. A test that tries to accurately duplicate actual usage will probably be expensive and not easily replicated. For example, most energy test procedures for room air conditioners measure efficiency while a unit is operating at steady state with a specified outdoor temperature. This is a relatively easy mode to test after the test chamber has been created; efficiencies can be measured quickly and reliably. In practice, however, air conditioners operate mostly at part load or at outdoor temperatures higher than specified by the test procedure (efficiency will typically be lower at higher temperatures). Part-load performance is much more complicated to measure, and results are more difficult to reliably duplicate. Likewise, most energy test procedures measure efficiency at a single specified ambient air temperature. Testing at different ambient temperatures requires costly reiterations and still fails to capture all differences in ambient conditions. Testing to country-specific ambient temperatures makes it difficult to compare product performance across borders.

We can clearly see from the qualifications noted above that an energy test procedure is a compromise; it does not fully meet any of the criteria for an ideal test, but it satisfies enough of them to discourage excessive complaints. At a minimum, a ranking of different models by their tested energy performance should correspond reasonably closely to a ranking by the models' field energy performance. Even this modest criterion has not been widely confirmed owing to a general lack of comparisons between laboratory and field measurements (Meier 1995).

Tested energy performance reflects an appliance's performance only as the appliance leaves the factory and therefore does not account for anything that may happen to the product during transport, installation, or operation. Central air conditioners, for example, require matching and connection of indoor and outdoor components. Mismatched components or improper installation can seriously reduce efficiency. Policies such as training for installers must be used to address these issues.

4.2 Step T-1: Establish a Test Procedure

The first step in developing an energy-efficiency standard or label is to establish energy test procedures for the products that are to have labels or be covered by standards. This step can and should begin even before the standards legislation has been approved. Establishing test procedures requires a significant investment in technical analysis, including participation in meetings and foreign travel to observe test facilities and international standards committees in action. In most cases, test procedures already exist although they may not be formally recognized as established. Manufacturers frequently test their units for quality control and comparison with competing products.

The fundamental choice for a government that is building an energy-efficiency labeling or standards program is whether to develop and achieve consensus on a unique domestic procedure or adopt an established international procedure. In considering this choice, governments will want to review international test procedures, decide which existing test procedures are best suited to modify/use in their country for measuring product energy efficiency or which new procedures to develop, assess the capacity for in-country and neighboring-country laboratories to test energy performance of priority products, and decide whether to expand existing test laboratories, construct new test laboratories, rely on laboratories in neighboring countries, or rely on private-sector laboratories.

4.2.1 Key Institutions Responsible for Making Test Procedures

Test procedures are typically created by manufacturers' associations, government agencies, non-government organizations (NGOs), and professional societies. A partial list of the major institutions responsible for energy test procedures covering appliances is presented in Table 4-1. The two international entities responsible for appliance energy test procedures are the International Organization for Standardization (ISO) and its sister organization, the International Electrotechnical Commission (IEC). ISO mainly focuses on mechanical performance, and IEC mainly focuses on electrical performance. These organizations rely on an international network of regional and national standards organizations. In Europe, the European Committee for Standardization (CEN) and its sister organization the European Committee for Electrotechnical Standardization (CENELEC) are the respective regional equivalents of the ISO and IEC. They have assumed responsibility for European-Union (E.U.)-wide test procedures. In Japan, the Japan Industrial Standards Association (JIS) is responsible for all appliance test procedures. In Korea, the Korea Standards Association (KSA) is responsible for all appliance test procedures, and some other test procedures are in the Korean Ministry of Commerce, Industry, and Energy announcements. In the U.S., the U.S. Department of Energy (U.S. DOE) is primarily responsible for appliance test procedures, with assistance from several organizations. International test procedures are not limited

Table 4-1 **Key Institutions Involved in Creating Energy Test Procedures for Appliances**

A variety of institutions around the world are engaged in creating and harmonizing energy-efficiency test procedures.

Institution	Acronym	URL
International Standards Organization	ISO	www.iso.org/iso/en/ISPPOOnline.frontpage
International Electrotechnical Commission	IEC	ww.iec.ch
European Committee for Electrotechnical Standardization	CENELEC	www.cenelec.be
European Committee for Standardization	CEN	www.cenorm.be
Korean Standards Association	KSA	www.ksa.or.kr
Japan Industrial Standards Committee	JIS	www.jisc.go.jp/eng
American National Standards Institute	ANSI	www.ansi.org
Air-Conditioning and Refrigeration Institute	ARI	www.ari.org
American Society of Heating, Refrigerating, and Air-Conditioning Engineers	ASHRAE	www.ashrae.org
United States Department of Energy	U.S. DOE	www.eere.energy.gov/buildings/appliance_standards www.access.gpoaccess.gov/cfr/index.html
World Standards Services Network	WSSN	www.wssn.net

to IEC and ISO standards. For example, U.S. DOE test procedures for several appliances are used as a basis for standards throughout North America.

4.2.2 Existing Test Procedures

All major appliances have at least one established energy test procedure, and most appliances have several. Refrigerators alone have at least five international or national energy test procedures (although this number is slowly declining as a result of harmonization). The general approach for each appliance is described in Table 4-2.

Each product requires its own test facility and general approach to testing.

Table 4-2 General Approach for Testing Energy Performance in Major Appliances

Appliance	Description of Energy Test Procedure
Annual Energy Use	
Domestic Refrigerator	Refrigerator is placed in environmental chamber with doors closed. Ambient temperature is slightly higher than room temperature to account for door openings and food loading (IEC and U.S.). In Japan, doors are opened at specified intervals.
Domestic Water Heater	Storage losses are measured under specified conditions. The energy required to service specified hot water draw cycle is sometimes added to this (U.S.).
Efficiency or Efficacy	
Room Air Conditioner	Air conditioner is placed in calorimeter chamber. Heat removal rate is measured under steady-state conditions and at only one level of humidity.
Central Air Conditioner	Heat removal rate is measured using a combined air enthalpy approach at one or more load conditions.
Heat Pump	Heat removal rate is measured using a combined air enthalpy approach at one or more load conditions.
Motor	Motor is placed on a dynamometer test stand and operated at full load and normal temperatures (U.S.). Alternatively, input power and losses are measured, and the difference is assumed to be the output (Japan and IEC).
Furnace/Boiler	Furnace or boiler is operated under steady-state conditions. Heat output is determined indirectly by measuring temperature and concentrations of combustion products. Fan and pump energy is sometimes added to input energy.
Light	Light output is measured in an integrating sphere. Light input is measured differently for each component, depending on type of light, ballast, and other features. Combination yields an efficacy.
Energy Use per Cycle	
Dishwasher	Energy consumption is measured for a standard cleaning cycle. Cleaning performance may also be included (IEC).
Clothes Washer	Energy consumption is measured for a standard cleaning cycle. Cleaning performance may also be included (IEC).

Table 4-3 is a partial list of test procedures that have international significance or recognition for major appliances. The same test procedure often has several different names because it is may be adopted by several different standards organizations. For example, an IEC test standard may reference an identical CENELEC test standard. In addition, many test procedures refer to other test procedures for certain details of the testing process; thus, it is often necessary to obtain several documents to understand the full scope of a test. The exact citation often changes when a test procedure is updated or harmonized, so it is important to determine the most current document before proceeding. A detailed and comprehensive description of current energy test procedures for appliances in the Asia-Pacific region is available in a recent Asia-Pacific Economic Cooperation (APEC) report (Energy Efficient Strategies 1999).

Each product requires its own test procedures.

Table 4-3 Energy Test Procedures for Common Appliances

Appliance	International	Japan	United States
Refrigerator/Freezer	Freezer ISO 5155 (freezers), ISO 7371 (refrigerators without freezers), ISO 8187 (refrigerator-freezers) , and ISO 8561	JIS C 9607	Code of Federal Regulations (10 CFR Part 430 Subpart B Appendices A1 and B1)
Room Air Conditioner	ISO 5151-94(E)	JIS C9612-94	Code of Federal Regulations (10 CFR Part 430 Subpart B Appendix F)
Central Air Conditioner	ISO 13253	JIS B 8616-93	Code of Federal Regulations (10 CFR Part 430 Subpart B Appendix M)
Heat Pump	Treated as an air conditioner	Treated as an air conditioner	Treated as an air conditioner
Motor	IEC60034-2A	JIS C4210	National Electrical Manufacturers' Association (NEMA), MG 1-1987 (equivalent to Institute of Electrical and Electronics Engineers, (IEEE) 112)
Furnace/Boiler	Depends on fuel used	Depends on fuel used	Code of Federal Regulations (10 CFR Part 430 Subpart B Appendix N))
Water Heater	IEC60379		Code of Federal Regulations (10 CFR Part 430 Subpart B Appendix E)
Light	There is no explicit energy-efficiency test procedure.	There is no explicit energy-efficiency test procedure.	NEMA LE-5
Dishwasher	IEC60436-81		Code of Federal Regulations (10 CFR Part 430 Subpart B Appendix C)
Clothes Washer	IEC60456-98	JIS C9606-93	Code of Federal Regulations (10 CFR Part 430 Subpart B Appendix J)

Energy test procedures for consumer home electronics, such as televisions, VCRs, and audio equipment, have only recently been developed. These are summarized in Table 4-4. A large portion of the total electricity consumed by these appliances is used in standby mode, so the focus of energy test procedures has largely been on standby electricity consumption rather than consumption in the "on" mode.

Information is available in the E.U., the U.S., and Japan regarding newly emerging test procedures for consumer home electronics.

Table 4-4 Energy Test Procedures for Consumer Home Electronics

Appliance	Europe	Japan	United States
Television	www.gealabel.org	www.eccj.or.jp	www.energystar.gov/
Videocassette Recorder	www.gealabel.org	www.eccj.or.jp	www.energystar.gov/
Audio Equipment	www.gealabel.org		www.energystar.gov/
Standby Power	www.gealabel.org		www.energystar.gov/

4.2.3 The Difficulty of Modifying Existing Test Procedures

Modifying an energy test procedure is typically cumbersome and time consuming. Most standards organizations are inherently conservative, so there must be strong pressure before a modification is considered and approved. Thus, standards-setting organizations are typically slow to modify test procedures in response to new technologies in appliances. When regulatory labeling and standards-setting programs are linked to test procedures, modifications become even more difficult. Nevertheless, in cases where there is a consensus that rapid change is needed, such change is possible. For example, the Japanese government was able to significantly modify the test procedures for refrigerators in approximately one year so that these procedures would be in force in time for a new Japanese efficiency standard. This unusually rapid change was accomplished only because of close cooperation among the Japanese government, the manufacturers, and the standards association.

4.2.4 The Difficulty of Translating Results from One Test to Another

Energy tests, whether for labels or standards, are expensive. The efficiency test for a gas-fired water heater costs about US$1,000 per unit. One internationally recognized testing laboratory charges roughly US$2,000 to perform the U.S. DOE test procedure on a single refrigerator and US$6,000 for a central air-conditioning unit. The laboratory tests and administrative work needed to create an E.U. energy label for a clothes-washing machine cost about US$3,800 (Sommer 1996). Because of the cost of testing, it is tempting to try to compare results from one test to those from another. This should generally be avoided, however, because test procedures often differ in important aspects, which leads to widely different energy values. For example, furnace and boiler efficiency tests in the E.U. are based on the fuel's "low heating value," that is, excluding the latent heat of condensation of the combustion gases. Tests in the U.S. typically use the "high heating value." This difference alone will cause at least a 5% difference in reported efficiency. Formulas for converting values from one test to another have been attempted but with little success (Meier 1987; Bansal and Krüger 1995). One exception is motors. An algorithm has been prepared for translating motor test results from one protocol to another within specified margins of error (de Almeida and Busch 2000).

Tests sometimes differ in underlying philosophy as well as in method. European tests for washing machines seek to measure the energy required to achieve a standard level of cleaning performance. U.S. test procedures simply measure energy consumption for a standard cycle and allow the manufacturer to determine the level of cleaning performance. Performance tests, like those used in Europe, are generally more complicated and expensive; combining cleaning performance with energy measurement tends to make the test procedure less repeatable and reproducible than is possible when only energy is measured. These differences lead to significantly different test procedures.

4.2.5 Selecting a Test Procedure; Considering Alignment

Creating an energy test procedure requires investments in a physical setup, including test facilities and trained technicians, as well as the resulting institutional investments in the administrative apparatus and representation at technical meetings. Stakeholders, such as manufacturers, trade organizations, and government agencies, are involved in supporting these investments. The infrastructure will be different for each appliance depending on the level of sophistication and advancement of the industry, the extent of imports, and the choice of test procedure. Small or poor countries may be unable to support these costs and therefore may be obliged to accept internationally sanctioned test procedures from ISO and IEC. Countries with close economic ties to Japan, the E.U., or the U.S. may find it convenient to align with their strongest trade partner. If the U.S. is the strongest partner, it may be simpler to align with the Canadian Standards Association (CSA) test procedures because CSA tests, while nearly identical to U.S. tests, are specified in Système Internationale (SI) units. Alignment has the advantage of allowing a country to draw upon an existing test and an international network of testing facilities to reduce barriers against import and export of appliances. Local manufacturers planning for eventual foreign trade or multinational firms seeking to standardize production facilities will likely support this approach.

By contrast, a country may be saddled with a test procedure that is unnecessarily complex or simply inappropriate for local conditions. Japan decided that the ISO test for refrigerators was not appropriate because it ignores the impact of humidity and door openings, so Japan replaced the ISO test with its own procedure. Particular costs imposed by certain tests should also be considered. For example, some clothes washer and dishwasher tests require a standardized detergent. Special test materials are typically available from only one or two suppliers at high prices. For example, the ISO refrigerator test requires the use of thermal mass with specific properties (to simulate food), which is available from only a few suppliers.

Modification of recognized international test protocols should be approached with caution. In addition to eliminating the potential for aligning or harmonizing test protocols with other regions, alterations introduce the need to verify repeatability and reproducibility of the test. These changes increase the cost of developing the test protocol.

In deciding whether to develop a unique domestic test procedure, adopt an established international procedure, or adopt a simplified version of an international test procedure, policy makers should consider the criteria discussed in Section 4.1.3. Because a new domestic procedure will take more time to develop and maintain than an existing test procedure, there must be strong reasons for not selecting an existing test procedure. Small countries or those with a very small local appliance manufacturing base should have extraordinary reasons not to adopt an internationally recognized standard before proceeding to develop their own. Countries with a large appliance manufacturing industry have more flexibility regarding local test procedures. One example is the case of Japan and washing machines. The IEC test procedure is strongly oriented toward hot water washing. Japanese clothes washing practices rely almost exclusively on ambient water temperatures (thanks to the presence of soft water throughout Japan). Because the efficiency of hot water use is not relevant to Japan, Japan's tests emphasize motor efficiency over hot water use. It is sometimes possible to align some aspects of an appliance's test procedures with international procedures while establishing local procedures for others. As conditions in the country change, the mix of local and international test procedures can also change.

Choosing a test procedure for a product may be especially difficult if several different tests are used by manufacturers in a country (perhaps because the manufacturers are local subsidiaries of companies from different countries that use different procedures). A trade association of manufacturers and the domestic standards association (the local counterpart to ISO) typically work together to establish a test procedure, but the government can also assemble its own advisory group and select a test procedure on its own. In the long run, however, some sort of technical review group will be required to enhance and/or legitimize in-house government expertise.

The process will generally be faster if an existing test procedure is simply adopted than if a unique domestic procedure is established. The speed of adoption will also depend on the extent to which the government decides to involve local manufacturers; the greater the involvement, the slower but more effective the process. The speed will also depend on the government's approach to certification and enforcement (discussed in Chapter 8). If a completely new test procedure is created, then it must be publicly announced and field tested, and staff must be trained to perform it. This process can easily take longer than one year. Staff training is particularly important because most of the tests will be conducted by manufacturers in their own facilities.

4.2.6 Considering Regional Harmonization

There is an increasing trend for neighboring countries within a formal or even loosely defined trade region to go beyond unilateral alignment and to harmonize their energy-efficiency test procedures by mutual agreement. Harmonization involves the adoption of the same test procedures, mutual recognition of test results, and/or alignment of performance standards levels and energy-labeling criteria for particular appliances. Like alignment, this approach allows countries, companies, and consumers to avoid the costs of duplicative testing and non-comparable performance information and to access a wider market of goods.

Recognizing this, many countries are participating in regional activities directed at harmonizing energy-efficiency standards and labels and the testing that underlies both of these measures. As mentioned in Chapter 3, such activities are being undertaken by APEC, the South Asia Regional Initiative for Energy Cooperation and Development (SARI/E), the Pan American Standards Commission (COPANT), the Association of Southeast Asian Nations (ASEAN), and the North American Energy Working Group (NAEWG).

Harmonization discussions are complex and slow because standards, harmonization, and regulations can create non-tariff trade barriers. Reduction of trade barriers is not necessarily "beneficial" to all concerned.

Regional Efforts to Harmonize Test Procedures and Enhance Mutual Recognition of Test Results in South Asia

In July, 2003, a SARI/E energy project sponsored by the United States Agency for International Development (U.S. AID) had the goal of assessing the capabilities of testing facilities in South Asia and determining the improvements needed in order to support a regional standards and labeling program. Test facilities in India, Bangladesh, Sri Lanka, and Nepal were assessed for their capabilities to test refrigerators, ceiling fans, lighting, and motors. The end goal was for the region to use common test procedures and to allow for the test results in one country to be valid in another. To achieve this goal, test laboratories must have adequate facilities, trained personnel, and calibrated instrumentation to provide test results that are both repeatable within the same laboratory and reproducible at other test facilities.

Not all of the countries had adequate facilities to test all of the four products. The assessment uncovered a need to upgrade some test facilities and to provide training in conducting tests. Differences and similarities in the test standards and facilities were listed.

To create confidence in the repeatability of test results from the same laboratory and reproducibility of test results between laboratories, it was recommended that the laboratories be accredited by an internationally recognized body. As part of the accreditation, a round-robin, inter-laboratory comparison testing program would be implemented. This approach is especially important in cases where ambiguity in the test procedures could result in different laboratories interpreting the test procedure differently.

Although some countries had the ultimate goal of establishing their own internationally recognized accreditation bodies, a cost-effective alternative was to use the services of the National Accreditation Board for Testing & Calibration Laboratories (NABL), an International Laboratory Accreditation Cooperation (ILAC)-recognized accreditation body in India. Mutual recognition agreements between standards-setting and labeling agencies would also be necessary to insure that the results from a laboratory in one country are accepted in another country.

Results of this project were made publicly available in a report available on the internet: www.sari-energy.org/projectreports.asp?ReportCatID=energy%20efficiency. In addition, a workshop entitled "Designing and Managing Energy Test Facilities & Protocols" was attended by all of the SARI/E countries. India, Bangladesh, Sri Lanka, Nepal, Bhutan, and Maldives participated in the workshop. The purpose of the workshop was to bring together both technical and policy experts involved in standards and labeling efforts in each country to discuss energy test protocols, capabilities of test facilities, and possibiities for harmonizing the test protocols and accreditation procedures. Continuing dialog among the SARI/E countries is needed to complete the goal of harmonized test procedures and standards-setting and labeling programs.

Countries and world bodies promoting regional endeavors must understand and account for the trading patterns of the manufacturers they are trying to influence. The following inserts provide a glimpse of such deliberations in the SARI/E and NAEWG regions, respectively. (See inserts: *Regional Efforts to Harmonize Test Procedures and Enhance Mutal Recognition of Test Results in South Asia* and *Regional Efforts to Harmonize Test Procedures and Enhance Mutal Recognition of Test Results in North America*.)

Regional Efforts to Harmonize Test Procedures and Enhance Mutual Recognition of Test Results in North America

Recognizing that differences among national test procedures and the failure to accept each other's test results are barriers to regional trade in energy-efficient products, Canada, Mexico, and the U.S. have been exploring the harmonization of test procedures and the mutual recognition of test results.

In 1992, The Energy Efficiency Expert Group of NAEWG analyzed the commonalities and differences among the three countries' test procedures to identify areas for potential harmonization. By meeting on a regular basis and frequently exchanging information, the dozen individuals participating in the Expert Group determined that there were 46 energy-using products for which at least one of the three countries had energy efficiency regulations. Three products—refrigerators/freezers, room air conditioners, and integral horsepower electric motors—appeared to have nearly identical test procedures in the three countries; 10 other products had different test procedures but showed near-term potential for harmonization. Through line-by-line comparisons of the three most similar test procedures, the NAEWG Expert Group verified that, apart from minor wording differences, they were identical. The next three products for comparison will likely be dry-type distribution transformers, residential central air conditioners, and linear fluorescent lamps.

The Expert Group has also been exploring mechanisms for facilitating mutual recognition of testing laboratory results among the three countries to minimize duplicative testing requirements. One possibility is to enhance mutual accreditation of the three countries' test laboratories, e.g., by having Mexican entities join international agreements in which U.S. and Canadian accreditation bodies already participate (such as ILAC). In addition, the Expert Group is compiling guidance on requirements for manufacturing and selling different products in the three countries and exploring ways to facilitate the process at each stage.

After three years, the Experts Group is still meeting regularly with a full agenda. Each country has solicited the input of its domestic stakeholders on both the harmonization of test procedures and the mutual recognition of test results. In addition to consulting with domestic manufacturers and trade associations, the Expert Group has consulted with the international Council for Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), which has agreed to review its test procedure comparison results.

By collaborating, the three countries hope to reduce the costs of compliance with standards and mandatory labeling programs in the region, accelerate the replacement of less efficient products, and facilitate the transformation of the regional market for energy-efficient products (NAEWG 2002).

4.2.7 Announcing the Test Procedure

The final test procedure needs to be decided and announced well in advance of the start date for efficiency labels or standards. Manufacturers need time to equip and certify their own test facilities and then more time to determine which models comply.

4.2.8 Normalizing Energy Values for Volume, Capacity, and Performance

Most energy measurements are normalized by volume or capacity or categorized by some other feature. These numbers typically become the "denominators" used in stating energy performance test results. Usually, separate test prescriptions define the way volume, capacity, illumination, performance, or other characteristics are to be uniformly measured. These details are as important as the energy measurements themselves. For example, inappropriate measurement of an appliance's capacity can result in an inaccurate declaration of efficiency. Therefore, along with establishing the test procedure, it is beneficial to establish a procedure for measuring capacity.

4.2.9 Reconciling Test Values and Declared Energy Consumption

There is a natural variation in the energy efficiency of appliances as they come off the assembly line. For example, two air conditioners leaving the assembly line one week apart may differ in efficiency by as much as 5% depending on the degree of quality control in the manufacturing facility. This variation arises from minute differences in components, materials, and assembly. There must, therefore, be a separate procedure for converting measurements of individual appliances' energy performance into a value representing the entire production run (the "declared" energy consumption). The choice of procedure is important because it has a major impact on the cost of testing (that is, on the number of units that need to be tested), the ability to provide accurate declared values, and the ease of enforcing energy standards.

Most tests include a procedure to establish a declared energy consumption for an appliance. This typically involves randomly selecting two or more appliances after they leave the assembly line. The declared value is usually the mean of the measurements of these two units. However, if their test values differ by more than a certain amount (determined by a statistical formula), then additional units must be tested. Here is the current ISO (1999) procedure for refrigerators:

> If the energy consumption is stated by the manufacturer, the value measured in the energy-consumption test shall not be greater by more than 15% of the stated energy consumption.
>
> If the result of the test carried out on the first appliance is greater than the declared value plus 15%, the test shall be carried out on a further three appliances.
>
> If the three additional tests are required, the arithmetical mean of the energy-consumption values of these three appliances shall be equal to or less than the declared value plus 10%.

In practice, some manufacturers measure the energy performance of one unit and then declare the energy consumption to be 15% less than the measured value. This yields a declared energy consumption that, while clearly avoiding the intent of the procedure, remains legitimate. The U.S. has established more stringent criteria for establishing declared values in an effort to reduce misleading ratings.

4.2.10 Emerging Issues in Energy Testing

It is important to recognize some of the emerging issues that will affect all energy test procedures, especially issues related to regulatory standards and energy labels. These issues will be discussed in future meetings of technical committees of the standards-making bodies.

Appliances increasingly contain microprocessors linked to an array of sensors and controls. Microprocessor control offers many opportunities for energy savings, such as variable-speed drive in air conditioners, the ability to adjust a wash cycle based on how soiled the clothes are, or the ability to vary combustion conditions in a boiler based on demand. Savings of more than 30% are often easy to achieve with microprocessor controls, and test procedures should be changed to credit these savings.

However, the same technology also can be used to circumvent or defeat a test procedure (Meier 1998). The authors are aware of two cases where a microprocessor was designed to sense when an appliance was being tested, and, in response, switch to a special low-energy mode. Several manufacturers of automobiles and diesel engines were caught using this strategy and were fined nearly US$1 billion. Although such deception is highly unusual, it is useful for practitioners of appliance testing to be aware of the possibility.

Eventually, all appliance energy test procedures will need to be revised to reflect the increasing use of microprocessor controls because the tests will need to assess both the behavior of the mechanical components (the "hardware") and the programming (the "software") installed to operate the device.

Standards-setting organizations are beginning to address this dilemma, especially in office equipment, in which power-management logic is already widely used (and required for endorsement by ENERGY STAR).

The World is Starting to Adapt Test Procedures to More Fairly Characterize "Smart" Devices

The original U.S. DOE test for dishwasher energy performance required that clean dishes be inserted in the racks during the test. Units with soil sensors appeared to be very efficient because they used the minimum amount of water to clean the already-clean dishes. During the late 1990s, a U.S. consumer organization observed that in real-world situations many dishwashers with soil sensors actually used more hot water and energy than traditional, mechanical designs. The organization advised its members to ignore the energy labels because they were misleading. As a result, U.S. DOE developed a new test involving soiled dishes. This is the first and only time that the authors are aware of an energy-performance test for a white goods appliance being modified for such a reason. The revision also included a measurement of standby power consumption (which was also a first).

The approach involves developing a typical operating cycle that captures all of the major operating modes. There has been less progress with respect to white goods and microprocessors. The recent modification of the U.S. DOE test for dishwashers to reflect microprocessors appears to be the first (see insert: *The World is Starting to Adapt Test Procedures to More Fairly Characterized "Smart" Devices* on the previous page).

The separation of energy test procedures and mandatory regulations is becoming less clear. One example of this situation arises in the relation of testing tolerances to energy labels. The European A-G energy-efficiency labeling scheme assigns a range for each letter category roughly equal to 10% of the efficiency range. Because the ISO test procedure for refrigerators establishes a 15% tolerance in measurements, manufacturers exploited the tolerance limit in the early years of the labeling scheme and sometimes claimed a C refrigerator to be an A (Winward 1998). Although round-robin testing, industry testing guidelines, and increased check testing since then appear to have reduced the magnitude of routine exploitation of tolerances, the European labeling system is putting pressure on ISO and IEC to require narrower tolerances.

4.3 Step T-2: Create a Facility for Testing and Monitoring Compliance

Test facilities are needed to perform energy tests. Almost every appliance requires a unique energy test setup. For example, a refrigerator requires an environmental chamber, and an air conditioner requires a calorimeter chamber. A list of some firms capable of performing internationally recognized energy tests along with an accompanying certification of results is shown in Table 4-5. The websites listed in the table describe the kinds of facilities and special features available. Most modern facilities can test several units at one time and collect all data on a data logger system. A country may decide to avoid developing

Many firms around the world are available to perform internationally recognized energy tests and certify the results.

Table 4-5 **Some Firms that Can Perform Internationally Recognized Energy Tests along with Accompanying Certification of Results**

Name	Country	URL
Intertek Testing Service	U.S.	www.itsglobal.com
Underwriters Laboratories, Inc.	U.S.	www.ul.com
CSA	Canada	www.csa.ca/
Korea Testing Laboratory	Korea	www.ktl.re.kr/eng
Le Laboratoire Central des Industries Electriques (LCIE)	France	www.lcie.fr
Laboratoire National d'Essais (LNE)	France	www.lne.fr

its own test facility and use commercial facilities for occasional compliance testing (such as random tests) because test facilities are expensive to construct and maintain. A fully operational (i.e. turnkey) motor testing facility, for example, costs up to US$100,000. A turnkey room air-conditioning test facility (a balanced calorimeter room) costs about US$500,000 and requires at least two staff members to operate efficiently. A new turnkey facility capable of testing all major appliances (including motors and lights) costs many millions of dollars and requires at least 15 full-time staff members.

Most large, international appliance manufacturers maintain their own in-house test facilities to ensure that their units comply with energy regulations. These firms use energy tests not only to verify compliance but also as an element of quality control, prototype testing, and checking competitors' models. For these reasons, appliance testing most often takes place on the manufacturers' premises. Smaller manufacturers may rely on cruder test facilities with less precise results and contract with private, independent test laboratories when more precise measurements are needed.

A government that operates a labeling or standards-setting program must have a facility that can perform reliable, unbiased energy tests. The facility can be operated by the government or a private firm. Few, if any, countries maintain government laboratories for large-scale appliance testing. Even the U. S. lacks a full-fledged, government-operated appliance test facility. Other national testing facilities, such as those in France, Australia, and Canada, perform private testing to defray the cost of maintaining the facilities. By contrast, in the Philippines, testing fees go back into the federal treasury instead of being reinvested in the facility, so it is difficult to maintain the facility's performance and capabilities (Egan et al. 1997). A preferred course of action is to reinvest the fees in the facility to help guarantee its long-term existence and value.

If energy testing is not widely practiced in a country, a government testing facility may be needed to stimulate improvements in the quality of private test facilities. One procedure is the round-robin test in which several facilities test the same appliance and compare results to those obtained in the government facility. This process identifies incorrect procedures or equipment. Round-robin measurements have been conducted occasionally in Europe and the U.S. and have often revealed surprisingly large variations in measurement results. The Philippines has also used this strategy.

Energy tests, including setup and breakdown, take considerable time to perform. Room air conditioners require four to six hours. Refrigerators must be tested for a minimum of 24 hours. Most protocols require at least two tests to bracket the desired temperatures. Many tests, such as those for refrigerators and air conditioners, require that the test facility and the appliance reach steady-state conditions for at least an hour before the test may begin. These requirements severely restrict the ability of a test facility to test many units rapidly.

Regardless of who actually performs energy tests, the government must establish a procedure for monitoring compliance with labels or standards. The process must specify how test appliances are to be selected from the factory inventory or off the floor at appliance stores, how many units must be tested, and who pays for the tests. This procedure can be aggressive, with a schedule of random testing, or activated only in response to complaints. An aggressive policy is advisable in the beginning so that manufacturers take a standard or label procedure seriously. Later, a complaint-triggered compliance check can be substituted. In the U.S., the standards program appears to have operated reasonably honestly with almost no government-initiated compliance monitoring. In Europe, manufacturers began more honestly reporting test results only after a compliance-monitoring scheme was initiated. The role of testing in the compliance regime of any standards-setting or labeling program is described further in Section 8.8.

4.4 Step T-3: Incorporate Testing into Enforcement

Many of the administrative aspects of establishing and administering appliance efficiency labels and standards are discussed elsewhere in this guidebook. However, a brief overview of administrative matters specifically related to test procedures and enforcement is provided below.

4.4.1 Establishing Administrative Mechanisms for Certification, Data Collection, and Appeal

The government or an NGO must prepare forms, organize procedures for reporting test results, and establish a database of compliant units. These mechanisms must be in place before labels or standards become mandatory.

First, the government must establish a procedure to certify test results. The two primary options, government testing and self-certification, are discussed in detail in Chapter 8. A self-certification procedure is generally superior because it is cheaper, faster, and relies on manufacturers' existing test facilities. For short periods, while the industry is in its infancy, it may make sense to have a higher-precision central facility administer tests and charge manufacturers for this service. Manufacturers are often uncomfortable with government certification because they would rather keep results secret until it is necessary to submit them. Over the long run, manufacturers will likely try to replace government certification with self-certification. A compliance-monitoring procedure must accompany any self-certification to ensure that manufacturers submit accurate results to the government. This procedure should include a process for considering complaints from one manufacturer about another and complaints from consumer associations. Japanese consumer organizations, for example, were instrumental in causing Japanese energy test procedures to be modified, and various European consumer organizations have exerted considerable pressure on European manufacturers to more honestly report energy efficiency.

No test procedure can adequately characterize 100% of the products that must conform to a label or standard requirement because new technologies or special features appear faster than tests can be modified to accommodate them. It is therefore essential to develop a flexible, intelligent, and rapid mechanism for administering enforcement and waivers. A process must be available to address the small percentage of products that cannot be tested using the recognized test. A manufacturer may be prevented from offering a product if it is inefficient but should not be prevented from offering a product because the product cannot be tested.

4.4.2 Establishing Procedures to Certify Independent and Manufacturer Test Facilities

The government must also create a procedure to ensure that testing facilities correctly perform tests with properly calibrated equipment. The procedures for conformity certification, often called accreditation, are well documented by international standards organizations (Breitenberg 1997). As mentioned earlier, an important aspect in less-developed countries will be staff training, including regular testing using round-robin measurements.

No matter which aspect of energy testing is being addressed—establishing a test procedure, creating a test facility, or creating the administrative apparatus for enforcement—it is important to remember that all of these elements should be addressed as early as possible in the process of developing labeling and standards-setting programs. An early start ensures time for proper technical analysis, observation of international test facilities, and review of existing international test procedures. After a testing capability is developed, the next step is to design and implement a labeling program, to analyze and set standards, or both, depending on the overall program. The development of a labeling program is described in Chapter 5; standards-setting is described in Chapter 6. A more thorough discussion of how verification and compliance regimes ensure the integrity of energy-efficiency labeling and standards-setting programs appears in Chapter 8.

5. Designing and Implementing a Labeling Program

Guidebook Prescriptions for Designing Labels

1. Develop an overall strategy for labeling, including goals, priorities, relationship to other energy-efficiency programs, and institutional roles and responsibilities.
2. Work closely with stakeholders. Elicit broad support from manufacturers, retailers, and consumer groups during design and implementation of the program.
3. Decide early on product priorities and label type(s).
4. When designating accredited laboratories, specifying energy- and non-energy-performance test protocols, and defining tolerances, consider aligning with international or regional test procedures.
5. Conduct some market research with stakeholders prior to implementing a labeling program. Use this research as the basis for designing an effective label.
6. Use consistent formats for comparison and endorsement labels across all product types. This will make it easier for consumers to understand the label and will increase its overall effectiveness as a policy measure. If launching both endorsement and comparative labels, integrate the two labeling approaches.
7. Identify resources for ongoing program promotion and marketing, policing and enforcement, and updating of test procedures and information about new technologies on the market. Include, if possible, links to programs sponsored by other government or non-governmental organizations that can increase incentives and resources for promotion.
8. Develop an evaluation plan at the beginning of the program. Collect both process and impact data. Use the results to improve the program.

5.1 The Basics of Energy-Efficiency Labeling

This chapter is designed as a primer and resource for regulators, officials, manufacturers, and advocates (i.e., consumer groups) who wish to understand international best practice and options for designing, and implementing labeling programs for energy-consuming appliances, equipment, or lighting products. It has been extensively updated since the first edition of this guidebook and now includes new details on the types of labels in use internationally and a detailed discussion of the potential for integrating comparison and endorsement energy-labeling programs.

5.1.1 Why Energy Labeling?

Like other energy-efficiency programs, labeling aims to shift markets for energy-using products and appliances toward greater energy efficiency. Energy-labeling programs help consumers understand which products are most efficient and what the benefits of this efficiency are. Labels not only influence consumers to choose more efficient products but also create competition among manufacturers to produce and market the most energy-efficient models, which engages retailers in promoting efficiency.

The energy efficiency of an appliance is usually hidden from the naked eye. Without a credible energy label, a consumer looking at an appliance has no idea whether a product saves energy or is an energy guzzler. Yet energy consumption determines the operating cost of most appliances and is therefore of concern to the consumer and her/his pocketbook. Consumers are sometimes aware of basic details about a product, such as wattage, and act on that information, for example, by buying 18-W compact fluorescent light bulbs instead of 70-W incandescent bulbs. But wattage is no substitute for the information that an energy label provides—lumen output and product life, for example—which is information that is not readily available to consumers unless it is included on a product label.

Energy labeling of appliances, equipment, and lighting products helps improve overall energy efficiency. The first evaluation of the impact of the recent European Union (E.U.) labeling scheme for refrigeration appliances, washing machines, and lamps, for example, showed a measurable shift toward sales of more-efficient appliances. The sales-weighted average energy efficiency of refrigeration appliances improved by 26% between 1992, just before the scheme was adopted, and late 1999. It has been estimated that 16% of the impact resulted from minimum efficiency standards and 10% resulted from labeling (Bertoldi 2000). Manufacturers' association sales data from the European Community of Domestic Equipment Manufacturers (CECED) show a significant increase in sales of A-rated appliances in the E.U. between 1999 and 2000. The data also show significant differences between countries, with A-rated products, in general, having a much larger market share in countries that have a rebate program or other consumer incentives (www.gfkms.com). It is estimated that in 2003 alone, the U.S. ENERGY STAR labeling program resulted in savings of more than 60 billion kilowatt hours (kWh) and 12 million tonnes of carbon equivalent (see insert: *ENERGY STAR is Being Adopted in Countries Around the World*). ENERGY STAR survey data also show marked differences in effectiveness between regions of the U.S. that have strong incentive and promotion programs and those that do not (CEE 2003).

Energy savings are not always the sole focus of an energy-labeling program. Because energy service—comfort, a cold soda, clean and dry clothes, cooked food, or light for reading—is the immediate benefit that consumers receive from energy-using appliances or equipment, some labels provide information about the level of service provided by an appliance. Many performance attributes, such as quality of lighting and service life for lighting products and minimum noise and moisture condensation for cooling products, can be important factors in consumer choice. Labelers can best promote efficient products by linking energy efficiency and high-quality performance.

ENERGY STAR Is Being Adopted in Countries Around the World

ENERGY STAR is a U.S. government/industry endorsement labeling partnership designed to make it easy for businesses and consumers to choose energy-efficiency solutions, thereby saving money and protecting the environment. ENERGY STAR is a joint program of the U.S. Environmental Protection Agency (U.S. EPA) and the U.S. Department of Energy (U.S. DOE). It was initiated in 1992 by U.S. EPA as an outgrowth of the Green Lights Program that encouraged businesses to replace incandescent lighting with fluorescent lighting. Two years after undertaking Green Lights, U.S. EPA converted this effort into the expanded ENERGY STAR program, which initially recognized energy-efficient computers. Since then, the ENERGY STAR endorsement labeling program has grown to identify efficient products in more than 40 categories, including household appliances, home electronics (televisions, audio systems, etc.), computers and other office equipment, residential heating and cooling equipment, and lighting. U.S. EPA collaborates with U.S. DOE, which is responsible for some ENERGY STAR product categories. In total, consumers bought more than 100 million ENERGY STAR-qualified products in 1999. Efficient new homes became eligible for the ENERGY STAR label in 1995. Efficient buildings became eligible for the label in 1999 when U.S. EPA unveiled a new standardized approach for measuring the efficiency (or energy performance) of an entire building. ENERGY STAR also works with industry partners to promote voluntary energy-efficiency improvements in manufacturing facilities.

A recent survey indicates that 56% of Americans recognize the ENERGY STAR label, and American consumers have purchased more than one billion ENERGY STAR-qualified products (CEE 2003). These products have helped reduce greenhouse gas emission by more than 60 million tonnes of carbon equivalent. In 2003 alone, ENERGY STAR helped Americans save $9 billion on their energy bills and 115 billion kWh—enough electricity to power 20 million homes. The associated reductions in greenhouse gas emissions were equivalent to taking 18 million cars off the road (www.energystar.gov).

Beyond the label, U.S. EPA and U.S. DOE offer many tools and materials to help partner organizations' efforts to promote energy efficiency. These include: promotional ENERGY STAR marks, national public service advertising campaigns, promotional and national campaign materials, performance rating systems, sales training materials, educational brochures, and awards in recognition of excellence. More than 1,400 manufacturers, 550 retailers representing 21,000 storefronts, and 330 utilities and state administrators have developed efforts around the ENERGY STAR brand. ENERGY STAR has become a platform through which each of these organizations/partners can demonstrate their environmental commitment while moving the market toward energy efficiency. U.S. EPA and U.S. DOE also partner with national and regional non-profit organizations that help increase consumer awareness and understanding of the benefits of energy efficiency.

The ENERGY STAR label is also used by other energy-efficiency programs. In 2001, an extensive household survey found that ENERGY STAR-qualified products were being promoted by a total of 86 utilities, market-transformation groups, and state administrators, reaching one-half of U.S. households. It also found that awareness of the label and its influence on consumer purchase decisions were substantially higher in regions where these other programs were prevalent (Cadmus 2001).

ENERGY STAR is also now being adopted in countries around the world. International agreements allowing the implementation of ENERGY

Continued on next page

Continued from previous page

STAR for selected products are currently in place in Canada, the E.U., Japan, Taiwan, Australia, and New Zealand.

Although ENERGY STAR initially targeted individual consumers, U.S. EPA and U.S. DOE also work with government, corporate, and institutional buyers. Information is available at the ENERGY STAR website (www.energystar.gov/index.cfm?c=pt_reps_purch_procu.pt_reps_purch_procu), including sample procurement language, qualifying product information, and savings calculators that help buyers estimate their potential energy and cost savings.

Reference: U.S. EPA 2004a, U.S. EPA 2004b

5.1.2 Types of Energy Labels

Broadly speaking, there are two distinct types of energy labels in use around the world: endorsement labels and comparison labels (Egan 1999, Harris and McCabe 1996). Table 5-1 highlights their essential features.

Endorsement labels

The purpose of endorsement labeling is to indicate clearly to the consumer that the labeled product saves energy compared to others on the market. Endorsement labels are a seal of approval indicating that a product meets certain specified criteria. These labels are generally based on a "yes-no" cutoff (i.e., they indicate that a product uses more or less energy than a specified threshold), and they offer little additional information. Typically, endorsement labels are applied to the top tier (e.g., the top 15 to 25%) of energy-efficient products in a market.

One example of an endorsement label for energy efficiency is the U.S. ENERGY STAR label. During the past 12 years, the ENERGY STAR program has grown to encompass a wide range of products and international partnerships.

There are two types of energy labels.

Table 5-1 Characteristics of Endorsement and Comparative Energy Labels

Type of Energy Label	Description
Endorsement	Indicates that product is among the most energy-efficient models available on the market. Endorsement labels may or may not be directly linked to comparative labels and/or be integrated and shown on comparative labels.
Comparative	Shows the relative energy use of a product compared to other models available on the market. There are three subcategories of comparative labels: *Categorical* labels use a step ranking system to indicate relative energy use compared to other models on the market. *Continuous* labels use a bar graph or scale to show the range of models available on the market. Unlike categorical labels, continuous labels do not have discrete "categories" of efficiency levels. *Information-only* labels give data on a product's technical performance but offer no simple means (e.g., a scale or categories) that allow consumers to compare energy performance among products.

In Canada, the Power Smart endorsement label was developed by a Canadian utility as a means of "branding" the most energy-efficient electrical products. Recently, the Canadian Government has joined in a comprehensive partnership with the U.S. ENERGY STAR program (see insert: *Canada Has Partnered with ENERGY STAR*). Power Smart utility programs generally now refer customers to ENERGY STAR-labeled products for appliances and equipment purchases.

Canada Has Partnered with ENERGY STAR

Natural Resources Canada has been the administrator of the international ENERGY STAR Program in Canada since May 2001 under a broad arrangement between it, U.S. EPA and U.S. DOE. This broad arrangement was considered desirable because of the similarity of the U.S. and Canadian markets, a prior familiarity of Canadians with the ENERGY STAR label and support expressed for endorsement labels during Climate Change consultations in Canada, the absence of any competing endorsement labeling scheme, the comparability of energy consumption testing procedures and minimum efficiency standards in the two countries, availability of the necessary staff and budgetary resources at Natural Resources Canada, and the desire by both countries to further integrate the North American market. Despite these advantages, it took considerable time and effort to ensure consistency and credibility of the joint program.

Currently, Canada promotes ENERGY STAR criteria for seven product categories comprising 45 products. The decision to engage in ENERGY STAR was made for many reasons including:

- Stakeholders showed strong support for ENERGY STAR as part of Canada's Climate Change Plan
- Endorsement labels have inherent appeal and marketability
- ENERGY STAR fits naturally into Canada's comprehensive equipment efficiency program, which already included strong minimum efficiency standards and comparative labeling approaches
- Canada's participation in ENERGY STAR helps integrate the North American market in many product categories.

Since its introduction to Canada, aided awareness of the ENERGY STAR mark by Canadians has risen from 26% to 44%. Energy Star criteria have been incorporated into federal government and some provincial procurement specifications and have formed the basis for federal and utility rebate programs throughout the country and for provincial sales tax rebates for qualifying products in a number of provinces. Canadian equipment suppliers and retailers have embraced ENERGY STAR and use it in all energy efficiency-related promotions. It is fair to say that ENERGY STAR has become pervasive in Canada.

With success come challenges, most of which are shared by ENERGY STAR users throughout the world. Keeping the criteria relevant and focused on high potential areas in a world in which technology changes so rapidly requires constant attention. The obligations that accompany shared ownership of an international program can raise local market and political issues. Maintaining balance between the voluntary high-performance ENERGY STAR program and an aggressive standards regime also requires attention. In addition, attribution of savings and emissions reductions to the program is crucial and remains an ongoing focus of efforts in Canada. Despite these challenges, ENERGY STAR has made and is expected to continue to make an important contribution to the efforts to meet Canada's energy-efficiency and environmental objectives.

Source: Natural Resources Canada 2004

During the past decade, a number of endorsement labels have been developed and implemented in developing countries. The Chinese government initiated an energy-efficiency endorsement labeling program in 1998 and founded the China Certification Center for Energy Conservation Products (CECP) in that same year to manage the program's design and implementation. The program is modeled in some ways after the U.S. ENERGY STAR program, and it has benefited from technical collaboration with the U.S. EPA. As of 2003, 21 product categories had been labeled including household appliances, lighting, motors and office equipment (Liu and Li 2003). A recent analysis of minimum energy-efficiency standards and endorsement-labeling programs in place and under development estimated that together they would reduce projected residential energy use by 9% in 2010 avoiding emissions of more than 11 million tonnes of carbon in China (Lin 2002).

Building on the success of programs to promote efficient lighting in Poland and Mexico, the three-year Efficient Lighting Initiative (ELI) was launched in 2000 to reduce greenhouse gas emissions by increasing the use of energy-efficient lighting technologies in seven countries: Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines, and South Africa. ELI was funded by the Global Environment Facility (GEF) and implemented by the International Finance Corporation (IFC). A second generation of ELI is anticipated to involve additional developing countries worldwide. ELI programs in all countries are built around the development of a recognizable ELI consumer logo representing efficient, reliable product performance.

Endorsement labels provide a government stamp of approval.

Figure 5-1 Examples of energy endorsement labels

Figure 5-1 shows some examples of endorsement labels.

Another type of endorsement label is the "ecolabel." (See Figure 5-2). Ecolabels indicate that a product or process has superior environmental performance or minimal environmental impact. Ecolabeling programs are being implemented by a number of governments and, in some cases, non-governmental organizations (NGOs) in countries around the world. Most ecolabeling programs for appliances and equipment include energy efficiency as one major component in the label rating scheme, but it is not always the primary factor in the rating.

E.U. ecolabel | Singapore's ecolabel

Figure 5-2 Examples of Ecolabels

An ecolabel indicates that a product meets certain environmental criteria.

Comparative Labels

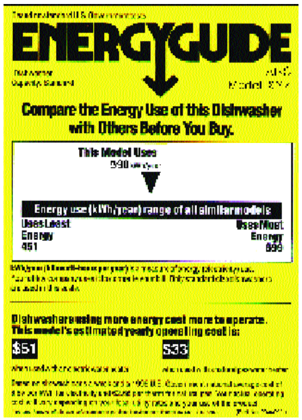
Comparative labels, as seen in Figure 5-3 on next page, allow consumers to compare energy use among available models in order to make an informed choice. Generally speaking, two forms of comparative labels are in use around the world: one uses a categorical ranking system, and the other uses a continuous scale or bar graph to show relative energy use. A third form, information-only labels, gives information about the labeled product without comparing its energy use to other models. Information-only labels are not often used for promoting energy efficiency.

Categorical Labels use a ranking system that allows consumers to tell how energy efficient a model is compared to other models on the market. Rather than relying on the simple "yes or no" assessment of efficiency relative to the single threshold value that is used for endorsement labeling, categorical labels use multiple classes that progress from least efficient to most efficient or most energy consuming to least energy consuming. Most categorical labels in the world use between five and seven categories for defining the range of performance. A few countries, like Australia, have initiated half-step ranking that effectively doubles the number of qualifying categories. The main emphasis of policy makers should be on establishing clear categories, so a consumer can easily tell, by glancing at a label, how energy efficient a product is relative to others in the market. Categorical labels may or may not give detailed information on the operating characteristics, costs, and energy use of the models.

Continuous-Scale Labels use a bar graph or line to show the range of models available on the market. The scale allows consumers to see where the labeled unit fits into the full range of similar models without sorting performance into specific categories. Continuous labels typically also contain detailed information on the operating characteristics, costs, and energy use of the models.

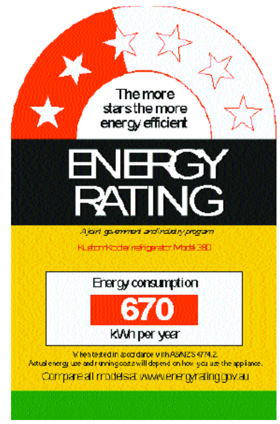
Information-Only Labels such as that used in the Philippines give data on the technical performance of the labeled product but offer no simple way (such as a ranking system) to compare energy performance among products.

Comparison labels use either categories or a continuous scale.

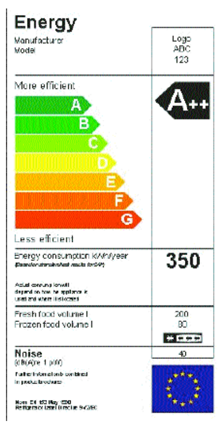


U.S. Label
(Continuous)

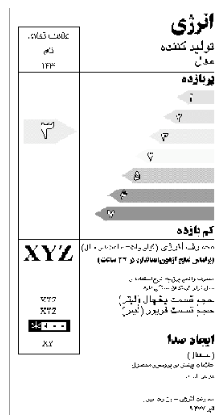
Thailand's Label
(Categorical)



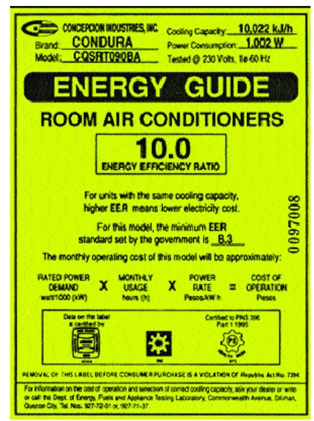
Australia's Label
(Categorical)



E.U. Label
(Categorical)



Iran Label
(Categorical)



Philippines Label
(Information)

Figure 5-3 Examples of comparative energy labels

Most Common Label Styles in Use

There are two general formats that are used around the world for categorical labels, and there is one format for continuous labels, as described in the following paragraphs.

Australian-Style Categorical Label (dial). The Australian-style label has a square/rectangular base with a semi-circle or "dial" across the top. The "dial" resembles a speedometer or gauge; the further advanced the gauge indicator is, the better the product. This type of label is used in Australia and Thailand, until recently was used in Korea, and will soon be implemented in India. In Australia, the dial contains stars (up to a maximum of six stars), and in Thailand the dial contains a one-to-five numbering system. The number of stars or the numerical "grade" on the scale depends on the highest pre-set threshold for energy performance that the model is able to meet.

European-Style Categorical Label (bars). The European-style label is a vertical rectangle with a series of letters ranging from "A" (the best) at the top of the label to "G" (the worst) at the bottom.

There is an arrow next to each letter that uses both length and color progression to communicate relative energy efficiency (short and green for "A" and long and red for "G"). All seven graded, colored, and size-varied arrows are visible on every label. The grade of the product is indicated by a black arrow-shaped marker located next to and pointing toward the appropriate bar (e.g., for a "C" grade product, the marker carries the letter "C" and is positioned against the C bar). Because of language requirements of the E.U., the label is in two parts. The right-hand part, which shows the base data common to all products, is not language-specific and is generally affixed to or supplied with an appliance at the point of manufacture; the left-hand part, which gives the explanatory text particular to the model in question, is language specific, and is generally supplied and affixed in the country of sale. This label style is used throughout Western and most of Eastern Europe as well as in Brazil (with a different basis for the A to G category definition than in Western and Eastern Europe). Iran uses a variant of the European-style label that is a mirror image of the European label because Persian script reads right to left, and it uses numerals rather than Roman script letters for ranking: i.e., 1 (best) to 7 (worst). Tunisia uses a European-style label with French on one side of the arrows and Arabic on the other to address the country's bilingual population. South Africa announced plans in 2004 to launch a European-style label.

Canada-U.S. Style Continuous Label (horizontal scale). The rectangular Canada-U.S.-style label shows a linear bar scale indicating the highest and lowest energy use of models in a particular product category [e.g., room air conditioners of similar size in terms of British Thermal Units (Btus)] and shows the position of the specific model on the bar scale. U.S. and Canadian labels are now technically but not 100% visually harmonized; e.g., U.S. labels show annual energy operating costs in small font at the bottom of the label, but Canadian labels do not. The primary use of monetary units (dollars) was abandoned in favor of physical units (KWh or efficiency) because variability in energy prices regionally and from year to year can cause the cost information to be confusing for customers whose rates are not close to the national average. The international trend is strongly toward adoption of categorical energy labels.

5.1.3 How Labels Affect the Market

Energy labels affect stakeholders in four interconnected ways:

- They provide consumers with data on which to base informed choices and encourage selection of the most efficient and suitable product available.
- They encourage manufacturers to improve the energy performance of their models by making energy efficiency transparent to the market place and—at least for endorsement or categorical labels—by providing clear targets or thresholds to aim for in improving energy efficiency.
- They encourage distributors and retailers to stock and display efficient products by offering a selling point for energy-saving models. (Retail salespeople can either advance or impede a labeling program depending on how they treat the relative energy efficiency of models as a part of the sales pitch.)
- They can provide a basis for a wide range of other stakeholders—including other government programs; consumer or environmental groups; electric utilities; and other local, state, or regional organi-

zations—to implement outreach and education, utility demand-side management (DSM), and tax rebates or other programs that provide incentives or otherwise encourage purchase of high-efficiency products.

On the consumer side, energy labels promote the purchase of more efficient models. Energy labels give consumers information that would otherwise be unavailable and that allow consumers to factor operating costs and energy use into decision making. This information (and associated promotion of the labels) results in more efficient purchases.

Once a label is seen as having an actual or potential consumer impact, manufacturers may be motivated to remove their worst models from the market and improve the efficiency of their current models. For example, evaluations have shown that many new products being produced in the E.U. are being designed to just cross the threshold of the higher-efficiency categories, as can be clearly seen in Figure 5-4 (Waide 1998). During the 1990s, the highly competitive and innovative computer and office equipment industries responded to U.S. ENERGY STAR label specifications by building in power management to reduce energy use by up to 50%. By 1999, approximately 80% of new personal computers, 95% of monitors, 99% of printers, and 65% of copiers qualified for the label (Geller 2000).

Distributors and retailers may respond to labels by changing the mix of products they stock and display. Research has indicated that retailers in particular can influence the consumer's final decision in a large percentage of appliance purchases (du Pont 1998). The engagement of retailers and their support for an energy label can be critical to program success. A labeling program needs to account for the fact that retailers and salespeople in many countries get commissions for selling particular brands or models of appliances. To avoid having commissions function as counter-incentives, programs like the ongoing

Within a few years, the E.U. market moved from a random distribution of sales by energy efficiency prior to labeling to a distribution that shows very large peaks at the thresholds of the efficiency classes, demonstrating the clear influence of the label.

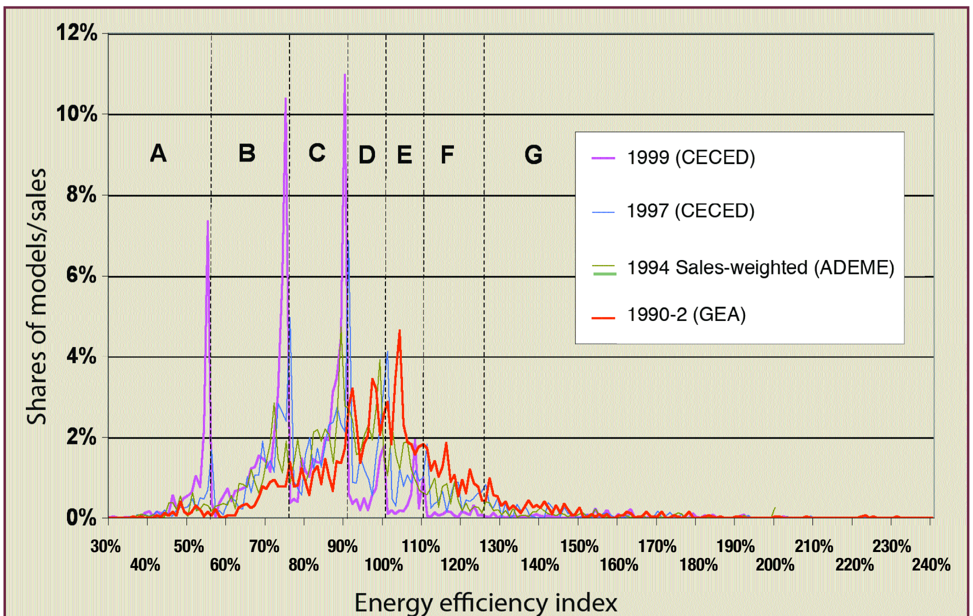


Figure 5-4 Impact of the E.U. refrigerator energy label on sales by efficiency index

China CFC-Free Energy Efficient Refrigerator Project include targeted financial incentives to retailers and salespeople (Phillips 2003).

Experience has shown that the average efficiency of products on the market can be clearly influenced by changes in the incentives offered by manufacturers and distributors as well as by the mix of products that retailers stock and display. Thus, the impact of a label extends beyond energy-aware consumers and affects the average consumer as well.

Programs that promote market response can enhance the impact of energy labels. Consumers will respond if they are made aware of labels, understand the information that labels communicate, and perceive that there are good reasons to make choices based on the labels. Government procurement specifications that require or encourage the purchase of energy-efficient products by government agencies can also dramatically enhance the market for labeled products and can evoke a manufacturer response that affects products provided to the entire market. Other energy-efficiency programs, such as utility incentive programs and building energy codes, can greatly enhance consumer response to labels. Interactions of energy-efficiency labels with a wide range of related programs are discussed in Chapter 10.

5.1.4 Understanding and Involving Program Stakeholders

One of the first steps in designing an energy-labeling program should be to identify relevant stakeholders and form stakeholder decision groups to provide input that will help officials develop the program. It is essential to establish early on a process of stakeholder consultation by convening representatives of all interested parties to gather input on how the program should be designed and marketed. Stakeholder consultation should be linked to a market research effort to design the label and the overall program for launching and promoting the label. Interviews and meetings should be used to formulate and test the mechanics of how the program will operate and to answer the many program design questions that need to be addressed, such as:

- Which agency will manage product testing?
- Will private-sector laboratories be certified for testing?
- Is the proposed label design understandable by and effective with consumers and acceptable to all stakeholders (especially suppliers)?
- Are the proposed label thresholds acceptable to stakeholders?
- Who will issue the labels?
- How will the labels be displayed on the product?
- How will monitoring and enforcement work?
- Who will evaluate the program, and how often?
- How can consumers be convinced that the label is credible?
- How can salespeople be recruited to promote the program?
- Will the labeling program pave the way for minimum efficiency standards?

These questions must be addressed by the lead label-implementing agency (or agencies). This agency is not generally considered a stakeholder but rather leads the consultation process and is responsible for balancing the specific vested interests of the many stakeholders. The agency is often a government body although this need not be the case. Its role in an energy-labeling program includes:

- defining the detailed technical requirements in consultation with stakeholders
- developing and maintaining the legal and/or administrative framework for the program
- registering, policing, and enforcing compliance, if applicable, to ensure that the program remains credible
- providing information to consumers, including ensuring press and TV involvement in the promotion campaign
- evaluating and improving the labeling program

The lead agency often establishes partnerships with key government partners and NGOs, including research institutions [such as the Lawrence Berkeley National Laboratory (LBNL) in the U.S., the China National Institute for Standardization (CNIS), and the Bureau of Indian Standards (BIS)]; utility companies [such as the Electricity Generating Authority of Thailand (EGAT)]; test laboratories; local government agencies; and others whose cooperation is important in establishing program credibility. These program partners must maintain the same independence and neutrality as the lead agency when dealing with the stakeholders.

The lead agency and its partner institutions can obtain input through a combination of individual meetings with key stakeholders and a structured consultation process with stakeholder committees. Eventually, if the stakeholder process is well managed, the private sector will buy into and support the program.

Stakeholder consultation of the type described here was performed in India (Dethman et al. 2000) and China (Waide et al. 2004) and is currently being carried out in Malaysia as part of a Danish-funded effort to design and implement DSM programs, including an energy-labeling program for refrigerators and electric motors (Jensen 2004). This sort of relationship-building and stakeholder mobilization is a time-consuming but critical part of initial program development.

Below, we briefly describe the groups of stakeholders who are typically affected by an energy-labeling program and can be approached to help design and promote the program.

Manufacturers

Manufacturers and importers of products manufactured abroad are key stakeholders. They are the sources of the products to be labeled and are generally responsible for testing products and placing energy labels on products that they sell. Because manufacturers have designed their products and, in most cases, tested them extensively according to local and international test procedures, it is critical that any labeling program include a full and ongoing dialogue between the manufacturers and the implementing agency.

The primary goal of manufacturers is to make products that consumers will want to purchase. Manufacturers have to balance a wide range of elements of product design, including quality, reliability, performance, and price. The introduction of energy labeling makes a product's energy efficiency an important design parameter, at least in cases where the label is effective and influences the decisions of a significant percentage of consumers. Manufacturers of the most-efficient products tend to be supportive of energy labeling; manufacturers that have large sales of low-efficiency products tend to be opposed to or less supportive of energy labeling.

Retailers

Although retailers are often considered to be minor stakeholders in an energy-labeling program, salespeople influence appliance-purchase decisions in a large percentage of cases. One study found that U.S. salespeople have a significant influence in approximately 30–50% of sales of "white goods" (refrigerators, freezers, dishwashers, clothes washers, dryers, and stoves) (du Pont 1998). Salespeople's attitudes can range from highly supportive of the extra cost for energy-efficiency features to neutral or negative regarding energy efficiency.

Retailers can play a very supportive, positive role in energy-labeling programs, especially if they are actively engaged by the implementing agency to assist in marketing the programs and/or if retailer training is provided. Retailer impact can also be negative if increased energy efficiency reduces profit margins or if there is low regard for energy-saving features. In the worst case, retailers may denigrate the credibility of the label or discount its importance if they believe that this will improve their chances of a sale or increase their profit. Many salespeople work on a commission basis, which may provide them with an incentive to sell more costly models with features that may use additional energy rather than promoting energy-efficient models of the same or lower class of refrigerator that may be less expensive.

Consumers

Consumers are a diverse, diffuse group. It takes significant work to obtain reliable information about consumer use and understanding of energy labels and even more effort to determine the changes in consumer purchasing patterns that are likely to result from the presence of energy labels. Nonetheless, consumer involvement is critical in all phases of the program, from market testing of label designs with focus groups to consumer surveys to marketing of the program and dissemination of information. Consumers cannot be expected to change their purchasing patterns if information is inaccurate or unavailable or if the label is unclear and difficult to use.

Consumer and Environmental NGOs

In some countries, NGOs such as consumer and environmental groups take an interest in energy programs. These groups can play the roles of: advocate, acting as a counter-balance to industry in the process of analyzing the market and encouraging the development of higher energy-efficiency thresholds; "watchdog," reviewing the results and progress of a program; promoter, collecting data and providing information to consumers, often through advertisements, brochures, and web sites; and compliance monitor, carrying out random testing and quality checks to ensure that labels are applied and that the information provided to consumers is adequate.

In many countries, NGOs have their own internal, independent test laboratories and are able to provide well-balanced input to technical discussions. There is growing awareness among some NGOs that energy use is a central element in the environmental problems that many countries face. NGOs can provide important input on a range of issues, including testing, labeling, program marketing, and public awareness (see insert: *Consumers Are Becoming Increasingly Involved in Standards-Setting and Labeling*).

In cases where NGOs are large and sufficiently well funded to actively participate in the process of developing and maintaining energy labels, they can provide valuable input. (Environmental groups in particular are taking an especially keen interest in energy efficiency as concern over climate change spreads.) Increasingly, NGOs are developing the skills to analyze and advocate energy-efficiency policies. In cases where NGOs have relevant expertise, they can play an important role in advocating an aggressive and effective labeling program. In this sense, NGOs can help keep implementation agencies focused on broad goals and program outcomes.

5.1.5 Energy Labeling Is the Tip of the Iceberg

From a consumer's perspective, the label itself is the most important and obvious element of an energy-labeling program. The label design is critical because it must convey information in a way that is easy to understand and assist the consumer with purchase decisions.

Consumers Are Becoming Increasingly Involved in Standards-Setting and Labeling

Worldwide, mainstream consumer groups are taking an active role in campaigning on environmental and energy-related issues. At an Asia-wide forum on sustainable energy use and consumer information, the NGO delegates listed appliance labeling as one of their primary policy recommendations. The declaration is excerpted below:

> The Forum gave unanimous support to the establishment of appliance labeling schemes for the widest possible variety of electrical products. While a voluntary system may be adopted initially, it is believed that a compulsory system, based on legislation, is preferable and more effective in the medium to long term. The Forum participants noted the variety of different forms of labels currently in use in different countries, and expressed the strong view that labels should be kept as simple as possible and may include a simple categorical rating scheme (e.g., 1-5 stars, A-G categories). Labels should indicate estimated annual energy use in monetary terms rather than kilowatt-hours. Any categorical system of labeling may need to adjust or recalibrate its rating system periodically so as to distinguish adequately between the efficient and non-efficient products. While consumer organizations need not be directly involved in the implementation of labeling schemes, they should have a role in monitoring compliance by appliance manufacturers.

Source: UNESCAP 1999

However, as Figure 5-5 illustrates, the *energy label that appears on a product is only a small part of an elaborate infrastructure of elements and activities that are the foundation of an energy-labeling program.* Many officials designing energy-labeling programs focus primarily on the design and content of the energy label, but the underlying infrastructure that supports an energy-labeling effort is critical to the program's success. Even though consumers may never be aware of these underlying elements of the program, these elements must be carefully planned, implemented, and maintained to ensure that the program is effective.

The main steps in developing a labeling program are shown in Figure 5-6 and described below.

5.2 Step L-1: Select Products and Decide on the Labeling Approach

In making any design decision for an energy-labeling program, including identifying which products should be labeled and what types of label(s) to apply, it is important to collect and analyze data on the energy-using products sold in the country or region. For a complete discussion of data needs, types of data, and data analysis, see Section 3.4 of Chapter 3.

Once a policy maker has a view of the energy use, market size, and characteristics of the major energy-using products in his/her country, s/he can begin to decide which products should be included in the program and whether to apply comparison labels, endorsement labels, or both.

The energy label is just the tip of the program iceberg.

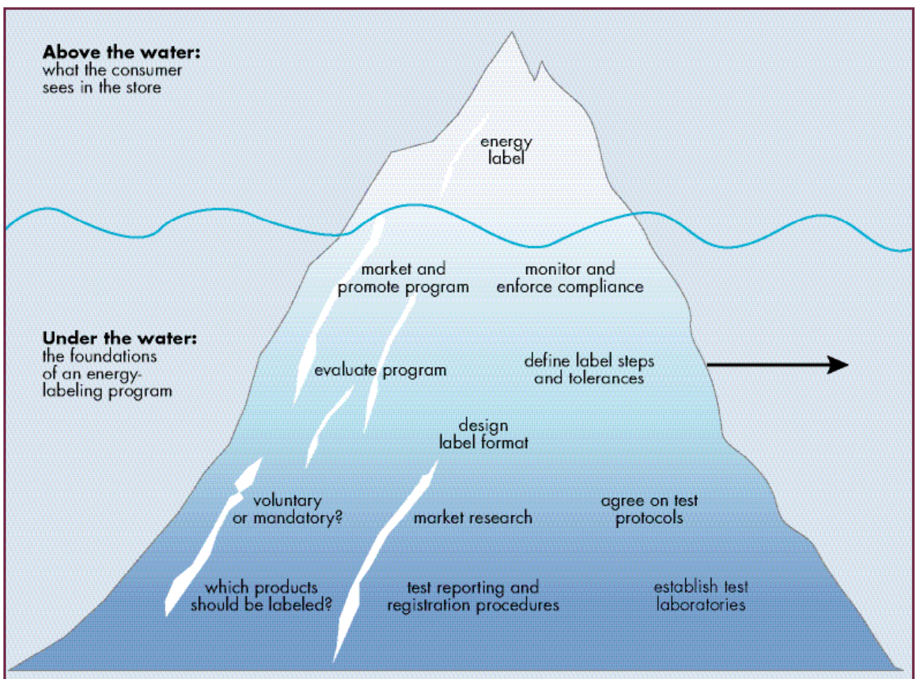


Figure 5-5 The "Iceberg" of energy labeling

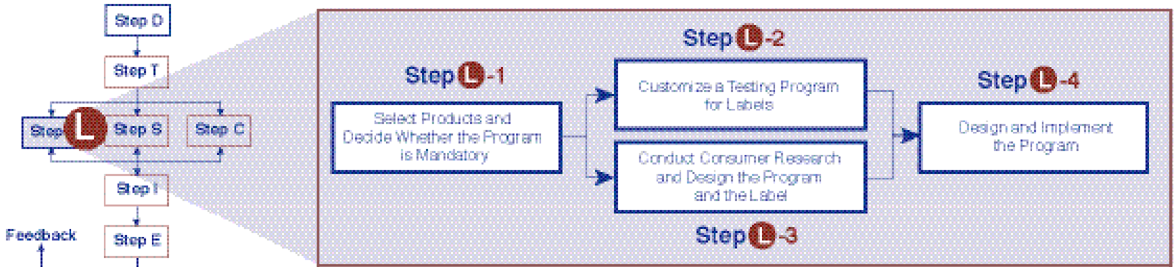


Figure 5-6 Major steps in designing and implementing an energy-labeling program

5.2.1 Selecting Products

As a general rule, energy labeling will realize the greatest energy savings for products:

- that use a significant amount of energy on a national scale
- that are present in most households, offices, or businesses or that are predicted to rapidly increase their saturation
- for which energy-efficient technology exists that is not being used or is under-utilized in most products on the market
- for which the purchaser pays the energy bills (although there are a number of exceptions, such as water heaters, furnaces, and heat pumps, for which labels have effectively impacted markets)
- for which there is (or could easily be) significant variation in the energy efficiency of different units

If a product does not meet most of these conditions, then energy labeling of that product may have little beneficial effect.

Aside from the magnitude of potential savings, other considerations sometimes enter into the selection of products for endorsement labeling. The U.S. ENERGY STAR program, for example, has defined six key principles known as the ENERGY STAR guidelines to determine the feasibility of addressing new product categories (McWhinney et al. 2004):

1. Significant energy savings can be realized on a national basis.
2. Product performance can be maintained or enhanced with increased energy efficiency.
3. Purchasers will recover their investments in increased energy efficiency within a reasonable time period.
4. Energy efficiency can be achieved with several technology options, at least one of which is nonproprietary.
5. Product energy consumption and performance can be measured and verified with testing.
6. The label would effectively differentiate products and be visible to purchasers.

For some product types, minimum energy-efficiency standards, rather than labeling, may be the best alternative. Many experts believe that this is especially true for products like water heaters and central air conditioners that are generally purchased by a third party (i.e., a purchaser who does not pay the energy bills associated with the product). Nonetheless, for both of these products, some countries have decided that labeling is also useful. For example, water heaters are labeled in Australia, and central air conditioners are labeled in the U.S. For other products, such as refrigerators, energy-efficiency standards and labels can work best together.

There will always be an element of the market that is "energy-label resistant." Many consumers are not interested in energy use and will ignore a label's message. Still, an energy-labeling program can achieve significant energy savings even when a large number of consumers ignore labels so long as there is also a large segment of the population that is influenced by the label.

Questions to consider when deciding on how to approach an energy-labeling initiative include:

- Should one start with an endorsement or a comparative labeling program?
- If comparative, should the label be continuous or categorical?
- If comparative, should the labeling program be mandatory or voluntary?
- How, and to what degree, should endorsement and comparative labels be linked?

5.2.2 Endorsement vs. Comparison Labels

Endorsement labels and comparative labels can be—and often are—used together. Choosing one label type at the inception of a program does not preclude adding the complementary label, if applicable to the product, later. In view of the learning curve for implementing any new program, it may be best to start with a single label type and allow time for its credibility to be established before launching a second labeling program. This section of the guidebook focuses on the strengths, weaknesses, and applicability of endorsement versus comparison labeling. Section 5.2.3 describes how and when it might make sense to combine the two types of labels in a single program or label format.

The appropriate choice of label is not always obvious; the effectiveness of the two basic label approaches for the same product may differ widely in different countries or regions. The type of label that will work best depends on a number of factors: the local culture, consumer knowledge and attitudes, and the program design framework and goals. As noted above, factors such as good program design, consistency over time and products, and effective marketing and promotion may be as important as the choice of initial label type in determining a label's impact on the market. In choosing a label type, consider the following characteristics:

Applicability

Comparison labels, especially categorical ones, are most frequently applied to major appliances (durable goods) that use large amounts of energy, have long lifetimes, and have design cycles of several years or more. These appliances are the largest energy users that are normally purchased directly by household consumers; for these products, comparative labels can influence consumers and manufacturers and affect the market in ways that endorsement labels cannot. Although both label types are commonly used for durable household appliances such as refrigerators, air conditioners, and clothes washers, endorsement labeling is applicable to a wider range of products, including consumer electronics, lighting, and office equipment. These latter products are difficult to include in comparison labeling programs for several reasons: Many have shorter lifetimes and design cycles, and some, such as consumer electronics and computers, demonstrate relatively narrow ranges of energy consumption among models or bimodal distributions related to specific efficiency features (e.g., the sleep mode on computer monitors). Even if the range of energy consumption among products is relatively narrow, a high and expanding rate of market penetration can mean sizeable energy savings for countries that promote energy-efficient models. Other products, such as motors, central air-conditioners, commercial refrigerators and freezers, and transformers—are not purchased directly by the consumer. For these products, the detailed information provided on a comparative label is often not worth the effort and time to provide it. The simpler, more rapidly implemented, and less costly endorsement label is preferable in many of these situations

Consumer impact

Endorsement labels have a simple message that is easy to understand: is this product energy efficient or not? Because they provide the minimal information directly on the label, they require minimal thinking by the consumer. For consumers who are weighing many other factors when making a purchase and who prefer a simple endorsement from a trusted source, this benefit should not be underestimated. For consumers who have greater interest and are more influenced by detailed and technical information, comparative labeling may be preferred. This is true particularly for relatively expensive and long-lived durable goods. Comparative labels provide more detailed information than endorsement labels, so consumers who wish to invest the time are likely to grasp the label content: how much energy is saved, compared to what, etc. When they are mandatory, comparison labels provide consumers with information about all products in the market. When endorsement labels are used, the vast majority (75–85%) of lower-efficiency models on the market will not qualify for an endorsement label and will therefore remain unlabeled. By contrast, comparison labels can help consumers identify the most efficient products on the market and also avoid the least efficient products. Neither approach will suit all consumers at all times or even any one consumer all the time.

Impact on manufacturers

Comparative labels are more effective than endorsement labels at spurring manufacturers to discontinue low-efficiency models because manufacturers generally like to avoid being seen as having the worst product. Particularly in the case of categorical labels, as mentioned earlier, it has been demonstrated that manufacturers tend to design products that just cross the threshold of the next efficiency level on the label (Figure 5-4). In addition, over time, low-end categories become irrelevant as product efficiencies leap from one label category to the next. Because endorsement labels are voluntary and limited to the high-efficiency end of the market, these labels tend to engage progressive manufacturers in a constructive relationship. Endorsement labeling can be a good mechanism for introducing industry to standards and labeling programs, particularly in countries where companies are hesitant about or averse to such efforts. The endorsement label program does not directly threaten manufacturers of less-efficient models because it allows them to remain in the market without unwanted attention drawn to these models. Manufacturers who produce or could produce highly efficient products self select by partnering with the program and see it as beneficial in differentiating their superior products. The simplicity of endorsement labeling allows for easy integration with product marketing by manufacturers, retailers, and others.

Complete market coverage

Because of their detailed and often mandatory nature, comparative labeling schemes tend to generate more comprehensive, publicly available data on product efficiencies than endorsement labels do. This is advantageous for policy makers because it facilitates program evaluation and tracking and documenting of energy savings over time, which is crucial for proving program success to sponsors.

Flexibility and response time

Endorsement labels require less time than comparison labels and no regulatory process for implementation and revision. Endorsement labels can stay relevant in markets that shift every few years or less. Also, as manufacturers improve the energy efficiency of their products over time to achieve higher ratings under a categorical label scheme, endorsement label criteria can be more easily adjusted to closely track this upward movement and thus can continue to differentiate the most-efficient products.

Cost of implementation

Because endorsement labels are non-regulatory and simpler than comparison labels, government administrative costs for them are lower. From the perspective of individual manufacturers, the costs of participation are voluntary rather than being required as a part of a regulatory burden. For either type of label, manufacturers and retailers will likely view the outreach and promotion expenditures by government, utilities, NGOs, and other stakeholders as free leverage to their own advertising dollars. The program benefits by leveraging the significant resources that manufacturers routinely devote to their own product advertising.

Cross-program application

Labels can be utilized by other market-transformation programs such as financial incentive programs and government procurement. It is simple to identify the top one or two classes in categorical comparison labels as the required levels for participation in these other programs. With continuous comparison labels, a percent above the minimum could be used, but the label itself offers no convenient benchmark for use by the other programs. With endorsement labels, qualification for the endorsement would be the requirement for participation. The simple message of buying or qualifying only products that meet these predetermined and publicly disclosed thresholds can reduce the financial, staff and transaction costs associated with the supplemental programs. If endorsement labels are used in these programs and are well publicized—see, e.g., the recommendations in Chapter 7—they may also appeal to a targeted mix of consumer preferences (e.g., environmental protection, monetary savings, international credibility) and be quite effective, at least with a segment of the market.

5.2.3 Additional Design Issues for Comparison Labeling

If policy makers decide to implement comparison labeling for specific products, it is also necessary to decide whether the program should be mandatory or voluntary and whether to use a categorical or continuous format.

Mandatory or voluntary

Depending on the product and its range of energy consumption, market readiness, degree of stakeholder support, budget for marketing and outreach, and a host of other factors, either a mandatory or voluntary approach can result in substantial energy savings. The key is that the program be well designed and that policy makers assess the benefit and appropriateness of these two policy approaches at the outset and in the broader context of a country's energy-policy goals.

For a number of reasons, it is sometimes easier to start with a voluntary program. First, it can be easier to reach agreement with stakeholders—particularly manufacturers—on a voluntary program. Second, the voluntary program can provide a good learning experience for both the implementing agency and industry, allowing each to adjust and understand its role and responsibilities. Voluntary labeling programs can also be more flexible and adaptable than mandatory labeling programs because their non-binding and non-regulatory approach generally means less lead time, less stakeholder analysis, and more marketing flexibility.

A phased approach with eventual transition to mandatory labeling for all products after completion of a successful, well-defined voluntary period can also be beneficial. This arrangement is best designed into the program at the outset to clearly set expectations and avoid confusion or misgivings. This transition would typically be applicable only to comparative programs and not endorsement programs, which are best implemented on a voluntary basis.

A major limitation of voluntary comparison labeling programs is that manufacturers typically choose not to place labels on products with low ranking (e.g., 1 or 2 stars). (Agra-Monenco International 1999 and Danish Energy Management 2004) If products with a poor energy rating have no labels, some consumers who might avoid these products if all the information about the products were available could end up buying them. Ultimately, comparison labeling programs work best if consumers can easily distinguish between poor-, average-, higher-, and highest-efficiency products.

Categorical versus Continuous Labels

Research has indicated that categorical labels are generally easier for consumers to understand than continuous labels (du Pont 1998). Categorical labels provide more information about energy use and, if well designed and implemented, can provide an easily identifiable basis for buyers to focus on energy efficiency from one purchase to another, across or within equipment categories (e.g., "That product was an 'A' and this one is a 'C'"). Furthermore, categorical labels can provide a clear basis for other market-transforming programs such as the utility DSM incentives discussed in Chapter 10.

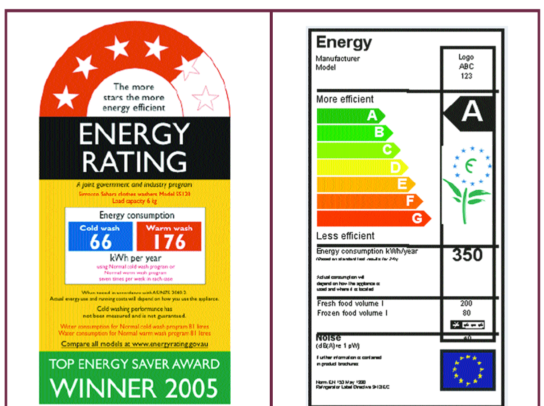
As noted above, categorical labels have a drawback that must be addressed by program designers: every few years, as the labeling program succeeds in encouraging manufacturers to improve the energy efficiency of their products, the models of a particular product will likely cluster in the highest (most energy-efficient) categories. When this happens, the label categories need to be revised. In this case, either the criteria for the categories must be revised, or new categories must be added in a way that consumers will notice. Adjusting category criteria minimizes consumer confusion. Adding categories requires re-educating consumers and may reduce the label's effectiveness.

In an analogous manner, the end points of the continuous label scale need to be revised when new products are released that redefine either the least or most energy-efficient product in its class.

5.2.4 How and When to Combine Endorsement and Comparison Labels

As the previous section clearly illustrates, comparative and endorsement labels each have unique advantages. As labeling programs expand and mature, it may make sense to display both labels simultaneously on some products. In several countries, both types of labels have been joined into an overall strategy with the idea that complementary labels for certain products can result in greater energy-efficiency improvements than would result from a single label alone. Two examples of integrated labeling programs currently in place, in Australia and the E.U., are shown in Figure 5-7. In Australia, the integration of the endorsement label into the comparative label was announced in 2004, with implementation starting in 2005 (www.energyrating.gov.au/tesaw-main.html). In Europe, manufacturers have the option of integrating the European Eco-label into the appliance energy label. In practice, however, this is rarely done, and it appears that manufacturers do not see the Eco-label as a competitive advantage for appliances in Europe (Lebot 2004).

To date, multiple labels have been most commonly applied to major home appliances for space heating and cooling, refrigeration, and clothes and dish washing (see Table 5-2). Endorsement labels are commonly used for these products as well as for a wider range of products, including consumer electronics and office equipment that have shorter life and design cycles. Comparison labels, especially of the categorical type, are normally applied to appliances that use large amounts of energy, have expected lifetimes of many years and have design cycles that extend over several years. Thus, these large appliances are the most attractive candidates for integrated labeling.



Australian integrated label | E.U.'s integrated label

Figure 5-7 Two examples of integrated labels

Integrating endorsement labels with comparison labels can enhance the effectiveness of labeling.

Combining labeling programs entails visual integration or "co-location" of labels on

Table 5-2 **Products with Multiple Labels in Use or Under Consideration**

Label integration has been applied mainly to major home appliances.

Product Type	European Union[1]	Australia	United States
Refrigerators	✓	✓	✓
Freezers	✓	✓	
Clothes Washers	✓	✓	✓
Dishwashers	✓	✓	✓
Air Conditioners		✓	✓
Space-heating Equipment		✓	✓
Water Heaters		✓	
Lighting Products	✓		✓

[1]In the European Union, appliances can carry both comparison label and an ecolabel (that is broader than an energy endorsement label, but for these products energy consumption is a key component).

Source: IEA 2003, , Marker et al. 2003

products, coordination of marketing and consumer education, and integration of the labeling procedures, including the process and timing of setting performance levels and specifications, revising specifications, and testing and verifying performance. Current experience suggests that visual integration is desirable and important for success, as is coordination of marketing campaigns. Integration of the labeling procedures is a more complex question.

Close integration and coordination of processes has the advantages of simplicity and efficiency; however, if integration is too rigid, both labeling programs may suffer. Some flexible coordination of labeling procedures is beneficial and can enhance program efficiency and improve overall market-transformation effectiveness. The mechanics of visual integration and process coordination are discussed further in the following paragraphs.

Visual Integration

Comparison and endorsement labels may be integrated visually either by merging both labels into a single display or by "co-location" of both labels in the same general place on the product. Co-location is consistent with the fundamental marketing principle of making the message and consumer decision p rocess as simple and reinforcing as possible. Placing labels together side by side or in a well-designed, common format can help avoid confusion and make it easy for consumers to understand the information presented. Figure 5-7 shows the E.U. comparison label with an embedded Eco-label and the Australian comparison label combined with the Top Energy Saver Award (TESAW) endorsement label. Market research on label design (discussed in Section 5.3) should consider alternative arrangements of the two labels together as well as alternative designs to determine what options are most meaningful and least confusing for consumers. In a U.S. survey, researchers found that the location of the ENERGY STAR label within the overall layout of the comparison label can determine whether it creates confusion or increases understanding in the minds of consumers. Specifically, the study found that defining a discrete and consistent space for the ENERGY STAR label separate from the comparative and technical information of the U.S. EnergyGuide label was essential because: this practice limited confusion between the information contained in the two indicators individually and it was obvious that if the ENERGY STAR space was empty, the model did not qualify for the program. Figure 5-8 shows the label integration layout suggested by this study to be most effective. The study also found that when the message was conveyed by both labels within the same visual format, most consumers had a good understanding of it and further found the two to be mutually reinforcing (Thorne and Egan 2002b, Shugoll 1999).

Process Coordination

In deciding whether to combine endorsement and comparative labeling programs, it is important to understand the technical capacities, institutional arrangements, laws, and regulations already in place. For example, what is the best way to coordinate the activities of the lead institution(s) for labeling programs, the roles of other key players, and the objectives of different programs and institutions? For comparison labels, it is important to understand the legal/regulatory basis of the labeling requirement as this may limit flexibility for coordination. For example, the category levels and requirements for a comparison label may be directly linked in a legal/regulatory way to the energy-efficiency standard for a particular product, and this may have major impact on the process and timing of label revisions.

Poor integration risks "buyer confusion," potentially incompatible technical requirements, and unacceptable compliance costs and hassle for industry. It makes it difficult to "manage convergence" of energy and other resource-conservation efforts (e.g., water). Conversely, there is potential to increase the impact of all labeling systems by harmonizing their visual formats and streamlining supplier and administrative costs" (Marker et al. 2003). Good integration has the potential advantage of combining and simplifying each of the separate processes of developing the labels, including the processes of technical analysis and setting of levels, stakeholder consultation, testing and reporting, publication, and dissemination. This simplification can, on the one hand, reduce the burden on manufacturers, improve the efficiency of resource use by the government agencies involved, and result in a well-defined and easily understood program. On the other hand, overly rigid linkage of labels may sacrifice some of the potential benefits of the voluntary endorsement program. As discussed above, voluntary endorsement labeling programs allow for flexibility in setting and revising specifications in response to changing market conditions as well as in including non-energy-performance attributes that consumers may value as much as or more than energy. Voluntary endorsement programs also make it easier than is the case with mandatory labels for regulators to develop a constructive and collaborative relationship with industry and to promote a consistent message across a large number of products. Very tight or rigid linkage to a regulatory, mandatory comparison labeling process will almost certainly change the character of the voluntary program and can risk undermining its effectiveness.

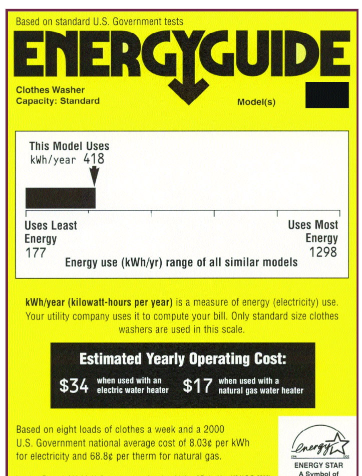


Figure 5-8 Recommended integration of ENERGY STAR logo into U.S. EnergyGuide Label

The placement of an endorsement logo within a comparison label affects its impact.

The objective should be to find the balance between integration and flexibility that works best in a specific situation. In the U.S., E.U., and Australia, officials set and update performance specifications for endorsement labels relatively independently from comparison labels. For continuous comparison labels (like those in the U.S. and Canada), the performance specifications for endorsement and comparison can be established and updated independently even though the two labels are combined visually and are based on the same testing protocols.

If both comparison and endorsement labels are employed, it is essential that energy-performance testing procedures be harmonized; that is, the required test procedure should be the same for both labels as should the minimum energy-performance standards (MEPS), if the latter exist for the particular product. Multiple procedures result in wasted time, extra paperwork, confusion, and unnecessary burden for industry and regulators. There may also be a need for testing of non-energy-performance attributes that may be specific to one label, particularly for endorsement labeling. If one or both labels have been in place for some time, careful consideration should be given to prior investment in and benefits achieved by these programs. An integrated labeling strategy should be designed to retain and build on existing market awareness among consumers. It is critically important to avoid confusing consumers with multiple or conflicting messages.

When the comparison label is categorical, as in Australia and the E.U., a complicated set of questions arises because of the need to match or coordinate the threshold levels for classes on the categorical label with the threshold level for the endorsement label. The difficulty arises from the different objectives of comparative and endorsement labels. The comparative label should be designed so that the label categories cover the range of efficiency levels on the market: some models should get low ratings, some should get middle ratings, and some should get high ratings. However, the endorsement label is designed to show the special status (i.e., "energy efficient") of the top tier of models in the market, usually the top 15–25% of models in terms of energy efficiency. Consumer understanding will be enhanced if the endorsement performance specification is set in relation to one or more of the category thresholds. Initially, for example, the endorsement specification may be set equal to the top (e.g., "A" or "5-star") category of the comparison label. Once in place, however, the two labels may need to be periodically evaluated and updated using independent but coordinated processes.

In Australia, the TESAW endorsement label is voluntary and updated once a year, but the comparative label is mandatory and likely to be updated only every five to 10 years. The TESAW label applies for a 14-month period from November of the prior year through the end of the year specified on the label. Specific performance requirements for a product may or may not change in a given year, but a new criteria document is issued, and manufacturers need to certify their products against the new document each year (AGO 2004). The categories of the comparative label are designed so that, when they are established or updated, there are few, if any models in the top categories. Over time, as the comparison label and other efficiency measures are successful in transforming the market, models will move up until eventually they will be bunched primarily into the top categories on the label. When the algorithm that establishes the values for the thresholds of each category is periodically revised, the categories shift up, and this moves currently highly rated models down into the lower categories. The Australian Greenhouse Office (AGO) and other stakeholders recognize that there is potential for consumers to become confused at points in the cycle when many models have high comparative ratings, and for the endorsement label to help consumers distinguish which models are actually the most efficient on the market. For this and other reasons, the endorsement label is seen as a valuable complement to the comparative label.

The E.U. documented the benefits of a somewhat similar strategy in which the energy criteria for the E.U. Eco-label were used to foreshadow when a model would qualify for the highest new categories (A+ and above), which had been approved for the comparison label for refrigerators but would not go into effect for several years. This strategy was intended to allow manufacturers of more-efficient models to continue to differentiate their models by qualifying for the Eco-label and at the same time to allow consumers to identify efficient products even though a large fraction of the market had become bunched in the highest energy label category (category "A" at that point in time) (Dolley 2004). However, as mentioned previously, manufacturers have not responded this way to any great extent.

In this process of combining comparative and endorsement labels, it is important to maintain a consistent meaning and message for each label. For endorsement labels in particular, the consumer impact is magnified if the label is consistently applied across a large number of products so that consumers see it frequently and increasingly recognize it and understand its meaning. It is also important that coordinated application of the endorsement and comparison labels is consistent with the broader meaning of the labels. That is, the endorsement label should retain its purpose of identifying the top-efficiency models on the market.

Other details may need to be adjusted when labeling programs are integrated, e.g., how are labels produced and by whom? In Australia, the E.U., and the U.S., manufacturers are provided with formats and images for both labels along with instructions for visual integration, and the labels are produced by the manufacturers. In the E.U., labeling is a two-stage process: manufacturers produce the images, but retailers insert the text in the appropriate language for the country of sale. There are no direct charges associated with the application of either type of label in these three countries.

However, in some developing countries, like China, manufacturers are charged a fee for use of the endorsement label to generate revenue for program operation (Liu and Li 2003). This can create a coordination issue when a new comparison label is introduced for a product that was previously only covered by an endorsement label. If the comparison label is mandatory, policy makers should take care to demonstrate clearly to manufacturers that the paid endorsement label program is not redundant.

Marketing and promotion campaigns should be coordinated to reflect integration of the labels. Enforcement and verification procedures as well as stakeholder consultation processes need to be coordinated in order to minimize duplication, confusion, and the burden of paperwork, without sacrificing the features that establish the separate identities of the two types of labeling programs.

5.2.5 Harmonization Considerations

The points raised in the three previous sections need to be tempered by consideration of the relation of any labeling programs to the markets of a country's trading partners. If products are compared using a category-type rating scale, such as stars, numbers, or letters, it is important to tailor the energy-efficiency algorithms to regional or national markets. Although it may be difficult, if not impossible, to translate an energy-rating system from one country to another, the benefits can be large.

Harmonization of the design and format of an energy label across countries is not necessarily recommended. In fact, given local cultural differences, it is unlikely that an energy label that is effective in one country will have the same impact in a neighboring country. As a general rule, it is important to adapt label design to facilitate communication and maximize consumer understanding. The Korean and Thai categorical labels are an example of the importance of cultural adaptation of labeling content and meaning; although these labels are quite similar in their numeric approach to rating energy consumption, the highest and most energy-efficient rating is a number "1" in Korea but a "5" in Thailand; these differing scales were chosen in response to survey results in the two countries. As previously noted, the European-style label was reversed in Iran to reflect the fact that the Persian language is read from right to left.

Within some trading regions, it may be worthwhile to consider harmonization and/or regional recognition of labels. The most prominent example is the European comparative label, which applies across all 25 European countries. Another type of regional energy label is now being developed for Southeast Asia, by the Association of Southeast Asian Nations (ASEAN). The programmatic details of the ASEAN endorsement label are being worked out. Initially, the label will be used to certify ballasts manufactured or sold in the ASEAN region that meet a threshold efficiency level. Later, the program may be expanded to include other products, such as refrigerators, electric motors, or air conditioners. (See insert: *The ASEAN Energy-Labeling Scheme.*)

5.3 Step L-2: Conduct Market Research to Design the Label(s)

After selecting products to label and the types of labels to use, the next step is to conduct market research on the label design (Step L-2 should proceed simultaneously with Step L-3, which is described in Section 5.4 below). Market research focuses on the following elements of the label: its visual design, the technical specifications that it will represent, non-energy attributes that might be included on it, and any details that will help in outreach/marketing campaigns.

No matter how meager or generous the resources are for market research, it is desirable to solicit views from a range of stakeholders. Appropriate involvement of key stakeholders can dramatically enhance public acceptance of the label, so it is essential early on to identify relevant stakeholders and form stakeholder decision groups. An inclusive process will ensure that some level of agreement about the "best" label design will be forged. Given that a good deal of money will likely be spent to develop, implement, and evaluate a labeling program, market research is a small investment to help ensure the program's success. It is generally useful for stakeholders to be involved during the market research through a committee or working group, so that they can review interim results and be consulted as the process moves forward.

Consumers are the primary users of the information presented on energy labels, so it is appropriate that labels should be designed to present information to them in as useful and accessible a manner as possible. It is difficult for policy makers to know, without consumer input, what label format and content will be most effective. As noted above, a label design that has been effective in one region and culture may not necessarily be effective in another. Market research is the only way to ensure that a label design is appropriate to a particular country context or target market.

To be effective market-transformation instruments, energy labels should be designed to affect not only consumers but also manufacturers and retailers. Market research with suppliers has a double benefit: it provides feedback on how the label design can influence suppliers, and, at the same time, it allows suppliers, with their firsthand, in-depth experience of marketing and selling the products, to provide input on how to influence consumers.

The ASEAN Energy-Labeling Scheme

The energy ministers of ASEAN have identified the development of an ASEAN regional energy-labeling program as a priority action needed to accelerate the rate of improvement in the energy efficiency of end-use equipment while avoiding the introduction of regional non-tariff trade barriers. The objective of developing an ASEAN regional energy-labeling program was adopted by the Senior Officials Meeting on Energy (SOME) in July 1999, and the ASEAN Energy Efficiency and Conservation Sub-Sector Network (EE&C-SSN) was given the mandate to develop and implement the program.

The ASEAN EE&C-SSN has organized a number of meetings to move the program forward, and they have agreed in principle that the ASEAN regional energy-labeling program will be implemented on a voluntary basis and the label will initially be an endorsement label. Six types of appliances and equipment are to be covered by the program: lighting products, fluorescent lamp ballasts, fans, air conditioners, refrigerators, and electric motors. Of these, fluorescent lamp ballasts were selected as the priority product. The EE&C-SSN is now developing a regional implementation master plan for fluorescent lamp ballasts, which will be a model for eventually expanding the program to cover other products on the list.

Source: AMI (Agra-Monenco International) 1999

The design of a label also needs to take into account the goals and concerns of policy makers who may wish to stress particular design elements to reflect policy goals.

Accordingly, the label design process should be based on market research that draws on input from all key stakeholders: consumers, manufacturers, retailers, and policy makers.

Data can be obtained from either primary sources generated by the project itself or from existing secondary sources, i.e., past market research or research from another country that can be applied to the current situation. Primary research collects new quantitative or qualitative information. Insights from secondary research can help inform primary research efforts; however, because label preferences may be quite subjective and may change across cultures, it is important to make sure that the secondary research is applicable to the current context.

At least some primary research should be done as part of every label design effort because, by relying solely on secondary data, policy designers run the risk of missing design nuances such as color preference and scale comprehension that are linked to specific cultural values, types of products/features available in the market, and prior energy-conservation messages in the country where the program is being implemented. For example, market research found that Chinese consumers much preferred energy consumption information in the units 'per day' rather than the units 'per year' that are used in Europe. Manufacturers had previously marketed refrigerator energy consumption in terms of kWh per day in China, so this was a familiar unit of measure for Chinese consumers (Waide et al. 2004). We cited other examples earlier in this chapter of differences in label design in Iran, Thailand, and Korea, which were dictated by different local perceptions.

5.3.1 Market Research for Visual Design

Market research on the design of the visual imagery and technical elements that will be included in the label can be either quantitative or qualitative. Quantitative research uses surveys of randomly selected samples of a particular population. Surveys can be done in person, by telephone, over the internet, or by mail. If sample sizes and compositions are representative, the results of quantitative surveys can be projected to the whole population from which the sample is drawn.

Qualitative research can include focus groups and one-on-one interviews. Focus groups are generally useful at the outset of label design efforts to gather broad feedback on the range of labels under consideration. The goal of a focus group is not so much to rank each initial candidate label design but to establish which elements of each label are likely to be successful and why. Focus groups can also be helpful as a last check before selecting the designs that will be tested in quantitative research. Consumer focus group research is a specialized discipline that requires professional expertise. It is common for program managers to hire a professional organization to design and conduct such research. Guidelines for focus group research are found in insert: *Guidelines for Focus Groups* (Egan et al. 2000).

One-on-one interviews are best utilized for testing comprehension and interpretation of the various labels under consideration as well as for identifying the reasons behind preference-related statements. Specifically, interviews illuminate the interpretation of elements in labels, the overall interpretation of each label, and the cause of difficulties in understanding the labels. Interviews reveal interpretive enhancements that can be incorporated in the label graphics (Egan et al. 2000).

Both focus groups and individual interviews shed light on in-depth views of key audiences for labels and are particularly useful for gathering responses to visual information to be used on labels and in marketing. However, because of the limited number of respondents generally involved in qualitative research, these studies should be regarded as exploratory and the results used to generate hypotheses for later verification using quantitative methods. The non-statistical nature of qualitative research means the results cannot be generalized to the greater population with a known level of statistical precision (Shugoll Research 1999).

Consumer research is best designed to follow an iterative process with the dual and contrasting aims of allowing the maximum number of design concepts to be explored at each stage and progressively narrowing down the sets of viable design concepts by successive exclusion of the least successful concepts. A multi-method design to elicit feedback from consumers, policy makers, manufacturers, and retailers is optimal. For example, Figure 5-9 shows the logic and approach that was used in research to design a comparative energy label for China (Waide et al. 2004).

An example of the benefit of market research using focus groups comes from Mexico. A study of the potential effectiveness of Mexico's comparative label tested the appeal of the existing label and various alternatives and consumers' understanding of the content. The study found that what was most

Guidelines for Focus Groups

- Select only locally based, experienced, native-speaking firms to arrange and moderate groups, in order to avoid reactivity to foreign, outside, or novice group leaders.
- Design a guideline for moderators that is comprehensive to ensure that sessions are conducted consistently (which facilitates comparison) and without leading of the responses (avoidance of bias).
- When possible, use state-of-the-art facilities including a one-way mirror for unobtrusive client observation and audio/video recording equipment for data gathering. The use of a one-way mirror, in combination with simultaneous translation, can permit international experts to watch for consistency in the moderation of the focus groups from one session to another.
- Consider demographics to determine effective socio-economic groupings (e.g., high education/income versus low education/income) and an appropriate geographic spread. If different groups are likely to react to energy labels differently by virtue of demographics alone (e.g., are women likely to have different reactions to energy labeling than men?), focus groups should be conducted separately because homogeneity of respondents is important for the success of focus groups. If separate groups are not possible and subgroup trends are observed, demographic data of interest should be collected for later breakdown.
- Screen participants to ensure that they are members of the target population and to avoid the accidental inclusion of participants with either specific technical knowledge of appliances and/or energy use or experience in market research.

Sources: Egan et al. 2000, Waide et al. 2004

Label design research deserves careful thought.

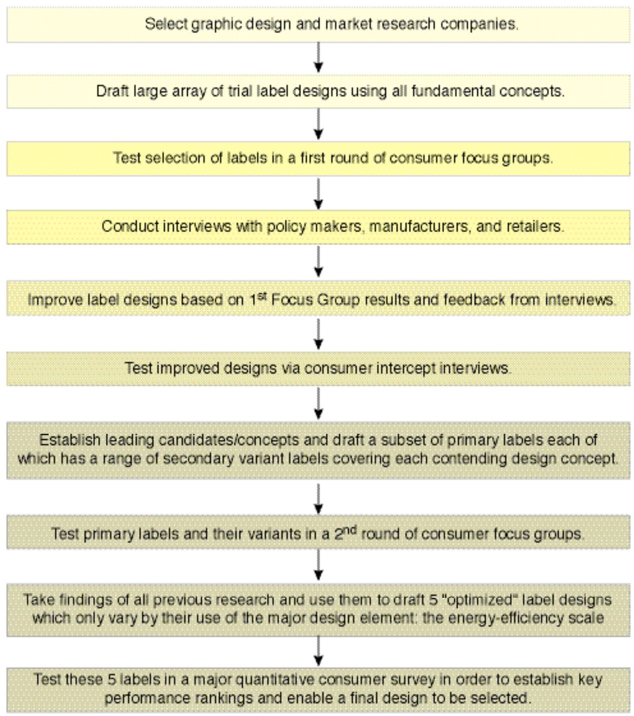


Figure 5-9 Label design research flowchart

appealing was not always best understood, as is shown clearly in Figure 5-10 (www.gdelta.com). Consumer understanding is discussed further in Section 7.5.6.

Another good example of using consumer research to develop an effective label design comes from India (see insert: *Research in India* on page 119). Researchers there used a phased approach that included both quantitative and qualitative research methods and involved not only consumers but also other key audiences (IRG 1999). The final label design was based on broad consensus among these various audiences.

Care must be taken to use best-practice research design methods in order to avoid bias in the results. For example, a well-documented problem is known as the "deference effect" in which participants bias their responses to please the interviewer (Bernard 1994). A 1991 Australian study showed that energy efficiency and operating costs ranked second in importance after unit capacity and that running costs and efficiency were reported as the most important attributes in the choice of a dishwasher. However, because the facilitators introduced themselves as energy researchers conducting a study on energy efficiency, these results must be viewed with skepticism; a response bias in favor of energy efficiency may well have been generated by the introduction (SEC Victoria 1991). Well-designed and professional research plans can be structured to avoid these problems.

Once market research is completed and all the issues noted above have been considered, recommendations must be reviewed following a specified process that leads to a final decision on the label format.

5.3.2 Market Research for Technical Specifications

In parallel with visual label-design research, it is important to gather data on the size of the market and the efficiency distribution of models sold as well as the cost and potential technologies for efficiency

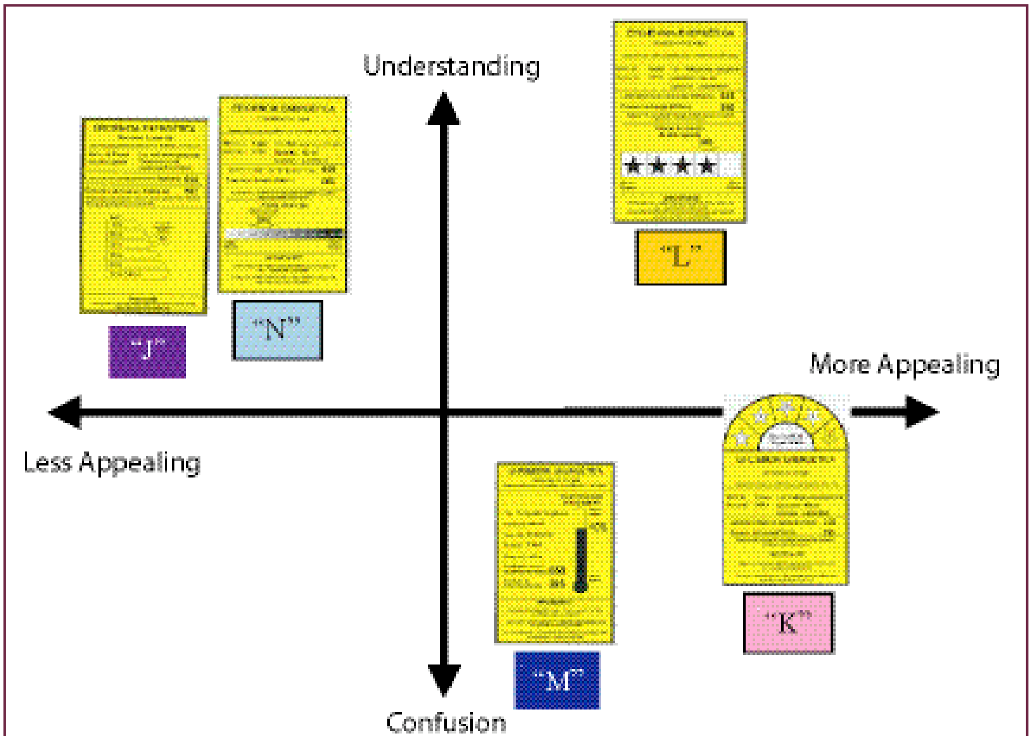


Figure 5-10 Focus group results of four finalist label designs in Mexico

Balancing appeal and consumer understanding can be a challenge.

improvements. These data are necessary to estimate the potential savings from the energy-labeling program.

Market analysis can rely on secondary data available from manufacturers, government statistics, and research firms. If resources are available, the program manager may hire a consultant to carry out new market research and analysis. It is important to have as much data as possible based on results of energy-performance testing in accredited laboratories (see Section 5.4 below). In addition, as noted above, it is advisable to have a process for regular consultation with stakeholders (see Section 5.1.4) and to use this process to assist in collecting market data and reviewing the market analysis, to ensure an accurate overview of market size and efficiency levels. The process of market analysis is described in Section 3.4 of Chapter 3.

Performance Specifications

A process for developing appropriate performance specifications is essential to ensure the effectiveness and credibility of the label over time. Performance levels should be based on the energy saved for each individual product, the cost effectiveness of the levels, and the acceptability to consumers of incremental costs. They should avoid performance levels that can be met by only one or very few manufacturers with proprietary technologies.

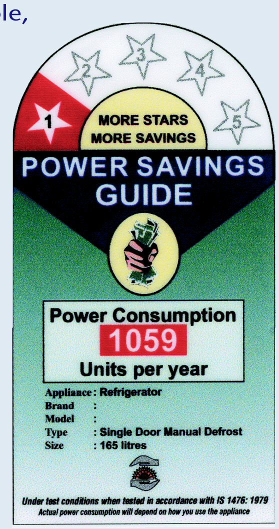
For countries developing their first label for a product, the process of creating workable, effective technical specifications can be considerably simplified by starting with specifications already published

Research In India

To understand India's diverse consumers and develop an appliance efficiency comparison label that would attract, persuade, and communicate clearly to those consumers, the U.S. Agency for International Development/India sponsored a three-phase, two-year consumer research project. Phase I, a baseline survey, set the stage for many decisions that followed, including whether or not label development should proceed. In-home interviews with 1,833 urban consumers in six major cities revealed that:

- Because of their penetration and brand homogeneity, refrigerators would be the best appliance for initial standards and labeling.
- Consumers could be reached through and would respond very positively to a labeling regime.
- The label design should appeal to both men and women because both were involved in buying decisions.
- Consumers did not connect energy efficiency to appliance purchases even though energy issues (e.g., shortages, quality) were of high concern to many consumers.
- For the labeling program to be effective, a strong marketing/information campaign would need to be coupled to it.
- Program planning should address consumers' distrust of appliance salespeople and resulting heavy reliance on manufacturers and word of mouth in appliance purchase decisions.

Phase 2 convened 10 qualitative consumer focus groups to test 17 different label designs constructed from existing successful label formats elsewhere, using design elements meant to appeal to Indian consumers. Consumers reviewed the options and selected the ones they found most understandable, appealing, and persuasive. The groups also "constructed their own favorite label" from the individual label elements. Despite the many label formats and elements, much consensus emerged. Consumers favored and best understood two label types, one using stars as the rating scale and one using a single-bar, sliding scale. Participants also identified many specific likes and dislikes.



Phase 3 consisted of a focus group to factor the opinions of key government and appliance industry experts into the label development process and a quantitative survey of 673 consumers who were placed in a buying context. Consumers rated four "final" labels for their appeal, comprehensibility, and persuasiveness. Although all four labels scored high, some differences in these three areas resulted in the recommendation of the label shown here.

Source: IRG 1999

in other countries for the same product. Such specifications should not be adopted wholesale but can often be adapted to fit the distribution of products in the host countries and to accommodate other specific conditions in the particular country. The CLASP website (www.clasponline.org) and the Asia Pacific Economic Cooperation (APEC) Energy Standards Information System (ESIS) website (www.APEC-ESIS.org) offer easy access to a wide range of national programs and specifications, searchable by product.

Specifications for *continuous comparison labels* (like those used in the U.S. and Canada) require the least analysis to establish technical requirements. Key components of the analysis include specifying product size and performance classes (e.g. the size of the refrigerator, and features such as automatic ice making), compiling the energy-performance information for all products of a class, and specifying the end points of the range for each product. The labeling requirements specify the product classes and ranges and the procedure for calculating the performance of each model. The manufacturer is then required to produce the label and indicate where the product falls in this range. (For an example of this type of specification, see the U.S. Federal Trade Commission website instructions for the U.S. Energy Guide label—www.ftc.gov/appliances).

Technical specifications for *categorical comparison labels* involve more complicated analysis and decisions. In addition to analysis similar to that described above for continuous labels, establishing categorical comparison labels requires that product distribution data be analyzed to develop the threshold values for each category. It is also necessary to perform engineering analysis of potential technical improvements in efficiency and costs. The category thresholds are normally expressed either as percentages above or below a weighted average of the market or as actual energy-performance values. The thresholds can define uniform steps or steps of different sizes depending on the product distribution and the overall objectives of the program. In the E.U., for example, categories for cold appliances were established with a fairly even distribution, based on the policy objective of encouraging improvements in efficiency during subsequent years and the requirement that products not yet available in the market should fall into the highest efficiency class if they used the best available technology. The categories were specified as an algorithm with percentages above and below the average value for each model class. When the label was introduced in 1994, there were almost no available models in the best-performance class (A), but a detailed engineering analysis had shown that is was quite possible for manufacturers to produce class-A products (Lebot et al. 2001). The Australian label appliance-rating categories also reflect an ambitious approach; when they are updated, the most efficient products are generally rated at only 3 or 4 stars although the most-efficient category (5 stars) is determined to be achievable based on engineering analysis (See www.energyrating.gov.au).

For *endorsement labels*, a detailed analysis is needed to establish the performance threshold for a high-efficiency portion of the market, commonly the top 10–25 %. The intent is usually to reflect current market conditions and to update the threshold frequently as the market shifts toward greater efficiency over time. The U.S. ENERGY STAR program provides an example of the process of developing performance specifications for endorsement labeling (McWhinney et al. 2004). This multi-step process includes early consultation with manufacturers and engineering analysis to determine the:

- energy-performance distribution of models currently in the market
- technical potential for efficiency improvements
- national energy saving estimates for alternative proposed efficiency levels
- time needed to introduce product design changes
- potential technical barriers
- cost effectiveness of technical improvements

Based on the analysis, draft specifications are developed and additional consultations are held with manufacturers, other stakeholders, and independent technical experts before final specifications are issued. The program staff works in close cooperation with interested industry partners during the collection of the necessary engineering, technical, and market data; during the process of review and comment on the analysis; and in drafting the specifications themselves.

Often, the process of consumer research and consultation with manufacturers, retailers, and other experts identifies *non-energy-performance features* that are more important than energy performance in consumer choices. It may be necessary to include these other performance measures and their test procedures in the technical specification. For example, the color and other qualities of light or the delay in start-up for some fluorescent bulbs may be critical for consumer acceptance of lighting products. Cleanliness, noise, and time per wash may be greater determinants of the desirability of a clothes washer than energy performance. If some manufacturers were to meet energy requirements at the expense of these features, consumers might be dissatisfied, which would undermine the credibility of the entire labeling program. This is especially important for endorsement labeling because the linkage of energy efficiency with high quality is a key message in marketing labeled products (McWhinney et al. 2004).

It is also sometimes necessary to specify these additional performance measures for categorical comparison labels, as in the E.U. label for clothes washers, which includes an A through G rating for washing performance (Lebot et al. 2001). The establishment of a set of categories for other performance attributes is quite complicated and is therefore less extensively applied in comparison labeling than in endorsement labeling.

Production and Placement Specifications

Many well-established labeling programs provide formats and label requirements to manufacturers but rely on manufacturers to print and attach labels before products are shipped to market. The specifications include detailed instructions for the appearance and content of the label as well as its placement on the product. These instructions are available on program websites such as the Australian Greenhouse Office site (www.energyrating.gov.au) and the U.S. ENERGY STAR site (www.energystar.gov/).

In the E.U., the process of producing and affixing labels is complicated by the need to accommodate many languages in the different member countries. As noted earlier, the label is created in two parts, with manufacturers required to produce the portion that contains technical and rating information in numeric and visual form shipped with the product. The balance of the label is provided by retailers in the appropriate language; retailers are also responsible for ensuring that labels are placed on products in the required position.

5.4 Step L-3: Customize a Testing Program for Labels

Because Step L-3, customizing a testing program for labels, and Step L-2, market research (described in the previous section) explore and amplify similar information, they should proceed simultaneously.

A labeling program is unlikely to be effective without an appropriate testing program. Energy-performance testing is discussed in detail in Chapter 4. In this section, we briefly discuss testing issues related specifically to designing and implementing a labeling program.

Initiating a testing program requires access to competent government or private testing laboratories, which should be accredited and/or certified to ensure accuracy of and confidence in the test results. Accreditation is especially necessary when in-country testing laboratories are not available. Such acceptance also eliminates duplicate testing and thus reduces the cost of importing goods. Accreditation of testing laboratories and mutual recognition agreements can be important and are discussed in Chapters 3, 4, and 8.

Once a system for energy-performance testing is in place, the results of initial testing of a sample of products can be used to:

- characterize the range of efficiency of models sold in the market
- estimate the potential savings from the labeling program
- form the basis for developing the label categories
- provide the energy-performance results used to label each product

5.4.1 Design of the Testing Program

Tests must verify all the important information on the label. The test data required for an energy-labeling program should at a minimum include three essential elements:

- **Energy consumption.** The metric of energy consumption will be shown on the comparative energy label or provide the threshold for qualifying a product for an endorsement label. For example, the test might specify energy use per day, per hour, per month, or per cycle.

- **Performance.** A description of other measurements or separate tests that must be performed to establish the product's capacity (e.g., kilowatts of cooling capacity for air conditioners, liters of internal volume for refrigerators) or function/performance (e.g., a washing and drying index for dishwashers). If other non-energy-performance features such as washing performance or quality of light are to be included in the label specifications, testing protocols for these features must be included.
- **Tolerance.** Rules specified by regulators to ensure that values reported by tests are within acceptable error bands and to provide for retesting and resolving any apparent differences in results.

There is a range of approaches to publishing the rules that govern product testing. Some tests and rules may be published by a country's standards-setting agency, as references to standards from an international agency such as the International Standards Organization (ISO) or International Electrotechnical Commission (IEC). Alternatively, lawmakers or regulators in any country may publish all energy-related requirements, from the test procedure to the requirements for energy labeling, in an official government regulation.

In practice, there is a continuum, and the approach differs in every country. Experience suggests that if large volumes of technical requirements are embedded within regulations, these requirements can be difficult to change and keep up to date. A second problem with extensive reliance on regulations is that often the people responsible for writing regulations, usually lawyers, are not experts in energy efficiency, so drafting errors can be common unless the text is carefully verified.

There are also cases in which a number of states, provinces, or countries have separate laws and regulations but implement a common labeling program (e.g., the Australian states, Canadian provinces, and European countries). In cases like these, it is preferable to have technical requirements referenced to a single source (e.g., a national or international standard) rather than replicating copies of the requirements in numerous separate acts or local legislation.

5.4.2 Product Registration and Test Reports

Requirements for the certification of test results for energy labeling vary. Certification often but not always involves some form of registration or filing of test reports. Many countries, including Europe, the U.S. and Australia, allow manufacturers to self-certify their products. Self-certification only works, however, if the regulatory agency can effectively monitor and enforce compliance. The cost of a testing and certification program depends directly on how stringent the process is, but the total costs associated with product testing for an energy-labeling program are relatively small in comparison to the total costs of product manufacture although the costs of testing for products exported to multiple countries with differing test requirements can significantly reduce manufacturers' profit margins.

In some countries (e.g., Australia), manufacturers have to submit test reports for approval of an energy label for a product. These reports are usually submitted as part of the process of product registration. An alternative approach, used by the E.U., is to require manufacturers to retain copies of formal test reports until manufacturing of the model has ceased (or, more commonly, for a period of some years after manufacturing has ceased). The manufacturer is usually required to produce these test reports only if there is a question regarding the validity of the label claims. Although this approach reduces the government's administrative costs for the program, it makes verifying declared performance difficult. It also makes it difficult to track products on the market and to ensure ongoing monitoring of the compliance and accuracy of the information on labeled products.

In Thailand, registration of test results is done by the DSM Office at EGAT, and all products must be tested at a government-certified laboratory. An advantage to this approach is that the DSM Office now has a complete database of all products labeled since labeling programs began in 1996, and they can easily review the data to analyze trends and track improvements in energy performance over time.

5.5 Step L-4: Implement the Program

Once a labeling program is designed, it is important to have a clear plan for implementing the program, including rules and guidelines, marketing and promotion, compliance and enforcement, and regular revision of technical specifications.

5.5.1 Establish and Announce Regulations and Procedures

At the program outset, it is important to develop an action or implementation plan covering all aspects of the program. The plan does not need to be long, but it should specify the main implementation steps and identify which agencies are primarily responsible for each step. In general, the main steps include:

- consulting with stakeholders to agree on roles
- securing budget and resources for program implementation
- finalizing technical specifications for the program
- announcing technical specifications to stakeholders
- drafting step-by-step guidelines for the program, including timing of implementation
- consulting with stakeholders on draft program guidelines
- finalizing and disseminating program guidelines and implementation schedule
- initiating program implementation

5.5.2 Program Marketing and Promotion

Placement of an energy label on a product is only the first step in attempting to influence consumers' purchase decisions. Research has shown that education and media promotion, e.g., newspaper, magazine, radio or television ads, are valuable aids in making a label effective. A number of related measures within a program increase the effectiveness of an energy label, including:

- retailer support for the program (hostile retailers can neutralize the impact of labels)
- government promotion of the program (e.g., frequent public-service announcements and annual efficiency awards)
- publication of lists of current models on the market (e.g., a brochure and an internet site that are easily accessible)
- point-of-sale information and support

Promotional marketing is most effective when consumers receive numerous, consistent messages regarding energy efficiency, not just as part of the energy-labeling program but also in other, related energy programs that may be running in parallel. Repeated messages reinforce a culture of energy efficiency among consumers and industry and help to create an energy-efficiency ethic within the country.

Often the most important promotion and marketing efforts are carried out by some of the other energy-efficiency programs described in Chapter 10. For example, China's refrigerator labels are being promoted in a larger refrigerator market-transformation project that includes a variety of stakeholder activities and consumer communication. Chapter 7 describes in more detail the techniques for successful label marketing and outreach.

5.5.3 Compliance and Enforcement

For a labeling program to be truly effective, it must be credible to consumers, manufacturers, and other stakeholders. A mechanism is needed to ensure that manufacturers, distributors, and retailers comply. For a mandatory labeling program, it is usually necessary to establish a policing and enforcement scheme to detect instances in which labels are not displayed on products. Violation of the labeling requirement must be penalized to discourage continued noncompliance.

Compliance is important with any type of label—endorsement, or mandatory or voluntary comparison—though the mechanisms and penalties may be quite different. The voluntary U.S. ENERGY STAR program, for example, relies heavily on stakeholders to check compliance and bring problems to the attention of the program managers. It also carries out "check testing," periodically buying a random sample of appliance models from stores and testing them in independent laboratories. The primary penalty for noncompliance is to remove the label from the manufacturer; information about the removal is posted on the ENERGY STAR website. Because the program is voluntary and manufacturers are choosing to participate, they usually try to resolve problems to avoid label withdrawal. The withdrawal of a label has occurred only rarely during the 12-year history of the program.

If an energy-labeling program is to be credible to the public, it is necessary to ensure that claims made on any energy label are reasonable and accurate. This requires verification of claims about capacity, performance, and energy consumption, as applicable, through independent testing. In a competitive market, much of this policing can be undertaken by competing manufacturers. Detailed discussion of policing and enforcement can be found in Chapter 8.

5.6 Program Monitoring, Evaluation, and Revision

Monitoring is an ongoing process of providing timely and regular information about the progress of a labeling program, and *evaluation* assesses the effectiveness of a label, usually at the end of a program. Regular *revision* of technical specifications and label designs is also an important element of a program.

5.6.1 Monitoring vs. Evaluation

Monitoring tracks key data and indicators and acts as an "early warning system" for problems. By contrast, evaluation is not ongoing but is carried out at a discrete point in time, usually at the completion of the project, and usually entails comparison with a baseline that was established at the beginning of the project. For multi-year projects, evaluation may also be performed as a mid-term review. Evaluations take longer than monitoring and go into depth to understand causes and effects (Danish Management A/S et al. 2001).

5.6.2 Monitoring Strategy

From the outset, the program management team should establish a system for tracking and monitoring key program data. The monitoring system should provide results-oriented information and report its findings in a user-friendly and timely manner to the main stakeholders.

It is important for the implementing agency to discuss and agree on a set of program indicators by which the agency measures its progress toward achieving its goals and, ultimately, measures program success. Some tracking indicators for a labeling program for a particular product could include:

- number of label applications and percent increase/decrease from previous period
- number of manufacturers participating in labeling program and percent increase/decrease from previous period
- number of labeled models currently in market as percent of all models sold and percent increase/decrease from previous period
- number of labeled units currently labeled in market as percent of all units sold and percent increase/decrease from previous period
- percent of labeled units in each label category and increase/decrease from previous period
- average efficiency of all labeled models in market and percent increase/decrease from previous period
- percent of check-tested models that pass/fail and increase/decrease from previous period

The best way to make a monitoring system transparent is to make it web-based, with access provided to program staff and consultants as needed. For example, program staff and consultants might have access to raw data on test results, label registrations, market estimates, and check-test results while the public website might show regular updates of the number of models labeled, average efficiency of models labeled, trends in efficiency levels in the market, etc.

Chapter 9 addresses the basics of program evaluation. The discussion below treats aspects of program monitoring and evaluation that are specific to labels.

5.6.3 Evaluation Approaches

To assess whether an energy label is effective, a policy maker can ask the following basic questions:

- Are consumers and retail sales staff aware of the label, and does it grab their attention in a retail environment?
- Do they understand the label and make correct conclusions about the energy efficiency of models depicted?
- Do they find the label credible and interesting or otherwise have a positive reaction to the label's appearance and technical content?
- Do they state a willingness because of the label to purchase more-energy-efficient appliances than they would have otherwise?
- Do they change their behavior and/or purchase more-energy-efficient appliances?
- Are manufacturers influenced to produce more-efficient products by the labels or by consumer reactions to the labels?

Measuring Awareness, Understanding, and Impact

Label awareness is commonly used as a proxy measure of label effectiveness. However, awareness surveys do not provide useful information about consumer understanding or decision making. In addition, awareness surveys require careful construction. Simple exercises such as showing a label and asking study participants if they have seen such an information tool before have been shown to yield inflated results. Open-ended questions that ask study participants what energy indicators they use or see in a retail context typically yield more conservative results. Such "unaided" questions should precede any "aided" questions that display the target label. This will indicate a range of results, with the unaided measure usually reflecting the likely lowest level of awareness and the aided measure the likely highest level.

Consumer understanding is more difficult to measure than awareness and requires a mixture of research techniques, including in-person interviews and surveys. The important variables to measure are the relative importance of the label (compared to other features of the appliance) in the purchase decision, how well consumers understand the label's central message and its individual elements, the extent to which consumers' conclusions and/or take-away messages reflect the actual product performance, the amount of time required to respond to and understand the label (particularly the likelihood that this amount of time would be committed in an actual rather than experimental buying environment), and the degree to which consumers recall the label's key elements.

Analysts and program managers often fail to measure the most important label impact: whether the label can be linked to consumer decisions to purchase more efficient appliances. This effect can be assessed by surveying consumers to see whether those who are aware of the label rely on it to select efficient products. The effect on purchase decisions can also be assessed broadly by tracing shipment-weighted average efficiencies in the market and attempting to correlate changes over time with the introduction and characteristics of a labeling program.

Most previous evaluations of energy-labeling programs have shown a high level of consumer awareness of labels. Generally, awareness tends to increase during the life of the labeling program, and the vast majority of shoppers are aware of labels after they have visited stores to make purchases.

Evaluations have found that simple, uncluttered label designs with related information grouped and delineated by outlines or shading are the most effective for conveying information about energy efficiency. These evaluations have used focus groups, interviews with consumers and salespeople, and laboratory tests designed to measure consumers' understanding of different label designs. Some studies suggest that categorical comparison labels tend to be more readily understood by consumers than continuous comparison labels (Thorne and Egan 2002b, Egan et al. 2000, and du Pont 1998). However, a recent Canadian impact analysis (Tiedemann et al. 2003) found that the Canadian EnerGuide continuous label was quite effective in influencing consumer choices and improving energy efficiency of products in the market.

Ways of Evaluating Labeling Programs

There are two main types of evaluation of labeling programs: process evaluation and impact evaluation. These are covered in detail in Chapter 9. Below, we summarize the main elements of each type of evaluation.

Process Evaluation

Process evaluations are often qualitative in nature and measure how well a program is functioning. Although process elements are sometimes seen as relatively unimportant by policy makers, these elements are critical to the implementation and success of a program. Process elements include:

- assessing consumer's priorities in purchasing an appliance
- tracking consumer awareness levels
- monitoring correct display or application of the label in retail settings
- valuating administrative efficiency (e.g., registration times etc.)
- checking and verifying manufacturer claims (maintaining program credibility) and label application procedures
- documenting the range and equivalent cost of the supplemental resources that stakeholders outside the implementing agency (e.g., NGOs, industry, retailers) have contributed to the labeling process

Impact Evaluation

Impact evaluations assess the energy and environmental effects of a labeling program. Impact data can also be used to determine cost effectiveness and can assist in stock modeling and end-use (bottom up) forecasting of future trends. Impact elements include:

- influence of the label on purchase decisions
- tracking of sales-weighted efficiency trends
- determining energy and demand savings

Impacts can be very difficult to determine accurately, especially for a labeling program because labeling programs, unlike standards programs, have no prescribed efficiency improvement. One of the fundamental problems is that, once an energy-labeling program has been in place for a period of time, determining a "base case" against which to compare the program impact becomes increasingly difficult. Furthermore, labeling programs usually exist along with standards programs, and separation of the impacts of the two is extremely costly and difficult. (One approach to the evaluation of some elements of a labeling program can be found in Webber et al. 2000, 2003, and 2004). In general, it is safest to evaluate and report the combined impact of the labels and standards rather than to attempt separate attribution.

5.6.4 Regular Revision of Technical Specifications and Label Design

Test procedures need to be periodically revised to accommodate changes in any related international test procedures and to address new products and technologies that come onto the market and may not be adequately addressed by the published testing method, as described previously in Chapter 3 and in Section 5.4. Likewise, the technical specifications, such as the acceptance threshold for an endorsement label, require the same considerations described in Section 5.3.2.

However, revision of the categories of a categorical comparison label and changes in the label format require special attention because they are readily noticeable to the consumer. Some special considerations for this revision process are described below.

Revising Classes on a Categorical Comparison Label

When a label has been in the market for a few years (or sometimes even less time), the products offered by manufacturers will likely cluster in the higher efficiency levels. When this happens, the cutoff for the classes that define categorical comparison labels needs to be incrementally adjusted ("ratcheted") upward. As mentioned in Section 5.2.2, this can be accomplished by changing the cut-off criteria for the existing categories or by defining new categories. Defining new categories can be controversial because the results will be noticeable to the public and the redefinition affects manufacturers whose model designs and marketing programs may have been tailored to the current label rating scheme. These concerns were especially important when the E.U. label was revised; this revision process offers some useful lessons for a label program manger (see insert: *The A+/A++ Controversy*).

Updating the Label Format

It is important to periodically evaluate the label design to determine whether it is well understood by consumers and is affecting consumer decision making. Australia, Thailand, Korea, and the U.S. are in various stages of redesigning their appliance energy labels. The experiences of some of these efforts to date suggest that label redesign offers an opportunity for significant improvement in program effectiveness after a label has been in use for several years.

The Australian government is finalizing the first update of its 14-year-old appliance energy-labeling scheme, partly in response to the introduction of mandatory MEPS for certain appliances that will render the current efficiency-rating system obsolete. The Australian scheme was one of the first in which a categorical energy label was revised and the efficiency categories "ratcheted" upward. In addition, regulations have been formulated to promote harmonized implementation of the program, and

The A+/A++ Controversy

In 1999-2000, the European Commission funded a major technical and policy assessment of cold appliances (refrigerators and freezers). Two objectives of the study were to analyze and propose a revision of the existing energy label and potentially propose new MEPS in order to take into account: 1) the observed market transformation, 2) a new life-cycle cost assessment, and 3) other factors, such as industrial impacts. This study concluded that a regrading of the A to G label thresholds was appropriate, the new A class should be 45% more efficient than the existing A class, and the new G class should be between the current C and D levels (reflecting that most products worse than class C are prohibited from sale by the MEPS that came into effect in 1999) (ADEME and PW Consulting 2000).

Despite the recommendations of the study, European suppliers of cold appliances negotiated a different route with the E.U. Energy Labeling Regulatory Committee (ELRC) and the European Commission, proposing the introduction of two more categories (A+ and A++) in addition to the existing ones and a voluntary agreement in place of MEPS for cold appliances. This proposal was accepted but was viewed by many delegations to the ELRC as a temporary solution. The revised European label, which was launched in 2003, maintains the colored A to G format on the left side, and the A+ and A++ ratings are displayed on the white column on the right side of the label (see Figure 5-3). Industry also made a unilateral commitment to phase out class-C or lower efficiency appliances by 2004 and to attain a production-weighted efficiency average of slightly better than the current class A by 2006.

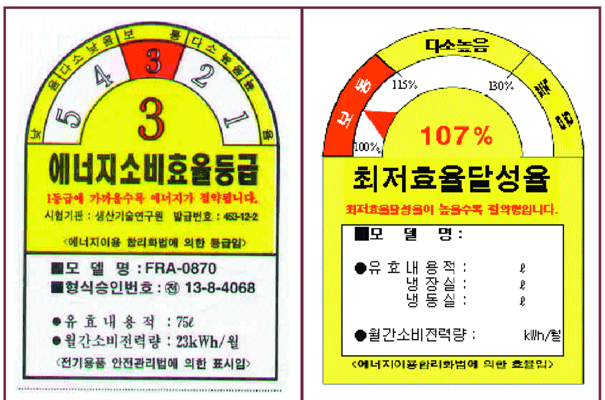
In 2002, European manufacturers also requested the introduction of a new A+ category for clothes washers, but this was ultimately rejected by the ELRC and the European Commission, largely because the A+ approach adopted for refrigerators was seen as a temporary measure in advance of a more holistic revision of the existing labeling scheme.

Australian national test standards (known as "Australian Standards") have been modified to conform to labels and efficiency-standards requirements. These actions are part of a broader set of measures aimed at reducing greenhouse emissions and energy use.

As part of the labeling review, market researchers were commissioned to benchmark consumer understanding and acceptance of the current energy label. The response was clear and strong: the label in its current form was well liked and had a high degree of credibility. It quickly became clear that there was a substantial amount of investment in the current label in terms of consumer understanding and image recognition, so the label redesign transformed into an attempt to improve how the label communicates to consumers. A number of new designs were tested with a series of focus groups. It was found that the basic design was well recognized, but there were areas where information could be more clearly presented. There were also calls for limited amounts of additional information, such as a website to provide further information and the inclusion of water consumption data for products that use water. The new label (see Figure 5-3 on page 94) is similar to the old label in color and appearance, but the design is simplified, and the font sizes and text positions are clearer, to facilitate consumer understanding. There was also a conscious decision to visually separate the star rating at the top of the label (the part most commonly used by consumers) from the more technical data at the bottom of the label (energy, capacity, and so on) to make the label as friendly as possible (Appliance Efficiency 1999, Artcraft Research 1998).

The Thai DSM Office decided to recalibrate its label in 2001 after 85-90% of all single-door refrigerators models clustered in the top ("5") category. The categories were ratcheted up by one level and a "2001" watermark was placed on the label background to differentiate it from the previous label.

The Korean government has redesigned its 12-year-old refrigerator, air-conditioner, and rice-cooker labels (see Figure 5-11). The Korean energy-efficiency labeling program rates each particular model (or type of product) on a five-level scale of efficiency with level 1 representing the highest energy efficiency. Labels must be affixed on all products and must provide information on energy consumption, determined in accordance with test standards. The program also requires that energy consumption information be displayed on any technical material associated with the sale of the products. The labeling is mandatory and helps consumers take energy efficiency into consideration when making purchase decisions.



Old refrigerator label

New refrigerator label

Figure 5-11 Korea label redesign

Korea has redesigned its refrigerator label.

Korea also has mandatory energy-efficiency standards. It recently upgraded its MEPS for refrigerators, air conditioners, and rice cookers because the market no longer showed product discrimination: more than 90% of models qualified as level 1 or 2. The new MEPS level for a refrigerator is now almost the same as old level 2. The Korean government took this opportunity to redesign the label as well. Instead of five levels of performance, the label now features the percentage, on a continuous-scale dial, by which the model is better than the minimum standard.

In the U.S., recent research has shown that the EnergyGuide label (shown in Figure 5-3 on page 94) is not well understood by a majority of consumers. In response, the American Council for an Energy-Efficient Economy (ACEEE) is leading a multi-task, interdisciplinary research effort to document how U.S. consumers perceive and use the current EnergyGuide label and to explore options for improving the label design by building on successful label designs elsewhere in the world. The project focuses on products currently covered by the Federal Trade Commission's EnergyGuide label program, including white goods, water heaters, and, to a lesser degree, heating and cooling equipment. The task force is conducting primary and secondary research along with extensive stakeholder outreach. The goal of this project is to develop an EnergyGuide label that the vast majority of consumers can easily understand, that provides motivating and comprehensible information on appliance efficiency, and that positively impacts the consideration of energy efficiency in consumer appliance purchase decisions. The project includes two major activities: research and communications (Thorne and Egan 2002 a, Egan et al. 2000, BPA 1987, Carswell et al. 1989, and du Pont 1998).

International experience in the field of energy labeling is growing rapidly in all aspects—program design, implementation, evaluation, enforcement, and redesign of labels. This chapter is intended as a beginning guide for officials or advocates considering or starting to implement a program. The websites, authors, agencies, and other resources mentioned in this chapter should provide the most current information to readers as they implement, maintain, and refine their labeling programs. Programs work best if all products are labeled and if consumers can easily distinguish between poor-, average-, higher-, and highest-efficiency products.

6. Analyzing and Setting Standards

Guidebook Prescriptions for Analyzing Standards

1. Plan a continuous process over a period of years with an opportunity for updates.
2. Prepare to negotiate. Develop a process for involving stakeholders (manufacturers, distributors, retailers, consumers, environmental organizations, and energy suppliers), for identifying their concerns, and for addressing those concerns.
3. Establish an objective research team. Have the members gather information from diverse sources.
4. Thoroughly document assumptions, methods, and results for review.
5. Use the information collected to characterize current and potential markets and technologies.
6. Construct a base case and several alternative policy scenarios.
7. Select among existing analysis methodologies. Customize methods whenever appropriate.
8. Estimate impacts of possible policies on consumers, manufacturers, energy suppliers, the national economy, and the environment. Use quantitative estimates of observable impacts as much as possible, supplemented by qualitative analysis.
9. Consider uncertainty explicitly, including estimating maximum and minimum impacts and distribution of impacts among diverse populations and identifying the most important assumptions that influence the policy impacts.
10. Eliminate untenable policy options. Repeat the analyses to account for comments from reviewers. Support efforts to build consensus.

6.1 Establishing a Technical and Economic Basis for Standards

A transparent and robust analysis of the impacts of energy-efficiency standards can greatly aid in the regulation or negotiation of those standards. Key decisions for the analyst include the products to be analyzed, the analysis method to be used, and the criteria to be used for evaluating energy performance. It is essential to document all assumptions, methods, and results, and it is extremely beneficial to include an open process of review and consultation with stakeholders.

An analysis estimates the potential impacts of policies and the uncertainties in the estimate. The purpose of the analysis is to provide sufficient information to decision makers to enable good decisions and discourage bad ones. An analysis is successful if it is accepted by all parties, including advocates of regulation, regulated industries, and government agencies, as a reasonable estimate of likely impacts. The analysis may include:

- documentation and assessment of available information (quality, quantity/coverage, applicability)
- collection of new data
- synthesis and analysis of information from diverse sources, including model building and consistency checks
- importance analysis to determine which assumptions are the key factors
- scenario analysis to account for alternative assumptions or different possible future conditions
- uncertainty analysis to establish confidence in the policy

Policy makers interested in implementing minimum energy-performance standards (MEPS) generally require analyses performed by disinterested parties to assess the impacts of alternative policies. The stakeholders (all interested parties) in a standards proceeding also look to third-party analyses to focus their supportive or critical comments.

This chapter describes some of the methods that have been developed to select efficiency levels and to analyze the energy, economic, and environmental impacts of alternative efficiency standards. Two main approaches to carrying out analyses, statistical and engineering/economic, are discussed in detail. The actual approach or combination of approaches chosen by a country depends on the resources and time available to policy makers and also on the quality and quantity of the data that can be obtained for specific appliances or equipment.

For any analysis approach, the level of detail can range from simple estimates to detailed probabilistic analysis. Simple analysis is almost always a useful first step. The subsequent level of analytical detail depends upon availability of data and the needs of the program. If the existing products in the market are relatively inefficient, simple analysis may be sufficient to justify efficiency increases. If the market is already relatively efficient or the market or policy atmosphere is sufficiently complex and the resources are available, additional analysis may be warranted or even necessary to set standards.

One caution noted in Chapter 2 is especially important when designing mandatory standards: poorly designed or executed standards can actually harm consumers, manufacturers, other stakeholders, and the overall economy and the environment. Inattention to detail in the development and implementation of a standard can have especially devastating impacts on poor consumers or small manufacturers. Poorly designed standards can cause overinvestment in energy efficiency, which results in consumers paying, on average, more for a product than they will recover in utility bill savings. This note of caution is worth remembering when applying the material that follows.

6.1.1 Types of Efficiency Standards

This section describes three types of energy-efficiency standards:

- prescriptive standards
- MEPS
- class-average standards

any of which could be either mandatory or voluntary.

Prescriptive standards require a particular feature or device to be installed in all new products. For example, the U.S. government required that new gas-fired clothes dryers not use standing pilot lights from January 1987 on. Determining compliance is simplest for prescriptive standards because it requires only inspection of the product.

Performance standards prescribe minimum efficiencies (or maximum energy consumption) in all products manufactured after a certain date. For example, some refrigerator standards require that each unit use no more than a maximum amount of energy per year (kWh/a) under test conditions. These standards specify the energy performance but not the technology or design specifications of the energy-efficient product. Generally, a technical analysis supports the cost effectiveness of achieving prescribed efficiency levels. In the case of a statistical analysis, required levels are usually met by models already on the market. In the case of an engineering / economic analysis, efficiency levels are generally set that are shown to be achievable using available designs known to be cost effective, but these options are not the only possibilities for achieving an efficiency goal. Performance standards therefore permit innovation and competing designs. Assessing compliance with performance standards requires establishment of a well-defined test procedure and verification process (see Chapter 4).

Standards can also be based on the average efficiency of a class of manufactured products in a year. This approach has been used in the U.S. for automobile fuel efficiency and in Japan for several products where a sales weighted average efficiency must be achieved or exceeded by each manufacturer. A sales-weighted average takes into account the market share of models of varying efficiency to achieve a targeted gain in overall energy savings rather than specifying the efficiency of each unit. The sales-weighted approach can be particularly useful to promote a leap in technology (e.g., from electric-resistance storage water heaters to heat-pump water heaters) because sales of a very efficient product can dramatically reduce the sales-weighted average energy use. Class-average standards require more record keeping than other approaches, however, and verifying compliance is more difficult. Nonetheless, this type of standard allows manufacturers more flexibility in meeting the goal of improving energy efficiency than do the other types. Unlike the first two types, class-average standards require that manufacturers or governments implement methods to induce consumers to purchase enough of the higher energy-efficiency product to meet the sales-weighted average efficiency goal. (See insert: *Performance or Class-Average Standards?* on next page.)

Performance or Class-Average Standards?

Heat-pump electric storage water heaters, CFLs, and condensing furnaces are three examples of products whose energy efficiencies are far higher than those of conventional products. U.S. DOE's 1994 proposal of an electric storage water heater MEPS initially required use of a new technology, the heat-pump water heater (U.S. DOE 1994). What ensued illustrates the limitations of performance standards and the usefulness of class-average standards.

There were two problems with a step transition to the heat-pump water-heater MEPS. First, few heat-pump water heaters were being manufactured, and their first cost was relatively high (at least twice that of electric-storage-type water heaters with electric resistance heating). The reality is that a mature market with high-quality, reliable products is difficult to create in a few years' time, and the necessary infrastructure of trained installers and service technicians might not be put in place rapidly. The second problem was that consumers in some parts of the country (with lower electricity prices, colder ambient temperatures, and lower hot water use) might not recover, through decreased operating costs, the increased purchase price of this more expensive product. After hearing all the arguments, U.S. DOE set a performance standard that did not require heat-pump water heaters and instead set the standard at the efficiency of the best conventional units.

One solution in this case would have been to recommend set class-average standards. Class-average standards could have required a sales-weighted average efficiency higher than that of the then-current conventional technology but lower than that of the heat-pump technology, instead of requiring all models to meet the same MEPS. The sales-weighted average would have to have been met by a set date. This alternative approach would have encouraged a more rapid phase-in because a fixed fraction of production capacity would have been required to meet the new standards. This approach would have offered the opportunity for consumer acceptance of the new technology to build gradually but steadily.

The appliance efficiency standards of most of North America and many other nations (e.g., China, Australia) are in the form of mandatory MEPS. Some countries (e.g., Japan, Germany, and Switzerland) have instituted voluntary or target levels rather than mandatory efficiency standards. Voluntary agreements are usually worked as a consensus between the government and manufacturers. In some cases, (e.g., Switzerland), manufacturers are given a set time period to reach the voluntary standard, and, if they do not comply, the regulatory agency can substitute mandatory standards.

6.1.2 The Process of Analyzing and Setting Standards

The steps in analyzing and negotiating standards are shown in Figure 6-1 and discussed in sections 6.2 through 6.8.

Table 6-1 on pages 138–139 outlines the analytical elements of the standards development process. The elements of priority setting, initial-product (design-option) screening, engineering review, and economic

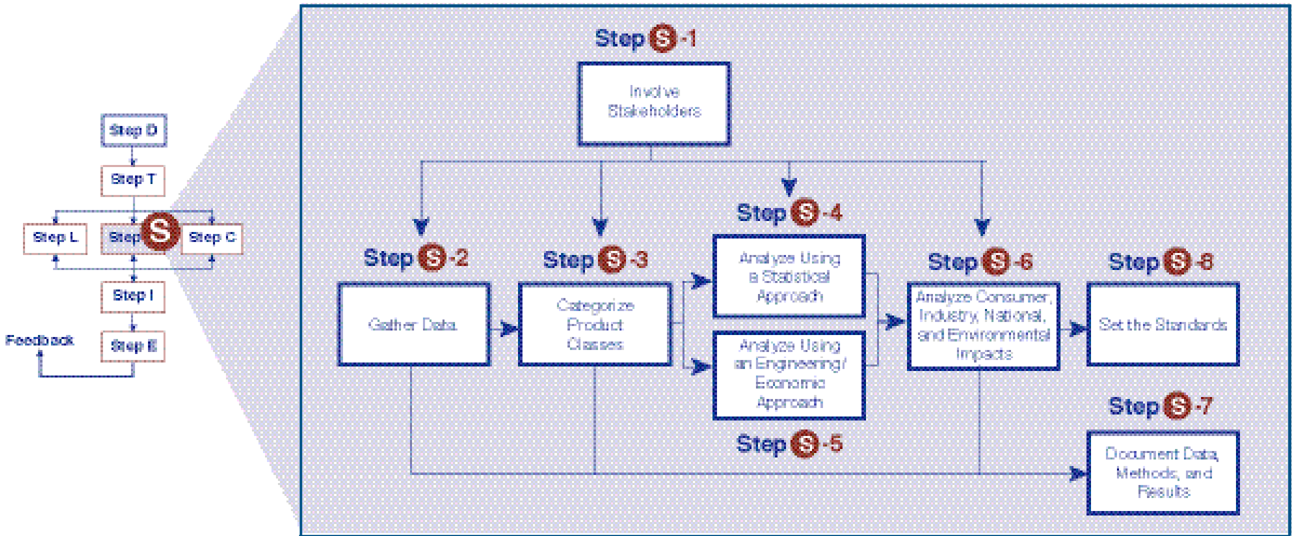


Figure 6-1 Major steps in analyzing and setting standards

impact review are generally applicable. The second element, initial product screening, will differ according to whether an engineering/economic or statistical standards-setting approach is used.

The analytical process is not a one-time-only exercise. Standards are updated periodically to keep current with local, regional, or international technology and market and economic trends. Thus, the priority-setting step may be undertaken frequently, i.e., every year or two. The other steps are generally done every four or five years, depending on technology trends and product development cycles. It is very important that the standards revision process is rigorously scheduled so that manufacturers are kept aware of the need for continued efficiency improvement and have time to adjust.

6.1.3 Types of Analysis

This section describes the two most widely used analytical approaches for standards setting:

- statistical analysis of current products
- engineering/economic analysis of potential technologies

These approaches can be used in combination and are not mutually exclusive. They can also be used with other approaches; one example of a third approach, used in Japan, is to establish standards according to recommendations of a group of industry and government participants relying less on analysis and more on expert knowledge of the marketplace and available technologies for a particular product. No single method is best for establishing a standard in all circumstances. The best approach or combination of approaches may differ with appliance type, policy goals, and local conditions, including data availability.

Most approaches begin with a data-collection phase, followed by an analysis phase and then the standards-setting process. Analytical approaches range from simple estimates based on limited data to

Table 6-1 **Analytical Elements of U.S. Standards-Setting Process, as Revised in 1996**

Stages, Primary Inputs (•), and Outputs (⇒)	Factors Considered
PRIORITY SETTING • Preliminary Analysis • Stakeholder Consultation on Draft Agenda ⇒ Regulatory Agenda—annual publication of rule-making priorities and accompanying analysis and schedules for all priority rule makings anticipated within the upcoming two years	• Potential energy savings • Potential economic benefits and costs • Potential environmental and energy security benefits • Applicable rule-making deadlines • Incremental government resources required to complete the rule making • Other regulatory actions affecting products • Stakeholder recommendations • Evidence of energy-efficiency gains in the market in the absence of new or revised standards • Status of required changes to test procedures • Other relevant factors
DESIGN-OPTION SCREENING • Expert and Stakeholder Consultation ⇒ Identification of product categories and design options to be analyzed further or to be eliminated from further consideration ⇒ Identification of key issues and expertise necessary to conduct further analysis ⇒ Identification of any needed modifications to test procedures	• Technological feasibility • Practicability of manufacture, installation, and service • Adverse impacts on product utility or availability • Adverse impacts on health or safety (Note: initial criteria for screening according to these factors are written directly into the rules, e.g., design options not incorporated in commercial products or in working prototypes will not be considered further nor shall design options having significant adverse impacts on the utility of the product to significant subgroups of consumers.)

continued on next page

statistical analysis of the energy efficiencies of currently available products to engineering analysis of possible future designs. Key outputs from the analysis include many factors representing costs and benefits that must be considered; projected energy savings and associated environmental consequences; economic costs and savings to subsets of consumers; and investment and employment impacts on manufacturers, energy suppliers, and the general economy. Economic indicators can include cost of conserved energy (CCE), average payback period, consumer life-cycle costs (LCCs), manufacturer or industry cash flow, and national expenditures.

Different standards-setting methods have been successful in achieving their objectives—new or revised efficiency standards—in different settings and at different times. Analyses have been used to forecast the impact of efficiency standards on consumers, manufacturers, utilities, and the environment. These projections have been used to compare options and to quantify uncertainties. In most cases, decision makers have used these data to implement effective policies.

Statistical Analysis of Currently Available Products

The statistical approach is most appropriate where products with a wide range of efficiencies are already available, and the goal is eliminating the least efficient products. The statistical approach

Extensive analysis is prescribed in the U.S. standards-setting process.

Stages, Primary Inputs (•), and Outputs (⇒)	Factors Considered
ENGINEERING REVIEW • Engineering Analysis—to establish the likely cost and energy performance of each design option or efficiency level • Expert and Stakeholder Consultation ⇒ Candidate Standards—Advance Notice of Proposed Rule (ANOPR) that specifies a range of candidate standards but does not propose a particular standard ⇒ Technical Support Document (TSD)	Excluding design options that do not meet the screening criteria or that have payback periods greater than the average life of the product, the candidate standards levels will typically include: • the most energy-efficient combination of design options, • the combination of design options with the lowest life-cycle cost, • the combination of design options with a payback period of not more than three years, and • other options to provide a more continuous range of opportunities.
ECONOMIC IMPACT REVIEW • Economic Impact Analysis—impacts on manufacturers, consumers, competition, utilities, non-regulatory approaches, environment and energy security, and the national energy, economic, and employment situation • Public Comments and Stakeholder Negotiation • Stakeholder Review ⇒ Proposed Standards—Notice of Proposed Rule (NOPR) ⇒ TSD	• A high priority is placed on consensus stakeholder recommendations and supporting analysis. • Principles for the analysis of the impacts on manufacturers (in terms of costs, sales, net cash flow, etc.) and consumers (in terms of product availability, first costs, payback period, etc.) are written directly into the rules. • Analytical assumptions are specified for cross-cutting factors, such as economic growth, energy prices, discount rates, and product-specific energy-efficiency trends in the absence of new standards.
STANDARDS SETTING • Final Public Comments and Stakeholder Negotiation ⇒ Final Standards ⇒ TSD	Standards must meet statutory requirements to be: • technologically feasible and economically justified, • likely to result in significant energy conservation, • unlikely to result in the unavailability of any covered product type with performance characteristics, features, sizes, capacities, and volumes generally available in the U.S., • unlikely to cause substantial increase in consumer costs, and • unlikely to create an anti-competitive environment.

requires data that may be easier to obtain than the engineering/economic approach, but it typically results in standards that are restricted to efficiency levels within the range of already available products. The data required are those that characterize the current marketplace for the products of interest, in terms of the number of models available in each efficiency range. Data can be collected for the national market only or can include products available on the international market. The impact of possible efficiency standards is expressed in terms of the percentage of available models that would be eliminated by requiring a particular efficiency and the number of manufacturers producing these models. The energy savings can be estimated from the change in average efficiency before and after standards.

The statistical approach avoids the need for cost data from appliance manufacturers or suppliers (these data are often very difficult to obtain for reasons of confidentiality) and for a representative survey of retail prices, which may be difficult or costly to obtain. The statistical approach also has political advantages because it avoids explicitly disclosing the cost of compliance. On the other hand, by masking the costs, it prevents economic optimization of the program and therefore may result in either an overly costly investment in efficiency or a lost opportunity to achieve more cost-effective efficiency improvements through standards.

Statistical analysis of current products is discussed in more detail in Section 6.5. The statistical approach has been utilized in the European Union (EU) (Group for Efficient Appliances 1993) and in Australia (Wilkenfeld 1993). In Japan, the Ministry of International Trade and Industry (MITI) has used statistical data to define minimum energy-efficiency targets for several products, including refrigerators, televisions, and air conditioners. This "Top Runner" program requires the future sales-weighted average of any brand of appliance sold on the Japanese market to meet efficiency thresholds set at or above the level of the most efficient products on the market at the time the legislation was announced (Murakoshi and Nakagami 1999).

Engineering/Economic Analysis of Potential Technologies

Engineering/economic analysis seeks to determine the full range of potential energy-efficiency improvements and their costs. In contrast to the statistical approach, the engineering/economic approach has the significant advantage of determining the energy savings and cost effectiveness of a wide range of designs even if the technologies are not yet available in mass production. Because it requires estimates of the efficiency and costs of new designs not yet widely marketed, this adds some uncertainty and may be subject to challenge by stakeholders opposed to stringent standards.

The engineering/economic approach allows for a great deal of policy flexibility. For instance, policy makers can choose an option that minimizes overall consumer costs or an option that maximizes energy savings but is still cost effective. The economic analysis associated with this approach addresses the impact of standards on consumers, including LCC and payback period calculations. It can also include impacts on national or regional energy use, manufacturers, and electric or gas utilities. In general, however, this type of analysis is more expensive and time-consuming than a statistical analysis. If resources are limited, there is a recently developed spreadsheet tool that can estimate potential energy savings and financial impacts based either on user-supplied or default engineering and market parameters built into the model. The more country-specific data that are used, the more accurate the results, but estimates are possible with very limited data (see insert: *The Policy Analysis Modeling System for Simplified Engineering Analysis*). Section 6.6 describes engineering/economic analysis in more detail.

6.2 Step S-1: Involve Stakeholders

Experience from many countries has shown that effective standards programs are difficult to establish without stakeholder involvement. At a minimum, the principal stakeholders—manufacturers, consumers, utilities, local governments, and environmental or energy-efficiency interest groups—should

The Policy Analysis Modeling System for Simplified Engineering Analysis

The Policy Analysis Modeling System (PAMS) is a spreadsheet tool developed by LBNL for CLASP. PAMS estimates the following potential energy savings and financial impacts resulting from government energy labeling or minimum efficiency standards, based on user-supplied or default engineering and market parameters:

- Life Cycle Cost Savings—Financial savings to each consumer (household or commercial enterprise) for each product purchased, calculated over the product's lifetime (described in Section 6.7.1)
- National Energy Savings—Primary (source) energy savings (described in Section 6.7.3),
- Net Present Value—National financial impacts (described in Section 6.7.3)
- Greenhouse Gas Emissions Reduction—Based on source energy savings and forecast of electricity generation mix (described in Section 6.7.5)

The model is sophisticated in that it allows either for input of relevant detailed data or, when obtaining these data is difficult or prohibitively expensive, for an estimate based on data from other countries. Macro-economic forecasting is built into the model using engineering data from countries other than the target country; market trends are forecast based on well-established econometric methods coupled with publicly available economic data.

The tool also provides the user with the option to manually input country-specific field data to take into account the particular characteristics of product markets and economic scenarios. Inputting the country-specific data listed in Table 6-2 can greatly increase confidence in the model's results, increasing the usefulness of the tool for determining the direction of labeling or standards policy. Collecting the data listed as "recommended" requires moderate effort and significantly improves the accuracy of the model. Providing "suggested" data increases confidence in the results, but these data may require significant effort to collect.

PAMS generates forecasts for one country and one appliance at a time. The model is capable of creating a general picture of impacts with a minimum investment of local resources.

be represented. Including representatives from importers and international organizations, where applicable, is useful to ensure that programs are feasible internationally. To avoid the perception of favoritism, the government must ensure that all stakeholder interests are fairly represented.

Furthermore, there must be an open and transparent process through all steps of the standards-setting process for these stakeholders to contribute information and raise concerns and for the implementing agency to receive and process these contributions. By this means, the implementing agency can obtain technical support in the form of data and review of analytical methods and results. Generally, stakeholder contributions are incorporated through public meetings or invitations to provide written comments. Including stakeholders in the analytical stages of the standards development process can engender a spirit of trust among stakeholders, thus increasing the likelihood of the program's success. Responding to stakeholder comments and adapting proposed standards to reflect the most relevant stakeholder input helps accomplish this trust and can even lead to negotiated consensus standards. Negotiations among

Process for Stakeholder Involvement

Stakeholder discontent with the standards revision process in the U.S. led to extensive reform of the process in 1996. The general findings of the process improvement exercise are applicable elsewhere. The exercise involved many stakeholders, manufacturers, and environmental public interest groups deliberating issues of planning, input and analysis, and decision making. The major objectives of the new rules fall into three categories:

Procedural—provide for early input from stakeholders; increase the predictability of the rule-making timetable; reduce the time and cost of developing standards.

Analytic—increase the use of outside expertise; eliminate less feasible design options early in the process; conduct thorough analyses of impacts; use transparent and robust analytical methods.

Interpretive—fully consider non-regulatory approaches; articulate policies to guide the selection of standards; support efforts to build consensus on standards.

The U.S. process rule is Title 10. United States Code. Section 430.34. The rule with a brief description can be found at: www.eere.energy.gov/buildings/appliance_standards/get_involved.html

The process has led to several consensus rules. To show the complexity of such consensus building, here is the list of the signatories to the recent consensus rule for commercial air conditioners and heat pumps:

Air-Conditioning and Refrigeration Institute, Arlington, VA
American Council for an Energy-Efficient Economy, Washington, DC
Aaon Heating and Cooling Products Tulsa, OK
Alliance to Save Energy, Washington, DC
Appliance Standards Awareness Project, Boston, MA
Armstrong Air Conditioning Inc., Bellevue, OH
California Energy Commission, Sacramento, CA
Carrier, Farmington, CT
Daikin, New York, NY
Lennox International Inc., Dallas, TX
Mammoth, Inc., Chaska, MN
McQuay International, Minneapolis, MN
Natural Resources Defense Council, San Francisco, CA
Nordyne Inc., O’Fallon, MO
Northeast Energy Efficiency Partnerships, Lexington, MA
Rheem Manufacturing Company, Fort Smith, AR
Sanyo Fisher (USA) Corp., Chatsworth, CA
Trane/American Standard, Tyler, TX
York International, York, PA

stakeholders are a standard element of Japan's and Australia's standards-setting processes and led to consensus standards for refrigerators, clothes washers, and fluorescent lamp ballasts in the U.S.'s sometimes adversarial regulatory environment. Once trust is established, it is easier to conduct good-faith negotiations, concentrating on issues of legitimate disagreement (Thompson 2003) (see insert: *Process for Stakeholder Involvement*).

The purpose of analysis is to create a sound basis for the government's policy choices, to detail the technical information and assumptions underlying those choices, and to quantify the likely impacts of policies. Analysis gives the regulating agency the necessary basis for decision making, informs regulated parties (appliance manufacturers and importers) about the government's understanding of the factors related to regulation, and advises all stakeholders (including regulated parties, environmental advocates, energy providers, and consumers) of the likely impacts of proposed regulations. The analysis process focuses attention on a limited range of policy options and creates a transparent, public basis for discussion and debate.

Typically, most of the research on the impacts of standards is conducted under the sponsorship of the government agency that is responsible for setting the standards. Frequently, however, the technical team performing the analysis is independent of the implementing agency, e.g., a private contractor or academic institution.

The implementing agency has a fundamental interest in the quality of the analysis as high-quality analysis will ensure a well-informed decision leading to economically optimum standards levels. The analysis may also have a role to fill in satisfying specific statutory requirements, e.g., requirements that standards do not unduly burden consumers or that they provide at least minimum benefits. Regulators overseeing the standards process must insure that the technical analysis is robust and thorough enough to avoid unintended negative consequences, without exceeding budgets and deadlines and thereby reducing the effectiveness of the program. The analysis should also be clear and definitive, to allow for open and fair resolution of disputes that arise among stakeholders. As with any policy, it is difficult to totally eliminate uncertainty and arrive at a unique, scientifically defensible conclusion. However, demonstrating that the likely impacts are favorable and politically supportable for a range of plausible future scenarios is generally sufficient.

At every stage, the usefulness and feasibility of international cooperation should be assessed. In the best case, international experience can usefully be duplicated. Often, because of the integration of the market on a regional or even global scale, regulators in different jurisdictions are working with the same multinational companies or their subsidiaries.

6.2.1 Appliance Manufacturers and Importers

Energy-efficiency regulations limit the set of products that may legally be produced or imported. Manufacturers and importers are directly impacted by these regulations that can increase the costs of doing business. Standards must be technologically achievable and affordable and should preserve adequate competition among manufacturers. Manufacturers and industry experts have valuable information about production costs and market structure. Some manufacturers oppose government regulations as unwarranted or ineffective interference in markets or as barriers to trade, but most manufacturers have a practical attitude about the authority of governments to impose standards if the standards are perceived to be fair.

Depending on the degree of competition in the market and the strategic positions of each company, including the structure of distribution channels, the impacts of a regulation vary, potentially impacting some manufacturers more than others. Policies must be applied uniformly without favoritism and the implementation schedule must allow manufacturers sufficient time to adapt. Standards are most cost effective when they are timed so that marginal increases in investment are minimized, for example by coordination with normal investment cycles or with investments required to meet other regulations. Manufacturers' and importers' interests may be partially served by analysis that:

- demonstrates technological or market solutions to the challenge of improving energy efficiency (e.g., performance standards permit different companies to adopt different technological solutions)
- fairly considers manufacturers' and importers' increased costs
- estimates the effect on total volume and value of future sales
- considers the effects of competition on regulated parties

As an example of the first point, the Thai government worked with Thai refrigerator manufacturers to develop and test prototypes that could meet or exceed proposed standards.

Stakeholder involvement is also valuable in establishing a schedule for standards development, compliance, and updates. One reason is that industrial stakeholders will push to synchronize the program with product and process development cycles. This synchronization lowers the overall cost of the standards program because efficiency improvements made during routine product changes have lower marginal costs and can be more readily accommodated by manufacturers. This timing is particularly important where other government agencies are imposing regulations affecting the products. For example, making a design change that simultaneously achieves both improvement in energy efficiency and elimination of ozone-depleting chemicals (e.g., refrigerants or insulation blowing agents) is less expensive than making two uncoordinated design changes. Manufacturers' and importers' interests may be partially served by scheduling that:

- recognizes the need for sufficient lead time between deciding on a new standard and the effective date (typically 3 to 5 years)
- takes into consideration the cumulative regulatory burden affecting manufacturers from other non-related regulations (e.g., refrigerant phase-out)

Although the benefits of synchronizing the timing of standards-driven product changes with the timing of changes driven by other factors can be significant, different manufacturers will generally have different timing preferences (a possible exception is the example cited above of the synchronization of response to two regulatory drivers). This difference in product and process life-cycle timing is one of the reasons for variability in the impact of regulations on manufacturers, which contributes to there being winners and losers as a result of regulatory actions.

6.2.2 Consumers

Consumer groups may generally be interested in ensuring that government regulations are not overly burdensome to those who purchase energy-consuming products. They may also be concerned about overly strong standards that raise the price of appliances or about overly weak standards that don't result in sufficient savings on utility bills. Analysis of payback periods (included in LCC analyses) illustrates these tradeoffs and helps identify policies that will have net benefit for consumers. Other elements of the analysis that may be important to consumers include: consideration of different impacts among consumers based on the energy prices they pay and their actual appliance usage (which may differ from laboratory or test procedure conditions), possible impacts on the service provided (the utility to the consumer) by a product as a result of design changes, and possible shifts to competing technologies (e.g., switching between electricity- and gas-fueled storage water heaters).

6.2.3 Energy Providers

Energy-efficiency standards reduce energy consumption, which may reduce the need for new energy supply or make more new supply available for other applications. Governments involved in planning and investing in both energy supply and energy demand have an opportunity to use energy-efficiency standards to reduce overall system costs. In some cases, fuel competition (e.g., between electricity and natural gas for space heating or water heating) may be an important concern to energy suppliers. The analysis of impacts can address likely market shares by fuel type. Private energy providers may be affected by reduced demand among regulated end uses. The analyses that accompany energy-efficiency regulations typically benefit both utility planners and private energy providers by reducing uncertainty about future demand.

6.2.4 Environmental Advocates

When energy-efficiency standards reduce combustion of fossil fuels, they not only reduce energy consumption but also associated environmental emissions such as CO_2, oxides of sulfur and nitrogen, mercury, and particulates. Environmental advocates will be especially interested in the magnitude of these impacts. Other environmental factors subject to analysis include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and other alternative refrigerants or insulation blowing agents. There may be tradeoffs between reducing ozone-depleting chemicals and reducing global warming potential; for example, eliminating ozone-depleting chemicals (such as replacing CFCs as blowing agents for insulation) may lead to less effective insulation and therefore higher energy consumption and associated carbon emissions. Past analyses have identified solutions that both protect the ozone layer and simultaneously improve energy efficiency (e.g., choosing alternative insulation for refrigerators in consideration of the 1993 U.S. standards).

6.3 Step Ⓢ-2: Gather Data and Forecast Input Parameters

The information needed to perform an analysis of standards depends on the method used to establish standards, or, for governments with limited resources, on the information that is readily available. To select products for analysis, it is necessary to understand the market structure, including the manufacturers, importers, and distributors.

6.3.1 Effect of Data Availability on Selection of Analytical Method

Figure 6-2 is a schematic diagram showing the decision logic for analyzing standards depending on what data are available. We have already briefly described the statistical and engineering analysis methods. More data are needed for the engineering analysis than for the statistical analysis. In some developing countries, there will not be enough available information to utilize either of these methods, so a simplified method will be needed.

An example later in this section (in the sub-section on end-use metering) describes a situation in China in which a moderate amount of information was available but not enough to perform even a statistical analysis. Statistical data on efficiency or energy use by model number are difficult to obtain unless test procedures and energy-use or efficiency labels have been in effect for some time. Without labels, it is still possible to collect (or request that manufacturers provide) energy use or efficiency data for each model produced (or imported) if government or manufacturers are familiar with an existing test procedure and have testing laboratories available to them. Statistical data on efficiency by model are also needed for a thorough engineering/economic analysis, to establish baseline models.

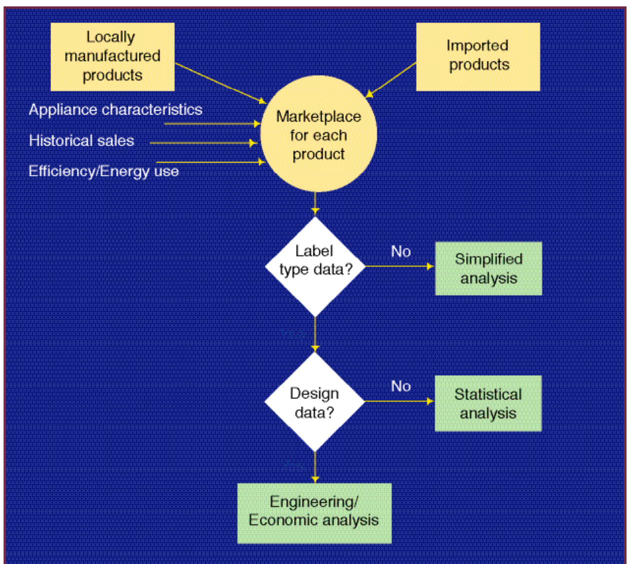


Figure 6-2 Decision tree for choosing appliance standards analysis method

The analytical approach to standards-setting depends on data availability.

6.3.2 Deciding What Data to Collect

Enough data should be collected to estimate roughly the percentage of sectoral (residential or commercial) energy use that is accounted for by each major end use. Examples of end uses are refrigerators, water heaters, air conditioners, lighting equipment, and televisions. An end-use analysis allows policy makers to select the products that offer the greatest potential for energy savings from efficiency standards. The products contributing the most to the growth in energy demand should be considered for standards; these may be products with high unit energy consumption (UEC) or products that show high unit sales and are gaining in ownership.

The analytical approach to standards-setting depends on data availability.

Table 6-2 Data Needs for a Complete Appliance Standards Analysis

Economic Data	Market Data	Engineering Data	Energy Sector Data
Recommended	**Recommended**	**Recommended**	**Recommended**
• Electricity (or natural gas) tariff schedule for residential or commercial customers (as applicable)* • Residential or commercial consumer discount rates (as applicable) • Societal discount rate	• Market Structure: manufacturers, importers, and distribution channels • Average retail price of appliance baseline model* • Percent of households or commercial buildings that have each major energy-using product* • Historical time series of annual shipments of each class of product* • Relative market share of product classes • Share of contribution of imports to total shipments	• Annual UEC for existing models of each class of product* • Annual UEC for more efficient models (or technologies) of each class of product* • Average product lifetime* • Retail price increase associated with higher efficiency	• Conversion factor from site electricity to source energy • Electricity generation fuel mix*
	Suggested	**Suggested**	**Suggested**
	• 10–to 20-year forecast of annual product shipments* • 10–to 20-year forecast of product price trends* • Share of product shipments by efficiency level • Manufacturer, distributor, and retailer price markups*	• Relationship of manufacturer cost to design efficiency* • Energy consumption test data as collected by regulating agency or other certifying entity	• 10–to 20-year electricity-generation carbon factor forecast • 10–to 20-year electricity-generation nitrogen oxide (NO_X) and sulfur oxide (SO_X) factor forecast

*In the absence of these data, PAMS provides a default value or an estimate based on macro-economic trends.

If information on the technologies available for improving the efficiency of each product is available, the potential energy savings from these improvements should be estimated. Some products may represent a larger percentage of national energy use, but their energy savings potential could be smaller than that of another, less efficient product. Section 6.1.3 describes a simplified method for estimating energy, economic, and greenhouse gas savings when sufficient data are unavailable for the more sophisticated analyses. Although that approach may be used with almost no country-specific data, the more data collected and used, the more accurate the results will be. The type of data that energy analysts would, ideally, like to have to thoroughly analyze appliance energy-efficiency standards are listed in Table 6-2, with the data requirements for the simplified tool indicated.

Although collecting data can be difficult, approximate information is often better than none at all. To collect enough information for analysis, it is often necessary to search out many different sources of information, sometimes partial or incomplete and sometimes derived. Because even official or well-accepted data can be inaccurate, analysts should address important information needs through several independent approaches to identify where good agreement is found and where large uncertainty indicates the need for additional data collection or analysis.

Energy Consumption Surveys

Performing a survey of energy-consuming appliances in households and commercial enterprises often provides a useful basis for characterizing market and use patterns. This survey may be done explicitly as part of the standards-setting process. If program resources do not allow for a survey, information may often be obtained from utilities or government statistics agencies, which perform related surveys for different purposes. The most obvious and readily obtainable information provided by an energy consumption survey is the current and historical ownership of each type of equipment. The relative market share of particular product classes (e.g., single vs. two-door refrigerators) and fuel types (e.g., electric vs. gas water heaters) can also be revealed by a survey. A detailed survey can give a rough estimate of the use patterns of certain appliances although this type of questioning can significantly lengthen the interview time and is dependent on the respondent's willingness and ability to accurately characterize energy consumption habits. Finally, survey data related to appliance brand and model can be correlated to manufacturer data to characterize the market in terms of appliance capacity and efficiency. However, this level of detailed information is often quite difficult to obtain.

The following prescriptions apply to the collection of survey data:

- The survey should focus on equipment that has a high ownership rate or rapid growth in ownership, and uses a significant amount of energy.
- Care should be taken to make sure the survey sample is representative of the country as a whole.
- The benefits of collecting as much data as possible should be balanced with the cost and burden to consumers of a lengthy interview.
- Surveyors should be adequately trained to collect data as accurately as possible, with minimum inconvenience to the interviewee.

The 1995 survey results presented in Figure 6-3 show that the largest electricity users in urban China were refrigerators and televisions. In order to decide which appliances to consider for standards analysis, it was necessary to evaluate possible technological efficiency improvements for each appliance type. Based on the extent of energy consumed and the potential efficiency improvements for each product known in 1995, China modified its efficiency standards for refrigerators and room air conditioners. Using updated survey data, China has since modified its standards for refrigerators a total of three times (effective in 2000, 2003, and 2007). Efficiency standards for room air conditioners were revised in 2001 and 2004. A revised efficiency standard for clothes washers took effect in 2004 as well. A new standard has also been proposed for televisions that will regulate both standby and active power consumption. For lighting products, efficiency standards were announced for compact fluorescent lamps (CFLs) and linear fluorescent lamps in 2003. Incandescent bulbs are still the dominant light source used in Chinese residences, so the greatest savings in residential lighting are likely to come from switching from incandescent lamps to CFLs.

Household surveys show relative use of different appliances.

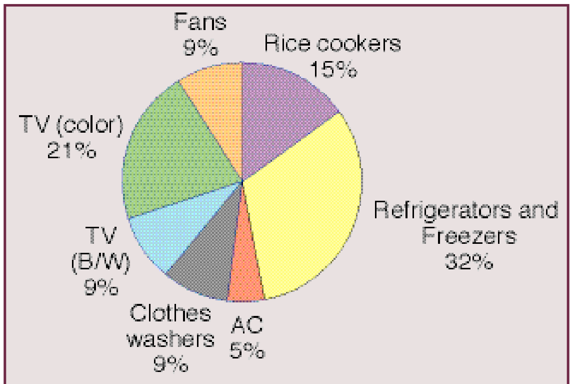


Figure 6-3 End-use electricity consumption (1995) in China households (lighting electricity consumption excluded)

Laboratory Measurements

Laboratory measurements for energy consumption of appliances are most useful if a well-defined test procedure has already been established for targeted appliances, and a significant number of test data have been gathered as part of a comparison or endorsement labeling program. Thoughtful design of a test procedure and certification process is critical to any standards and labeling program. Testing and certification are described in detail in Chapter 4. Testing data submitted by manufacturers participating in an existing program can give a good indication of actual consumer consumption.

There are two caveats regarding the use of test data in designing standards, however. First, while test procedures are designed to emulate actual use patterns and environments, actual consumer use may vary considerably. For example, most refrigerator test procedures simulate household ambient air temperatures but do not include the opening and closing of doors that are a part of actual refrigerator use and which can significantly affect energy consumption. Second, the operation of some products, like heating and cooling equipment, is highly variable due to variations in climate. These variations cannot be accounted for with any single procedure. Therefore, test procedures give information only on relative consumption–actual savings from efficiency improvement can only be determined with additional characterization of use in the field. Test procedures may be best interpreted as providing an estimate of actual use that is inexact but sufficiently accurate for the purposes of designing standards.

End-Use Metering

End-use metering can be the most accurate method for collecting energy consumption data, but it is also the most expensive and time consuming. Laboratory measurements or engineering estimates may be substituted if necessary but are less accurate representations than metered end-use data of actual household energy consumption.

The minimum data needed depend on whether the statistical or engineering approach is used. In many developing countries, sufficient data may not be available to analyze standards using either of the two methods described above. This was the case in China during the late 1990s when official stock figures had not been publicly reported for more than five years, so current stock figures were derived from known saturation rates of appliances in urban and rural households by multiplying the number of households by the saturation rate (percent of households owning each appliance, as determined by surveying a sample of households). End-use metering was performed in a small sample of urban Chinese households to test the viability of an energy-efficient prototype refrigerator and to compare the prototype's energy performance to that of ordinary refrigerators. These annual energy consumption data for refrigerators were useful for analyzing potential impacts of new standards. A similar study, with even fewer data, was done for lighting, refrigerator, and air conditioner energy use in Ghana (Constantine et al. 1999).

In countries without energy use labels or end-use metering data, it is often difficult to collect UEC data, so rough estimates must be made until these data can be collected. For example, in the study on air conditioners in Ghana mentioned above, an estimated power demand was multiplied by estimated hours of operation to get the UEC. In the China example, end-use metering was used to obtain air-conditioner UECs. Refrigerators are a prime example of a product for which household surveys will not yield a UEC because occupants will not know how many hours a refrigerator compressor is in operation, and the power demand is also usually unknown.

6.3.3 Market Data

In order to project potential national energy savings (not just unit savings) from energy-efficiency standards over time, it is necessary to forecast shipments of the product for which a standard is being proposed. This forecast serves as an estimate of future sales and thus future ownership and use. Ideally, data are available regarding recent trends in appliance sales by product class. Examples are data collected by retailers or manufacturer/industry groups and/or import data collected by customs officials. Often, however, data of this type are not available. In their absence, some idea of future sales may be derived based on current ownership rates, assuming that currently installed equipment will be replaced at the end of its lifetime. These estimates can then be combined, as in the case of China, with projections of future saturation rates and population growth. One way to assess the configuration of the current market is through a retail survey, in which appliance dealers (including importers) are asked about market shares of product types (classes) and efficiency levels. Although retail surveys give only a partial picture of the market and responses may be somewhat subjective, they offer a relatively low-cost way of estimating the base-case configuration of products targeted for standards as well as an up-to-date picture of trends in consumer product preference. Section 6.7.3 discusses how to use these market data to calculate national energy use and energy savings from standards.

6.3.4 Data for Assessing Economic Factors

Many inputs are needed for economic analyses of such quantities as LCC, payback period, and net present value. For example, to calculate LCC (see Section 6.7.1), data are needed on the incremental purchase price for the more efficient product. Both the efficiency improvement and the ultimate cost increase that will be passed on to the consumer are based on experts' judgments of the effectiveness of particular efficiency-improving designs and the additional material and labor costs required to implement them. The expected costs of manufacturing, installing, and maintaining each design option must be estimated, including the ability of the after-market service sector to effectively maintain the performance of high-efficiency equipment. Data are usually obtained from appliance manufacturers and component suppliers (e.g., compressor and fan motor manufacturers). In some cases, manufacturer costs are very difficult to obtain, and it may be necessary to go directly to retail prices. This is a feasible approach if all the model designs under consideration already exist in the marketplace. This approach was used in the U.S. analysis of fluorescent lamp ballasts (Lawrence Berkeley National Laboratory 1999). Obtaining average retail prices for particular designs can also be very difficult because of the significant temporal and regional variations in consumer prices. In some cases, it may be possible to find two models of a product that only differ by the presence or absence of a particular design feature. The price difference between two matched models differing only in efficiency can be valuable information.

In addition to engineering data, energy price, appliance lifetime, and consumer discount rate are needed to calculate LCC. To calculate the payback period, only incremental cost, energy savings, and energy price are needed. Fuel or electricity price should be projected into the future if it is expected that this price will change appreciably from the current price. Discount rates are needed to determine the present value of future energy cost savings for the more efficient product, to calculate either LCC or national net present value.

6.3.5 Proprietary Information and Confidentiality

Publicly available information should be used as much as possible. In a competitive market, individual companies have good reasons for protecting the confidentiality of their proprietary information, particularly their costs and sales data, to keep it from falling into competitors' hands. It is useful to establish rules that permit policy makers to have access to proprietary information in exchange for strictly protecting it. The government must first identify the nature of the essential information, determine how it will be used, and ascertain that it is not already available from other sources. The government should request from manufacturers only specific information necessary for the analysis that is not otherwise available.

Confidentiality can be arranged either directly between regulators and the concerned industry or through an independent third party. Under third-party agreements, several companies often provide proprietary information essential to the analysis to an independent organization, which can be a trade association or a contractor to the government. Depending upon the details of the agreement, the third party gives the government either aggregated information (e.g., industry-wide totals or averages) or statistical information in which company identities are masked (e.g., information is attributed to Company A, Company B, and so on). The original proprietary information remains confidential as it is not shared directly with the government or the public.

In the early stages of a standards program, there is likely to be a problem with information asymmetry during discussions between government and stakeholders. The government, depending on the openness of the deliberations, may know more about the overall program plans while manufacturers and other industrial interests will almost certainly know more about the technical aspects of the products, the processes (and costs) involved in manufacturing, and the markets in which the products are sold. If either of these parties refuses or otherwise doesn't share this information with all the other stakeholders, the resulting information imbalance can hamper the process of developing economically optimum standards. Such an information imbalance will probably never be eliminated completely, but it can be made more equitable by establishing a practice of full exchange of technical information, with appropriate protections for confidential information.

6.4 Step S-3: Categorize Product Classes

Depending on the nature of the product being analyzed for standards, there are usually reasons to create separate product classes based on consumer amenity. Manufacturers often argue that it is critical that product classes be developed to avoid hindering commerce and limiting consumer choice and welfare. Separate product classes allow for differences in energy consumption resulting from additional features or utility in different models. Without these distinctions, standards might decrease the level of service provided by the product. A reduction in service is undesirable because the intent of standards is to provide the most service for the least energy rather than simply discouraging energy use. For example, manual versus automatic defrost of freezers and the different locations of freezer compartments (e.g., side by side or freezer on top of fresh food compartment) are typically distinguished by product class. In the E.U., there are separate product classes for refrigerator-freezers with different capacities to reach specific freezer temperatures. If there were only one product class for all refrigerator-freezers, models with more energy-intensive features (that provide consumers particular amenities) would have greater difficulty achieving an efficiency standard than would models without those same features. Conversely, dividing a product into a large number of product classes can help stimulate the sale of higher-energy appliances and thus limit the potential overall energy savings.

Another issue is whether to develop efficiency standards that are dependent upon the capacity or volume of the product. In all countries with mandatory refrigerator and freezer standards, the standards are a linear function of adjusted volume. Adjusted volume accounts for the different temperatures in the fresh food and freezer compartments of refrigerators, refrigerator-freezers, and freezers. If maximum allowable energy consumption were not a function of volume (but instead a constant for all capacities), then larger models would have a harder time meeting the standard, which would discourage manufacturers from producing them. If policy makers wish to retain consumers' option to purchase larger-volume models, then the standard should be a function of volume.

A particular product can be divided into classes in many ways, and this division can be both contentious and very important to the energy savings that will result from efficiency standards. For example, when electric storage water heaters were analyzed in the U.S., there was a debate about whether heat-pump water heaters (HPWHs) should be considered as a design to improve the efficiency of electric water heaters or whether a special product class should be established for them. Some arguments in favor of a separate product class were that HPWHs were very different than standard electric water heaters in that HPWHs require more space, need sufficient air circulation, and must have a provision for condensate drainage. U.S. DOE decided that a separate product class was not needed because HPWHs provide the same utility as electric resistance storage water heaters and that all of the issues related to the debate were economic in nature and were treated as such in the analyses of standards for these products (U.S. DOE 1994).

6.5 Step Ⓢ-4: Analyze Using a Statistical Approach (Method 1)

A statistical approach is one option for analyzing the desirable level of a proposed standard. An example of the statistical method is the analysis performed by the Group for Efficient Appliances (GEA) for three-star refrigerator-freezers. Adjusted volume (AV) accounts for the different temperatures in the fresh food and freezer compartments of refrigerators, refrigerator-freezers, and freezers. Figure 6-4 shows a statistical analysis of a set of energy-use data for three-star refrigerator freezer models available in E.U. countries in 1992. For each model, energy use is plotted as a function of adjusted volume. For this product class and for the European test procedure (EN 153), AV is equal to the fresh food volume plus 2.15 times the freezer volume (volumes are in liters) to account for different internal temperatures in the compartments. Four lines are shown in this figure; they represent the average energy use obtained through a regression analysis of all of the data points (called the reference line), a 10% energy savings line, a 15% energy savings line, and a long-term standards line. The method used to obtain the first three of these energy-savings equations is described immediately below. The fourth line was obtained through an engineering/economic approach, described in Section 6.6.

After the regression line is calculated, the impact of any proposed standard is calculated by assuming that manufacturers will react by replacing each model having energy efficiency below the standard with a model of higher efficiency. The number of models in the analysis stays constant. The energy savings for the improved-efficiency models are calculated, and energy savings are aggregated until the total savings reaches the goal (10%, 15%, etc.). Then, the resulting data points are used to derive a new regression line. An efficiency index was defined to aid in this process, namely the percentage by which the energy use of each model is above or below the reference line. GEA studied four of the many possible ways to analytically replace the least-efficient models with more efficient ones:

- Replace each model with a fictitious unit of similar adjusted volume and the closest energy-efficiency index.
- Replace each model with an existing unit with the closest adjusted volume and energy-efficiency index.
- Replace each model with a fictitious unit with an adjusted volume and an energy-efficiency index, both calculated as averages of the other units within the same volume interval.
- Replace each model with a fictitious unit of similar adjusted volume and an energy-efficiency index that is the average of the other units within the same volume interval. The volume interval is arbitrary but should not be too large.

The analyses performed by GEA utilized the fourth method. The report stated that this method is thought to represent the appliance industry's behavior in the process of replacing inefficient appliances with improved units (GEA 1993).

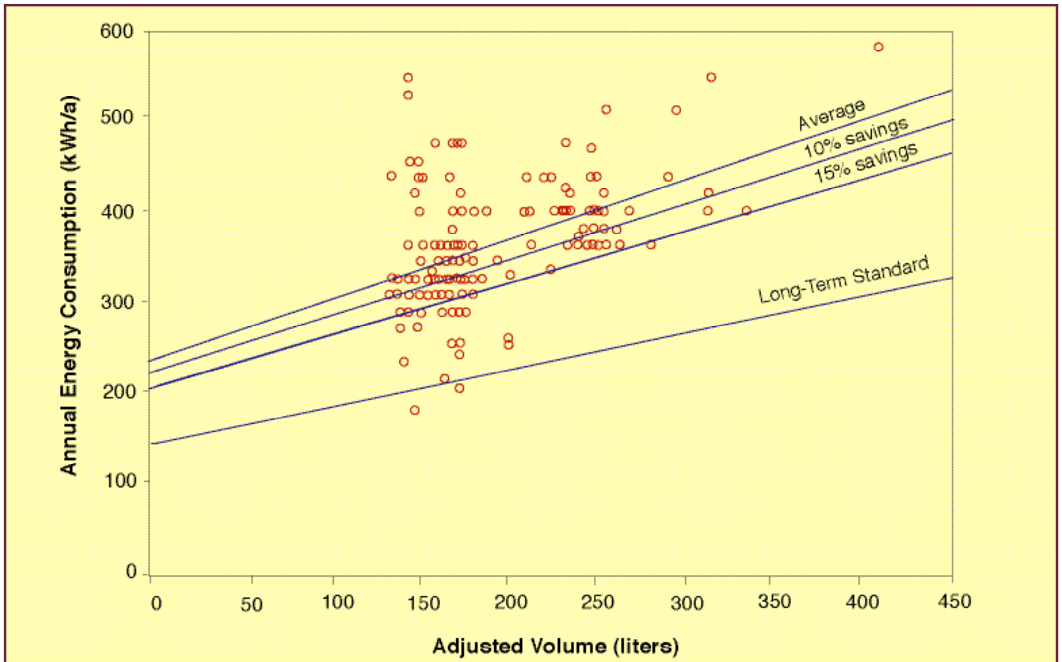


Figure 6-4 Statistical approach applied to E.U. refrigerator-freezers

Statistical analysis is one method that can be used for setting a standard.

The analyses described above are very simple compared to engineering/economic analyses, which require extensive time and resources from both direct employees and contractors. The statistical approach can be used to simply raise the average efficiency of products by periodically eliminating the least efficient 10%, 20%, 50% or more of products. If the standard level is revised frequently enough, this strategy might achieve a similar effect over time as other approaches without many of their complexities.

6.6 Step Ⓢ-5: Analyze Using an Engineering/Economic Approach (Method 2)

An engineering/economic approach has been widely used by U.S. DOE since 1979 to analyze all U.S. standards. An engineering/economic approach has also been used to propose long-term refrigerator efficiency standards in the E.U. (Group for Efficient Appliances 1993). An engineering analysis is first carried out for each product class within a product type to estimate manufacturing costs or retail prices for improving efficiency compared to a baseline model. Installation and maintenance costs are also calculated. The engineering analysis can be described in seven steps shown in Table 6-3.

Engineering/Economic analysis is considerably more complex than statistical analysis.

Table 6-3 Steps for Engineering Analysis

Approach
1. Select appliance classes
2. Select baseline units
3. Select design options for each class
4. Calculate efficiency improvement from each design option
5. Combine design options and calculate efficiency improvements
6. Develop cost estimates (include installation and maintenance) for each design option
7. Generate cost-efficiency curves

As with the statistical approach, the first step in the engineering analysis is the segregation of a product into separate classes to which different energy-efficiency standards apply. Classes are differentiated by the type of energy used (oil, natural gas, or electricity) and capacity or performance-based features that provide utility to consumers and affect efficiency.

Selecting a baseline unit from a distribution of models is step two in the analysis. A baseline unit is the starting point in analyzing design options for improving energy efficiency. The baseline model should be representative of its class. For products that already have standards, a baseline model with energy use approximately equal to the minimum efficiency requirement is usually chosen. For products without an existing standard, a baseline model can be chosen with energy efficiency equal to the minimum or the average of the existing distribution of models. Selecting the least efficient model as the baseline is recommended because this permits analysis of all possible levels of efficiency standards starting from eliminating the least-efficient ones.

The third step is selecting design options for each product class. Design options are changes to the design of a baseline model that improve its energy efficiency. These options are considered individually and in combinations when appropriate. For each design option or combination of design options, energy use or efficiency is determined through measurements or calculations using the appropriate test procedure. Calculating the efficiency improvement from each design option is the fourth step in the analysis. Calculating the efficiency improvement from combinations of individual design options is the fifth step in the analysis. These calculations are usually performed with spreadsheets or engineering simulation models that account for the various energy-using components of a product.

In the sixth step, the expected costs of manufacturing, installing, and maintaining each design option are estimated, including the ability of the after-market service sector to effectively maintain the performance of high-efficiency equipment. Data are usually obtained from appliance manufacturers and component suppliers as described in Section 6.3.4.

An engineering/ economic analysis shows the extra manufacting costs that accompany increases in energy efficiency. These must be weighed against the targeted reductions in energy costs.

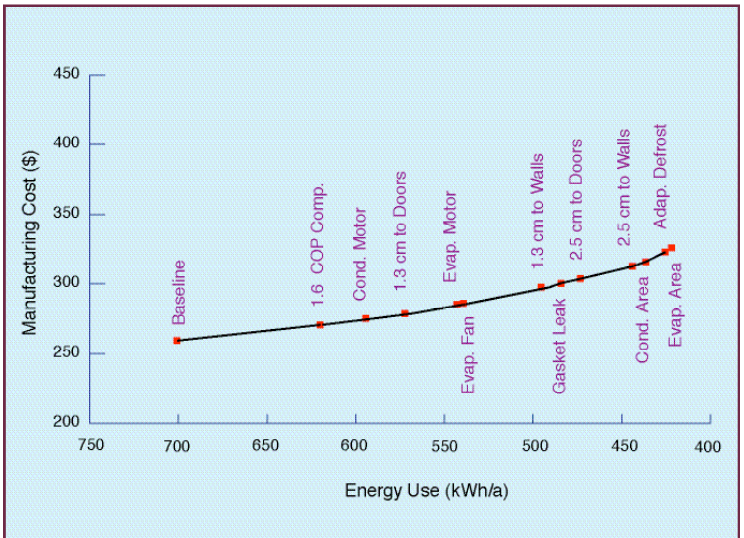


Figure 6-5 Example of fundamental data for engineering analysis: U.S. top-mount auto-defrost refrigerator-freezer

The seventh and final step in the analysis is to generate cost-efficiency curves. Figure 6-5 illustrates the results of an engineering/economic analysis for an 18.2-ft^3 (515-liter), top-mount, auto-defrost refrigerator-freezer. In large part, this analysis was used as the basis for the consensus efficiency standards established by U.S. DOE in July 2001 (U. S. DOE 1995). Manufacturing cost is plotted as a function of refrigerator annual energy use. Efficiency gains become more expensive as energy use decreases. Most of the design options are self-explanatory. The compressor efficiency increases from a coefficient of performance (COP) of 1.37 to 1.60 [or an energy-efficiency ratio (EER) of 4.7 to 5.45]. Door insulation thickness is first increased from 3.8 to 5.1 centimeters (cm) (1.5 to 2.0 inches) and then from 5.1 cm to 6.3 cm (2.0 to 2.5 inches). Insulation in the sides of the cabinet is also increased by similar amounts. The evaporator and condenser fan motor efficiencies are improved so that their power consumption decreases from 9.1 Watts (W) and 12.0 W, respectively, to 4.5 W each. Other design options shown are reduced gasket heat leak, adaptive defrost, and increased heat-exchanger area. The use of vacuum-panel insulation was also studied although it is not shown here.

This engineering/economic analysis suggested a standard more stringent than any that could have been considered using a statistical analysis. Calculations of consumer LCCs based on the engineering/economic analysis led to a maximum energy use standard for an 18-ft^3, top-mount, auto-defrost refrigerator-freezer below 500 kWh/y at a time when no models with such a low energy use were commercially available. The engineering/economic analysis doesn't prescribe that manufacturers meet the standard using the technical options used in the analysis. It simply ensures that there is at least one practical way to meet the standards. The history of responses to new standards is evidence of great design ingenuity among manufacturers.

6.7 Step Ⓢ-6: Analyze Consumer, Manufacturer, National, and Environmental Impacts

There are separate methods for estimating consumer LCC and payback period, national energy savings and economic impact, manufacturer impact, energy supply impact, and environmental impact. Figure 6-6 shows the connection between the engineering analysis and the other analyses described below.

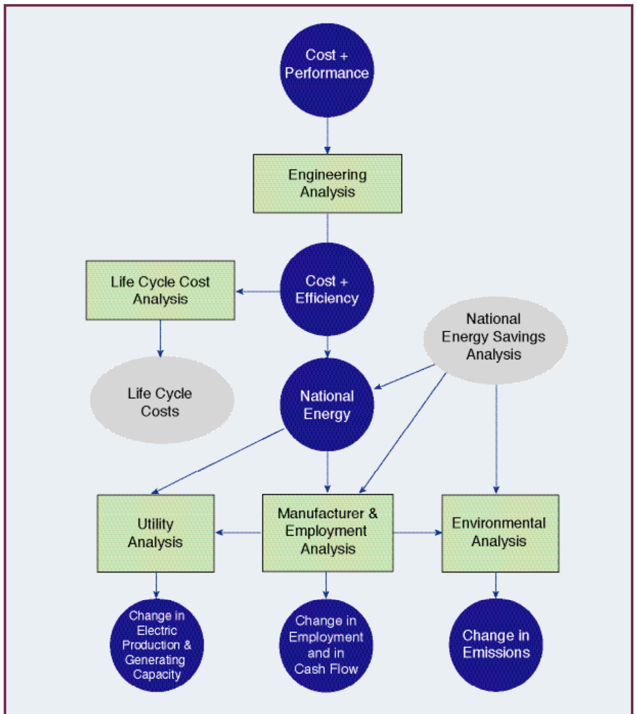


Figure 6-6 The relationship of engineering analysis to other impact analyses

An engineering analysis is only one of several analyses that must be performed to assess the potential consumer, industry, national, and environmental impacts of proposed standards.

6.7.1 Consumer Payback Period and Life-Cycle Cost

Economic impacts of potential efficiency improvements are generally determined by analyzing consumer payback period and LCC. The ability to accurately determine consumer payback periods and LCCs depends greatly on the data collected during the previous stage of analysis. Generally, the statistical method can provide an adequate determination of energy impacts but relies on current retail prices to project the anticipated purchase prices of products that incorporate technology to enhance efficiency. These prices may be difficult to obtain and may shift under a standards scenario. In contrast, the detailed data necessary for an engineering/economic analysis generally permit an accurate projection of consumer payback periods and LCCs, using allegedly more accurate manufacturer costs and distributor markups to arrive at consumer equipment costs.

Retail Prices and Markups

Future consumer prices for more efficient designs are estimated by applying markups (multipliers that translate manufacturer costs into retail prices) to the expected manufacturer costs or by using a survey to directly determine retail prices. The survey approach works only if the designs being assessed exist in products that are currently manufactured in large quantities; otherwise, current prices for models in limited production may be high compared to future prices of those models in full production. Surveys of retail prices can be difficult to interpret when variability in retail prices resulting from different features and among brands, regions, and retailers obscures the underlying relationship between efficiency and manufacturer cost. Additionally, it is often difficult to find two models of a product that differ only in the presence or absence of the particular efficiency option being evaluated. The survey approach may be the only available option, however, if the statistical method was used in the previous step of analysis.

The alternative is to develop a markup, typically the ratio of the retail price of a baseline model to the manufacturer's cost. If market statistics are available, the markup is often developed from aggregate industry-wide data. The ratio of the average manufacturers' selling price to the average manufacturer's cost is usually assumed to remain constant in the standards case compared to the case with no standards. Actually, some distribution costs (e.g., labor by distributors and retailers) are unlikely to be changed when standards take effect, so a markup slightly lower than that before standards would maintain profits in the distribution channel at their former level.

Payback Period

The payback period measures the amount of time needed to recover the additional consumer investment (P) for an efficient model through lower operating costs (O). The payback period is the ratio of the increase in purchase price plus installation cost (from the base case to the standards case) to the decrease in annual operating expenses (including energy and maintenance). For example, if the increased price for an efficient unit is $30, and the energy savings are $10 per year, the payback period is three years. Appliance lifetimes range from several years to several decades. A payback period less than the lifetime of the product means that the increased purchase price will be fully recovered in reduced operating expenses.

Payback periods can be computed in two ways: by calculating cumulative payback for each design option relative to the baseline from the engineering analysis or by using a distribution of design options projected for the base case without standards. In the second

Calculating Payback Period and Life-Cycle Cost

Payback period (PAY) is found by solving the equation

$$\Delta P + \sum_{1}^{PAY} \Delta O_t = 0$$

for PAY. In general PAY is found by interpolating between the two years when the above expression changes sign. If the operating cost (O) is constant over time, the equation has the simple solution

$$PAY = -\frac{\Delta P}{\Delta O}$$

The equation for LCC is a function of price (P) and annual operating cost (O)

$$LCC = P + \sum_{1}^{N} \frac{O_t}{(1+r)^t}$$

If operating expenses are constant over time, the above equation reduces to LCC = P+PWF*O where the present worth factor (PWF) equals

$$PWF = \sum_{1}^{N} \frac{1}{(1+r)^t} = \frac{1}{r}\left(1 - \frac{1}{(1+r)^N}\right)$$

where N is lifetime (years), and r is the discount rate.

payback calculation (which is usually used to evaluate potential standards levels), only designs that would be eliminated by the standard are included in the calculation of paybacks; the fraction of the market that is already more efficient is ignored as unaffected. Consumers whose base-case choice is eliminated by standards are assumed to purchase the design option corresponding to minimum compliance with the standard under consideration. The second method tends to yield slightly longer payback periods (see insert: *Calculating Payback Period and Life-Cycle Cost*).

Payback period analyses demonstrate the enormous cost-effectiveness for consumers of some standards.

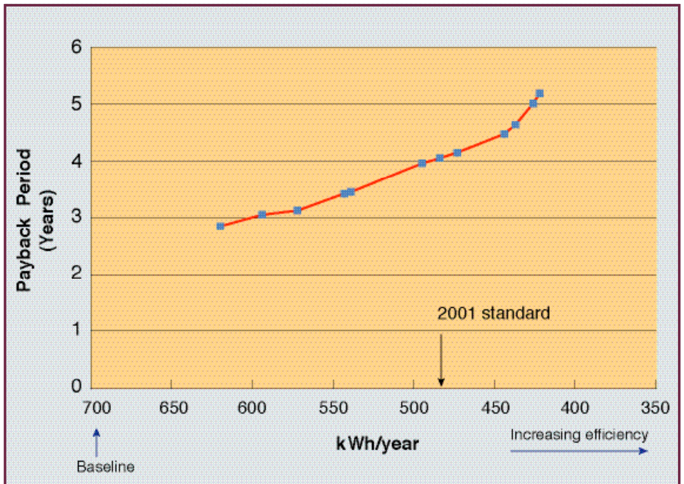


Figure 6-7 Payback periods for top-mount automatic-defrost refrigerator-freezers

Figure 6-7 shows the payback periods obtained by the second method using the estimated base-case distribution of model efficiencies when calculating paybacks for the various design options. The left-hand axis shows the cumulative simple payback period. The consumer payback period for the reduced gasket heat leak design option, which has an energy use close to the consensus standard, is less than four years. Incremental payback periods can also be calculated to determine the marginal benefit of adding the last design option compared to the previous design level (rather than to the baseline) although this approach has rarely been used.

Life-Cycle Cost

The LCC is the sum of the purchase and installation cost (P) and the annual operating and maintenance cost (O) discounted over the lifetime (N, in years) of the appliance. Compared to the payback period, LCC includes consideration of two additional factors: lifetime of the appliance and consumer discount rate. The LCC is calculated with inputs for the year in which standards are to become effective, using a discount rate, r, to determine the present value of future energy savings in energy costs over the life of the appliance. The determination of the appropriate discount rate to use in the calculation is often quite controversial.

Figure 6-8 on next page shows the LCC analysis results for two sets of U.S. standards for a top-mount, auto-defrost refrigerator-freezer. The earlier curve was used by U.S. DOE as part of the basis for setting standards that took effect in 1993. The later curve was used by negotiators to establish the consensus standards that took effect in 2001. In the latter case, the minimum LCC (where the consumer receives the most benefit) is around 450 kWh/a. At a lower discount rate, future savings in utility bills

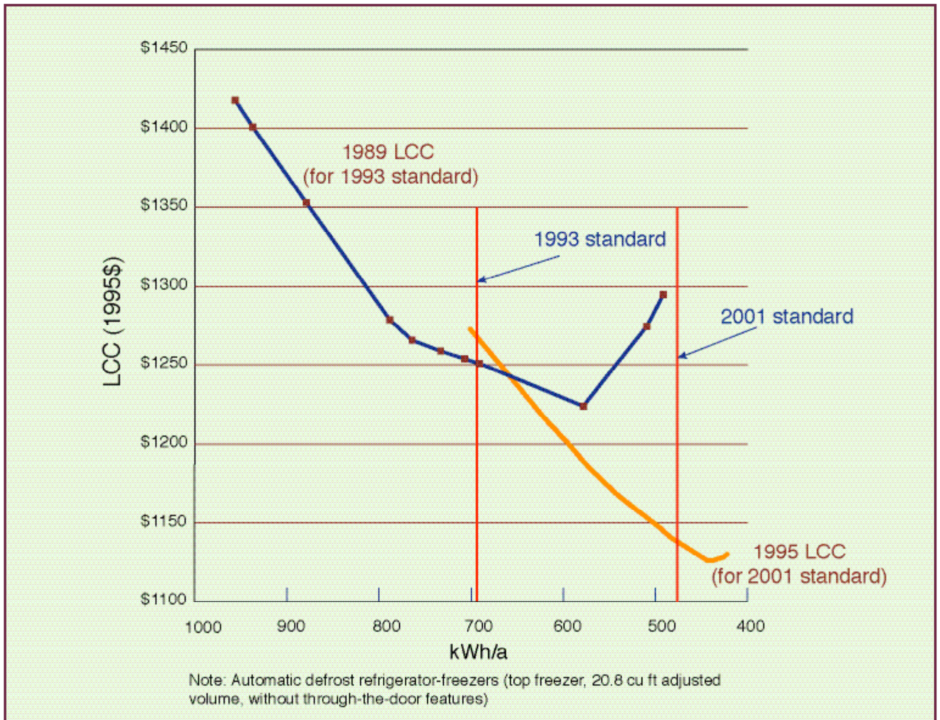


Figure 6-8 Life-cycle cost (LCC) vs. annual energy use (kWh/a)

A life-cycle cost analysis identifies the standard level that will minimize the combined purchase price plus ongoing energy costs.

become relatively more important, and the LCC minimum shifts toward lower energy consumption options; at higher discount rates, the LCC minimum shifts toward higher energy consumption options. Options below 470 kWh/a were rejected for use in a proposed standard because the increased insulation thickness would make these refrigerators too wide to fit into fixed spaces in some existing kitchens, assuming that internal volume remains constant as insulation thickness increases. If the goal were to maximize energy savings rather than economic savings, a policy maker could choose a standard that is beyond the LCC minimum as long as there is still a reduction in LCC relative to the baseline. In any event, the LCC minimum is not always the point chosen for a new standard because many other factors must be considered.

Other Consumer Costs

Installation and maintenance costs need to be included in the payback and LCC analysis only if they change with energy efficiency. Installation costs are added directly to the purchase cost, and annual maintenance costs are added to the annual operating cost and discounted along with the energy cost. For water-using appliances, such as clothes washers, the costs of water and detergent should also be considered if their consumption changes with energy efficiency.

Standard Depends on Size

To determine how energy use varies with size, for example with adjusted volume of refrigerator-freezers, one method is to calculate the energy performance for several top-freezer models with different adjusted volumes but otherwise similar characteristics. A regression equation for each standard level can be fit to the combined results for all design options. Once the standard level is selected, the standard is expressed as a linear equation for energy use as a function of adjusted volume (Hakim and Turiel 1996).

6.7.2 Manufacturer and Industry Impacts

The impact of standards on manufacturers and their employees, distributors, retailers, and customers is an integral part of the analysis. In order to avoid disrupting the product market being regulated, policy makers and analysts must understand the sources of products, whether domestic or imported, and their distribution channels. Significant issues can include effects on consumer demand; competition among manufacturers, including between domestic and foreign producers; and cumulative impacts of regulations, including employment impacts. In Thailand, an analysis of the refrigerator industry as a whole rather than of individual manufacturers was adequate to determine general trends and to address uncertainty by sensitivity analysis. Elsewhere outside the U.S., manufacturer impacts are usually discussed using an informal, consensus-type approach. In the U.S., interviews are usually conducted individually with many of the manufacturers of the product under consideration in order to gain insight into the potential impacts of standards. During the interviews, both qualitative and quantitative information is solicited to evaluate cash flows and to assess employment and capacity impacts.

In U.S. (DOE 1999) and the E.U. (Commission of the European Communities 1999), quantitative analyses have been performed to determine the impact of potential efficiency standards on appliance manufacturers. For the cash-flow analysis, information is requested on the possible impacts of standards on manufacturing costs, product prices, and sales. Cash-flow analyses are performed using a spreadsheet model on a company-by-company basis and then aggregated to the whole industry. The cash-flow analysis uses annual shipments, selling price, manufacturer costs such as materials and labor, selling and administration costs, taxes, and capital expenditures to generate annual cash flows. The industry net present value (NPV) can be calculated by inflating the annual cash flows from the period before implementation of standards to some future point in time.

Accurate estimation of the benefits of energy-improvement options is difficult, and errors can compound when options accumulate. Probabilistic treatment is prudent, with a goal of identifying the likely range of impacts among different manufacturers. In the U.S., the Government Regulatory Impact Model (GRIM), a flexible, transparent tool, has been developed for analyzing the impact on manufacturers. This model uses readily obtainable financial information to consider the impact of government-imposed costs on profitability and cash flow, based on a variety of assumptions that can be varied to study alternative scenarios.

6.7.3 National Energy and Economic Impacts

Policy makers are often interested in knowing the national or regional (e.g., for the E.U.) energy savings from proposed energy-efficiency standards. These energy-savings estimates can be converted directly into economic savings and reduced emissions of carbon dioxide and other combustion products. Other impacts of interest are peak-load reductions, reduced oil imports, and avoided power plant construction.

The expected national energy savings from alternative standards are calculated by first using forecasting models (usually spreadsheets) that estimate annual energy use for several decades under different scenarios. Summing discounted energy cost savings and subtracting additional first costs over a time period determines the NPV for the policy. National energy savings are calculated by subtracting energy use under a standards scenario from energy use in a base case (no-standards scenario). Inputs to a typical national energy-savings model include the:

- effective date of the standard
- time period of the analysis (usually the initial year is the effective date and the final year is considered sufficient if it accounts for at least one replacement of existing appliances)
- UEC with and without standard
- annual shipments forecast
- projected energy price trend
- discount rate

A probability function is often used to account for retiring appliances as their useful lifetimes are completed. Additionally, a time series of conversion factors is used to convert from site (at the appliance) energy to source (or primary) energy, accounting for power plant efficiency, transmission and distribution losses, and continuing improvements in power-plant transmission and distribution technology.

Table 6-4 **Energy Savings and Net Present Value from U.S. Standards for Fluorescent Lamp Ballasts Starting in 2005**

National energy savings analyses often show significant savings from standards over a wide range of future scenarios.

Electronic Standards for Units Sold from 2005 to 2030

Scenario	Low	Middle	High
Total Energy Saved*, Quads (Exajoules)	1.20 (1.27)	2.32 (2.45)	4.90 (5.17)
Total Energy Bill Savings (billion $)**	1.95	3.51	7.24
Total Equipment Cost Increase (billion $)**	0.53	0.91	1.83
Net Present Value (billion $)**	1.42	2.60	5.41

*For energy savings only, Total Benefit and Net Present Value do not include heating, ventilation, and air conditioning (HVAC) savings.
**In billion 1997 dollars, discounted to 1997 at 7% real.

Table 6-4 shows an example of national energy savings and NPV results for fluorescent lamp ballasts. The range of cumulative energy savings (for the period 2005 to 2030), including net cooling energy savings, is from 1.27 to 5.17 EJ for the three shipment scenarios analyzed.

Although national energy savings and NPV are the major energy and economic effects of standards, an input/output model may be used, if sufficient data are available, to estimate other national economic impacts, including job loss or creation by sector. Standards typically shift consumer spending by decreasing energy expenditures, and consumers typically spend the savings on other items. The result can be job creation in other sectors, offsetting possible job losses in the appliance-manufacturing and energy-supply sectors.

Analysis of the effects of proposed standards on electric and natural gas utilities has historically focused on estimated fuel savings, capital cost savings, and the reduction in revenues that will result from lower electricity or natural gas sales. The impacts of standards on utilities are reported using several key industry parameters, notably electricity (or fuel) sales, generation, and capacity. Figure 6-9 shows energy supply analysis results for the fluorescent lamp ballast energy-efficiency standards most recently enacted by U.S. DOE. The results are expressed as a change in electricity sales, generation, and installed generating capacity relative to the reference case.

Avoidance of power plant construction and reduction in the use of fuel for electricity generation are two major benefits from energy-efficiency standards.

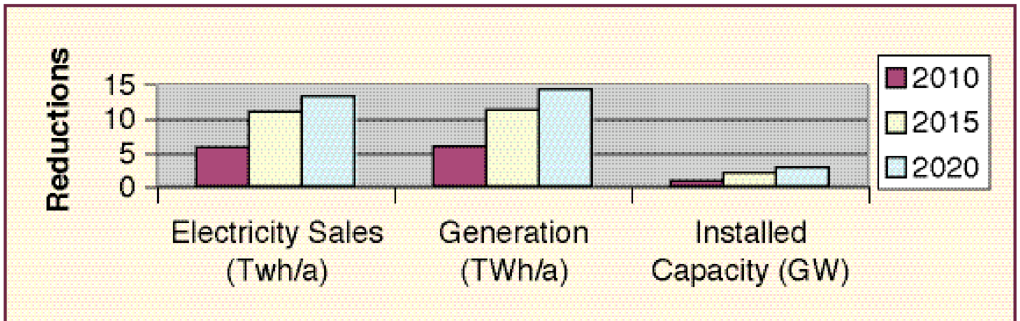


Figure 6-9 Example of utility impacts: new ballast standards effective in year 2005/2010.

6.7.4 Energy Supply Impacts

In the U.S., the effects of proposed energy-efficiency standards on the electric utility industry have been analyzed using a variant of the Energy Information Administration (EIA) National Energy Modeling System (NEMS) called NEMS-BT, together with some exogenous calculations (EIA 1998). NEMS is a large, multi-sector, partial-equilibrium model of the U.S. energy sector that produces the Annual Energy Outlook, a widely used baseline forecast for the U.S. through 2025, which is available in the public domain (www.eia.doe.gov/oiaf/aeo).

The comprehensiveness of NEMS-BT permits modeling of interactions among the various energy supply and demand sectors and the economy as a whole, so it produces a sophisticated picture of the effect of standards, including major environmental impacts. Perhaps most importantly, because it explicitly simulates dispatch and capacity expansion of the industry, NEMS-BT can estimate marginal effects, which yield better indicators of actual effects than estimates based on industry wide average values.

6.7.5 Environmental Impacts

Environmental analysis provides information about the effect of new standards on greenhouse gas emissions (primarily CO_2) and regional pollutants (such as sulfur oxides and nitrogen oxides). Energy savings are typically converted to emissions reductions using conversion factors (e.g., grams of emission per unit energy saved). The conversion factors can account for average current emissions or emissions associated with marginal energy supply when new supply is avoided. In-house emissions (e.g., from gas-or oil-fired water heaters, furnaces, or boilers) must be estimated separately from those for the energy supply sector (e.g., central electricity generating stations and associated fuel supply effects).

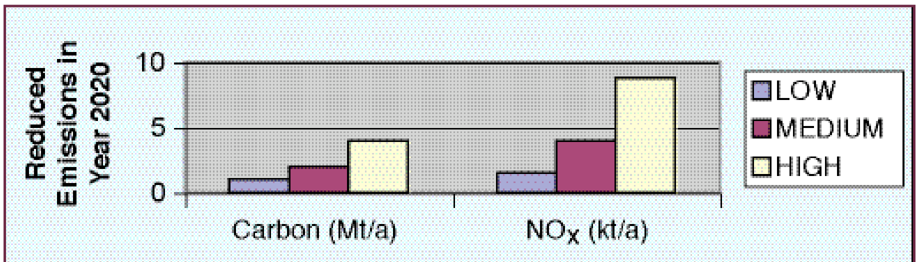


Figure 6-10 Example of environmental impacts: new ballast standards effective in year 2005/2010

Reductions of CO_2 and NO_x are major environmental benefits of energy-efficiency standards programs.

Figure 6-10 shows environmental analysis results for three fluorescent lamp ballast standards scenarios, representing a range of possible base-case shipments in the analysis of U.S. standards presented in Figure 6-9. The annual carbon emission reductions range up to 4 million metric tons and the nitrogen oxides emissions reductions up to 8.8 thousand metric tons in 2020.

6.7.6 Improving Analytical Methods

Analysis methods and standards-setting processes can be improved over time. In the international arena, discussions of harmonization or alignment of test procedures and appliance efficiency standards continue. In the long-running U.S. standards program, many significant changes have already taken place, including increased participation of manufacturers in the process and development of more transparent and robust analytical methods. Some enhancements to current methods may be needed to assess standards across countries or regions. One such method emphasizes uncertainty analysis, (Turiel et al. 1993).

Uncertainty analysis allows explicit consideration of uncertainty in inputs and model parameters and an assessment of which of the various factors that influence analysis results are most important (importance analysis). Combined with scenario analysis, these techniques offer means for comparing alternative policies and choosing among them with greater confidence in the outcome than would be possible otherwise (McMahon 2003).

6.8 Step Ⓢ-7: Document Data, Methods, and Results

The subsections below describe the objectives, benefits, and practical mechanics of analysis documentation.

6.8.1 Documentation Objectives

The three primary objectives of documentation during the process of setting a standard for a particular product are to:

1. identify precisely and thoroughly the source of each component of the analysis (e.g. quantitative and qualitative information, expert judgments, models, other analytical tools)
2. trace the use of each of these components throughout the analysis so that, if any component changes in value or formulation, the individual elements of the analysis that will be affected are known
3. enable staff to retrieve information efficiently and, if necessary, to reconstruct how the analysis was conducted and reached the conclusions that were reported at various points in time

After the standards for a particular product are set, the documentation should meet two additional objectives:

4. enable staff to revise parts of the analysis if legal challenges are raised
5. find information or simulations that may be helpful for setting subsequent standards

Benefits

The benefits of documentation are significant but may not be realized immediately. Benefits include improved:

- preparation of the report that supports efficiency labeling or standards
- control of the version of the analysis that is used for various types of work within the particular standards-setting project
- ability to respond to comments and defend work questioned by stakeholders or other interested parties or independent reviewers

- internal quality control
- transfer of work among staff
- peer review
- resumption of the analysis and rule-making process after delays
- consensus rule making

The immediate pressures of project deadlines, difficulties in obtaining data, and schedule changes all work against maintenance of thorough documentation. Nevertheless, neglecting documentation is risky because it leaves the work vulnerable whenever staff members leave the project or methods or data sources are questioned and makes it more difficult to realize the benefits listed above. Staff who analyze labeling and standards must ensure that every effort has been made to eliminate mistakes before their work is circulated to government agencies, legislators, and stakeholders. Documentation contributes to this assurance.

Frequency of Documentation Efforts

Documentation should be defined as a major task that is as close to continuous as possible and integral to each step in setting standards for a particular product. For example, for the data-collection stage that is part of any labeling or standards project, documentation should be conducted as the data are collected rather than at the completion of this stage. The objective is to document as frequently as possible so that the total time spent on documentation is minimized and the chances of identifying errors early are maximized. Documentation entries should be recorded at least weekly and more frequently if small, distinct portions of work are completed in shorter time intervals.

Mechanics

To facilitate documentation of labeling and standards efforts conducted by several individuals, a template with titles and space for documentation contents can be developed. The space available for each item should be designed so that it can be expanded as needed. For each project that sets a standard level for a particular appliance or equipment, the template should be stored in a separate, dedicated documentation subdirectory on a shared computer drive and should not be maintained in any other location. Only one documentation subdirectory should be created for use in any standards-setting project, but the template may be used many times over the course of the project. The project manager should review the documentation files periodically to ensure that they are kept up to date.

To the extent that it is practical, the same subdirectory structure should be used and maintained when setting standards for any other product. For example, there should be a designated subdirectory for the most current version of each type of work, for older versions, for data, for models, etc. This helps staff to retrieve information efficiently, especially when it is transferred from one project to another or when work stops on the project for significant periods of time. It is also helpful for controlling which version of the work is being used and eliminating confusion about which version is the current one.

One approach to organizing project documentation is to create a database that contains summary information about reports, models, data, and simulations. If each staff member adheres to protocols established at the beginning of the project regarding what information is documented, where it is stored in each file, and which key (e.g., most current) files are stored in designated directories, these contents can be extracted automatically to populate the database. Supplementary, more detailed documentation may be entered manually after the summary information is stored, especially information concerning interdependencies among files.

A log should be included at the beginning of the documentation contents so that each person who contributes to project documentation can record his or her name, the date, the portion of the work being documented, and the revision number. This serves as a record of all documentation entries made. Only one person should be permitted to make entries at any given time within any particular project. If another person attempts to open the documentation file while entries are being made to it, that person should receive a message to make the entry at a later time.

Templates, directory structure, protocols for frequency and content, logs of activity, and databases are examples of approaches to structuring the documentation process. In the implementation of any structure, care must be exercised to account for the prevailing culture of the work environment, the manner in which the individuals involved think and organize their work, the project objectives, and problems encountered in past efforts. Not all structures are suited to all individuals and all work environments.

Contents

The insert *Contents of Documentation* on pages 168–169 lists what is necessary to keep track of the major types of work performed in efficiency labeling or standards. The major types of work anticipated are:

- project management
- analysis and/or reporting
- data collection
- software or model development
- computer simulation runs

6.9 Step S-8: Set the Standards

After all analyses have been completed and documented and stakeholder comments have been collected and reviewed, government officials are responsible for weighing the various burdens and benefits of each alternative, deciding which standards levels to implement, and documenting the rationale for their deci-

CONTENTS OF DOCUMENTATION

Some of the documentation contents listed below may be contained in automated documentation procedures associated with software that is used or developed by the project staff. If this is the case, reference to the document, page number, and/or item number in the automated procedure that contains the required information is sufficient.

I. PROJECT MANAGEMENT

A. Overall project identification

1. Project name (e.g., equipment to which the labeling or standard applies)
2. Project stage (e.g., Advanced Notice of Proposed Rule Making, Notice of Proposed Rule Making, Response to Comments)
3. Account number
4. Project manager
5. Agency contact(s) for the project

B. Update log

1. Version number being revised
2. Name of person making revisions
3. Date of the revision
4. Section revised
5. Purpose of the revision, i.e., what is changed and why

C. At the response-to-comment stage include the following:

1) Name of the individual submitting the comment
2) Page number of the individual's document on which the comment appears
3) Organization, if applicable
4) Date received
5) Date of the response

II. ANALYSIS AND/OR REPORT

A. Date

B. Time

C. Version number

D. Author

E. Objective

F. Target audience

G. Description of approach to meet objectives, including major tasks and how they fit together

H. Assumptions

I. Caveats (limitations, omissions)

J. Results

1. Calculations and models on which results rely
2. How results are used as input to subsequent phases of the analysis
3. Transfer mechanism to subsequent phases of the analysis

K. Data used

1. Person responsible
2. Source (see data collection below for list of contents required)
3. How used as input to subsequent phases of the analysis
4. Transfer mechanism to subsequent phases of the analysis

L. Models used (see software and model development below for list of contents required)

M. Bibliography

N. Experts consulted

III. DATA COLLECTION

A. For data sources that are documents or electronic storage media

1. Author
2. Title
3. Organization
4. Publisher
5. Place of publication
6. Date of publication
7. Publication number

8. Page number(s)
9. See item "C" (all data sources) below for additional contents that must be included

B. For data sources that are telephone conversations, faxes, email transmittals, letters

1. Name of speaker or sender
2. Title
3. Institution
4. Location of the institution
5. Date
6. See item "C" (all data sources) below for additional contents that must be included

C. For all data sources above

1. Data name (e.g., manufacturing cost, maintenance cost, installation cost, energy efficiency, energy use, retail price, producer price, shipments)
2. Value or range of values
3. Type of data (e.g., empirical observation, survey response, expert judgment, averages, other statistical measures)
4. Purpose for which the data are used (e.g., baseline design, design option, test procedure, consumption forecast, profit forecast, cost-effectiveness forecast)
5. Estimated error bars associated with the data
6. Storage location
   a) Electronic copy (directory\subdirectory)
   b) Location of computer, if not stored on a shared drive
   c) Hard copy (physical location)
7. Names of reports, models, and equations in which the data are used

IV. SOFTWARE AND MODEL DEVELOPMENT

A. Software developed outside of the group conducting the analysis (purchased or free)

1. Name of product
2. Version number
3. Generic type of software (e.g., building energy simulation, economic forecast)
4. Software developer name
5. Storage location
   a) Electronic copy (directory\subdirectory)
   b) Location of computer, if not stored on a shared drive
   c) CD (physical location)
6. Uses or purposes of the software or model in the analysis
7. Output of the model
   a) Variable name
   b) Variable definition
   c) Units of measure
   d) Level of disaggregation
   e) Descriptions of table(s) and/or output file(s) in which the output occurs
      1) Table and/or file names
      2) Variables included
      3) Format options
8. Names of reports, models, and equations in which the results are used
9. Data requirements
   a) Data name
   b) Data description
   c) Units of measure
   d) Level of disaggregation
   e) Format
   f) Name of table(s) and/or input file(s), etc., in which data appear
   g) Storage location
      1) Electronic copy (directory\subdirectory)
      2) Location of computer, if not stored on a shared drive
      3) Hard copy (physical location)

B. Original software and models written in-house, and modifications written in-house to existing models

1. Author(s)
2. Version number
3. Date
4. Language in or platform for which the software is written
5. Storage location:

continued on next page

a) Electronic copy (directory\subdirectory)
b) Location of computer, if not stored on a shared drive
c) CD (physical location)

6. Purpose of the software in the analysis
7. Overview of the approach used to accomplish the purpose
   a) Capabilities of the software
   b) Limitations
8. Output
   a) Variable name
   b) Variable definition
   c) Units of measure
   d) Level of disaggregation
   e) Descriptions of table(s) and/or output file(s) in which modifications occur
      1) Table and/or file names
      2) Variables included
      3) Format options
9. Names of reports, models, and equations in which the results are used
10. Description of calculations for the portions developed (line by line of code or equations, or in blocks of lines, whichever is appropriate)
    a) Purpose
    b) Explanation of equation form and interaction of the variables
    c) Relationship to other equations
    d) Links to other spreadsheets or models
    e) Assumptions
11. Variables in the models developed
    a) Names
    b) Definitions
    c) Source
    d) Number of characters
    e) Units of measure
    f) Level of disaggregation
    g) Format
    h) Name of table(s) and/or file(s) in which variable occurs
    i) Field type (e.g., character, alphanumeric, note, date)
    j) Field length of the data
    k) Validation criteria, for example:
       1) Value range
       2) Computational check related to other fields
       3) Number of digits
       4) Number of decimal places
       5) Letters only
       6) Numbers only
       7) Upper or lower case only
    l) Status of each variable by name (proposed, in use, obsolete)
    m) Date of status
    n) Storage location
       1) Electronic copy (directory\subdirectory)
       2) Location of computer, if not stored on a shared drive
       3) Hard copy (physical location)
12. Operating instructions
13. Debugging instructions

V. COMPUTER SIMULATION RUNS

A. Objective

B. Name of model, application, or software used

C. Version number of model, application, or software

D. Simulation run identification (denoted by input and output file identification numbers that are identical except for the prefix "input" or "output")

1. Input file identification number and location
2. Output file identification number and location

E. Description of parameters and/or assumptions that characterize the uniqueness of simulation run

F. Date and time

G. Operator of the simulation run

sions. Following that decision, a public announcement should be made of the standards levels, the effective dates, and the procedure for compliance. In most countries, national law prescribes the announcement procedure. For example, in Mexico, the law prescribes that final standards must be published in the *Diario Oficial* for a final six-month review before they become law and the clock starts ticking toward the specified future effective date. The name of the official government publication and the period of review vary by country, but the process is similar in most places. There should be no surprises for the stakeholders at this point. The process and schedule for the final promulgation of the standards should have been set publicly and collaboratively early in the development process. Typically, manufacturers are given several years' lead time (between publication of a standard and its effective date) to make changes in their designs and production processes to meet the new standard.

The analytical process of a standards-setting program may be a lengthy one, and policy makers and their technical staff should plan ahead for the years of effort it may take to get a good standard in place. Analysis is one of the more time-consuming steps in the overall process of developing a standards and labeling program. This is true not only because of the need to involve all relevant stakeholders but also because of the time required to gather data; categorize the product classes; conduct the proper analysis (statistical or engineering/ economic); assess the consumer, industry, national, and environmental impacts; and document the data, methods, and results. These processes have been described in this chapter. In parallel, those in charge of implementing standards and labeling programs should be preparing the outreach component of the program described in Chapter 7. The next step, maintaining and enforcing the standards-setting program described here, is examined in Chapter 8.

7. Designing and Implementing Communications Campaigns for Labeling and Standards-Setting Programs

Guidebook Prescriptions for Designing and Implementing Communications Campaigns

1. Include a communications campaign at the outset of the design of a standards-setting and labeling program, setting aside sufficient budget for this activity and securing stakeholder support for the task.
2. Specify clear goals and desired outcomes of the campaign.
3. Focus on specific target audiences for each element of the campaign.
4. Develop a few well-articulated messages that encapsulate the campaign.
5. Choose an implementation strategy that can fully reach the target audience within the available budget.
6. Include industry, consumer groups, and corporate retail representatives as campaign partners.
7. Choose a realistically long timeline for the campaign (because people change slowly).
8. Remain flexible to make mid-course corrections to campaign messages, information distribution, or overall strategy.

7.1 The Definition and Importance of Communications Campaigns

Public communications campaigns seek to educate and mobilize the public in support of social or behavioral change (CCMC 2004). It has been said that public communications campaigns:

- "impart ideas for a strategic purpose (and) may be singular events or long-term courses of action, but all have a specific purpose" (Dorfman et al. 2002)
- can be highly formal efforts or a loose collection of goal-oriented outreach activities (CCMC 2004)
- "use the media, messaging and an organized set of communications activities to generate specific outcomes in a large number of individuals and in a specified period of time" (Rogers and Storey 1987, as quoted in Coffman 2002)

For efficiency standards and labeling, a communications campaign is one part of a larger long-term policy strategy to save energy used by appliances, lighting, and commercial equipment.

Campaign managers sometimes distinguish between two types of campaigns, integrated marketing and social marketing, as follows:

- Integrated marketing is a multi-tiered informational campaign in which all elements and tactics are integrated and coordinated to deliver a consistent message to targeted consumers.
- Social marketing is "the application of marketing technologies developed in the commercial sector to the solution of social problems where the bottom line is behavior change" (Andreasen 1995 as quoted in Salmon and Christensen 2003). "Social marketers are advised to think of people as 'customers' rather than as campaign 'targets'; to think of being able to fill a customer's needs rather than having a great product or lifestyle to sell" (Salmon et. al. 2003).

During the past decade, energy-efficiency standards and labeling programs have played an increasingly important role in the national energy strategies of developed and developing countries. The benefits of these programs are multifaceted. At the national level, the main objectives are typically a mix of energy conservation, reduced greenhouse gas and other environmental emissions, and economic development. For equipment suppliers and manufacturers, standards and labeling programs may increase business opportunities and/or expand export markets. And for consumers, labeling programs provide detailed product information and result in improved product choices relative to what is available when labels are not in use, so consumer satisfaction is also improved. The whole scheme of energy labeling programs anticipates improved consumer awareness. Consumer purchasing decisions that favor energy-efficient products ultimately provide a "pulling" force in the market; encouraging consumers to buy products at the high end of the efficiency range creates a demand for these products. Thus, improving consumer awareness and changing purchasing behavior are key elements of success (Huh 2002).

For standards-setting and labeling programs (whether mandatory or voluntary) to be effective and accepted in the marketplace, program implementers must communicate with stakeholders—industry, retailers, and consumers. Implementers often overlook or underestimate the value of communications and instead focus attention on marketing and engineering assessments, specification development, product testing/verification, and program analysis. A "technical" mindset tends to dominate energy policy worldwide, and emphasis is not placed on strategies that influence consumer values or decisions. This helps explain why—despite time, effort, and governmental resources—energy labeling programs have sometimes been less successful than expected in changing individual consumer behavior (Huh 2002).

Several U.S.-based analyses of labeling programs and related market-transformation efforts highlight the importance of communications and promotional activities in program success (Nadel et al. 2003, Northwest Energy Efficiency Alliance 2003). These studies show, not surprisingly, that there is a correlation between level of effort—a large part of which is communications—and progress toward market acceptance of energy-efficient products and services. In a review of a decade of market-transformation efforts in the U.S., the American Council for an Energy-Efficient Economy (ACEEE) identified these lessons learned:

- success in the market is achieved when efficient products/services can be differentiated from conventional products in the eyes of consumers

- promotion (e.g. advertising and educational materials) is a key component of most successful initiatives; promotional activities raise awareness among potential purchasers as well as sellers and service providers and work best when these activities show the full range of benefits, not just energy savings
- understanding market barriers to energy efficiency helps policy makers develop and implement successful activities
- sales training, which can be part of an overall communications campaign, plays an important role in overall success
- most successful initiatives are multi-faceted efforts, which involve several different outreach activities that evolve over time (Nadel et al. 2003)

Depending on program needs, available resources, and design, a communications campaign can be limited to one or two simple tactics or can be a varied, multifaceted, highly planned and strategic "symphony" designed to increase awareness, inform, or change behavior among targeted audiences (Day and Monroe 2000). The range of communications tactics available to implementers falls broadly into three categories: advertising, public relations, and special events (Kohl 2000):

- **Advertising** is the use of media to market an idea (in the case of social marketing) or product. Ads in papers, in magazines, on television, on the radio, and online are common advertising tactics.
- **Public relations** is the use of publicity to create enthusiasm for an idea or product. Press releases, celebrity endorsement, and editorials are common public-relations tactics. According to Kohl (2000), "the objective of all public relations is free publicity" noting further that "news is free." Thus, public relations can be an important strategy for resource-constrained public-good campaigns such as the promotion of energy efficiency.
- **Special events** are often used in combination with advertising and public relations to focus attention on the issue in question. They often take advantage of important dates related to the issue. In the case of standards and labeling, common opportunities for special events include: the launch of a label, national energy conservation days or weeks (e.g., as celebrated annually in China), and Earth Day.

Specific dissemination channels include traditional methods such as mailings (e.g., consumer brochures, action guides, and utility-bill inserts), events, radio, newspaper and other print media, transit ads, and television as well as newer technology methods such as CD-ROM demonstrations, electronic mail distributions, dedicated websites and/or banner advertisement (Kohl 2000).

This chapter provides guidelines to help program managers develop communications efforts, a critical but often overlooked element in determining the success of standards-setting and labeling programs. We address key steps that program designers and implementers can undertake, independently, in combination with stakeholder working groups and with the help of experts and consultants, to develop effective communications campaigns. Basic communications and social marketing concepts are included as well as national and regional case studies in the U.S. and developing countries. The seven basic steps entailed in designing and implementing a communications campaign are shown in Figure 7-1 and described in the remainder of the chapter.

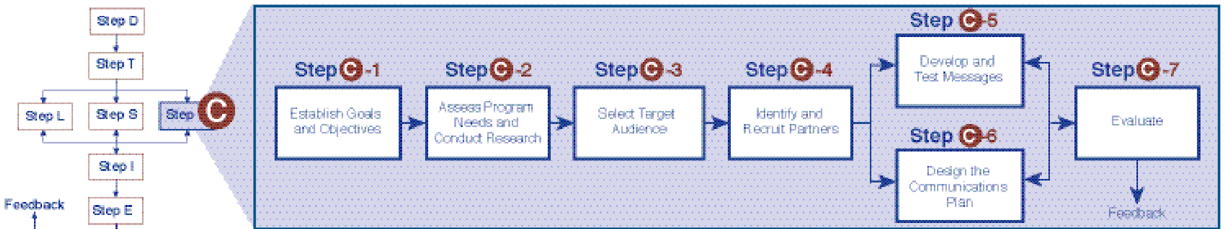


Figure 7-1 Major steps in creating a communications campaign

7.2 Step C-1: Establish Goals and Objectives

The first step in designing a communications campaign is to establish goals and objectives for the activities. Implementers must decide how to define success, and set limited and/or broad goals to accomplish that success.

The literature defines two types of communication campaigns according their basic goals. *Individual behavior-change campaigns* try to alter individual behaviors that lead to social problems and/or promote behaviors that lead to improved individual and social well-being. *Public-will campaigns* attempt to mobilize public support for an issue in order to motivate public officials to take policy action (Coffman 2002). Communication campaigns within standards-setting and labeling programs can be a combination of these two types. Table 7-1 lists typical objectives and other aspects of individual behavior-change and public-will communications campaigns.

Successful communications campaigns may selectively target consumer recognition and trust of energy labels, which is an important first step (Huh 2002). Or they may target consumer comprehension of energy labels and utilization, when analyzing a purchase, of the information presented on labels. Campaigns may target the use of energy labels by retail sales staff as a part of sales pitches. Or perhaps campaigns will comprehensively include all of these and more, to create a strong communications campaign that, over time, is designed to help create positive attitudes towards energy efficiency and the environment at the policy level and a sense of confidence or empowerment at the individual level about saving energy and enjoying other benefits of energy efficiency.

Most energy-efficiency campaigns have had a mix of individual-behavior and public-good goals in mind with the relative emphasis of each changing as implementation progressed. Germany, the U.S., China, and Thailand have all experienced a mix in their campaigns. The German experience is described in insert: *Summary of Goals, Objectives, and Tactics from Germany's Initiative EnergieEffizienz* on page 178. In the early stages of the U.S. ENERGY STAR program, for example, staff did not design a communications campaign to introduce the public to the new ENERGY STAR label. The program initially emphasized influencing upstream market actors (product manufacturers) rather than end users. The first label was intended to convince computer manufacturers to participate in the program by differentiating their products and to facilitate promotion of labeled products in the business community. Three years into the program, when the array of labeled products expanded, U.S. Environmental Protection Agency

Table 7-1 **Goals, Objectives, Target Audience, Strategies, and Messages by Campaign Type—Individual Behavior Change and Public Will**

Communication campaigns seek to influence individual behaviors and mobilize public support.

Campaign Type/Goal	Individual Behavior Change	Public Will
Objectives	• Increase awareness and understanding of an energy label • Increase consumer confidence in the credibility and importance of the information contained in an energy label • Increase appliance shoppers' intent and stated willingness to purchase energy-efficient appliances • Increase actual rate of purchase of energy-efficient appliances	• Increase the visibility or perceived importance of energy efficiency • Increase the extent to which energy efficiency is seen as a problem with solutions (e.g., standards and labels) and entities responsible for those solutions (e.g. government, industry and consumers) • Engage and mobilize stakeholders in support of energy efficiency to positively affect policy makers and policies (e.g., affect the determination of what MEPS levels and/or label thresholds should or shouldn't be pursued)
Target Audience(s)	• Current and near-term appliance, lighting, and equipment purchasers • Retail sales staff • Product development engineers at manufacturers	• The general public • Environmental and consumer groups • Industry groups • Policy makers
Strategies and delivery channels	• Social marketing through advertising in print, television, radio, and electronic media	• Media advocacy, community organizing, public relations to obtain news coverage, and events
Sample Messages	"Buying a 5-star, energy-efficient appliance puts money in your pocket."	"Investing in energy efficiency makes the world a cleaner, safer place for future generations."

Modified from Coffman 2002

(EPA) began direct outreach to end users and consumers. A decade later, consumer education has evolved to be an essential component of the program (Egan and Brown 2001).

The China Certification Center for Energy Conservation Products (CECP) endorsement label program also began implementation not through broad public education but through communication and relationship-building among China's large appliance manufacturers and sales outlets. The program does not have the staff or resources required to communicate with all citizens; instead, implementers plan to deploy communications tactics using regional energy departments/utilities, in addition to in-store tactics focused on big population centers.

The Electricity Generating Authority (EGAT), in Thailand, keen to avoid subsidy programs and preferring instead to rely on voluntary agreements, market mechanisms, and intensive publicity and public education campaigns, created the Attitude Creation Division in their DSM offices. EGAT's program promoted energy efficiency through advertising campaigns, strategic partnerships with various ministries and agencies, and public education campaigns. Throughout the five-year DSM program, the Attitude Creation Division undertook several large-scale promotions to encourage voluntary shifts to energy-efficient equipment. The refrigerator-labeling program, for example, sought to encourage purchasers of the newly labeled appliances to read and understand the new labels. In a publicity campaign that sought to attract consumers' attention to the new labels, purchasers of new refrigerators were asked to send the details from their energy-efficiency labels to a contest with a prize of 5 million baht (US$200,000) in gold; consumers across the country responded to this novel campaign. The Attitude Creation program evaluators found that, by the end of the program, 87% of the Thai population was aware of the public energy-conservation programs and knew that EGAT had sponsored them.

Summary of Goals, Objectives, and Tactics from Germany's Initiative EnergieEffizienz

Germany's Initiative, EnergieEffizienz, is a collaboration between the German national energy agency Deutsche Energie Agentur and the German national association of power suppliers. From October 2002 through December 2004, the aim of this communications campaign was to improve the efficiency of domestic power consumption by raising public awareness of the benefits of energy-efficient behavior. The campaign engaged key stakeholders (consumers, retailers, and manufacturers) and focused on three main areas: electronics/standby power consumption, energy-efficient lighting, and white goods. Campaign results will be measured via quantitative and qualitative analyses.

Overall Goal:

- Reverse or lessen substantial increase of electric-power consumption in the domestic sector (between 1900 and 2001, power consumption of German households increased by 15%)

Objectives:

- Promote awareness of energy-efficient behaviors and improvements among a broad audience (consumers, retailers, manufacturers, etc.)
- Reduce stand-by electricity consumption of electronics and information-technology equipment
- Promote energy-efficient lighting purchases and replacements
- Position energy efficiency as a key criterion when purchasing appliances & white goods.

7.3 Step C-2: Assess Communications Program Needs and Conduct Research

It is necessary to understand market barriers in order to choose communications tactics and channels. What market barriers stand in the way of effective labeling/standards? For example, beliefs that all products are energy efficient or that energy conservation means sacrifice are common barriers to the success of labeling and standards in the U.S. Other market barriers might include lack of product availability, lack of information about the benefits of efficiency for consumers, poor knowledge by sales staff of label meaning, or distraction by or confusion with other labels (ecolabels, water-efficiency labels, recycled content labels, etc.). (Day and Monroe 2000, Nadel et al. 2003.)

Once market barriers are understood and goals and objectives are established, it is recommended that implementers:

- Assess needs before moving on to planning communications campaigns. A needs assessment—whether rapid or extensive, formal or informal—helps determine the starting place for communications with the public.
- Conduct research to supplement the needs assessment and consider the design of the campaign in the context of an understanding of the environment in which the campaign will begin. Sometimes some

Tactics:

- Label products (label shown in the second picture below)
- Develop "Initiative EnergieEffizienz" logo to "brand" the campaign (logo can be seen in the ad shown in the first picture below)
- Launch national advertising, press releases, interviews, and media outreach to television and radio (example shown in first picture below)
- Establish internet portal with detailed background information on the campaign
- Distribute postcards at public venues (e.g., restaurants)
- Establish toll-free consumer hotline
- Distribute range of informational materials at 3,500+ points of sale (reaching 6,000 total points of sale)
- Invite dialogue with manufacturers to encourage education about standby power

(Agricola and Kolb 2003)

Fig. 2. The advertisement for energy efficient domestic lighting

Fig. 3. The "label" to be placed on top of cooling equipment bearing an energy efficiency index of 0.42 or less. The text reads "cool device, isn't it ? ... cooling equipment with particularly low energy consumption".

of this research must be conducted as the very first step to understand the baseline environment and market barriers sufficiently well to be able to set the program's goals and objectives.

A typical needs assessment involves the following 10 steps:

1. Begin with a sense of the context for and history of energy efficiency in the implementation area, and identify the key implementing institutions that will manage communications efforts.

2. Determine resources (time, personnel, money) that the program can allocate to communications activities. Do you have staff trained in communications? Are printing resources available? If resources are limited, adjust your goals and objectives to fit your resources.

3. Review existing information on energy efficiency (if there is any). Do consumers have access to this information? Have they needed it in the past? How is energy efficiency being addressed in the implementation area? Are there broader, long-term goals associated with new standards or labels (e.g. CO_2 reductions, peak-load energy management, national energy management)?

4. Identify target audience(s). (See Section 7.4)

5. Determine baseline awareness and energy-efficiency behaviors through performing or reviewing quantitative research, e.g., in person, via mail-in, in community workshops, or through web-based surveys.

6. Gather information about attitudes toward energy efficiency and response to the message through qualitative research, e.g., in-person, in-depth interviews. Seek out representative comments and viewpoints from all potential stakeholders.

7. Consult with industry. The importance of this consultation during development of any communications strategy cannot be overemphasized. Consultation is essential for several reasons: it ensures that communications tools and key messages are appropriate for target audiences, increasing likelihood they will be well received; it ensures that potential issues are identified early on and can be managed accordingly; and it builds relationships with useful contacts, which in turn can help during the implementation phase (Phillips Group 2000).

8. Identify which consumers make appliance- and product-purchase decisions. Do men or women play the main role in product selection and purchasing in your program area? Gender considerations can greatly influence communications tactics and messages. Are other demographic groupings relevant?

9. Identify appropriate communications channels, i.e., where do most people get information about energy from: government literature, at point of sales/in store, through national or local mass media (newspapers, magazines, television, radio), community/consumer groups, or websites? Which information sources do consumers trust the most (from government agencies to local citizens groups)? This information will influence how you package and distribute information cost effectively.

10. Identify supplementing and partner organizations that can provide delivery channels and/or offer in-kind support for your communications campaign. These might include NGOs, consumer associations, or manufacturers (e.g., by committing a portion of their advertising budget to be coordinated with the campaign).

When assessing the communications context for a program and beginning to plan a consumer communications strategy, implementers should keep in mind the following principles of motivation (Energetics 1995):

- give consumers the opportunity to be involved in making decisions about actions that will affect them (through means such as stakeholder focus groups)
- inform consumers accurately about realities, problems, and reasons for decisions (e.g., through energy conservation centers and the mass media)
- give consumers the authority to decide on the most effective way in which to participate (through such means as stakeholder focus groups)
- recognize consumers for their contributions to the program (through acknowledgments in various media)
- show true interest and commitment (through supporting policies and training for implementers and relevant higher authorities)
- give consumers incentives and rewards (through rebates, discounts, favorable pricing, monetary conditions, increased trade or market share)
- make the consequences of failure clear and concrete to manufacturers and large commercial consumers (e.g., loss of capital, increased overhead, loss of competitiveness)

Another way to conceptualize the process that policy makers can follow in creating communications campaigns is known as “Ask-Agree-Give” (Morimura 2000):

- “asking” how people think they could individually contribute to saving energy through target group meetings or seminars
- “agreeing” on the objectives, targets, monitoring duties, incentives, and rewards through a working group meeting that formulates tangible action
- “giving” by providing agreed-upon incentives and rewards and positive feedback on the results of implementation, and thanking participants for their interaction (to maintain much-needed program support)

Experience has shown that, after program needs are assessed, research should guide program development (Day and Monroe 2000). Basic research will help create more effective communications campaigns, with messages that resonate with consumers and other stakeholders. Large-scale communications efforts may require marketing and social scientific research methods: surveys, focus groups, formal or informal interviews. It is best to conduct separate research at the various stages of program development:

at the front end (to determine baseline awareness or attitudes toward a new label or standard or to select messages and to test program materials); during program implementation (to monitor and refine communications tactics); and at the completion of a campaign (as part of an overall evaluation of impacts) (Egan and Brown 2001).

In Asia, for example, the Hong Kong Consumer Council has conducted its own research on energy consumption associated with consumer products such as refrigerators, air conditioners, washing machines, and gas water-heating systems. The organization publishes test results in a monthly magazine, which is highly respected by consumers.

The Czech Republic uses a mixture of tactics and dissemination channels. SEVEn, the Czech Energy-Efficiency Center, opened an internet portal (www.uspornespotrebice.cz) as a part of the Pan European Database of Energy-Efficient (PADE) appliances project supported by the E.U. The project's purpose is to provide Czech consumers with information about energy demand of white goods sold on the domestic market and labeling and energy efficiency in general. The Czech Republic uses another project, Energy-Efficiency Labeling of Large Household Appliances (ELAR), to reach producers, distributors, and sellers of appliances. ELAR's task is to help turn the statutory duty to use energy labels into a marketing benefit for businesses resulting in better awareness for their customers, who are the consumers of energy. The Czech Republic also informs the public about energy labeling via the Transforming the Market for Energy-Efficient Appliances and Products through the Use of Appliance Information Systems (TREAM) project, which, among other things, creates educational programs about energy efficiency for students (Vorisek 2003).

The state of California uses extensive primary and secondary research, including literature reviews, consumer focus groups, and psychographic analysis, to inform statewide efficiency communications plans. In one instance, staff used the surveys as a baseline against which the impact of statewide programs would be measured. Consumers were asked about energy-efficiency awareness, attitudes, and behaviors. Implementers found that the baseline studies "provided essential data on the current awareness of energy efficiency at the time, and what people knew or perceived energy efficiency was and their attitudes regarding it. The study provided strategic attitudinal segmentation needed for developing targeted messages that appealed to the…values most people have when it comes to energy decisions." The data contributed to strong, prioritized messages in the eventual communications campaign (Egan and Brown 2001).

A group of utilities in the northeastern U.S. also relied on varied research to develop regional outreach plans. Initially, the utilities conducted baseline studies regarding efficient, labeled products including clothes washers, appliances, compact fluorescent lamps (CFLs), and light fixtures. The assessments characterized the market for these products: product availability, percentage of market share, consumer and other market actor perspectives on sales barriers, and consumer product awareness. Focus groups, surveys, and in-depth interviews were also used. Differences in attitudes by gender were explored and became a key element in the first advertisements created to promote efficient products in the region. Later, non-energy benefits of products were emphasized in communications activities, also based on consumer research into product attributes. In other words, all of these assessments guided communications plans and market-transformation efforts (Egan and Brown 2001).

Baseline research also guided Natural Resources Canada during the early stages of Canada's implementation of the ENERGY STAR program. An initial survey of 1,000 Canadians revealed that 13% of Canadians could identify the ENERGY STAR symbol that was being used in the U.S. without any prompting, and 26% could identify it when prompted. Consumers most commonly associated office equipment with the symbol. Program implementers designed communications tools in response to this baseline, saving government resources by avoiding messages that consumers already understood (Wilkins 2003).

7.4 Step C-3: Select the Target Audience

The next step is to identify potential audiences for communications, prioritize the primary audiences, and allow for segmentation if needed. For example: the primary audience might include supply-side stakeholders, e.g. manufacturers, trade associations, equipment distributors, retailers, or sales cooperatives; the secondary audience might consist of consumers (whole population, or targeted to certain demographic groupings). Audiences are prioritized based on program goals and objectives, and a brief profile of each group should be created based on research or other information. Then, barriers and possible motivations that would influence each group's use of new standards or labels should be considered.

Does the up-front research show that some groups may be more receptive to the message than others? Should distinct messages be developed for distinct subsets of those targeted? If so, the target audience may be stratified. Possible stratification schemes may include:

- no stratification (i.e., focus on the general public)
- stratification by demographic groupings (e.g., gender, age, income bracket, ethnicity and/or geographical location)
- stratification by role in supply chain (equipment distributors, manufacturers, wholesalers, product reps, retailers, sales cooperatives, government officials, consumers)
- stratification by interest group (consumer groups, environmental groups, trade associations)
- stratification by the nature of the buying decision, considering separately the motivations of those purchasing a new appliance because of: replacement at end of an appliance's useful life; early replacement for remodeling; early replacement for efficiency; or retirement of an "extra" appliance. Table 7-2 on next page provides an example of how to organize program strategy around these factors

Implementers should also consider public participation in the communications program, including local or regional stakeholders, efficiency advocates or consumer groups in program design and should collaborate with them in the collection of research data and in decision making, target audience identification, and program implementation. Local participation has changed the basic nature of communications programs, with greater authority for program management moving to decentralized agencies and community groups (Day and Monroe 2000).

7.5 Step C-4: Identify and Recruit Partners

As stated earlier, communications programs work well when they involve multiple stakeholders. It is useful to identify who else might benefit from the program's efforts and which organizations can help carry campaign messages. Possible messengers for energy-efficiency standards and labeling communications programs include: national consumer groups, government agencies, electric and gas utility companies, and local citizens or women's groups. National communications programs can often leverage the resources and interests of local agencies and organizations. It is often helpful to go back to the program's needs assessment to verify the communications channels that consumers use to get information about energy.

It is useful to plan on sharing printed materials, messages, website content, and other information on efficiency standards/labeling. Local organizations are especially effective "ambassadors" for a program because their relationships with consumers may be stronger, more consistent, or better trusted than those of national government agencies.

Table 7-2 Research Stratification by Consumer Buying Decision

Focus on the consumers that you're trying to influence.

Decision	Consumers to Be Targeted	Major Program Emphasis
Upgrade to more efficient appliance	Considerers	• Point-of-sale information • Energy labels on appliances • Sales representative training and incentives
End-of-life replacement	Buyers	• Point-of-sale information • Easy-to-use cost and savings analysis (perhaps online) • Sales representative training and incentives
Early replacement	Considerers Satisfieds	• Mass communications (including cost and savings analyses) • Rebates, store credits, pick-up, recycling, buy-back programs
Appliance retirement	Satisfieds	• Mass communications (including cost and savings analyses) • Rebates, store credits, pick-up, recycling, buy-back programs

Derived from Shorey and Eckman 2000

Consumer organizations can play a powerful role. In many countries, their mandate and experience places them in a strategically important position with consumers. These organizations may be accustomed to conducting product tests and launching public-information campaigns for social objectives, for example health protection or anti-smoking, and thus may be well positioned to also support public education about energy efficiency and conservation. Their support or formal "endorsement" of standards and labels can help motivate consumer preferences for energy-efficient equipment and change consumption patterns. Their leadership as consumer advocates can also encourage industry due diligence.

In Vietnam, a group of grassroots organizations under the guidance of the Vietnam Energy Conservation Program (VECP) developed children's booklets on energy conservation between 1999 and 2003. These grassroots organizations were not only the creators, they were also the distribution channels for thousands of the booklets as well as collectors of valuable feedback. The feedback mechanism used in this campaign was a simple receipt which recipients (such as school teachers or community action organizations) signed, indicating how many booklets they had received, where they lived, and any comments for future issues. This simple feedback mechanism allowed implementers to track the penetration of 10,000 booklets into communities as well as to gain valuable commentary and suggestions for subsequent publications.

Finally, it is useful to take advantage of the fact that manufacturers and retailers share consumers as a target audience. Having met standards or labeling requirements, manufacturers are natural allies in marketing, promotions, or advertising for efficient products. Retailers, who play a critical role in consumer transactions and appliance/equipment purchases, are also ideal partners. Sales training is an important part of a communications campaign if resources allow.

In Korea, for example, the Citizens Alliance for Consumer Protection of Korea (CACPK) promotes environmentally conscious consumer behavior. In 1994, the group launched a nationwide survey on consumer behavior, which served as a basis for subsequent campaigns promoting sustainable energy and consumption patterns. The group also worked to expand the national energy-efficiency labeling program through workshops, government lobbying, and outreach to industry. Thus, the partnership supported two program goals: creating consumer awareness about energy use and responsible purchasing and recruiting industry partners into the voluntary labeling program. Consumer organizations have developed other broad based campaigns in Korea on efficient lighting and household energy conservation. All these activities have benefited from close collaboration between the government and non-governmental agencies (Song 2002).

7.6 Step C-5: Develop and Test Messages

Having completed the previous steps, implementers now have enough information to develop messages to communicate about their program. Research will already have indicated the target audience(s), the messages to be conveyed, the major themes to address, the data/charts needed to support the messages, and how the information will be packaged. This is where the fun begins! The basic principles applicable to campaign messages are discussed in the following subsections.

7.6.1 Keep it Simple

Messages should be as simple as possible, relevant to the audience(s), and focused on benefits. Messages should make the desired behavior—use of efficiency labels—attractive and easy and demonstrate benefits to consumers, starting with energy savings, and going beyond. In the U.S., monetary savings (including quick payback in exchange for investment in a higher-priced product) is a strong consumer motivator in all communications campaigns about efficiency. In some developing countries, messages that tap into a sense of national pride may resonate more strongly. Some industry representatives have indicated that helping the country or national economy is a key motivator for their support of standards and labeling programs. The list below gives an array of possible motivations and good messages that might be employed. Purchasing energy-efficient products:

- saves money
- helps the environment
- improves health
- is good for the country
- is a reason for social/civic responsibility/pride
- increases self assurance or esteem
- increases convenience
- increases comfort
- creates more/better choice
- gives consumers better quality

Implementers should not make the mistake of developing complicated or highly technical text, graphs, charts, or other communications. Messages should be factual enough to be compelling but also user friendly. A surplus of technical or administrative details can doom a well-intended communications piece meant for the average consumer. It is important to know the audience and design messages that are appropriate to it. Key messages that are focused on regulation and function are appropriate for manufacturers and retailers. Messages based on label usage/understanding and efficiency benefits are appropriate for consumers. Agency acronyms and other jargon should be avoided.

7.6.2 Consider Cultural and Societal Attitudes about Saving Energy

Messages must be compatible with cultural norms; i.e., messages must make socio-cultural sense (Day and Monroe 2000). In one unusual but interesting example of cultural sensitivity in a developing country, high consumption of electricity was found to be an acceptable social norm, an indicator of status, especially among middle- and upper-class families. People felt they had worked hard to obtain their income and deserved to consume all the resources their household could afford. In a context such as this, consumers may construe energy conservation or energy efficiency as incompatible with their socio-cultural norms.

The phrase “energy conservation”, for instance, is often equated in the U.S. with unacceptable personal sacrifice in comfort or level of service; however, “energy efficiency” has positive connotations and is equated with advanced, state-of-the-art technologies, monetary savings, comfort, quality, and environmental protection. For this reason, focus groups conducted by the Alliance to Save Energy showed a preference for using the term “energy efficiency” rather than “energy conservation” in messages. As a result, energy efficiency is thus used more consistently in product communications campaigns in the U.S. (Egan and Brown 2001, Alliance to Save Energy 2004).

Implementers should be mindful to verify expected cultural attitudes through market research, and create messages that work best for the consumers in the country.

7.6.3 Make Communications Personally Relevant

Beyond primary messages about energy and money savings, communications can be most effective if they convey how efficient choices are personally relevant to consumers. Messages should tie into motivations of target audiences and, if possible, make an emotional connection, which, for consumers, might include statements such as “energy efficient products with the (government’s) label are the right choice for your family” or “efficient products improve the comfort of your home and protect the quality of your environment.” Messages to retailers might include the added value of product differentiation or highlight that retaining a variety of properly labeled, efficient products in the store will improve customer service and increase sales volume.

7.6.4 Address Perceptions about Outcomes

Social science research has found that the most important determinants of behavior are attitudes and beliefs about consequences. The more a consumer believes that engaging in a behavior (in this case, selecting an energy-efficient product) will lead to positive consequences, the more positive her or his attitude will be. A wide variety of motivators and messages may be effective. The most promising strategy is to blend various messages and test them to find out which ones resonate best with consumers.

Results of some studies in the U.S. have found that money (specifically saving money on utility bills) is the *single greatest motivator* for purchases of energy-efficient products by U.S. consumers. In contrast, research in India found that a label logo that showed a hand holding money (representing the monetary savings of more efficient appliances) was viewed by some Indian consumers as an unappealing symbol of greed.

After money, concern for the environment is an important secondary motivator in the U.S.; choice, quality, comfort, and, to a lesser extent, civic pride are also effective. Examples of effective phrases include, “environmental benefit,” “less air pollution,” “better choice,” “higher quality, comfort and convenience,” and words that convey a sense of social/civic responsibility inherent in energy efficient behavior or a sense that a consumer is “doing her part.”

This consumer brochure promoting efficiency in the context of Canada's greenhouse gas reduction goals highlights both EnerGuide and ENERGY STAR.

Figure 7-2 Canada's One Tonne Challenge brochure

Awareness of energy efficiency can be negligible, favorable, or very diverse. Research shows that energy efficiency is a broad and amorphous concept to many people and has different meanings to different consumers. Many consumers do not know enough about energy-efficient measures in their home to assess costs and benefits or to analyze lifetime product savings versus first cost (Egan and Brown 2001). Understanding particularly breaks down when consumers are asked about specific measures or behaviors they can adopt to be more energy efficient. However, while efficiency may not be at the front of consumers' awareness, it is still often viewed as a desirable attribute because of its individual or societal benefits.

Communications campaigns should always accentuate the positive and focus on the range of benefits and outcomes that consumers will enjoy as a result of seeking out and selecting labeled equipment. If consumers can feel good about the outcome, they are more motivated to take an interest in the label and understand why it is meaningful to their purchasing decision. A dry, factual message will have less impact than positive, beneficial statements. Many early energy-information programs failed because they simply made information available without a serious effort to use psychologically motivating messages. It may also help to place energy-efficiency messages in a broad, societal context that consumers can rally around. Canada's "One Tonne Challenge" initiative, as seen in Figure 7-2, encourages citizens to take action on climate change following a step-by-step guide that includes energy efficiency and proper use of government efficiency labels. The overall tone is positive, motivating, and personally relevant.

Advertisements from Germany's EnergieEffizienz initiative (see insert: *Summary of Goals, Objectives, and Tactics for Germany's Initative EnergieEffizienze* on pages 179–180) used humor to communicate messages about energy efficiency and money savings.

7.6.5 Address Literacy and Language Issues

Implementers must consider the literacy levels of the program's audiences. In developing countries, materials aimed at rural audiences generally benefit from minimal text, familiar language, and culturally appropriate messages. Communications materials may have to be translated into multiple languages as has been done in Canada in the ads shown in Figure 7-3.

7.6.6 Design Label for Maximum Consumer Understanding

International experience suggests that the appearance of an energy label is a fundamental factor that influences its future impact (Minghong et al. 2003). The efficiency label itself is a powerful communication tool, so its design is an important element of the program's communications strategy. The label must be visually striking and convey information quickly and intuitively (IEA 2000). Although most international comparative information labels fit one of three primary categories, the optimal label design in any given region will have a strong cultural dimension and should be carefully determined based on quantitative and qualitative market research.

Coordinated education, promotional efforts, and salesperson training are important for sustaining awareness and understanding of labels. However, awareness of the label by itself is not enough to influence purchasing behavior. Good label design needs to be supplemented with effective communications about the program and its benefits.

These judgments are supported by recent research that shows that use of the U.S. Federal Trade Commission (FTC) EnergyGuide label has limited impact on product choices despite its widespread

Sometimes it helps to reach out in more than one language.

Figure 7-3 Natural Resources Canada ENERGY STAR ads in English/French

use in consumer information guides, brochures, websites and communications materials produced by FTC and the U.S. Department of Energy (DOE). Consumers are very familiar with the yellow color; however, use and comprehension of the label appear to be low. This is a result, in part, of the label's design, which shows a linear graph or (range) of estimated energy use/operating costs associated with the labeled product. Overall, consumers prefer and respond better to a categorical rating system, such as the E.U. and Australian energy rating labels displayed in Chapter 5. However, although comprehension of the EnergyGuide label is problematic, a more overarching problem is that consumers perceive the current label to be "boring," overly technical, and unmotivating (Thorne and Egan 2002, Egan and Brown 2001). One recent improvement is that the label now incorporates, where applicable, the U.S. EPA/DOE ENERGY STAR, which helps consumers distinguish the best-performing products. Research on the placement of the Energy Star logo, however, suggests that some consumers confuse the logo with the indicator on the comparative scale, a problem that might be avoided with a distinct outlined section dedicated to the logo (Thorne and Egan 2002).

Knowledge is the basic underpinning of consumer behavior. Simple notice of the existence of an efficiency label, without any further understanding on the consumer's part, is not likely to affect purchasing decisions. The way the information on the label is presented is vital. Energy labels should not be perceived as simply a "yellow thing" on products. Consumers have to comprehend what the label says and what the numbers/symbols stand for and then be able to process the information as part of their purchasing decisions.

7.6.7 Pre-Testing of Communications

Labels should be designed for the benefit and convenience of consumers. Many labels convey too much technical information that, in many cases, the consumer may not use. Labels must be simple and easy to understand, perhaps accompanied by supplemental information such as a brochure or user's manual (Huh 2002).

If time and resources permit, pre-testing campaign messages can be enormously beneficial. Pre-testing often means presenting the campaign items to a subset of consumers such as a focus group composed of members from the target audience and an array of grassroots organizations. Pre-testing often has unexpected results, revealing whether the information presented is clear, effective, and motivational.

For example, a recent focus-group study in China found that participants perceived a particular label as easiest to understand even though corresponding comprehension tests found it was the least likely to be correctly understood. This demonstrates a very important factor in communications about energy programs, namely that consumer perceptions of what is easiest to understand do not necessarily correlate with actual levels of comprehension (Minghong 2003). It's possible that many of the factors consumers found appealing about the design were actually distracting them from the main message. Such responses are rarely predictable. Although the China study assessed the impact of the label, pre-testing is also useful for other types of materials, with special focus for each as indicated:

Vietnamese Children Provide Useful Feedback in Grassroots Pre-Testing Program

Between 1999 and 2003, several grassroots groups in Vietnam developed a children's booklet on energy conservation, with the support of VECP. The short booklet introduced energy concepts including conservation, appliance awareness, and environmental consequences of energy use through a story that used a familiar folk character, "the tree of knowledge," from which the children in the story tested their knowledge.

The groups involved were the Vietnam Youth Union, an organization of young people between the ages of 17 and 35; members of the Vietnam Women's Union, a nationwide organization of 40 million women; the Vietnam Consumers Organization (VINASTAS), a nascent consumer outreach organization with readership of 10,000 issues each month; the Voice of Vietnam Radio, the most-listened-to station in the country; and Vietnam Television Stations 1 and 2, the science and public-interest channels.

Prior to printing, the working group tested the readability and acceptability of the booklet with a focus group of children in the target age group, six to 12 years. From the focus-group sessions, it became clear that the book engaged the attention of the intended target group and was effective. Such pre-testing can save enormous amounts of time and money during actual implementation. Once pre-testing and necessary revisions are completed, full-scale dissemination may occur.

- brochures and fact sheets (test key messages)
- advertising (test key messages)
- websites (test page content for clarity andusability)
- efficiency labels and logos (test for clarity, ability to differentiate products)

When VECP developed children's books on energy conservation (see Section 7.5), it pre-tested them with children between the ages of 6 and 12 years (see insert: *Vietnamese Children Provide Useful Feedback in Grassroots Pre-Testing Program).*

7.7 Step C-6: Design the Communications Plan

For years, communications experts have tried to identify factors that determine behavior and generate public will. Although there is still much progress to be made, one common conclusion is that information alone is not the solution to society's behavioral ills. Research in the field of environmental education and commercial marketing has shown that key factors in changing behavior are:

- perceived self-efficacy (perceived capability to perform the behavior)
- perceptions about what others, such as friends and family, are doing (social norms)
- perceptions about what others want us to be doing (subjective norms)

This research has also shown that there is no set cause-and-effect progression from knowledge and awareness of an issue like energy efficiency to attitude and behavior change. Thus, campaign designers must pay attention and link traditional media and behavior-change strategies with on-the-ground community action to make the social and policy environment supportive of the desired campaign results. Energy-efficiency campaigns have borrowed from social marketing models to create tactics that make label identification and use desirable and accessible. They look at the barriers to as well as benefits of energy efficiency as they develop communications campaigns (Coffman 2002, Day and Monroe 2000).

The literature on communications campaigns suggests developing a "Theory of Change" that expresses what program implementers are doing to lay out the pathway by which they expect change to occur (Coffman 2003). Figure 7-4 shows a theory-of-change diagram for a standards and labels communications program whose primary goal is influencing individual appliance purchases.

The guidebook authors' experiences with prior standards and labels communications campaigns revealed three additional relevant lessons:

1. It is much easier to influence consumers who are actively engaged in appliance purchases than to influence the general public.

2. Retail appliance sales representatives have substantial influence on consumer choice. Incentives oriented to retail sales representatives coupled with simple sales tools can help sales representatives influence consumer product selections.

3. Direct financial incentives to consumers may not be necessary, especially when consumers are already intending to purchase an appliance and the goal is to get the consumer to upgrade by purchasing a more-efficient model.

Having laid the foundation for communications through the preceding steps, it's time to finalize the communications strategies and tactics that we have been discussing. "To maximize their chances of success, campaigns usually coordinate media efforts with a mix of other interpersonal and community-based communications channels" (Coffman 2002). Some have called this mix of communication channels "air and ground strategies"; the air strategy refers to public media campaigns typically implemented through advertising, and the ground strategy refers to community-based communications or grassroots organizing often implemented through public relations and events (Coffman 2002). Research should already indicate which strategies and tactics will best achieve campaign goals and objectives. Tactics might include the following:

- internal communications
- presentations to industry/manufacturer/partner groups
- consumer brochures or action guides
- community workshops and outreach activities
- outreach via local utilities
- government websites/telephone hotlines
- media outreach/public relations

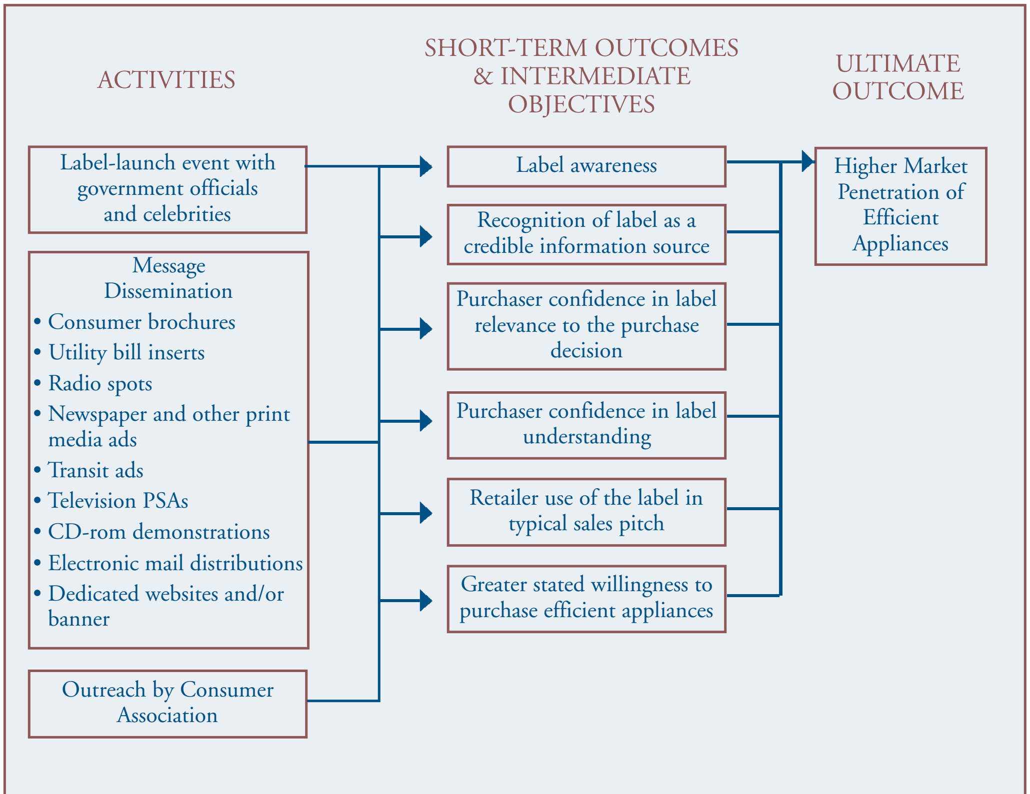


Figure 7-4 Theory-of-change diagram for a communications campaign

Theory-of-Change diagrams help campaign designers think through and communicate program strategy.

- sales training/sales workshops
- retailer/distributor displays and promotions
- advertising (paid spots or public service announcements)

7.7.1 How to Prioritize Tactics

The most effective communications campaigns use a variety of tactics to increase awareness throughout the product distribution chain and among consumers. The first tactics should reach consumers at the time of purchase. Consumer information must be available at the right time and in the right place, before or when purchasing decisions are made. A new labeling program and its benefits to consumers should be publicized, for example through a government press release, ceremony, advertisment, or announcement that would be disseminated by the media or community organizations.

Secondary tactics should help develop the infrastructure for a broad communications campaign to consumers. These tactics include a government website or hotlines containing databases of labeled or top-performing products, community workshops, sales training for retailers, retailer displays and promotions, and advertising. Messages should be consistent among all strategies, for each target audience identified.

Tertiary tactics for labeling programs that already have acceptance in the market can include awards for the most-efficient products. Awards programs, used in Australia ("Top Energy Saver Award"), Korea ("Energy Winner Award"), Japan ("Top Runner"), the U.S. ("ENERGY STAR Award"), and other countries, give an incentive to manufacturers as well as an opportunity to promote energy efficiency more generally. Figure 7-5 shows an example of an awards program as an element within a labeling program. There are a variety of tactics enployed by many countries (Korea, Canada, Australia and China for example). (See insert: *An NGO Initiated the Energy Winner Label in Korea* on page 196, insert: *Tactics Used in Communications Campaigns: Promotion of ENERGY STAR in Canada and Energy Rating Transition in Australia* on page 197, and insert: *China's Refrigerator Program is a Model of a Well-Executed, Integrated Labeling Communications Campaign* on page 199.)

As noted earlier, community-based outreach and collaboration with consumer groups can be tremendously helpful in any communications campaign and are often the most cost-effective tactics. Program implementers should never underestimate the role community, friends, and family can play as sources of consumer information. Trustworthiness and credibility make a great difference in a message's effectiveness. This fact helps explain the strong influence of information from (non-expert) friends and relatives on household appliance purchasing decisions. Studies in the U.S. indicate, as shown in Figure 7-6, that 64% of consumers consult with friends and neighbors for information on appliance, home electronics and lighting purchases (The Cadmus Group 2004). Consumers tend to base their decisions on information that captures their attention and wins their confidence. Programs should employ tactics that have this appeal and evoke similar trust among consumers.

Many regional ENERGY STAR partners in the U.S. focus primarily on the retail sector for marketing the benefits of efficient products to consumers through: sales training; placement of communications

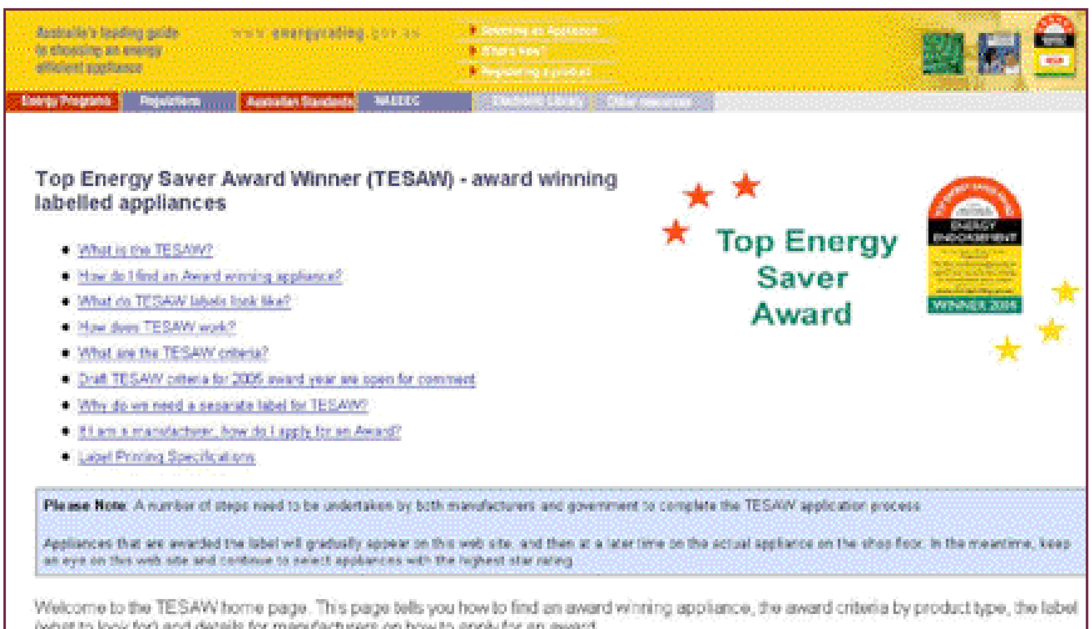
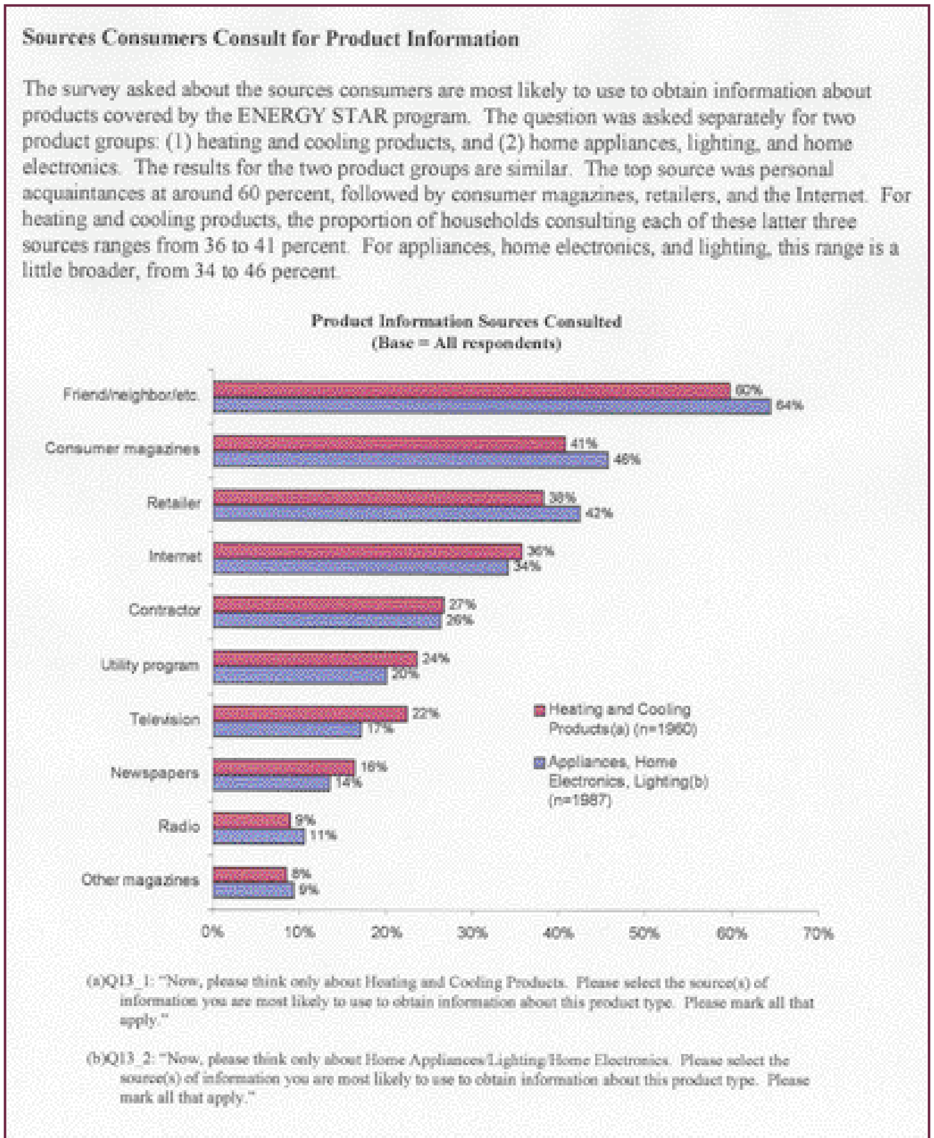


Figure 7-5 Australia's top energy saver award

Information on Australia's Top Energy Saver Award recognizes the most efficient products and promotes the label among consumers.

materials, posters, and signage in stores; and proper stocking and labeling of qualified equipment. Utilities, retailers, and lighting manufacturers, for example, collaborate on product discounts and special lighting displays in retail stores to promote sales of energy-efficient lighting fixtures and bulbs (Northwest Energy Efficiency Alliance 2003). Local partners can sponsor educational events, clinics, and workshops to promote energy efficiency and efficient products. If these channels or relationships do not exist in an area, policy makers can, at a minimum, develop and maintain strong ties with local energy/efficiency authorities or utilities. These groups can help share information with local citizens through utility-bill statements, bulletin boards, public meetings, and other channels.

U.S. consumers obtain information about ENRGY STAR-qualified products from a variety of sources.



Sources Consumers Consult for Product Information

The survey asked about the sources consumers are most likely to use to obtain information about products covered by the ENERGY STAR program. The question was asked separately for two product groups: (1) heating and cooling products, and (2) home appliances, lighting, and home electronics. The results for the two product groups are similar. The top source was personal acquaintances at around 60 percent, followed by consumer magazines, retailers, and the Internet. For heating and cooling products, the proportion of households consulting each of these latter three sources ranges from 36 to 41 percent. For appliances, home electronics, and lighting, this range is a little broader, from 34 to 46 percent.

(a)Q13_1: "Now, please think only about Heating and Cooling Products. Please select the source(s) of information you are most likely to use to obtain information about this product type. Please mark all that apply."

(b)Q13_2: "Now, please think only about Home Appliances/Lighting/Home Electronics. Please select the source(s) of information you are most likely to use to obtain information about this product type. Please mark all that apply."

Figure 7-6 Information sources that consumers consult
Source: Consortium for Energy Efficiency

An NGO Initiated the Energy Winner Label in Korea

Since 1994, CACPK has been educating the Korean public about how to lead energy-efficient lives. CACPK has launched a series of energy-efficiency campaigns, including consumer-education programs (seminars, lectures, press conferences), surveys and polls, and product tests. CACPK has urged the Korean government to adopt and extend the use of energy labeling and standards programs.

In 1997, CACPK expanded its activities and presented the first Energy Winner Award to encourage the manufacture and purchasing of energy-efficient items and the development of more energy-efficient lifestyles. Now, each year, private- and public-sector entities are invited to submit products and projects for an independent professional assessment and competitive review by the CACPK Energy Advisory Committee (Korea Factor4 Committee). Selected products and distinguished projects are given non-monetary awards, including permission to mark products with designated energy-efficiency labels that can attract consumer awareness in the market place. The selection is based on five criteria: innovation, appropriateness, energy efficiency, economics, and potential for energy conservation. Among the "Energy Winner" products, systems, and activities, the most energy efficient is selected and awarded "Grand Prize of the Year." Three "Energy Awards of the Year" are also given: the Energy-Efficiency Award, the Energy-Innovation Award, and the Energy-Conservation Award.

Year by year, CACPK's campaign has attracted growing attention and recognition by the participating private sectors. This award has served as a platform for promoting sustainable manufacturing and consumption in many facets of everyday life, including household appliances, office machines, buildings, schools, cars, and other energy-consuming fields and activities. Companies develop and produce energy-efficient technologies and products with the Energy Winner Award in mind. The energy winner logos on products, coupled with media coverage, inform consumers about energy-efficient products. This is an example of an NGO, the government, the media, and consumers working together to successfully stimulate a national energy-efficiency movement.

Energy Award of the Year

7.7.2 Timing

After the initial stages of introducing a program, a communications campaign can take anywhere from three months to three years to reach and begin influencing consumers. A campaign should be developed in stages with enough lead time to work with third-party distribution channels, such as retailers or buyers groups. If faced with the common market barriers to efficiency addressed in Section 7.3, implementers must sustain communications over the long term and raise and allocate appropriate resources to communications efforts. Programs aimed at creating preferences for energy-efficient products require long-term information and marketing strategies.

Tactics Used in Communications Campaigns: Promotion of Energy Star in Canada and Energy Rating Transition in Australia

The Canadian government used the following tactics to promote the ENERGY STAR program:

- a website (www.oee.nrcan.gc.ca/energystar)
- advertising, co-ops, and promotional activities
- marketing of initiatives directly to manufacturers and retailers
- development of agreements with organizations to promote ENERGY STAR, internally and externally
- sales incentives
- sales training
- a procurement initiative

Note: In 2001, Canada signed an agreement with the U.S. to begin implementing ENERGY STAR for 13 products in five categories: appliances; heating and cooling; office equipment; home electronics; lighting and exit signs. Additional products have since been added to the program (Wilkins 2003).

The Australian government used the following tactics to inform industry and consumers about the transition to its new Energy-Rating system:

- Industry bulletins
  - industry education (information booklet, video, poster)
  - point of sale flyers, signage
- Industry sales meetings
  - advertising
  - telephone inquiry hotline
  - website (www.energyrating.gov.au)
  - media outreach

Note: Australia revised its energy rating for appliances in July,2000. The improved efficiency of appliances in recent years resulted in a clustering of products at the top of the rating range. The government introduced the new label over a nine-month period, to encourage even greater energy-efficiency improvements and to increase consumer understanding of the transition. A full communications campaign supported the label transition (Phillips Group 2000).

7.8 Step C-7: Evaluate

Although evaluation is covered comprehensively in Chapter 9, aspects that relate specifically to communications campaigns are addressed here. Evaluation involves imagining the future; in the beginning stages of program design, it is often difficult to identify measures of success.

The broadest definition of the evaluation process starts with campaign planning and needs assessment. As needs are assessed and research is gathered to determine initial awareness, context, and behaviors related to efficiency, a type of evaluation is already in progress. The baseline data and context information collected beforehand will help measure changes attributable to the communications campaign.

It is important to design an evaluation strategy before implementing the communications campaign. Depending on resources available and information needs, the evaluation can use any or all of the following strategies (further summarized in Table 7-3):

Table 7-3 **Four Types of Evaluation Activities for Standards and Labels Communication Campaigns**

An evaluation strategy should be designed before implementing a communications campaign.

Evaluation Focus	Purpose	Example Questions
Formative	• Assesses the strengths and weaknesses of campaign materials and strategies before or during the campaign's implementation	• How does the campaign's target audience perceive the issue? • What messages work with what audiences? • Who are the best messengers?
Process	• Measures effort and the direct outputs of campaigns – what and how much were accomplished • Examines the campaign's implementation and how the activities involved are working	• How many materials have been distributed? • How many and what types of people have been reached?
Outcome	• Measures effects and changes that result from the campaign • Assesses outcomes in the target populations or communities that come about as a result of program strategies and activities • Measures policy changes	• Has there been any affective change (beliefs, attitudes, social norms)? • Has there been any behavioral change? • Have any policies changed?
Impact	• Measures community-level change or longer-term results achieved as a result of the campaign's aggregate effects on individuals' behavior, and the behavior's sustainability • Attempts to determine whether the campaign caused the effects	• Has the behavior resulted in its intended outcomes (e.g. higher sales of efficient appliances)? • Has there been any system-level change?

Source: CCMC 2004

- Formative evaluation usually takes place ahead of time, collecting information to help shape the campaign's activities. For a public-will campaign, this might involve measuring awareness through public polling or testing of messages and materials in focus groups, either formally or informally. Sometimes a "meta-survey" or summary analysis of existing polling data can serve the same purpose.
- Process evaluation examines the campaign's implementation or the way activities unfold. Process evaluation might count the number of materials distributed, the development and dissemination of messages and materials, and the number of efforts to work with the media.

China's Refrigerator Program is a Model of a Well-Executed, Integrated Labeling Communications Campaign

China's refrigerator industry is the world's largest. A project to transform the Chinese refrigerator market, funded by the Global Environment Facility (GEF) through the United Nations Development Program (UNDP) and the UN Foundation (UNF), is one of the best current examples of how technical assistance by U.S. EPA's ENERGY STAR program, the United Nations Department of Economic and Social Affairs (UNDESA), and others helped China undertake an integrated marketing approach, from research to end results.

Project partners identified nine barriers to the widespread adoption of energy-efficient-technologies in China. These barriers ranged from lack of consumer awareness about the life-cycle economic benefits of high-efficiency refrigerators to lack of reliable, comparative information about specific models.

A new endorsement label was designed, market tested, and inaugurated in 1999; household refrigerators were the first products labeled. After labeling, the project's first "market pull" activities (aimed to increase demand) were retail training and recycling programs.

The project included a mass-communications campaign, in which contracts for creative content development, media placement, public relations, and consumer surveys were competitively bid. The US$3 million communications campaign included prints ads, bus shelter and subway posters, elevator posters and postcards, in-store materials, TV ads, and other mass-media tools.

In addition to the consumer education campaign, "market push" activities were initiated, including refrigerator and compressor incentive programs for manufacturers. The success of the manufacturer initiative led four more refrigerator manufacturers than originally anticipated to request admission to the project, for a total of 16 manufacturers (representing nearly 90% of production and sales). Retail incentives, salesperson awards, purchaser awards, and consumer education programs were all undertaken to make consumers aware of the advantages of energy-efficient refrigerators.

A mass-purchase program is leading to new energy-efficient refrigerator specifications, mass-procurement procedures, and identification of potential large-scale purchasers of energy-efficient refrigerators. A recycling program is being developed to promote retirement and environmentally responsible recycling of old, inefficient refrigerators.

The project obtained commitments from each participating refrigerator manufacturer to design one new top-rated equivalent refrigerator (that consumes less than 55% of the current energy use); improve the efficiency of the average refrigerator by at least 10%; and invest at least 10% of advertising budget to promote energy efficiency. The communications campaigns were followed by surveys (funded by UNDESA) to gauge consumer responsiveness to the labels and evaluate consumers' increased awareness levels.

With all of these measures, the initial overall project goal of 20 million refrigerators sold, yielding lifetime product emissions reductions of 100 million tons of CO_2 and energy savings of 66 billion kWh, is expected to double, making it one of the most successful campaigns to date for helping the local and global environment.

- Outcome evaluation examines the campaign's results, which usually means its effects on its target audience(s). Evaluators often use surveys, polling, or other qualitative means of gathering this type of information.
- Impact evaluation examines effects at the community, state, national, or international level, or a campaign's long-term outcomes (including the effects of behavior or policy change). Impact evaluation can also attempt to determine causation, i.e., whether the campaign caused observed impact(s). This assessment typically requires rigorous evaluation design methodology, such as experimental or quasi-experimental techniques (CCMC 2004).

Whenever possible, it is best to track changes through the course of a campaign, using several data collection points. The focus should be on looking for trends in the data, and policy makers should be prepared to alter tactics to take advantage of lessons learned from evaluations.

Many U.S. communications programs sponsored by the federal government, regional market-transformation groups, and NGOs are routinely evaluated for success as well as lessons learned. Utilities in the northwestern U.S. recently compiled evaluation data on efficient lighting technologies (heavily promoted in the region during 2001-2003) that measure consumer awareness, purchasing barriers, and product satisfaction. Collected in telephone surveys of local rebate recipients, the data provide useful information on consumer response to communications and rebate programs and indicate what motivated efficient lighting purchases. The findings, which show high levels of awareness and purchase, also point to remaining market barriers and areas that need to be addressed (e.g., first costs and consumer dissatisfaction with color and brightness associated with CFL technologies). The findings suggest recommendations that would improve regional communications programs and consumer attitudes related to a key energy-efficient technology (ECO Northwest 2004).

The Alliance to Save Energy conducts annual evaluations of consumer attitudes toward energy efficiency, the results of which inform the organization's long-range communications campaigns. These evaluations have revealed, for example, consumer confusion between energy conservation and efficiency (see Subsection 7.5.2), a distinction the Alliance addressed through educational content on a new consumer energy-savings website. Most of the content on the website was developed and organized to meet the "needs of consumers" identified through market research and other evaluation over the years (Alliance to Save Energy 2004). Such evaluations help guide a government's communications campaign planning and implementation.

8. Ensuring the Integrity of Labeling and Standards-Setting Programs

Guidebook Prescriptions for Ensuring the Integrity of Labels and Standards Programs

1. Establish the existing testing capacities of industry and the public sector and identify appropriate national or international accreditation bodies.
2. Establish fair, consistent, and practical criteria for certifying the energy efficiency of products.
3. Tailor the compliance approach to practicalities and available public and private resources.
4. Regularly monitor progress. Report both compliance and non-compliance.
5. Establish a graduated response to non-compliance, including private warning, public notification, and ordering of changes.
6. Establish sufficient penalties and adequate administrative processes to pose a credible threat to transgressors.
7. Resolve questions, disputes, and allegations promptly with clear decisions.

8.1 The Importance of Reliable Energy-Performance Information

The integrity of energy-performance information for equipment covered by standards is a primary requirement for a successful standards-setting and labeling program. All standards-setting and labeling programs rely on measuring and accurately declaring the energy consumption and energy efficiency of the equipment concerned. Without a means of measuring equipment energy performance, it is impossible to launch a meaningful standards-setting and labeling program. It is also essential that equipment energy performance be measured in a consistent way and that the values reported within the program are accurate. Without these safeguards, apparent improvements in equipment efficiency and reported energy savings will likely be illusory. Consequently, a large part of the development of any standards-setting and labeling program revolves around establishing a reliable system for measuring and declaring the energy performance of the equipment covered by the labels or standards.

Standards-setting and labeling programs give a commercial advantage to products that appear to have higher energy performance and a disadvantage to those that appear to have lower performance.

Therefore, it is in a manufacturer's or vendor's interest to be seen as offering more efficient equipment. These commercial pressures can be a strong incentive to make false declarations about equipment performance; it is highly probable that some declared values will be bogus unless adequate controls are in place to detect false claims. Thus, it is critical to establish a testing and compliance regime that minimizes the risk of false and inaccurate declarations of product energy performance.

Appliance energy performance is determined by product testing; for the testing to be credible, there needs to be:

- confidence in the accuracy of the measured results
- confidence in the validity of the declared results

Chapter 4 addresses the establishment of test protocols and facilities. In this chapter, we examine the different types of testing and compliance regimes and their role in ensuring confidence and consistency in test results and communicating results to the public. In particular, this chapter addresses the establishment of a testing, accreditation, certification, verification, and compliance regime as a means of ensuring program integrity and public confidence. Each of the key terms is explained in the next section.

8.2 Concepts and Definitions

Once standards-setting and labeling programs are in place, energy-performance test results are needed before an appliance can be put on the market. The test results provide the information needed for the energy label and/or demonstrate that the product satisfies a minimum energy performance standard (MEPS). Additional energy-performance testing may be needed after an appliance has been on the market to demonstrate that the appliance still achieves the stated energy performance.

The degree of certainty required for the test results is a key aspect of program design and has implications not only for the credibility of the program impacts, but also for the cost of implementing the program. In practice, all standards-setting and labeling programs strike a balance between the conflicting aims of maximizing reliability of the reported test results and minimizing program costs.

8.2.1 What is a Test?

A test is defined by the International Standards Organization (ISO)/(International Electrotechnical Commission (IEC) Guide 2 as a "technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure." Test data result from the performance of a test. If the test method is well written, it is sufficient for the test data to comply with the test method's requirements for accuracy and variability. Testing is performed in test laboratories; energy-performance test protocols and facilities are discussed in Chapter 4.

8.2.2 What are Accreditation and Certification?

Accreditation is the process of verifying that a test laboratory is competent to do a specified test.

Certification is the process of endorsing (usually through verification) the validity of declared results.

8.2.3 What is a Verification Regime?

A verification regime is the process specified by the agency authorizing the standards and labels to determine whether the declared energy performance of equipment available on the market is accurate.

8.2.4 What is a Compliance Regime?

A compliance regime is the process by which the agency operating the program aims to ensure that market actors abide by the program requirements and that appliances are not labeled with false information. A compliance regime includes the elements above plus additional legal steps.

8.2.5 Steps in Establishing Testing, Verification, and Compliance Regimes

The major steps in ensuring the integrity of energy-efficiency labeling and standards-setting programs are shown in Figure 8-1.

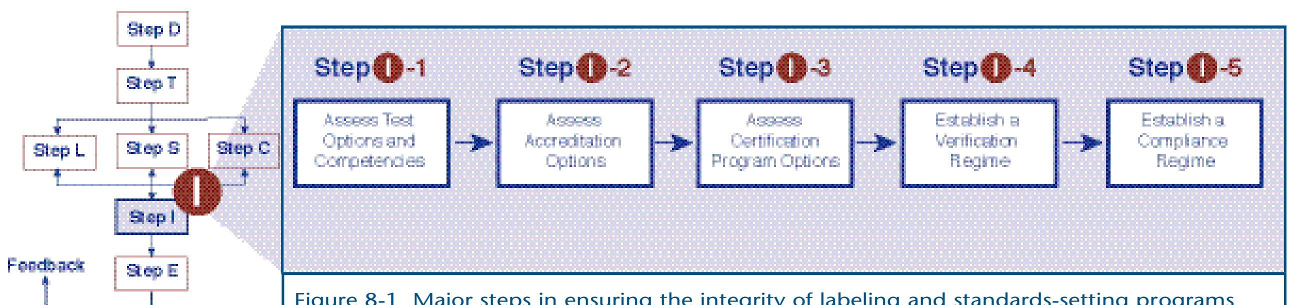


Figure 8-1 Major steps in ensuring the integrity of labeling and standards-setting programs

Each of these steps is discussed in Sections 8.4 through 8.8 below. It is important to note that the design of accreditation and certification regimes requires highly specialized expertise. It is generally best to consult an expert familiar with ISO test lab accreditation and test standards while designing these parts of a standards and labels program, as designing these elements would be extremely challenging work for a program manager who is new to the field.

8.3 Technical Sources of Error and Variability in Measuring Equipment Energy Performance

When designing a testing and compliance regime for standards-setting and labeling programs it is important to have a clear idea of how and why equipment energy performance might vary from one test to another and how the type of testing and compliance regime that is established might minimize variation. It is important that the testing regime minimize the risk of systematic errors. This might mean, for example, avoiding test labs that fail to adequately calibrate equipment or cross reference test results and that consistently record energy consumption values that are significantly lower (or higher) than the "true" values.

8.3.1 Sources of Error

In measuring the energy performance of equipment, technical errors can result from:

- inaccuracy in the equipment used to measure the test results
- variability in the accuracy of the equipment used to measure the test results
- variability in the environmental conditions maintained during the test (e.g., different ambient temperatures or airflow rates)
- variability in the procedure followed when conducting the test (i.e., variability in the way the test is set up and conducted)
- variability among individual products within a product class
- deterioration of a product's energy performance as the product ages
- inexperience of technicians performing the tests

The more complex the test procedure and the more sensitive the energy-performance results are to the test conditions, the greater the likely variability from one test to another. Furthermore, most standards-setting and labeling programs apply to mass-produced energy-using appliances such as refrigerators and air conditioners. Because energy tests for these appliances are time consuming and costly, it is impractical to require that each unit (e.g., every single air conditioner) be tested. Instead, testing regimes usually require that a sample of units be tested for each model. For example, if a manufacturer produces a particular model of refrigerator-freezer with a model reference code of ZK200, the test regime may require a small sample of all the ZK200 appliances to be tested to determine the energy performance of the model in general. The assumption is that the production of the ZK200s is sufficiently standardized that the measured energy performance of the sample will be representative of all the ZK200s being produced; however, in practice, the actual variation in energy performance from one ZK200 to another will depend on the degree to which the manufacturer has standardized the production process.

Most energy-using appliances addressed by standards-setting and labeling programs are relatively stable, so their physical characteristics are unlikely to change much within the first few years following their manufacture. If for some reason different-aged products were being tested, deterioration in performance over several years could introduce another source of variability.

8.3.2 Assessing the Competence of Testing Laboratories

Because of the inherent variability of products, described above, most test laboratories and procedures are evaluated by testing a single piece of equipment repeatedly in a single laboratory or shipping it from laboratory to laboratory to enable fair comparisons. Two concepts are applied to describe errors in measuring the energy performance of a single piece of equipment: *accuracy* and *variability*. The following paragraphs address the *accuracy* and two types of *variability* (*repeatability* and *reproducibility*) of test results.

8.3.3 Accuracy of Testing Laboratories

Accuracy refers to the degree of departure of the test result from the "true" value. For example, if a device whose power consumption is 1,000 W is measured and the result is 1,001 W, the test or measurement is inaccurate by 1 W. Benchmarks abound for the reasonably achievable accuracy of energy performance tests for various products. Labeling and standards program developers and mangers should insist on internationally accepted, high levels of accuracy for the equipment and procedures used in their verification regime.

8.3.4 Variability Among Testing Laboratories

Variability refers to the degree of difference among the results of several repetitions of the same test. For example, if the above device with a power consumption of 1,000 W were measured three times and the power consumption was recorded as 1,001 W, 999 W, and 1,000 W, these results are less variable than if measurements for that product were 950 W, 1,000 W and 1,050 W although the mean value is the same in both cases. This variability in test results for a particular new product may be different than the inherent variability in the performances of the many products that may be produced in a particular production line or the possible variability in the performance of a particular product as it ages. The issue here is in the variability in testing, not variability in the *product*. Variability in testing can be further defined in terms of *repeatability* and *reproducibility*.

Repeatability is a measure of the consistency of test results within a particular test facility. It is the variation among the test results when the same refrigerator, for example, is tested more than once in the same test laboratory.

Reproducibility is a measure of the variation of test results among different test facilities. It is the variation among the test results when the same refrigerator is, for example, tested according to the same test protocol in different test laboratories. Achieving an acceptable level of reproducibility is a key challenge for conformity assessment programs that use multiple laboratories. As with the testing accuracy, program developers and mangers should insist on internationally accepted, high levels of repeatability and reproducibility from the test facilities used in the testing regime.

8.3.5 Acceptable Targets for the Variability of Test Results

To meet good international standards, test labs doing compliance or certification testing for refrigerators should achieve:

- repeatability of measurements within ±2% and
- reproducibility (with other labs in the same testing program) of ±4%.

Failure to attain these levels implies a flaw in the testing system. The most serious flaws are fundamental inadequacies in the test facilities because these problems may require complete or partial rebuilding of the facilities to rectify the problem. Program managers need to be aware that existing test facilities in the private and/or public sector are not always adequate to meet internationally acceptable standards of repeatability and reproducibility. When this is the case, the facilities should be rebuilt or a decision must be made to allow measurements that fall short of international norms. In the latter case, it is often difficult to export products without paying for additional testing in an international facility.

8.4 Step I-1: Assess Options and Competencies for Testing Products

Generally, standards-setting and labeling programs are initiated and run by government agencies although some private-sector examples exist. Usually distinct bodies (agencies) are individually responsible for testing, certification, accreditation, and verification although some of these responsibilities may be assumed by a single entity. To be credible, agencies involved in accreditation and certification need to be independent third-party bodies, meaning that they are wholly independent from the suppliers of the equipment to be certified or of the test laboratories seeking accreditation. The agency operating the standards-setting and labeling program should designate the agencies responsible for each of these tasks within the program. For voluntary programs, the agency managing the standards and labeling scheme typically has complete freedom to set its own rules for program participation and to choose the agencies it wishes to handle testing, certification and accreditation. The situation can be more complex for mandatory programs because the choice of testing, certification, accreditation, and verification regimes may be constrained by existing legal precedents and jurisdictions (e.g., the government agency operating the program may be legally required to use a specific accreditation body or may have to implement its verification process according to some existing legal framework).

Many countries initiating a standards or labeling scheme will find that there are inadequate testing capabilities to support the program, so additional testing capacity will need to be developed. Testing can be performed by laboratories differing widely in size, legal status, purpose, technical competence, and range of services offered. They may be:

- government regulatory laboratories
- government research laboratories
- government-supported laboratories
- college/university laboratories
- independent private-sector laboratories

- laboratories affiliated with or owned by industrial firms or industry associations
- manufacturers' in-house laboratories

Test laboratories can be for profit or non-profit and operate facilities in one or multiple domestic locations or countries.

Selection of a test regime is an integral part of the selection of verification and compliance regimes as described in Sections 8.7 and 8.8. Preparation for selecting the test regime begins with a careful assessment of the pros and cons of all the options. The material presented in Chapter 4 can be useful in that assessment.

8.5 Step I - 2: Assess Accreditation Options for Verifying the Competence of Testing Facilities and Legitimizing Test Results

Product tests, as described in the previous section, are often complex and require that identical conditions and procedures be established and followed each time tests are conducted. As a result, program managers should not assume that a testing regime will produce acceptable levels of repeatability and reproducibility for test results until this has been reasonably proven. To increase the chances that testing will achieve repeatable and reproducible results, program managers must require verification of the competence of the test laboratories involved in the program and standardization of laboratory procedures. Accreditation aims to verify competence and standardization.

Laboratory accreditation is a specialized process and requires a competent accreditation body (AB) to carry it out. There are well-established and accepted international requirements for ABs, which are set out in ISO Guide 58 (ISO 1993). This guide stipulates that the AB should be an independent organization capable of auditing and assessing the proposed laboratories. The requirement of independence means that the AB should have no connection with the laboratories that it accredits and no interest in whether the application for accreditation is successful or not.

One of the goals of accreditation is to harmonize the application of test methods and submission of test results. In most industrialized nations, there is one national AB that is responsible for accreditation of all types of laboratory tests, most of which do not concern energy (e.g., product safety, noise, durability, electromagnetic properties). Thus, the decision of whether or not to establish a national accreditation body is normally made outside the domain of the energy-efficiency standards-setting and labeling effort and will typically be part of a national industrial strategy. If no competent national accreditation body is available, it is possible to seek accreditation from an established international AB (see insert: *International Accrediation Bodies* on next page). If an AB (national or international) is designated to support the labeling or standards program, it needs to have developed competency to accredit labs conducting each of the specific product tests being considered before it can issue accreditation for those tests. Accreditation is given on a test-by-test basis, not on a facility basis, so it is common that test labs are

International Accreditation Bodies

The International Laboratory Accreditation Cooperation, ILAC, has three types of members as defined below:

FULL MEMBERS

Accreditation bodies that meet the requirements for Associates and have been accepted as signatories to the ILAC MRA

ASSOCIATES

Accreditation bodies that:

1) operate accreditation schemes for testing laboratories, calibration laboratories, inspection bodies, and/or other services as decided from time to time by the ILAC General Assembly;
2) can provide evidence that they are operational and committed to comply with:
   (a) the requirements set out in relevant standards established by appropriate bodies such as the ISO and the IEC as well as ILAC application documents and
   (b) the obligations of the ILAC MRA
3) are recognized in their home economy as offering an accreditation service.

AFFILIATES

Accreditation bodies that are:

1) currently operating, being developed, or intended to be developed for testing laboratories, calibration laboratories, inspection bodies, and/or other services as decided from time to time by the ILAC General Assembly and
2) declare their intention to operate their accreditation programs in compliance with the requirements set out in relevant standards established by appropriate international bodies such ISO and IEC as well as ILAC application documents.

accredited to conduct some tests but not others (see insert: *The Process of Becoming Accredited* on page 212–213).

8.5.1 Ensuring International Acceptability of Test Results

Most countries, including all industrialized countries, are signatories of the International Laboratory Accreditation Cooperation (ILAC), which is a formal agreement to encourage international recognition of accreditation schemes and test results reported by accredited laboratories. If a test lab has been accredited by an ILAC member agency to perform a specific test, then ILAC signatory countries are legally obligated to accept the lab's results if produced according to that specific test. It takes considerable effort on the part of a national accreditation agency to receive ILAC membership; the agency must be able to demonstrate repeatedly high standards; however, once the agency is an ILAC member, the way is opened to much decreased accreditation costs and wide access for national producers to international product markets. A full listing of ILAC Members is in Table 8-1.

8.6 Step 1-3: Assess Certification Program Options for Validating That Products Comply with Standards and Label Requirements

As with the selection of a test regime, the selection of an AB and an accreditation process is an integral part of the selection of verification and compliance regimes as described in Sections 8.7

Table 8-1 **ILAC Members Listed by Category**

ILAC members are accessible around the world.

Full Members (MRA Signatories)	
1	National Association of Testing Authorities, Australia (NATA), Australia
2	Bundesministerium fur Wirtschaft und Arbeit (BMWA), Austria
3	Belgische Kalibratir Organisatie/Organisation Belge D'Etalonnage (BELTEST BKO-OBE), Belgium
4	General Coordination for Accreditation (CGCRE/INMETRO), Brazil
5	Standards Council of Canada (SCC), Canada
6	Hong Kong Accreditation Service (HKAS), Hong Kong, China
7	China National Accreditation Board for Laboratories (CNAL), People's Republic of China
8	Czech Accreditation Institute (CAI), Czech Republic
9	Danish Accreditation (DANAK), Denmark
10	Finnish Accreditation Service (FINAS), Finland
11	Comité Français d'Accreditation (COFRAC), France
12	DACH, Germany
13	Deutsches Akkreditierungssystem Prüfwesen (DAP), Germany
14	Deutsche Akkreditierungsstelle Mineralöl (DASMIN), Germany
15	German Accreditation Body Technology (DATech), Germany
16	Deutscher Kalibrierdienst (DKD), Germany
17	Hellenic Accreditation Council (ESYD), Greece
18	National Accreditation Board for Testing & Calibration Laboratories (NABL), India
19	National Accreditation Body of Indonesia (KAN), Indonesia
20	Irish National Accreditation Board (INAB), Ireland
21	Israel Laboratory Accreditation Authority (ISRAC), Israel
22	Sistema Nazionale per l'Accreditamento di Laboratori (SINAL), Italy
23	Servizio di Taratura in Italia (SIT), Italy
24	International Accreditation Japan (IA Japan), Japan
25	The Japan Accreditation Board for Conformity Assessment (JAB), Japan
26	Korea Laboratory Accreditation Scheme (KOLAS), Republic of Korea
27	Department of Standards Malaysia (DSM), Malaysia
28	Raad voor Accreditatie (RvA), Netherlands
29	International Accreditation New Zealand (IANZ), New Zealand
30	Norwegian Accreditation (NA), Norway
31	Romanian Accreditation Association (RENAR), Romania

Continued on next page

Table 8-1 **ILAC Members Listed by Category (continued)**

Full Members (MRA Signatories) - continued	
32	Singapore Accreditation Council (SAC), Singapore
33	Slovak National Accreditation Service (SNAS), Slovakia
34	Slovenian Accreditation (SA), Slovenia
35	South African National Accreditation System (SANAS), South Africa
36	Entidad Nacional de Acreditacion (ENAC), Spain
37	Swedish Board for Accreditation and Conformity Assessment (SWEDAC), Sweden
38	Swiss Accreditation Service (SAS), Switzerland
39	Chinese National Laboratory Accreditation (CNLA), Chinese Taipei
40	The Bureau of Laboratory Quality Standards, Department of Medical Sciences, Ministry of Public Health, Thailand (BLQS-DMSc), Thailand
41	Thai Industrial Standards Institute (TISI), Thailand
42	United Kingdom Accreditation Service (UKAS), United Kingdom
43	American Association for Lab Accreditation (A2LA), USA
44	International Accreditation Service, Inc (IAS), USA
45	National Voluntary Laboratory Accreditation Program (NVLAP), USA
46	Vietnam Laboratory Accreditation Scheme (VILAS), Vietnam
Associates	
1	Organismo Argentino de Acreditacion (OAA), Argentina
2	Instituto Nacional De Normalizacion (INN), Chile
3	State Office for Standardization and Metrology – National Accreditation Service (DZNM-NSO), Croatia
4	National Accreditation Body of Republica de Cuba (ONARC), Cuba
5	Egyptian Accreditation Council (EGAC), Egypt
6	National Laboratories Accreditation Bureau (NLAB), Egypt
7	Nemzeti Akkreditalo Testulet (NAT), Hungary
8	Iran Accreditation System (IAS), Iran
9	Jordan Institution for Standards & Metrology (JISM), Jordan
10	entidad mexicana de acreditación, a.c. (ema), Mexico
11	Pakistan National Accreditation Council (PNAC), Pakistan
12	Bureau of Product Standards Laboratory Accreditation Scheme (BPSLAS), Philippines
13	Polish Centre for Accreditation (PCA), Poland
14	Tunisian Accreditation Council (TUNAC), Tunisia

Associates (continued)	
15	Turkish Accreditation Agency (TURKAK), Turkey
16	Assured Calibration and Laboratory Accreditation Select Services (ACLASS), USA

Affiliates	
1	General Directorate of Standardization (DPS), Albania
2	Department for Standardization, Metrology and Certification under the RA Government (SARM), Republic of Armenia
3	Committee for Standardization, Metrology and Certification under Council of Ministers of the Republic of Belarus (Gosstandart), Republic of Belarus
4	Quality Management Program – Laboratory Services (QMP-LS), Canada
5	Cyprus Org. Standards & Control Quality (CYS), Cyprus
6	Organismo de Acreditacion Ecuatoriano (OAE), Ecuador
7	National Council of Science and Technology (NCST), El Salvador
8	Oficina Guatemalteca de Acreditacion (OGA), Guatemala
9	National Centre for Accreditation of Kazakhstan (NCAK), Kazakhstan
10	State Inspection for Standardization and Metrology of the Government of Kyrgyz Republic (Kyrgyzstandard), Kyrgyzstan
11	Mauritius Accreditation Service (MAURITAS), Mauritius
12	Department of Technical Supervision, Standardization and Metrology of the Republic of Moldova, Republic of Moldova
13	Ministry of Industry, Trade, Energy and Mines (MCI), Morocco
14	The Agency for Standardization, Metrology, Certification and Trade Inspection under the Ministry of Economics and Trade of the Republic of Tajikistan, Tajikistan
15	Trinidad & Tobago Bureau of Standards (TTBS), Trinidad And Tobago
16	International Accreditation Registry (IAR), USA
17	National Forensic Science Technology Center, Inc. (NFSTC), USA
18	TUV Rheinland of North America, Inc. (TUV), USA
19	National Accreditation Agency of Ukraine (NAAU), Ukraine
20	Uzbek Agency for Standardization, Metrology and Certification (UZSTANDARD), Uzbekistan

Reference: www.ilac.org

The Process of Becoming Accredited

Steps to Accreditation

The AB is responsible for developing an assessment procedure for each product category and test procedure for which it offers accreditation for (e.g., room air conditioners to be tested under ISO 5151: 1999).

To be internationally accepted, the accreditation assessment procedure should be based on ISO/IEC 17025 (ISO 1999) and assess the following items:

- staffing levels
- facilities or equipment available
- quality procedures
- test procedures
- calibration procedures
- maintenance procedures
- the qualification report

There is sometimes confusion between the ISO 9000 series requirements, which deal with general quality management and assurance issues) and ISO 17025. The latter is more stringent because it includes technical requirements for the operation of a testing laboratory [i.e., participation in proficiency testing (see below), adherence to specified test methodologies, and technical competence of laboratory personnel], which are not addressed in ISO 9002.

The accreditation body must test a laboratory's competence for each product and test category by:

- identifying the accreditation scheme and requirements
- preparing the program application form
- identifying standards and test methods
- making an informal visit
- evaluating the application and documentation
- performing on-site laboratory inspection
- resolving discrepancies (when found)
- witnessing testing and proficiency testing
- giving final approval and accreditation
- performing regular reassessment as defined in the accreditation scheme

Proficiency Testing

As discussed above, problems with the accuracy and variability of test results are due to not only

and 8.8. Preparation for that determination begins with a careful assessment of the pros and cons of all accreditation options.

Certification is done by a Certification Organization (CO). The CO provides the structure required and is responsible for defining and administering the certification program. The CO generally comprises either a governmental or an industry association tasked with implementing performance and energy-verification programs. Program documentation must be a procedural guide or operations manual. These documents should contain the information necessary to effectively operate a certification program for each product category.

The responsibilities of the CO may include:

- development of program documentation
- collection of statistical data

errors by laboratory staff or defects in test equipment but also to factors such as flaws or variables in the test method or in sample selection. The selection of good test methods is vital to the production of good test results. Because test results are an essential component of most conformity assessment programs, the ability to acquire good test data is also essential for the credibility of any certification program. Proficiency testing is defined in ISO Guide 43 (ISO 1997). A laboratory's compliance with ISO/IEC 17025 and ISO Guide 43 or their equivalent provides some assurance of the laboratory's competence. However, because ISO 17025 describes only general requirements, more specific requirements will likely be necessary for each product to be tested. A detailed acceptance criterion should be developed, which may include correlation (round-robin) testing of a reference sample at several laboratories. Round-robin testing is described in Subsection 8.7.2.

Role of the Assessor

An essential feature of all third-party laboratory accreditation schemes is on-site assessment for compliance with specified criteria. This assessment is carried out either by assessors directly employed by the accreditation body or, more commonly, by part-time expert assessors appointed by the body to act on its behalf. In either case, the assessor plays a vital role in determining the credibility of the scheme. Assessors should hold appropriate technical and professional qualifications and have recent experience in the activities they are going to assess. All potential assessors, regardless of background, experience, or qualifications, should attend an appropriate training course that familiarizes them with the relevant accreditation criteria, assessment techniques, and human aspects of assessment. At the end of a training course successful participants should:

- be familiar with the specific requirements of ISO/IEC 17025, ISO/IEC Guide 43, ISO Guide 58 and other requirements used by the AB
- know how to apply these requirements to specific calibration and testing laboratories
- be able, with the guidance and supervision of an experienced lead assessor, to plan, organize, conduct, and report on the assessment of a laboratory

- publication of directories of certified product
- selection of products
- ongoing evaluations of laboratories and proficiency testing

The CO may be required to:

- conduct factory inspections
- define and apply procedures to verify test data produced from a manufacturer's "Qualified Test Facility"
- set up and compile a verification record
- specify the information and format of a qualification report

8.6.1 Third-party Certification

With third-party certification, a producer's claim of conformity to a standard is validated by a technically and otherwise competent third party (i.e., a body not controlled by or under the influence of the producer or buyer).

The sponsor of the third-party program (the certifying organization) may be responsible for:

- collecting the required data
- generating test results or conducting inspections
- reviewing results of the above activities
- making a final determination on the product's conformance or lack of conformance

The certifying organization may also delegate all or part of the data collection and review activities to another party or parties.

The degree of confidence that can be placed in third-party certification programs varies greatly depending on:

- the number and types of testing/inspection methods used within the program to ensure product conformance
- the adequacy of the manufacturer's quality-control system
- the competence of the body that conducts the testing and/or inspection and evaluates the test results

Recommended criteria and procedures for third-party certification programs can be found in ISO/IEC Guide 65 (ISO 1996).

8.6.2 Laboratories Used for Product Certification

Testing laboratories will test the products and report the results to the CO as defined by the procedural guide for the standards or labeling program. Typically, testing laboratories need accreditation by the AB prior to initiating any testing for the CO. The test laboratory should be an independent third-party organization with strict confidentiality procedures.

Responsibilities of the test laboratory include:

- adherence to ISO 17025 requirements
- participation in ongoing laboratory evaluations such as proficiency testing
- independence, i.e. the laboratory should not be associated with manufacturers

As with the selection of a test regime, an AB, and an accreditation process, the selection of a CO and certification process is an integral part of the selection of verification and compliance regimes as described in Sections 8.7 and 8.8. Preparation for selection of a CO and certification process begins with a careful assessment of the advantages and disadvantages of all options. A list of standards applicable to test laboratories and to accreditation and certification bodies is provided in Table 8-2.

Table 8-2 **International Standards Applicable to Test Laboratories and Accreditation and Certification Bodies**

There are several international standards to help guide product certification.

ISO/IEC Guide 28:	General rules for a model third-party certification system for products
ISO/IEC Guide 43-1:	Proficiency testing by inter-laboratory comparisons
ISO/IEC Guide 44:	General rules for ISO and IEC international third-party certification schemes for products
ISO/IEC Guide 58:	Calibration and testing laboratory accreditation systems—General requirements for operation and recognition
ISO/IEC Guide 61:	General requirements for assessment and accreditation of certification/registration bodies
ISO/IEC Guide 65:	General requirements for bodies operating product certification systems
ISO/IEC TR 17010:	General requirements for bodies providing accreditation of inspection bodies
ISO 17025:	General Requirements for the Competence of Calibration and Testing Laboratories)

8.7 Step I-4: Establish a Verification Regime for Declaring and Verifying that Manufacturers Are Complying with Standards and Label Requirements

In both theory and practice, there are many permutations of the testing, reporting (declaration), and verification regime used to support standards-setting and labeling programs. Verification procedures can be separated into two broad categories: those that apply when a product is first introduced to the market and those that apply to products already on the market.

8.7.1 Verifying a Product's Performance When It Is First Introduced to the Market

Depending on the scheme adopted, product suppliers may have to meet certain requirements before they can put their products on the market. For example, a supplier may be required to register the product with a government office or a designated certification body, which may entail acknowledging awareness of all the legal requirements pertaining to the standards-setting and labeling program and asserting that the product meets those requirements. Alternatively, there may be no registration requirement, and the supplier may be free to put its product directly on the market as long as, for example, the product is supplied with an energy label.

Similarly, a supplier putting a product on the market may be required to prove that the product's energy performance has been tested. Proof may entail sending a test report to the registration or certification body. Alternatively, proof of testing may be accepted based on trust, and it might suffice to simply report the test values (either to the registration body or on the energy label and in the product documentation) without supplying a test report.

Also, there may or may not be requirements related to the competence and independence of the laboratory doing the test (i.e., the lab may or may not have to be accredited to do the test and be independent of the supplier).

If the supplier of the product (the manufacturer or importer) is allowed to make its own declaration of the product's energy performance when the product is first put on the market, this is termed "self-certification." Self-certification applies even when the product is tested in a third-party laboratory if the testing is done at the manufacturer's behest and the manufacturer controls the distribution of the test results. If a third-party laboratory is required to determine the energy-performance values and a third-party certification body to declare the results, this is termed "third-party certification."

The combinations of the elements described above result in four levels of self-certification and one of third-party certification as shown in Table 8-3.

Table 8-3 **Types of Certification**

Requirements for certification may vary.

Certification Type	Registration	Test Report	Proof of Accreditation of Test Lab
Requirement for Type A self-certification	–	–	–
Requirement for Type B self-certification	✓	–	–
Requirement for Type C self-certification	✓	✓	–
Requirement for Type D self-certification and 3rd-party certification	✓	✓	✓

In addition, any of the following test lab options may be used or required for initial testing with Type D self-certification and third-party certification:

a) a single government-designated lab

b) a single third-party lab managed by a certification body

c) one of several government-designated labs

d) one of several third-party labs managed by a certification body

8.7.2 Check Testing Products Already on the Market

Once a product has been placed on the market, the agency operating the standards-setting and labeling program can verify that the declared energy performance is accurate by operating a check-testing program. Check testing involves taking a sample of products either from the factory floor or from the point of sale for independent third-party testing. In some cases, a single test laboratory is used for this testing; in others, multiple laboratories are used.

If a single test laboratory is recognized as the reference laboratory for the program, it is not always necessary for the laboratory to be accredited (although accreditation is clearly preferable). However, if the lab is not accredited, the following complications can be expected:

- If the laboratory is not also used for the initial energy-performance tests that must be reported when a product is first released, suppliers can justly complain that they have no means of knowing whether the tests that they commission for first declarations will tally with the later check tests or not.
- Results will not be accepted outside the jurisdiction of the program.

If multiple labs are used for check-testing, it is essential that they be accredited and conduct regular cross-testing among each other (i.e., that they establish and regularly reestablish that they have acceptable levels of reproducibility for the given test). One commonly used cross-testing process is round-robin testing in which the same sample is sent for testing to each of the labs concerned. The sample can be tested at a coordinating lab at the beginning and end of the process to ensure that no significant changes have taken place in the sample during the round-robin test period, or the sample can be returned to the coordinating lab for testing after each test and before it is send out to the next lab. Comparison of the results produced by each lab identifies adjustments needed by any lab to produce conformance to the testing procedure.

Any of the test lab options listed for initial testing with Type D self-certification and third party certification may also be applied for check testing.

8.7.3 Advantages and Disadvantages of Each Approach

Program managers and regulators need to strike an appropriate balance between the rigor and comprehensiveness of the testing, certification, accreditation, and compliance regimes and the cost and feasibility of their implementation. It is important for standards-setting and labeling programs, particularly compliance requirements, to be designed to appropriately account for the capacity of market players to supply standardized products. The most appropriate solution will vary from one country to another and will depend on a number of locally specific issues. Nonetheless, the following broad conclusions can be drawn:

- Relying on pure self-certification with no additional means of verifying claimed performance may result in poor program credibility and widespread abuse.
- The degree to which manufacturers can be relied upon to check each other's products and report suspected abuses to regulators will depend upon the size, resources, and capabilities of the manufacturing sector. In general, this approach is only likely to be successful if there is strong competition regarding energy performance and if the industry is highly concentrated, well resourced, and strongly competitive.
- Industry is only likely to be able to establish a credible third-party certification program if the industrial sector is well organized, well resourced, and strongly competitive and if there is an established, dominant trade association.

- Verification testing is likely to be cheaper than government-operated certification, but is usually less comprehensive.
- Government-sponsored certification becomes a more attractive solution when local industry does not have the required testing capacity, and there is no third-party lab locally available for initial product testing.
- Accreditation and proficiency testing are essential if more than one laboratory is to be used for compliance (verification) testing or for government certification.
- Using a single lab for certification and/or verification testing avoids reproducibility tolerances but results in the lab in question becoming a reference lab for all self-certification testing (i.e., testing done in the suppliers' own labs).

8.8 Step I - 5: Establish a Compliance Regime for Ensuring that Manufacturers Are Complying with Standards and Label Requirements

Testing, accreditation, certification, and verification all contribute to the overall compliance regime; however, to be complete, the regime also requires additional measures to monitor compliance and address non-compliance.

8.8.1 Establishing a Legal Basis and Identifying Degress of Non-compliance

The legal basis of the program needs to be firmly established so the compliance conditions can be fixed. If the program is mandatory and a government driven program, it will require legal sanction and establishment of penalties and procedures to address non-compliance. The legal basis for punishing non-compliance sometimes has to be built from scratch, but it is also common that relevant legislation is already in place (e.g., for safeguarding the integrity of information provided to consumers), and non-compliance can be addressed within the framework of that existing legislation.

If participation in the program is voluntary, as for endorsement labeling, abuses can be treated softly e.g., with threats that endorsement will be removed and/or abuses publicized. If a country has a copyright law, it is possible to protect a voluntary label by copyrighting it and then addressing any abuses under the provisions of the copyright law.

8.8.2 Types of Abuse

Several types of potential abuse need to be considered in the compliance regimes of standards-setting and labeling programs, related to different actors in the marketplace.

Potential abuses involving suppliers of the original equipment (manufacturers or importers):

- failure to provide an energy label or other required energy-performance rating information
- failure to register a product (if required)
- failure to provide proof of testing (if required)
- failure to submit a product for testing (if required)
- failure to cooperate with certification or verification testing bodies
- falsification of a product's energy performance resulting in misleading labeling or a false statement of compliance with a MEPS

Potential abuses involving the resellers of equipment (retailers, wholesalers and distributors):

- failure to provide an energy label or other required energy-performance rating information
- failure to display an energy label or other required energy-performance rating information at the point of sale
- falsification of a product's energy label or a false statement of compliance with a MEPS
- failure to provide required energy-performance information in product catalogs, websites, or other promotional media (if required)
- failure to register a product (if required)
- failure to provide proof of testing (if required)
- failure to submit a product for testing (if required)
- failure to cooperate with compliance authorities

8.8.3 Establishing Penalties for Non-compliance

Penalties are a necessary but insufficient component of compliance regimes. Penalties need to be firm enough to deter non-compliance but, no matter how draconian, will have no impact if mechanisms are not also in place to monitor compliance. International non-compliance penalties range from informal warnings to exorbitant fines that could cause a business to go bankrupt. Typically, penalties take into account the scale of the abuse, the degree of intent or negligence, and other factors such as the financial resources of the perpetrator. A common penalty for manufacturers whose products fail to attain the required or stated energy performance level is removal of the right to sell the product plus some kind of fine. These measures can also be complemented by public embarrassment of the offender through publication of the offense.

8.8.4 Designing Compliance Agencies and Establishing Compliance Monitoring

Mandatory programs must establish or designate an agency that is responsible for coordinating compliance issues. This agency is sometimes the same one that initiated the standards-setting and labeling program [e.g., U.S. DOE or the Tunisian Agency for Renewable Energy (ANER)]. In other cases, agencies responsible for compliance are separate from the standards-implementing agency. For example, in Europe the labeling program is initiated and managed by the European Commission, but enforcement is the responsibility of each E.U. member state and its designated agencies. Whatever the coordinating agency is, it will often work with other governmental agencies to establish the compliance regime. For example, in the U.K., compliance actions are administered by the Department of Environment, Food, and Rural Affairs in coordination with Customs and Excise (which handles imports and exports) and local authorities who manage a network of officers monitoring trading standards compliance for all manner of traded goods and services.

Building a reliable compliance monitoring process is a key element in ensuring a program's integrity. In the case of mandatory MEPS, compliance authorities are concerned with 1) ensuring that all appliances on the market are registered as complying with the performance requirements (i.e., only registered appliances are on the market) and 2) ensuring that the declared energy performance of appliances is accurate. For mandatory energy labeling, an additional monitoring requirement is needed to ensure that labels are correctly displayed at the point of sale and that they are provided as required through all other points of the distribution chain.

Monitoring compliance regarding the correct display or provision of energy labels by retailers, wholesalers, and distributors is a simple matter of organizing inspections (typically unannounced) of premises. Incognito inspectors posing as consumers can also see if retailers make false claims about the information provided on labels. Assessing false energy-performance claims is more complex. Typically governments rely on some combination of the following mechanisms:

- Verification testing (check testing), in which samples of appliances to be tested may be taken either from the factory floor, the point of sale, or both; and
- Challenge testing, in which manufacturers are informally encouraged to test their competitors' products and inform the authorities of suspected falsification.

Verification testing has the advantage that the government or administering agency has full control of the scale and nature of testing and is not reliant on the cooperation of commercial agencies. It also has the advantage of not requiring any testing competence among manufacturers and of ensuring a level playing field for manufacturers regardless of their testing capabilities. Similarly, it avoids the risk of collusion among manufacturers.

A good program requires verification testing. Challenge testing can be a valuable addition to, limiting (though not to zero) the need for government verification testing. Challenge testing has the sole advantage that it can significantly reduce the testing burden and thus costs to the administering agency; however, challenge testing presumes that manufacturers have the capability and motivation to do regular tests of their competitors' products. Challenge testing can be a reasonable option when there is a large, well-organized, highly competitive industrial base as is the case in large economies such as Europe and the U.S.; however, it is much less feasible in less-developed markets.

8.9 International Examples of Different Program Integrity Schemes

Examples from Australia, the E.U., the U.S., Tunisia, and the Philippines illustrate compliance verification by a government agency, self-certification under a regional policy, government reliance on private compliance certification, and government control of certification, respectively.

8.9.1 Compliance Verification by Government: Australia

Australia offers a good example of how a government can ensure compliance through verification testing. In Australia, energy labeling is mandatory under state government legislation and regulations that give force to the relevant Australian national standards (Harrington 1999). Regulations also specify energy labeling requirements for appliances, including offenses and penalties for non-compliance. To ensure a high degree of credibility and compliance, the state governments of Australia use a national testing program in which appliances are purchased from retail outlets and tested in accredited independent laboratories to verify the claims on the energy label and compliance with MEPS. This check-testing program publishes selection criteria, which target those appliances that appear most likely to fail the test rather than using random sampling to verify the detailed registration test reports that regulators require from suppliers registering appliances. Table 8-4 shows the large number of check tests that are conducted to confirm the accuracy of the representations on labels in Australia.

A large majority of check tests confirm the accuracy of suppliers' labeling representations.

Table 8-4 Results from the Australian Check-Testing Program 1991 to 2000

Year	Total Number of Appliances Approved by Regulators	Total Number of Checktest Failures	Percentage of Registrations that Failed
1999-2000	624	1[1]	0.2%
1998-1999	525	31	5.9%
1997-1998	668	20	3.0%
1996-1997	490	28	5.7%
1995-1996	359	39	10.9%
1994-1995	386	11	2.8%
1993-1994	369	14	3.8%
1992-1993	414	8	1.9%
1991-1992	322	0	0.0%

Source: Grubbert 2001

[1]: This low figure resulted from the reduced scope of the check test program in this year

Appliances that fail check testing in Australia are subject to a range of sanctions under state laws. Regulatory agencies ensure that appliance suppliers who fail check testing are given a reasonable opportunity to respond. If a supplier agrees with the check test, the appliance is "deregistered" (the supplier's right to sell the appliance is withdrawn). If a supplier disputes the check-test finding, the supplier is required to supply three additional units for testing at an independent laboratory. Statistical modeling has shown that failure of four units indicates a high probability that the model could not meet the standard's requirements.

Australia acknowledges that significant public resources are required to support check testing, not only to purchase and test units but also to foster the skills of the accredited testing laboratories. The costs of the check-testing program are shared between the public and private sector; all initial check tests are funded by government agencies, but any subsequent testing to verify or overturn the check-test result is at the supplier's expense.

The Australian Greenhouse Office has established an enforcement mechanism by entering into a memorandum of understanding with the Australian Competition and Consumer Commission, which employs a range of sanctions for misleading and deceptive conduct arising from wrongly labeled or non-MEPS-compliant appliances and equipment. These sanctions include possible fines of millions of dollars. In 2003, the enforcement mechanism was activated, resulting in a Chinese manufacturer and an Australian retail chain entering into agreements with the commission to publicly correct marketing claims about the efficiency of a range of washing machines.

8.9.2 Self-certification within a Regional Policy Framework: The E.U.

The E.U. energy-labeling scheme operates based on a self-certification process in which the product supplier is responsible for the accuracy of the information it provides on the energy label. To avoid trade barriers under the terms of the European Single Market, the energy-labeling rules are developed centrally by the European Commission and the Energy Labeling Regulatory Committee where each E.U. member state is represented by appointed representatives. Energy-performance test standards are also developed centrally by the European test standards agencies CEN (the European Committee for Standardization,) and CENELEC (the European Committee for Electrotechnical Standardization), which are direct counterparts of ISO and IEC.

Product suppliers have to provide proof of testing (energy test reports) upon request of the E.U. member state where the product is sold. The labs used to do this testing do not have to be third-party labs or accredited by law (although these requirements do apply for safety testing). However, many retailers and/or distributors require third-party certification as part of their own requirements for the performance and quality of the products they sell.

Enforcement of the labeling scheme is the responsibility of each E.U. member state, not the European Commission. Thus, although the commission can oblige member states to have an enforcement process in place, the commission cannot determine what that process should be. In consequence, the approaches used vary considerably among member states.

The first round of control is provided by manufacturer challenge testing of competitors' products. For example, members of the European Committee of Domestic Equipment Manufacturers (CECED) instigated their own internal challenge testing program. Within this program, if a manufacturer tests a competitor's product and finds that the product's energy consumption has been underreported, the testing manufacturer can issue a challenge through CECED. CECED will then arrange to have the appliance tested at a third-party laboratory, and, if the challenge is supported, the product supplier has to pay for testing and administration costs and relabel the product. However, if the challenge is not supported, the challenger has to pay all testing and administration costs. This agreement only applies to CECED members and thus does not cover the 10 to 15% of products manufactured by non-members.

Alternatively, the European air-conditioning manufacturer's association, Eurovent, operates its own certification schemes for 14 different types of air-conditioning equipment. Within these schemes, any manufacturer who wishes its products to be included in the Eurovent catalog and database has to abide by the certification process, under which Eurovent makes unannounced factory inspections and sends a certain percentage (which varies depending on the product type) of models produced by the manufacturer to a third-party lab for verification testing. If the energy performance is found to be overstated based on testing of the sample, the manufacturer has to amend the declared performance to accord with the third-party results or withdraw from the catalog the whole series of models related to the tested base model.

Aside from manufacturers' associations' own efforts, many European countries rely strongly on the results of product testing by third-party laboratories operated by consumer organizations. If the test labs operated by these bodies find that energy-performance results are overstated, the findings are publicized in widely read consumer's magazine test reports. These tests can also act as a screening mechanism for governments who wish to do their own limited verification testing with the intent of launching legal proceedings against abuses.

Some E.U. countries operate their own check-testing programs, in which the governments purchase samples of appliances on sale in the national market, test performance, and compare the results with the declared values. The most comprehensive scheme is operated in Denmark, but the Netherlands and the U.K. also conduct check-testing programs. Some E.U. countries have reached informal arrangements to share compliance test results and coordinate compliance testing activities.

8.9.3 Government Blessing of Private Certification Programs: The U.S.

The U.S. essentially operates a system of self-certification for product energy performance; however, labeling and standards are enforced through a mixture of industry-sponsored third-party certification schemes and challenge testing, depending on the product.

Under U.S. law, the U.S. DOE is given certain rights to enforce product MEPS; these rights include:

- access to manufacturers' records
- the power to oblige a manufacturer to supply products for third-party verification testing at the manufacturer's expense

- the ability to levy penalties of up to $110 for each violation or instance of non-compliance

A "violation" is defined as each unit sold for each day of non-compliance. Thus, if a manufacturer unfairly declared the energy performance of a product for a year during which time 5,000 units were sold, U.S. DOE could levy a penalty of up to $110 x 365 x 5,000 = $200 million. The magnitude of the penalty is discretionary up to the maximum limit; in practice, U.S. DOE would likely negotiate a penalty.

Mandatory Market Access Conditions

Before distributing its products, a manufacturer or supplier must send a certification report to U.S. DOE, containing energy-performance data and a completed compliance conformity declaration. In addition, suppliers have to file a report each time they discontinue a model, keep testing records for not less than 2 years, and provide access to their records on request from U.S. DOE.

The compliance statement must certify that:

- the basic models comply with the appropriate energy-conservation standards
- all required testing was conducted in conformance with appropriate test procedures
- the reported information is true, accurate, and complete
- the manufacturer or private labeler is aware of the penalties for violations of the act

For each basic model of an appliance, the certification report documents the model's energy-consumption characteristics and capacity.

Testing and Certification Regimes

Product suppliers have to conduct their own energy-performance testing and supply the data for both U.S. DOE's minimum efficiency standards program and the Federal Trade Commission (FTC) EnergyGuide labeling program. The same test procedure, designed and maintained by U.S. DOE, is used for both.

For residential consumer products marketed in the U.S., manufacturers must test a sample of each basic model of the product to establish its efficiency level and verify its compliance with the applicable energy-efficiency descriptor value specified by law. The test procedure for each product incorporates a sampling plan designed to give reasonable assurance that the true mean performance of the equipment being manufactured and sold meets or exceeds the applicable value and is accurately determined.

A pragmatic approach has been adopted to manage certification so that in cases where there is a strong and well-organized trade association that has initiated its own credible product-certification scheme, U.S. DOE will allow the trade association to compile and report test results in the form of a directory of members' products. Otherwise, manufacturers and other suppliers will send the test results and a completed regulatory compliance statement directly to U.S. DOE program managers.

Examples of trade-association-led certification programs recognized by U.S. DOE include:

- The Air-conditioning and Refrigeration Institute (ARI) program for central air conditioners,
- The program of GAMA, an association of appliance and equipment manufacturers, for water heaters, furnaces and boilers and
- The Association of Home Appliance Manufacturers (AHAM) program for room air conditioners.

Each of these certification programs employs an independent third-party lab to conduct verification testing as follows:

- manufacturers test their own units and submit the results to the trade organization
- the trade organization publishes a directory of their members' products, which includes the energy-performance results
- the trade organization contracts the third-party lab to test some of the units
- the third-party lab selects units, at random and without prior notice, from a warehouse or assembly line
- U.S. DOE is sent a copy of the directory

Typically, the third-party test laboratory will allow a 5% difference (tolerance) between a supplier's self-certified energy performance results and its own test results before any revision is made to the claimed efficiency. Witnesses are not allowed for the first verification test of a product by the third-party lab; however, if a supplier contests the results of the third-party test, the supplier is allowed to witness a re-test. If a product is tested because of a challenge from a competitor (i.e., because a competitor claims that the self-certified energy performance is false and issues a formal challenge through the challenge test procedures of the certification program), the competitor is not allowed to witness the product test.

Each of these trade-association-managed certification schemes has its own specific features. In the case of AHAM's certification program for room air conditioners, these are as follows:

- a directory of members' products is published twice a year
- a single third-party lab is used to do all the product verification testing
- EER values are reported to FTC and U.S. DOE
- every year 50% of each manufacturer's new models are tested by the third-party lab, and
- 10% of all models carried over from the preceding year are retested

Thus, overall, about 25% of models in the directory are tested in a third-party lab each year.

The decision about which specific models will be tested is made by the third-party test lab, so manufacturers have no advance notice of which models will be tested or when. If a manufacturer has incorrectly rated a model's EER or capacity, the manufacturer must inform the dealers of the new rating and must supply corrected energy labels. Meanwhile, AHAM notes the revised ratings in its directory. Any participant who does not comply with these requirements can no longer take part in the certification program.

The costs of the trade-association certification programs are paid by a pro-rata charge based on an assessment of the numbers of each appliance that are shipped.

8.9.4 Government-controlled Certification: Tunisia and the Phillippines

The state-controlled approach that is being adopted by Tunisia for its refrigerator energy-labeling program has been in use in the Philippines for some years. In the Tunisian refrigerator certification program, every model of refrigerator to be sold on the market has to be tested by the state-operated lab. A single sample of each model is sent to the lab for an energy-performance test. If the manufacturer accepts the results, this information is included on the energy label. The label is then printed by the government and supplied to the manufacturer. If the manufacturer does not accept the test results, the manufacturer can pay for and witness additional tests of other samples of the same model. To ensure that there is a limited risk of modifications to the model delivered for certification-testing compared with the model sold on the market, the Tunisian government also plans to carry out verification testing of appliances chosen at random at the point of sale.

9. Evaluating the Impact of Labeling and Standards-Setting Programs

Guidebook Prescriptions for Evaluating the Impact of Labels and Standards

1. To ensure efficient program design and data collection, begin the evaluation process as soon as you decide to establish a labeling or standards-setting program.
2. Before conducting the evaluation, make sure all the key stakeholders understand the objectives of the evaluation and the resources that are available and necessary for conducting the evaluation.
3. To minimize costs, try to leverage existing sources so that data-collection efforts can focus on primary data. Allocate some of the evaluation budget to up-front costs.
4. Establish a national appliance database, and develop a baseline ("market characterization") representing the appliances that are currently being promoted on the market.
5. At regular intervals, evaluate both the program implementation process and the program impact on energy consumption, emissions, energy bills, and the appliance market.
6. Use a diverse group of data-collection methods rather than relying on just one method.
7. Evaluate the impacts on all key stakeholders, including consumers, manufacturers, retailers, and policy makers.
8. Focus on how the evaluation findings will be used in: a) refining appliance labels and standards, b) improving the implementation of the labeling and standards program, c) supporting other energy programs and policies, d) forecasting energy use, e) conducting strategic planning, and f) carrying out regulatory proceedings.

9.1 Why Evaluation Is a Must and Not a Luxury

Traditionally, energy-efficiency programs have received only a fraction of the attention and resources allocated to the energy supply side. There are many possible causes for this, but perhaps the most important is the relative invisibility of energy-efficiency impacts compared to the easily observable impact of adding new energy supply.

9.1.1 Making the Case

Unfortunately, a major barrier to the implementation and expansion of energy standards and labeling programs in many developing countries is policy makers' lack of confidence in the effectiveness of labeling and standards. This lack of confidence can in large part be addressed by the presentation of clear evaluation results. Evaluations are needed to "prove" program impacts. As standards and labeling programs are increasingly implemented in developing countries, evaluation is expected to play a critical role in enhancing these programs' effectiveness and in convincing policy makers to adopt these measures through a gradual chain reaction.

If energy-efficiency policies and programs are to take their proper place, their benefits need to be clear, measurable, verifiable, and transparent. Quantifiable benefits are especially important for justifying that adequate funding and resources be allocated to a program. Many labeling and standards programs in developing countries have received seed money from donor agencies; however, this outside support cannot be expected to continue indefinitely and does not form a basis for sustainable program planning. Therefore, over the long term, a case needs to be made for support of standards and labeling programs by national sources.

Properly carried out, program evaluations quantify impacts and benefits in concrete terms, which can be the main evidence of the need to support the programs. Measuring impacts can justify allocation of resources to the program and demonstrate the need for funding that is sufficient to make the program effective. Policy makers will find evaluation results useful during internal discussions about governmental resource allocation in which they may be asked to prove that a program is generating sufficient savings. An evaluation can be designed with almost any level of resources to meet prioritized needs of time, cost, or accuracy.

9.1.2 Assessing the Program

In addition to justifying program funding, evaluations serve a second, equally important function: they assess the efficiency and effectiveness of the program process, revealing potential weaknesses in program implementation so these problems can be corrected. In the long run, this helps guarantee and enhance the program impacts. For example, an early evaluation of the European Union's appliance labeling program showed that the label was not being applied correctly by a large number of retailers, which allowed corrective action to be taken.

9.1.3 State of the Art

Unfortunately, there has been very little post-implementation evaluation of appliance standards and labeling programs although this situation is beginning to change. In the U.S., most impact assessments of efficiency standards have taken place just prior to adoption of new efficiency standards, based on forecasted information about product shipments and customer use (Nadel 1997). These evaluations rarely use field measurements, nor do they attempt to systematically examine what would have happened if standards had not been adopted (Meier 1997; Nadel 1997).

One evaluation of the U.S. federal energy-efficiency standards for residential appliances used a spreadsheet accounting method that tracked shipments of a given product in each year (along with average annual energy use or energy efficiency of a given product sold in each year), created a base-case scenario that assumed no standards were or will be implemented, and then compared various scenarios with standards to the base case (Meyers et al. 2002).

Many past evaluations of appliance-labeling programs have focused on consumer awareness of the label but have not explicitly linked the label to actual behavior (i.e., to the efficiency of the appliances purchased and to the most likely purchase if there had been no label). However, some evaluations of appliance-labeling programs do include data on actual sales and behavior. Examples include evaluations of the European labeling program (Beslay 1999; Schiellerup and Winward 1999; Waide 1997, 1998; Winward et al. 1998) and the labeling programs in Australia (Harrington and Wilkenfeld 1997), Denmark (Karbo et al. 2002), Thailand (Agra Monenco, Inc. 2000a, 2000b), the state of Vermont (Rosenberg 2003), and the U.S. (du Pont 1998a 1998b; Thorne and Egan 2002).

Whether estimated or measured, the impacts of standards and labeling programs have been dramatic. For example, the E.U. energy label has been an undeniable success in terms of its market transformation impact. As described in insert: *Comprehensive Evaluation of the E.U.'s Labeling Program* on next page, market evaluations have shown a clear and strong evolution of the market toward higher efficiency products since the introduction of the E.U. label. Much of the credit for the label's success must be attributed to its design.

A series of evaluations has also shown that the Thai energy label has been effective (du Pont 1998a 1998b; Agra Monenco, Inc. 2000a, 2000b; Singh and Mulholland 2000.) Insert: *Evaluation of the Thai Labeling Program Using Manufacturer and Consumer Surveys* on pages 233–235 describes an evaluation of the Thai labeling program for refrigerators and air conditioners, which helped to solidify support among Thai policy makers for continuation and expansion of the program. In addition, the evaluation gave credibility to the program results, and Thailand is now known as a regional leader in energy labeling and is an example for policy makers designing programs in Southeast and South Asia.

Future evaluations of labeling and standards-setting programs are likely to be more comprehensive than has been the case so far because labeling and standards programs are designed to be market-transformation strategies (e.g., see Barbagallo and Ledyard 1998; Hagler Bailly 1996, 1998; HBRS 1995; Hewitt et al. 1998; Pacific Energy Associates 1998; Vine et al. 2003; Xenergy 1998).

9.1.4 Planning

Because appliance and equipment efficiency levels are incredibly dynamic and can change very quickly, evaluations are essential for planning the subsequent program steps. For example, categorical energy labels (which are the dominant form of label internationally) require regular evaluations of market impact to determine whether the top efficiency classes are becoming saturated. If this is found to be the case, then the label can be judged a success; however, it most likely also means that it is time to reclassify the efficiency grades upwards so the label can continue to have an impact on the market.

Comprehensive Evaluation of the E.U.'s Labeling Program

The E.U. introduced framework legislation for mandatory energy labeling in 1992 and has since issued product-specific energy-labeling directives for refrigerators and freezers, clothes washers, clothes dryers, combined clothes washers and dryers, dishwashers, household lamps, ovens, and room air conditioners.

Evaluation of the labeling scheme has monitored retailer, distributor, and manufacturer compliance with the legislation and assessed impacts on energy use, energy efficiency, CO_2 emissions, and cost trends. Because the energy label for refrigeration appliances (refrigerators, freezers, and their combinations) was the first to be introduced, this category has received the most attention to date. Two years after the implementation of the labeling program for refrigerators, the European Commission launched a study to assess legislative compliance and program implementation issues and a set of successive studies to assess quantitative sales-weighted energy efficiency, energy, and emissions trends. The implementation/compliance study involved the following steps:

- surveys of representatives to the European Commission's Energy Labeling Committee, (10 retail outlets in each member state, 16 mail-order catalogs in eight member states, and numerous customers), to assess compliance, learn about consumer attitudes and responses, and discover any legal and governmental issues that may have arisen in each country
- independent tests in consumer association laboratories across the E.U. to evaluate the accuracy of manufacturer product-performance declarations
- interviews with manufacturers and retailers to assess their attitudes and responses and discover any concerns that may have arisen

The successive quantitative studies evaluated the sales-weighted efficiency trends of refrigeration appliances, clothes washers, washer-dryers, and household lamps sold in the E.U. up to 1998 and compared these trends to the pre-labeling levels (e.g., circa 1992 for refrigerators). Although these studies examined the impact of labels, several interlocking policies, of which labeling was one, were in effect during this period, including pending minimum energy performance standards (MEPS) and/or voluntary agreements (depending on the appliance) as well as various national and regional incentive programs. Yearly data on the sales volume and average retail prices of individual appliances were purchased on a country-by-country basis from established market research agencies. These data were then matched to separate databases containing model-by-model information on the technical characteristics of the appliances, including all aspects needed to evaluate energy consumption and efficiency. The quantitative assessment found that the sales-weighted efficiency of refrigeration appliances improved by 17.6% from 1992 to 1998. Furthermore, this detailed evaluation provided clear evidence of the distinct impact of the energy label as opposed to other E.U. policy measures such as MEPS. The data on the distribution of refrigerator sales by energy efficiency index (Figure 5-3 in Chapter 5) demonstrate that the categorical label design has not only stimulated consumer demand for higher-efficiency products but has also moved manufacturers to develop products targeting specific higher efficiency thresholds both in advance of (i.e., in anticipation of) and in response to heightened consumer demand (Waide 1998, 1999). This demonstrates the clear value of using a categorical efficiency scale with higher efficiency thresholds that challenge manufacturers to develop more efficient products.

This kind of detailed evaluation based on matching between technical and sales databases has not been repeated since; however, market research companies have continued to collate data on sales by label class; from these data, it is possible to make a less refined evaluation of impacts than was made in the original evaluation. Average energy efficiency is estimated to have improved by 37% for refrigerators and freezers (Figure 2-5 in Chapter 2 shows the shift to higher efficiency label categories (Waide 2004; GfK 2003)), 21% for clothes-washers, and 35% for dishwashers since the introduction of labeling, at average rates of 4.0%, 3.7% or 6.5% per annum, respectively.

The use of a common efficiency scale and format for all labeled products is also reported to have aided comprehension and "brand" recognition levels, the latter of which are said to be very high. Regrettably, data are not available on the impact of the decision to add the A+ and A++ classes for the refrigerator label, but the small amount of information available suggests that consumers would have found a regrading of the existing A to G scale easier to comprehend.

Compared to a static-efficiency base-case scenario (assuming average efficiency frozen after 1999 at late-1999 levels), it has been estimated that the improvements in refrigeration appliance efficiency for the 25-year period ending in 2020 will be: 398 TWh of energy savings, 56 billion of avoided electricity bills , and 237 megatonnes of avoided CO_2 emissions. These figures are based on the assumption that declared energy consumption equals actual consumption, which is supported by some regionally specific end-use metering studies. The accuracy of the consumption numbers for individual models has sometimes been questioned based on concern that the results of these studies may not be applicable to the entire E.U. The uncertainty results primarily from assuming that energy consumption under standard test conditions is representative of energy consumption in consumers' homes. Also, the frozen-efficiency base-case scenario overstates the savings because efficiency would have increased to some degree in the absence of labels as a result of MEPS, other programs, and uninduced technological innovation.

The compliance/implementation assessment found that implementation of the legislation varied considerably among member states. Both Germany and Italy implemented the legislation within their borders only in 1998 and 1999, respectively, after receiving formal warnings from the European Commission. Retailer compliance was low, with only an average of 56% of refrigeration appliances on display across the E.U. in the summer of 1997 being correctly labeled and considerable variation among member states. There have been some ad hoc follow-up surveys since, and the level of compliance has generally been found to be much higher although some problems still remain. The implementation/compliance study also compared manufacturers' self-declared performance levels with those recorded by independent testing agencies such as those operated by consumer associations. A wide divergence was found because of deviations from the testing protocol by both manufacturers and independent agencies, with efficiency levels declared by consumer associations and manufacturers differing by up to four labeling classes with an average of one class. Since the 1997 analysis and following repeated efforts by member states, the commission, and industry associations to improve the accuracy of the self-declared values, the degree of discrepancy between manufacturer and third-party product energy-performance declarations is said to have diminished although there has been no comprehensive survey to assess the situation. The compliance/implementation assessment also found that the stated impact of the label on consumer purchasing patterns was substantial, from 4% (Greece) to 56% (Denmark), and was strongly related to the level of compliance.

Sources: Boardman 1997; Winward et al. 1998; Waide 1998, 2004; GfK 2003.

A common fault in program design is to postpone working on the evaluation until some years after the program has been implemented, which makes it impossible to confirm the state of the market before the program was implemented. A pre-program market assessment establishes the reference baseline efficiency trend against which impacts can be assessed. To allow for a pre-program assessment, it is essential to begin planning for the evaluation process when the labeling and standards program is being initiated. Early planning allows for effective design of the evaluation program, efficient collection of data, and adequate opportunity to make key stakeholders aware of the importance of the evaluation so that they will likely feel receptive to its findings. As noted below in Step 1, many of the data needed for evaluations are actually an integral part of effective program implementation. This chapter describes the types of activities involved in the evaluation of labeling and standards programs and provides a few examples of how labeling programs have been evaluated. (See insert: *Evaluation of the Thai Labeling Program Using Manufacturer and Customer Surveys.*)

It is important for policy makers to distinguish among different techniques for assessing program effectiveness. Three of the major approaches are described briefly below:

- Process evaluations examine all aspects of the mechanics and operation of a program, including applications, procedures, dissemination, awareness, etc. Process evaluations are usually primarily qualitative in nature, but they also have quantitative elements.
- Impact evaluations address the magnitude and timing of a program impact, such as equipment sales, electricity saved, and amount of pollution reduction attributable to the program. A comprehensive program evaluation will usually entail both a process and impact evaluation.
- Program monitoring is a technique for regularly assessing progress of activities and results against project targets. This useful tool is not discussed in this chapter but is briefly summarized in the insert: *Program Evaluation Differs from Program Monitoring* on page 236.

Figure 9-1 shows the four steps necessary for evaluating labeling and standards-setting programs.

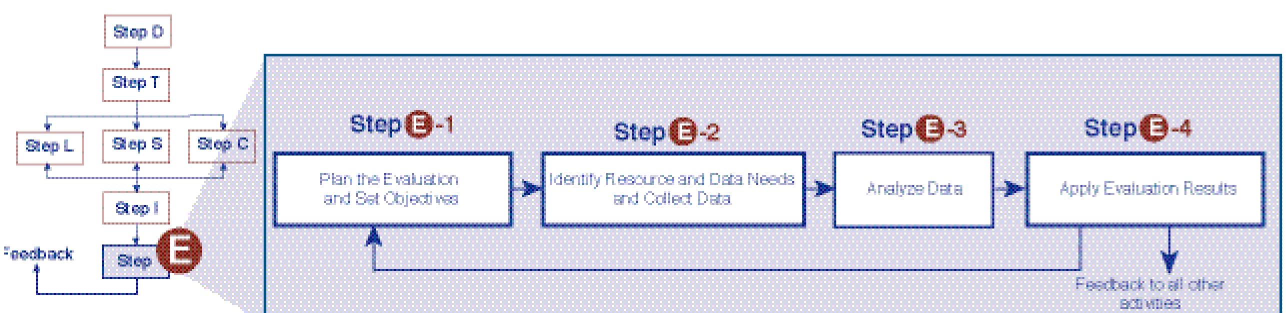


Figure 9-1 Major steps in evaluating a labeling or standards-setting program

Evaluation of the Thai Labeling Program Using Manufacturer and Consumer Surveys

In early 1994, the Electricity Generating Authority of Thailand (EGAT) approached the five Thai manufacturers of household refrigerators and quickly gained their cooperation for a voluntary energy-labeling program. The efficiency scale on the label ranges from 1 to 5, with 3 as the average and 5 as the most efficient. A selection of the models in this size range was tested during fall 1994 to establish the average efficiency level. Models that fell within 10% of the mean were rated at 3; models that were 10 to 25% more efficient than the mean were rated at 4; and models that were more than 25% more efficient than the mean were rated at 5.

A similar labeling program for air conditioners began in early 1996. Negotiations with air-conditioner manufacturers were more difficult than those with refrigeration manufacturers because of the diverse and fragmented nature of the Thai air-conditioner industry, which consists of 200 manufacturers, many of which are small, local assembly operations. Most Thai air conditioners are produced by the 15 largest firms. Unlike in the refrigerator market where efficiency levels were relatively similar among manufacturers, the Thai air-conditioner market has a trimodal distribution: low-cost, low-efficiency, locally produced models; higher cost, moderate-efficiency, locally produced models; and high-end, high-efficiency models dominated by imports. The air-conditioner manufacturers chose to place energy labels only on the most efficient units, those with a rating of 5. Thus, consumers were faced with a choice between buying a unit with a label (i.e., a rating of 5) or a unit with no label (i.e., an invisible rating of 4, 3, or worse).

In 1999, the Thai demand-side management (DSM) office commissioned a comprehensive evaluation of its energy-labeling programs. The evaluation had three major components:

- a process evaluation, to gather qualitative data about the behavior and attitudes of consumers and manufacturers and their reactions to the program
- a market evaluation, to assess the impact of the program on manufacturer decisions and market penetrations
- an impact evaluation, to assess the program's effect in terms of energy and demand savings

The study was carried out using two primary data collection techniques:

- a manufacturer survey, which entailed development of a detailed survey questionnaire that was administered through in-person interviews with marketing and production personnel at 50 manufacturing and distribution firms
- a detailed, five-page residential survey that was administered by a team of 18 surveyors to 2,000 households in Bangkok and in three upcountry cities in Thailand

The evaluation found a high level of awareness of the label among Thai consumers. Non-participants (consumers who purchased a refrigerator or an air conditioner without a label) indicated that they did not buy a labeled refrigerator for the following reasons:

- they were not aware of energy-efficient refrigerators
- labeled units were not available where they purchased the unit
- the salesperson recommended a non-labeled unit

The evaluation yielded the following findings specific to the air-conditioner program:

- participants tended to have higher incomes than non-participants
- testing and labeling had a high degree of credibility among consumers
- the zero-interest loan program offered by EGAT for air conditioners had a very low participation rate because of lack of

Continued on next page

Evaluation of the Thai Labeling Program Using Manufacturer and Consumer Surveys (continued)

support by retailers and the perception that the process was complicated and involved intensive paperwork.

The manufacturers of both refrigerators and air conditioners reported that they were highly satisfied with the program. For air conditioners, however, the retailers were not satisfied; only 29% of the Green Shops (stores that participated in EGAT's no-interest loan offer for models rated 4 and 5) surveyed felt that the marketing campaign by EGAT was adequate. A number of the manufacturers suggested that the program could be improved by improving the speed and accuracy of the testing process. They also recommended that EGAT consider targeting promotional and educational campaigns at increasing the interest and ability of salespeople to market the higher-efficiency models.

The impact evaluation was based on direct metering of air conditioners and refrigerators in several hundred homes. The metered savings were combined with data from the surveys of residential households and manufacturers and with program data on the size and efficiency of models, to estimate the energy and demand savings attributable to the program. The table below summarizes the savings for the Thai energy-labeling programs.

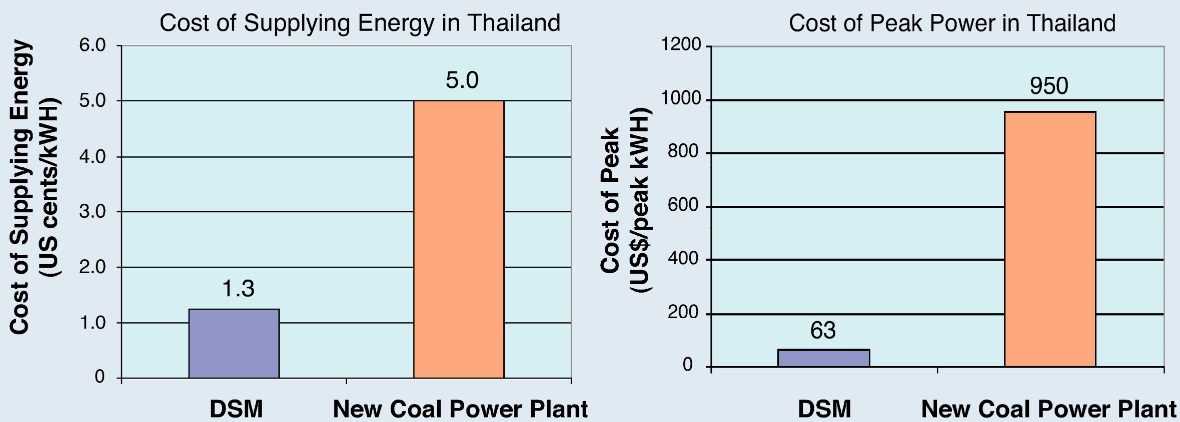
Since this evaluation, additional data have been collected and analyzed through 2000. Based on EGAT's final evaluation of the results of the DSM programs (including a thin-tube fluorescent lamp program in addition to the refrigerator and air-conditioner labeling program). The figures, opposite, show the favorable cost of saved energy and cost of avoided peak, which has increased the confidence of Thai policy makers in the program's benefits.

Source: Agra Monenco, Inc. 2000a, 2000b; Phumaraphand 2001.

Summary of Evaluated Savings from Thailand's Energy-Labeling Programs

Product	Number of labels	Energy Saving (GWh/yr)	Demand Savings (MW)		Benefit-Cost Ratio		
			Avg.	At peak	Customer Resource Cost	Utility Resource Cost	Total Resource Costs*
Refrigerators	3,698,117	235	80	14.0	2.2	9.8	2.8
Air conditioners	395,488,171	173	176	17.8	1.4	5.2	0.67

** The Total Resource Cost (TRC) is lower than anticipated because few residential air conditioners are running during the new afternoon system peak (14:00 - 17:00 hours), and because all differences in the price of efficient and standard units were assumed to be due to differences in the energy efficiency of the unit.*



Some of these steps are interactive and, as noted above, the conceptualization of them should be incorporated into an evaluation research plan early in the process of designing and implementing programs.

The remainder of this chapter discusses the four evaluation steps in detail.

9.2 Step E - 1: Plan the Evaluation and Set Objectives

Evaluation should be thought of as an integrated part of the overall data collection and management process of a standards and labeling program. Evaluations are built on data. The data used for evaluations—e.g., market size and shares, trends, drivers, breakdowns—are also an integrated part of the overall program design and implementation When planning an evaluation, policy makers should realize that the data collected will become part of an overall data set related to the program and thus part of an overall data-collection and management effort.

9.2.1 Evaluating Labeling vs. Evaluating Standards Programs

An impact evaluation of labels and standards will examine efficiency and capacity improvements, macro energy and environmental impacts, the range of models and features on the market, the costs and benefits to different groups (e.g., consumers, industry, retailers, society), and manufacturer competition. For both labeling and standards-setting programs, it is important to evaluate the program's process as well as its energy and economic impacts. For appliance standards, an evaluation should focus on manufacturers' decisions and changes in the efficiency of models sold in the marketplace and on the effectiveness of

Program Evaluation Differs from Program Monitoring

The terminology for monitoring and for evaluation is similar. The main difference is that monitoring is a part of the project implementation cycle, during which the project activities and results are measured against benchmarks or objectives set out in a logical framework approach (commonly called a logframe, or LFA, see Saldanha and Whittle 1998) or in a project agreement. Evaluations are carried out at a discrete point in time, usually upon completion or midway through a project (sometimes called a mid-term review) whereas monitoring is an ongoing process that should be carried out at regular intervals throughout the project. The results of monitoring are often used as input to the evaluation process. The frequency of monitoring may vary from project to project, but the aim should be to monitor at least annually.

Monitoring identifies day-to-day problems during implementation of the program and examines whether the past and planned activities will realistically achieve the planned results. Monitoring's main purpose is to track activities, identify weaknesses, and serve as an "early warning system" that allows for timely intervention if a project is not functioning well. Increasingly, international development assistance agencies are using monitoring to ensure the efficiency, effectiveness, and sustainability of their projects. Monitoring can also be used specifically within the energy sector as an essential tool for project management and quality control.

Source: Danish Energy Management A/S 2000

compliance procedures. The evaluation of a labeling program should include all of the above but should also assess the sales and purchase process to determine the impact of labeling on retailer and consumer decisions. An evaluation of a labeling program involves both quantitative and qualitative research to understand the process of consumer decision making and the actions of multiple stakeholders involved in the manufacture, sale, and distribution of appliances. Finally, labeling programs affect behavior over a longer period and their impacts are often more subtle than the impacts of standards because standards take effect in a step function on a particular date and can be fully verified over a reasonably short timeframe.

9.2.2 The Objectives of Evaluation

An evaluation can focus on a program's process and/or its impact on energy use and demand, the environment, and other areas that affect people and the economy. The best evaluations should have both process and impact components.

Process Evaluation

Process evaluation is an important tool for assessing program impacts as well as for improving program design, acquiring more participants, and increasing cost-effective energy savings generated by the program. A successful example of process evaluation, mentioned previously, showed that the E.U. label was not being applied correctly by a large number of retailers, which allowed corrective action to be taken. In contrast, the U.S. label was evaluated many years after it was first introduced and the evaluation found that the label was widely misunderstood (e.g., a large proportion of U.S. consumers mistook operating cost information for operating savings), and no corrective action was taken (du Pont 1998a).

A process evaluation measures how well a program is functioning and is often qualitative. Although policy makers sometimes assume that a program is functioning smoothly and therefore may not see the need for or value of this type of evaluation, process elements are critical to the implementation and success of a program. This is especially true because program success usually depends on a number of separate activities all functioning as designed. If one element doesn't function as planned, the program may either fail or have a significantly reduced impact. For example, the success of an energy-labeling program requires, at a minimum, the following:

- correct labels for the designated products to be supplied with the product
- product purchasers to see and use the labels when making purchase decisions
- the information on the labels to be accurate
- the information to be correctly interpreted by purchasers
- a significant number of purchasers to be motivated by the label to consider purchasing more efficient equipment
- the market to be able to respond by supplying more efficient equipment

Process evaluation elements include:

- assessing consumer priorities
- tracking consumer awareness
- monitoring correct display of labels in retail showrooms
- measuring administrative efficiency (e.g. registration times)
- checking and verifying manufacturer claims (maintaining program credibility)

Impact Evaluation

An impact evaluation determines the energy and environmental impacts of a labeling program. Impact data can also be used to determine cost effectiveness. Impact evaluations can also assist in stock modeling and end-use (bottom-up) forecasting of future trends. Impact evaluation elements include:

- determining the influence of the label on purchase decisions
- tracking sales-weighted efficiency trends
- determining energy and demand savings

Impacts can be very difficult to determine accurately, especially for a labeling program. One of the fundamental problems is that, once a program such as energy labeling has been in place for some time, it becomes increasingly difficult and hypothetical to determine a "base case" against which to compare the program impact.

Evaluation Issues

Both process and impact evaluations should be performed regularly during the life of a labeling and standards program, and especially during initial implementation. Evaluation frequency will depend upon the type of program and technology; as a general rule of thumb, an evaluation should be conducted every two to three years at a minimum. Waiting longer between evaluations can lead to neglect and result in a stagnant or ineffective program.

Process and impact evaluations of labels and standards can be conducted based on either "resource-acquisition" or "market-transformation" objectives. From a resource-acquisition perspective, the primary objective of evaluation is to calculate energy and demand savings (i.e., the reduced need to purchase energy from a power plant) and greenhouse gas (GHG) emissions reductions and the associated cost of acquiring these resources during the first few years of the implementation of a standard.

From a market transformation perspective, the primary objective of evaluation is to see whether sustainable changes in the marketplace have resulted from labels and standards programs. For example, although a labeling program may take longer to implement and its energy-saving impacts may be seen over a longer period of time than is the case for standards, changes in attitudes and purchasing behavior can be evaluated during the first year of a labeling program. Program designers with the goal of market transformation are increasingly relying on theories with hypotheses about how the program might affect market players (Theory Evaluation or Logic Models). Program designers with this perspective benefit from evaluations that test their hypotheses through interviews and tracking of market indicators, which can then be translated into impacts. In addition, there are theories of how a market will evolve so that private actors might shift toward promoting more efficient products in the absence of a program. A theory-based approach, similar to a process evaluation, would test many of the hypotheses presented in this chapter such as: "most/some/all consumers will use labels as part of their purchase decisions" or "labels will encourage manufacturers to improve the energy performance of their products."

An appliance-labeling program influences the activities of many market players, including consumers, retailers, and manufacturers. Figure 9-2 shows how the various actors interact and affect the purchase environment, and, ultimately, the purchase decision of the consumer. Evaluators initially focus on "leading indicators": changes in the attitudes and behavior of market players), which can be measured in shorter periods of time than "lagging indicators": energy savings, appliance sales, and GHG emissions reductions.

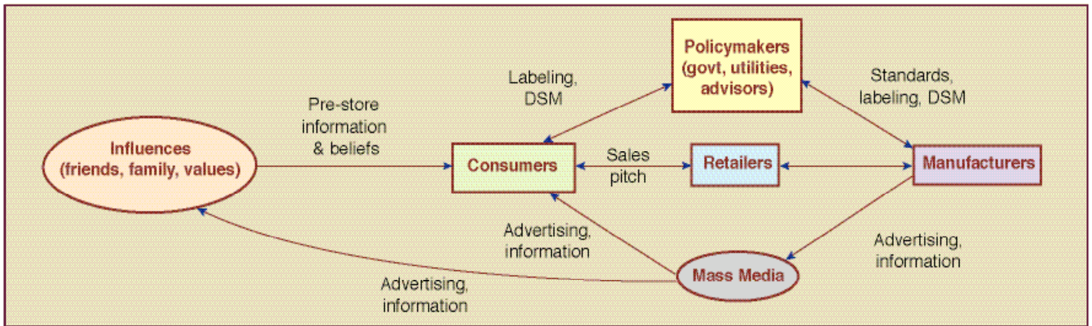


Figure 9-2 The appliance purchase environment

Planning the evaluation of a program with such complex interaction among stakeholders can be a challenge.

9.3 Step E - 2: Identify Resource and Data Needs and Collect Data

The costs of evaluation and the types of data needed vary depending on a number of factors, as described in the subsections below.

9.3.1 Resources Needed for Evaluation

The cost of evaluating labeling and standards programs varies depending on a number of factors, such as the type of evaluation (process, impact), the quantity and type of available data, and whether energy savings are calculated by engineering estimates based on data from manufacturers or textbooks, and/or by end-use metering of a sample of products. Most comprehensive evaluations rely on the collection of survey, sales, billing, and end-use data. The use of end-use monitoring equipment to measure energy consumption for specific appliances will increase the cost of evaluation, as will the purchase of commercially available market research data on sales of different models. Although most evaluation costs arise after a program has been implemented, some of the evaluation budget should be allocated for up-front costs when the labeling and standards-setting programs are being discussed and the evaluation research plan is being developed.

9.3.2 Data Needed for Evaluation

The *type of data* needed for evaluation will also vary depending on a number of factors, such as the type of evaluation (process, impact), the quantity and type of existing data (versus data that must be collected, i.e., primary data collection), and whether measured data are needed.

Many types of data are useful for evaluating the impact of labeling and standards-setting programs, and many methods are available for collecting these data. The data requirements for labeling programs are similar to those for standards-setting programs in many but not all ways. For example, label impact

Labeling and standards-setting program evaluation uses a variety of data from diverse sources.

Table 9-1 Evaluation Data: Type and Sources

Data Type	Main Data Sources
Customer and retailer knowledge, awareness, understanding, and decision making	• Surveys of customers and retailers and in-depth interviews
Availability of products	• Sales data from manufacturers, trade associations, or government • Surveys of manufacturers and retailers
Prices for efficient products	• Surveys of customers, retailers, and manufacturers
Market penetration	• Sales data from manufacturers, trade associations, or government • Surveys of participant and non-participant customers • Surveys of suppliers
Energy use	• Manufacturer data • Independent laboratory data • Engineering specifications • Metered end-use data
GHG emissions	• Reported emissions factors • Utility dispatch model data

evaluations are likely to rely more heavily on consumer surveys than would evaluations of standards programs although some assessment of individual consumer attitudes is useful in standards-setting evaluations as well. Much of the necessary data may already be available at the time the program is being designed. However, impact evaluation becomes especially important if inadequate research went into the design of the label initially. Whenever possible, secondary data sources (e.g., industry, commercial, and government reports) should be analyzed first because these are the most cost-effective sources of information. Once these sources are used, primary data collection should begin, based on interviews and surveys and focusing first on the most important data needs for the country in question. Table 9-1 gives information on the types of data needed and how they should be collected.

A caution is in order. Definitive data to support assessment of the impact of labeling and standards programs is, at best, difficult to obtain. Understanding of true consumer purchase behavior requires a carefully constructed research protocol, and ad hoc research is not likely to provide the necessary information. Consumers' verbal endorsements of the value of an attribute of an appliance or label may not coincide with their financial decision. Manufacturing costs and mark-up rates throughout the distribution chain are generally not available. Market share and consumer purchase choices are also influenced by many factors unrelated to relative energy efficiency. The amount of time and resources appropriate for evaluation are often greater than initially anticipated and budgeted.

A first step in evaluation is to collect model-specific data for establishing a national appliance database. This database will contain information on the models that are manufactured and their annual sales, prices, and technology characteristics. The database can be used to monitor national appliance-efficiency trends. When energy use is analyzed, utility bill data or end-use metered energy data should be collected (sometimes, the change in energy use for an appliance is too small to be reflected in a utility bill, hence the need for end-use metering).

When energy savings are projected, particularly near the beginning of a labeling or standards-setting program, data are typically collected on equipment energy-use trends under standard test conditions and then linked to sales and retirement data in a stock model to project past and future impacts. As a complementary activity, end-use metering data are collected to: a) calibrate the energy-use data based on engineering estimates used in the stock model; b) establish the accuracy and failings of the test procedure; c) enable corrections to be developed for energy data measured under the test procedure (e.g., a factor of 0.85 was applied for energy-labeling purposes to U.S. freezer energy-consumption results recorded under standard test conditions); and d) establish other avenues for energy savings (such as advice to consumers that is informed by data on their energy consumption).

9.3.3 Types of Data

Other types of data needed include the attitudes and behavior of key market players and characteristics of the market (e.g., number of manufacturers and retailers, percent of appliances in stock that are energy efficient). Finally, it is important to note that it is always possible to carry out some level of evaluation, no matter how crude the data sources and how limited the resources. Evaluators should not be discouraged if they cannot gather data of the highest quality; compromises in accuracy can be made to limit cost without making an evaluation useless.

9.3.4 Data-Collection Methods

As noted earlier, it is very important to collect data in the beginning of designing and implementing standards and labeling programs. Whenever possible, cooperative agreements with industry should be encouraged for the purpose of gathering data on sales and efficiency levels. Sales data can be obtained from surveys of manufacturers, retailers, and/or contractors. Products in stores can be inspected visually to assess compliance with labeling programs and to collect information on stocking practices (sometimes this is done by a "mystery shopper" who visits stores unannounced and unidentified). Appliances can be tested in laboratories to measure energy use and assess the accuracy of labels. Finally, interviews with consumers, retailers, manufacturers, and contractors often play a central role in assessing the extent of market transformation.

9.4 Step E - 3: Analyze Data

A comprehensive analysis is needed to evaluate resource acquisition and market transformation. For a simplified model of analyzing an appliance labeling program, see Figure 9-3. Although this type of analysis has usually been focused on labeling programs, it can also be used to evaluate standards programs.

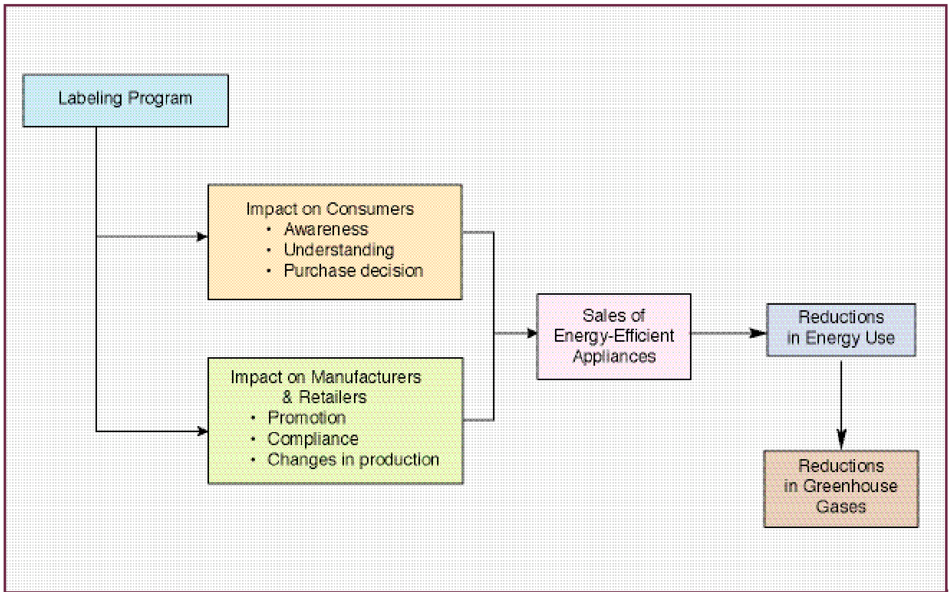


Figure 9-3 Simplified example of analyzing appliance-labeling programs

A simplified procedure is available to evaluate resource acquistion and market transformation.

9.4.1 Baseline

It is critical for an evaluation to establish a realistic and credible baseline, that is, a description of what would have happened to energy use if labels and/or standards had not been implemented. Determining a baseline is inherently problematic because it requires answering the hypothetical question "what would have happened in the absence of labels and/or standards?" To accurately evaluate energy savings, it is necessary to analyze energy use of a sample of households/facilities before and after the installation of an energy-efficient product. For example, energy use might be measured for a full year before the installation of the efficient appliance and then for several years after the installation. Some types of appliances may not require a full year of monitoring, however. If loads and operating conditions are constant over time, short-term (e.g., one-week) measurements may be sufficient to estimate equipment performance and efficiency. These data would then be used for calibrating engineering estimates that could generally be applied to the population of energy-efficient products. Frequently, load research data are available for establishing product baselines (see Section 9.3.4).

Market characterization studies are also necessary for developing a baseline of existing technologies and practices. These studies provide detailed data on end users (consumers), including estimates of market size, analyses of decision making, identification of market segments, and analysis of market share by market event (retrofit, renovation, remodeling, replacement). Market characterization studies also provide detailed data on the supply side—manufacturers, retailers, and contractors (e.g., designers and installers)—including information on relationships among supply-side actors; development of market segments; business models of each entity; and the nature of distribution channels, stocking/selling practices, and trade-ally reactions to labeling programs.

Baseline development is often highly contentious and, at best, a good guess of what might have been. In many cases, it is as important to quantify the level of efficiency improvement from before the time of the program startup in order to demonstrate that progress is continuing. Finally, it is important to note that the baseline issue is important for all types of energy-impact evaluations and is a crucial element of the assessments conducted to determine carbon savings from energy-efficiency and renewable energy projects under international carbon-trading provisions and agreements (see Section 9.4.6 below, Vine and Sathaye 1999, Kartha et al. 2004).

9.4.2 Impacts on Consumers

A key point in evaluating the effect of labeling programs on consumers is the degree to which the label's presence affects consumer purchasing decisions in favor of more efficient appliances. In addition to observing actual consumer purchasing and sales trends, consumer evaluations should also focus on consumers' level of awareness and understanding of energy and on the factors that affect their purchases of energy-efficient appliances. Specific types of questions to address in this type of evaluation include:

- What is the level of awareness, among buyers and potential buyers, of the energy label, related product materials, retailer advice, and advertising?
- What is the relative level of importance of various consumer purchase criteria—such as brand, price, perceived durability, product features, size, color, energy use, environmental factors – in the consumer's appliance purchase decision?
- What is the relative level of importance given to the energy label, related product materials, retailer advice, and advertising in the buyer's choice of appliance?
- How well does the customer understand the label, related product materials, and advertising?
- What is the customer's perception of the usefulness of the label, related product materials, retailer advice, and advertising?
- What sorts of changes do consumers propose to the label, related product materials, and advertising to make each more effective?
- What is the importance of energy or fuel efficiency in the buyer's choice of the appliance? How does this relate to other customer purchase priorities?
- How does the customer use the appliance?
- What are the life-cycle cost impacts, accounting for possible changes in the price of the equipment, operating expenses, and installation or maintenance expenses?

Socio-economic data can also be analyzed to help understand the effectiveness of labeling and standards-setting programs for different socio-cultural situations: e.g., low-income households versus high-income households, recent purchasers versus the general public. Market segmentation can be used to develop education, information, and advertising programs that complement labeling and standards-setting programs. For example, program material can be translated into different languages, and program providers can use residents of targeted communities to educate local populations about the benefits of energy-efficient equipment.

There is an array of econometric and statistical models for analyzing the contributions of many factors to program impacts on consumers. These are generally considered to be advanced evaluation tools and range widely in cost depending on many characteristics, especially their level of accuracy; however, it will often suffice to use simple tools and methods (see Vine and Sathaye 1999).

9.4.3 Impacts on Manufacturers and Retailers

Evaluators assess the impact of labeling and standards programs on appliance manufacturers and/or retailers by examining the following:

- consolidation of competition
- impact on features, product utility, and consumer choice
- impact on manufacturing jobs
- impact on private-sector advertising in support of labeling programs
- impact on sales (and market share)
- compliance with the programs
- promotion of labels to retailers (e.g., direct promotion, print advertising, in-house product presentations and training, trade fairs, product catalogs, help desks)
- direct promotion to consumers (by both manufacturers and retailers)
- direct and indirect costs to manufacturers (increased cost of production, research and development efforts to improve appliance efficiency, distribution of labels, promotion and support of labeling programs)
- changes in the production process to manufacture more efficient models
- impacts similar to those affecting consumers (see Section 9.4.2)
- placement of energy labels on appliances in retail outlets

9.4.4 Program Compliance, Enforcement, Training, and Education

Once appliance labels and standard-setting programs have been implemented, it is important to regularly monitor whether program requirements are met, enforcement measures are taken where there is non-compliance, retailers and distributors are trained in explaining the program to consumers, and consumers understand the meaning of the label and/or standard.

For example, in many labeling and standards-setting programs, it is the manufacturers' responsibility to ensure that the information they supply is correct. Often, there is no automatic system of independent testing. Occasionally, third-party testing agencies are used. In the U.S. and Canada, manufacturers test their own products in certified test laboratories and report the results on the label. In principle, such a system can work well because any manufacturer can challenge the veracity of a competing manufacturer's claim. This system of self-certification and challenges is used in the U.S. and is generally thought to provide acceptable compliance.

In Europe and Australia, the practice depends on the product concerned, but, for most household appliances, the test laboratory does not have to be certified. Manufacturers are responsible for the accuracy of their claims and are at risk if they use a non-certified laboratory and a control agency subsequently fails the product. Under E.U. legislation, it is the responsibility of the member states to ensure that E.U. law is enforced in their states (Waide 1997). In the past, some serious inaccuracies in energy consumption reporting have been identified for refrigerators, freezers, and clothes washers in the E.U. This indicates, as described in more detail in Chapter 4, that it is necessary to compare manufacturer-reported energy consumption to test results from a third-party laboratory as well as to monitor energy use in the field (although end-use metering in the field does not take place under standard test conditions, it gives information on the relevance of the laboratory studies) to determine whether the appliance rating and label should be changed (e.g., see Meier 1997; and Winward et al. 1998).

A labeling program also depends on retailers' efforts to make sure that labels are attached to appliances for consumers to read. Thus, it is imperative for evaluators to assess retailers' compliance with the program (see Winward et al. 1998). Australia has developed a model "Check Testing Program" for evaluating a sample of models in the market to monitor whether labels are applied and whether the test results reported on the label are accurate (Grubert 2001).

In sum, evaluation studies can assess current levels of manufacturer compliance and remedial enforcement activity. Evaluators may also examine the use of formal legal processes to impose penalties on persistent rule breakers (see Winward et al. 1998) and may assess the effectiveness of training and education programs as well.

9.4.5 Sales

As noted above, one of the two key "lagging indicators" for evaluation is sales. Market share is also considered a lagging indicator because it is established after the changes that actually cause a difference in purchase habits. Market-share information is critical for the final analysis of a program's effects, but it is often not immediately available during program implementation. Nevertheless, it is possible to evaluate the impact of a labeling program by comparing sales-weighted trends in appliance efficiencies both before and after the introduction of labels. For example, Figure 9-4 shows the sales-weighted, annual-average distribution of dishwashers by energy-label class in the E.U. in 1994, prior to the introduction of energy labeling, and in 2003 some years after labeling. The figure shows that the predominance of purchases shifted from inefficient models (classes D, E, and F) in 1994 to more efficient classes (A, B, and C) in 2003.

Analyses can focus not only on sales but also on changes in prices and technology characteristics (e.g., sizes of appliances). Improvements in appliance energy efficiency are not necessarily related to an increase in the price of the appliances sold. Despite the existence of a strong relationship within the market between average refrigerator price and efficiency, the average refrigerator sold in the E.U. in 2002 was 4 euros less expensive but significantly more efficient than the average sold in 1994 (see Figure 9-5).

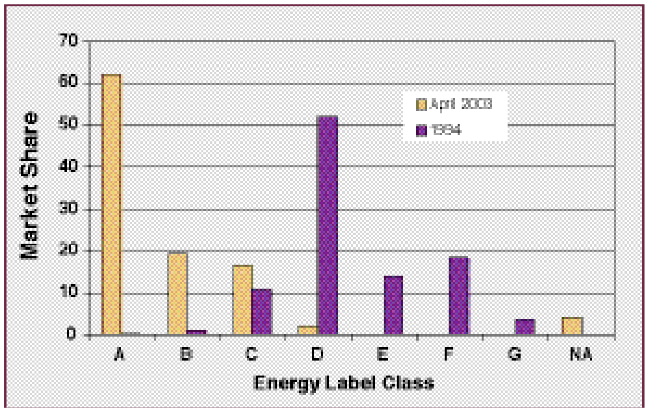


Figure 9-4 Impact of the E.U. dishwasher energy label (dishwasher sales as a function of energy label class from 1994 to 2003)

Impacts can be shown as increases in the sale of efficient products.

9.4.6 Energy Savings and Greenhouse Gas Emissions Reductions

Estimation of reductions in GHG emissions is becoming increasingly important as climate change becomes a driver for many sustainable-energy projects, including energy-efficiency efforts. The main international vehicle has been the Clean Development Mechanism; however, the future of this mechanism is uncertain due to the Kyoto Protocol taking effect February 2005. A number of institutions are being set up for trade in carbon reductions, and several international agencies (including the World Bank, the Dutch government, and others) have begun to actively purchase GHG reductions on a small scale.

Impact analysis can show that efficiency doesn't necessarily increase price.

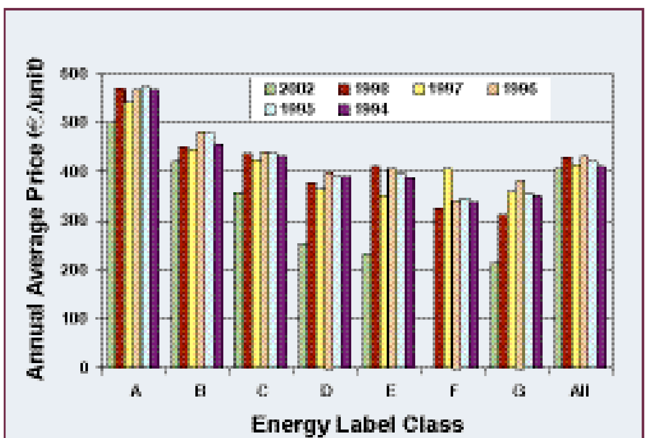


Figure 9-5 Impact of the E.U. refrigerator energy label (E.U. average refrigerator price as a function of energy label class from 1994 to 2002)

At the household or facility level, it is impossible to measure energy savings directly because, to do so, it is necessary to know how much energy would have been used if a specific appliance had not been purchased, which cannot be determined. Nevertheless, any of a number of evaluation methodologies can be used for estimating energy savings, especially for a large sample. These include engineering methods, statistical models, end-use metering, short-term monitoring, and combinations of these methodologies (Vine and Sathaye 1999).

Changes in market share of energy-efficiency products (sales), for example, can be estimated and multiplied by the amount of unit energy saved (e.g., on average or by type of product). Tracking changes in product and market characteristics over time gives a good initial indication of the type of market shift that takes place in the early stages of labeling or during the lead-up to a new standard coming into force. Detecting trends in consumer preferences toward more efficient products on the market is a more subtle exercise. Here, both sales-weighted trends and changes in consumer sentiment need to be monitored. To maximize the accuracy of the energy savings determined from shifting between any two models, a sample of products can be metered in situ to determine the actual amount of energy used.

At the national level, energy savings can be determined using simple calculations (e.g., spreadsheets) or detailed energy end-use models. The assumptions used in engineering analyses are adjusted to account for real-world data (e.g., actual consumption in the field, fraction of households owning a particular appliance, usage in hours per year) from surveys and end-use monitoring (see McMahon 1997 and Greening et al. 1997).

Once net energy savings have been calculated by subtracting baseline energy use from measured energy use, net GHG emissions reductions can be calculated in one of two ways: average emissions factors can be used, based on utility or non-utility estimates, or emissions factors can be calculated based on specific generation data (Vine and Sathaye 1999). In both methods, emissions factors translate consumption of energy into GHG emissions. Normally, the use of average emission factors is accurate enough for evaluating the impact of energy-efficiency labels and standards. In the rare cases where the other impact analyses are highly sophisticated and regional variations are important, use of plant-specific factors may be warranted.

In contrast to using average emission factors, calculated factors have the advantage that they can be specifically tailored to match, by time of day or season of the year, the characteristics of the activities being implemented. For example, if an appliance-labeling program affects electricity demand at night, then baseload power plants and emissions will probably be affected. Because different fuels are typically used for baseload and peak-capacity plants, baseload emissions reductions will also differ from the average.

The calculations become more complex (and more realistic) if the emission rate of the marginal generating plant is multiplied by the energy saved for each hour of the year instead of multiplying the average emission rate for the entire system (i.e., total emissions divided by total sales) by the total energy saved. For more detailed analysis, the utility's existing system dispatch and expansion plans can be analyzed to determine the generating resources that would be replaced by saved electricity and the emissions associated with these electricity-supply resources.

It is also necessary to determine whether planned energy-efficiency measures would reduce peak demand sufficiently and with enough reliability to defer or eliminate planned capacity expansion. If so, the deferred or replaced baseline source would be the marginal expansion resource. This type of analysis may result in fairly accurate estimates of GHG reductions, but it is more costly than the simpler method and requires expertise in utility-system modeling. In addition, this type of analysis is becoming more difficult in regions where the utility industry is being restructured. In restructured markets, energy may come from multiple energy suppliers either within or outside the utility service area, and the marginal source of power is difficult to forecast.

9.5 Step E - 4: Apply Evaluation Results

Initially, it is important to ensure that policy makers allocate funding for and place priority on developing a framework for evaluation and data collection. Later on, if a technically sound evaluation produces significant results, it is imperative that these results be used, where appropriate, to:

- refine the design, implementation, and evaluation of labeling and standards-setting programs
- support other energy programs and policies
- support accurate forecasting of energy demand for strategic planning
- improve the accuracy of models and analyses in regulatory proceedings

Because the value and amount of load reduction achieved by programs varies by time and location, it is very useful to categorize evaluation results by date, time, and geographical location.

9.5.1 Refining Labeling and Standards Programs

The results from evaluations can be used to improve the design, implementation, and future evaluations of labeling and standards programs. For example, evaluation results can be used to reexamine the accuracy of the inputs used in designing the program. In addition, they can be used to assess whether the programs can (or should) be extended to other appliances that are not currently covered. Ideally, the program designers become the clients of the evaluation department, and the evaluation results feed directly into the next round of program design or improvement.

9.5.2 Supporting Other Energy Programs and Policies

The evaluation of labeling and standards-setting programs can help design appliance rebate programs, appliance standards or negotiated agreements (if none exist), procurement actions, and labeling programs for other appliances. Chapter 10 elaborates on these topics.

9.5.3 Forecasting Energy Use and Strategic Planning

Evaluation results can be used, with caution, to support forecasting and resource planning. In particular, the following elements of an evaluation should be considered before the results are used:

- How representative is the study sample in relation to the population of interest to planners?
- How accurate and precise are the energy and demand impact results?
- Did the evaluation use appropriate control samples?

If comprehensive data on market energy-efficiency trends, sales volumes, and usage patterns are established as part of the evaluation process, these data can be used as inputs to an end-use stock model to make long-range energy consumption and emissions forecasts. This kind of forecasting is useful to guide policy development because it enables the estimated impact of various policy and implementation changes to be simulated in advance.

9.5.4 Using Evaluation Results and Data for Other Regulatory Purposes

Some regulators have standard practice guidelines or manuals on how to conduct cost-effectiveness analysis. Evaluation results are often vital inputs to the cost-benefit tests contained in these manuals. For example, the results from studies on measure retention, technical degradation, and persistence of savings are used for calculating the ongoing costs and benefits used in cost-effectiveness analysis.

9.6 Considering Key Evaluation Issues

This section describes a set of mitigating or potentially confounding issues—free riders, accuracy and uncertainty, and complexity—that may impact or bias the evaluation results and explains how to deal with these issues in the context of the overall evaluation. If resources are available, one must take these factors into account for the evaluation results to be completely credible and defensible.

9.6.1 Free Riders

To evaluate the impacts of standards and labeling programs, one needs to know what customers would do in the absence of these programs. Labeling and standards programs affect only some purchases. Furthermore, some consumers would have purchased the same efficient products even if there had been no program. In an evaluation analysis, these consumers are called “free riders.” The savings associated with free riders are not “additional” to what would occur in the baseline case (Vine and Sathaye 1999). Therefore, free riders should be excluded when estimating savings attributed to the programs. This can be accomplished either by accounting for free riders in the baseline or making a separate adjustment.

For example, if a comparison group's utility bills show an average reduction in energy use of 5% during a given period of time before a label or standard is implemented and then shows a total reduction in energy use of 15% during an equivalent period afterward, it may be reasonable to judge that 5% of the total reduction would have occurred anyway, consistent with the preceding period, and thus to attribute only a 10% reduction in energy use to the standards program (15% total minus the 5% trend that was already occurring and therefore would likely have continued).

Free riders can be evaluated either explicitly or implicitly. The most common method of explicitly estimating free ridership is to ask participants what they would have done in the absence of labeling (this is sometimes referred to as "but for the project" analysis). Based on answers to carefully designed survey questions, participants may be classified as free riders or assigned a free ridership score. As in other surveys, the questionnaire must be carefully worded and interpreted; people's stated preferences and anticipated behavior often differ from their actual preferences and behavior.

It can be especially challenging to evaluate free ridership for labeling programs when other market-transformation programs, such as rebates for efficient appliances, are in place. Because these market-transformation campaigns are specifically designed to create—over time—a situation in which purchasing energy efficient appliances is common practice even in the absence of any program, it is difficult to estimate the increasing rate of efficient purchasing that would result if only the other market transformation programs were in place.

Because estimating the free rider effect is difficult, simple and highly uncertain assumptions are often made about free ridership. If resources are not available for conducting a sophisticated analysis, evaluators may be able to use other sources that implicitly address this issue (e.g., comparing to appliance investment behavior in other regions or in other countries where there are no appliance labeling or standards-setting programs).

9.6.2 Accuracy and Uncertainty

Because of the difficulties and uncertainties in all aspects of estimating energy savings, the degrees of precision and confidence associated with savings measurements should be identified. Ideally, evaluators should estimate and report the precision of their measurements and results in one of three ways:

- quantitatively, by specifying the standard deviation around the mean of an assumed bell-shaped normal distribution
- quantitatively, by providing confidence intervals around mean estimates
- qualitatively, by indicating the general level of precision of the measurement using categories such as "low," "medium," and "high"

9.6.3 Policy and Market Complexity

One of the criteria for examining the success of a market-transformation program is whether observed market changes can be appropriately attributed to the program. Analysis can be conducted more reliably when there is a single type of intervention than when multiple actions (e.g., standards, labeling, procurement, rebates, the phase-out of chlorofluorocarbons, and industrial changes) are occurring simultaneously. It is difficult to distinguish the relative contributions of multiple activities to observed changes in the market. Although logic diagrams and market-influence diagrams are extremely useful tools to structure the analysis, they are generally not powerful enough to handle the evaluation of the complex characteristics of the appliance, equipment, and lighting markets.

In order to reliably claim that observed efficiency improvements were caused by labeling and standards programs, it is necessary to carefully consider and reject other possible explanations for the observed market changes. In particular, the presence of multiple interventions (e.g., changes in energy pricing and metering, financing and incentives, improvements in technology, and regulatory and voluntary programs by government and the private sector—see Chapter 10) may affect the baseline as well as the implementation of labeling and standards programs. An effective external comparison group may help isolate some of these influences. Also, causal modeling may provide a useful approach to making separate attributions to different influences although it is very difficult to create a quantitative model, and manufacturers are often reluctant to make the necessary data available. Quantitative determinations are often difficult to make and can involve substantial costs that may or may not be worthwhile. Venture into this realm of analysis with caution. Sometimes it may be best to simply report the total impact of the program and present the reasons that the program being assessed is a major contributor to that outcome.

Standards and labeling program planners have a strong interest in the evaluation process. Gathering evaluation results by defining objectives, identifying necessary resources, monitoring program performance, and assessing program impacts is a valuable output of a standards and labeling program. The results can be used either to revise an existing program's objectives or as building blocks in establishing a new program. But it is always difficult to measure a program's performance and impact. In some cases, this is the result of lack of data or lack of resources to obtain that data. In others, it may be that the program's direct results are masked by the effects of other complementary, simultaneous programs. Given real-world budget and time constraints, it is difficult to do a "perfect," comprehensive evaluation. However, even paying limited attention to evaluation and making approximate assessments can provide very useful input to program planners and implementers. Simple evaluations, done in a thorough and transparent manner, can serve most of the evaluation needs of a standards and labeling program. For energy-efficiency standards and labeling programs, doing some evaluation is almost always better than doing none.

10. Energy Programs and Policies that Complement Labels and Standards

Guidebook Prescriptions for Designing Comprehensive Energy Programs and Policies

1. **Combine labels and standards with other policy instruments, including incentives, financing, government buying power, marketing, and consumer education.**
2. **Find the right mix of these policy tools to match energy-efficiency objectives and market conditions, and then continue to adjust that mix as conditions change and lessons are learned.**
3. **Draw on the same infrastructure—technology and market information, analyses, and energy testing/rating—to support labels and standards as well as other policy instruments.**
4. **Create well-planned strategies to permanently transform specific markets toward increased sales of energy-efficient products. Consider energy-efficiency labels and standards as part of the overall strategy, and be sure to include an exit strategy that phases out government intervention.**

10.1 Developing a Program Portfolio: Regulatory Plus Market-Based Programs

This chapter discusses how labels and standards interact with other energy-efficiency policies and programs and how best to combine and sequence these programs to create an effective, sustainable market-transformation process. We do not attempt to provide a comprehensive listing of the many possible policy instruments to help increase efficiency and transform markets, nor do we intend to provide a "how-to" manual for designing or implementing any of the policy measures discussed. We do not even suggest priorities or an order of adoption because these depend heavily on local situations. Instead, we select a few promising policy examples and illustrate for implementers of efficiency labels and standards the value of designing them to help facilitate other measures.

10.2 Policy Objectives

Government policy instruments, including efficiency labels and standards, can be designed to achieve any of six sub-objectives that support the overall objective of accelerating the penetration of energy-efficient technology in the marketplace and meeting other national goals. The sub-objectives correspond to six steps in the flow of energy-consuming products from manufacturers to users. These steps include:

- technology advances
- product development and manufacturing
- supply, distribution, and wholesale purchasing
- retail purchasing
- system design and installation
- operation and maintenance

The matrix in Table 10-1 summarizes how eight policy instruments can address each of the six sub-objectives. The table not only shows the linkages between the policy instruments and the objectives but also the organization of this chapter. First, the objectives are discussed in subsections 10.2.1 through 10.2.5. Then, the policy instruments are discussed in subsections 10.3.1 through 10.3.8.

This matrix summarizes how various policy instruments can influence key policy objectives.

Table 10-1 Policy Objectives and Program and Policy Instruments

	Research and Development	Pricing and Metering	Incentives and Financing	Regulatory Programs	Voluntary Programs	Government Purchasing	Energy Audits, Retrofits	Consumer Education, Information
Stimulate new technology*	H	L	M	M	M	M	—	—
Influence development and manufacturing	H	M	M	H	M	M	—	M
Influence supply, distribution, and wholesale purchasing	—	—	H	H	M	M	L	M
Influence retail purchasing	—	M	H	H	M	L	L	M
Influence system design, installation		L	—	—	L	L	H	L
Influence operation and maintenance	—	M	—	—	L	L	H	M

*improve performance or lower production costs

Notes: *H = high potential M = medium potential L = low potential*

Usually, governments will use several policy instruments; a combination of measures is often most effective. A concept that has become important in the United States (U.S.), the European Union (E.U.), and some other countries is market transformation, which calls for specific interventions for a limited period, leading to a lasting shift in market structure and to greater energy efficiency (Suozzo and Nadel 1996). This subject is addressed in subsection 10.4.1 below. There is growing interest in applying market-transformation principles to energy efficiency in developing countries (MMEE 1999).

10.2.1 Stimulating New Technology

Although most market transformation programs and policies focus on increasing the use of today's commercially available technologies, it is also important to stimulate the introduction of improved technologies. Desirable new technologies may be more energy efficient than current ones, or less costly with similar efficiencies, or better adapted to local conditions. They may also perform well in non-energy terms that are attractive to buyers (e.g., reliability, safety, low maintenance). Policy strategies that can help speed the introduction of new technologies include:

- support for research and development to create new products or their components
- design (or revision) of energy-test methods to reflect and accommodate technical innovation
- organization of buyer demand to expand the market for available high-performing products and induce manufacturers to introduce new products

The second of these policy instruments, test procedure design/revision, may be a step in a standards-setting or labeling program or it may be undertaken to support other energy-efficiency programs. Either way, the considerations are the same and are discussed in Chapter 4. The third policy instrument, often termed "technology procurement," is best undertaken by setting a target for efficiency improvement. Although there is no set formula for the third policy strategy listed above (a technology procurement project), such projects typically involve organizing a group of large-volume buyers who, with the assistance of a technical organization, define technical performance and cost specifications for a new product they would like to see made available. Such specifications might focus on exceeding the minimum standard by, say, 30%, as in the example of Sweden's NUTEK refrigerator program. The buyers' group's interest in the new product is communicated to potential suppliers via an open solicitation for proposals. The suppliers then compete for the opportunity to supply the product to the initial buyers' group as well as others. This process helps reduce the risk to suppliers of introducing a new product and allows buyers to specify exactly what they are willing to buy without being limited to products already on the market. (See insert: *Technology Procurement: A Tool to Speed Introduction of a New Technology* on next page.)

10.2.2 Influencing Product Development and Manufacturing

Buyers can only choose to buy energy-efficient products that someone else has decided to produce and offer for sale. In many developing countries or subsectors of the economy, efficient products may not even be offered or may be available only as a custom order, as an imported option with long delivery

Technology Procurement: A Tool to Speed Introduction of a New Technology

A number of countries have used technology procurement to speed the introduction of new energy-efficient technologies to their markets. Technology procurement uses the aggregated buying power of several large-volume purchasers to establish market demand for new products and to clearly communicate this demand to potential suppliers. Technology procurement for energy-efficient products was pioneered and refined by the Swedish National Board for Industrial and Technical Development (NUTEK), now the Swedish Energy Administration (STEM) and subsequently used by a number of countries, including the Netherlands, Finland, and the U.S.

Examples:

1. As early as 1989, the Swedish Energy Authority, later NUTEK, formed a group of housing companies (municipality-owned social housing and cooperatives and a major part of the leading privately owned market) for a multi-year program which would use technology procurement to inspire innovation and introduce more-efficient products and systems. Over a number of years, NUTEK's housing companies purchased energy-efficient products, starting with energy-efficient refrigerators (30% more energy efficient than current models, CFC-free, and with labels showing actual energy use) and followed by electronic ballasts for lighting, energy-efficient clothes washers and dryers, and efficient windows that save 60% more energy than standard triple-glazed Swedish windows (Westling, 2000, 2001).

2. Starting in 1995, the New York Power Authority cooperated with the New York City Housing Authority and other public-housing authorities to create a technology procurement project for new refrigerators that would use 30% less electricity than those already on the market. The aggregated demand of several public-housing authorities convinced Maytag Corporation, the winning bidder, to invest in new refrigerator manufacturing capacity for its high-efficiency models.

3. The International Energy Agency's Annex on Demand-Side Management has sponsored technology-procurement projects for electric motors, heat-pump dryers, light-emitting diode (LED) traffic signals, and digital multifunction office copiers.

4. The U.S., Pacific Northwest National Laboratory evaluated six technology-procurement projects in the U.S, including government purchases and related government-utility partnership projects, and analyzed the successes and setbacks (Holloman 2002). The projects involved the Super-Efficient Refrigerator Program (SERP), Apartment-sized Refrigerator Purchase, High-Efficiency Clothes Washer Program, U.S. DOE Sub-compact Fluorescent Lamp, High-Efficiency Unitary Air Conditioner Technology Procurement, and Recessed Downlight Fluorescent Fixtures. Five project design lessons are found to be widely applicable (Ledbetter 2000):

- A two-phase solicitation was useful, including an initial phase to identify potential suppliers and buyers and to solicit feedback on appropriate specifications
- Modest-volume procurements worked well to achieve incremental improvements
- Long start-up times helped programs that depended on sales to large-volume buyers, particularly government agencies
- The participation of public agencies recognized for objectivity, consumer interest, and technical expertise was critical for program success
- The flexibility to take advantage of technology improvements during implementation helped the programs

time, or at significantly higher cost than other models, and these products may enjoy little or no customer support. Manufacturers may be reluctant (or financially unable) to invest in developing a new energy-efficient product and the manufacturing capacity for it unless they are assured of adequate, sustained buyer demand; they may also be fearful of losing their market share to competitors.

Standards that prohibit the manufacture, sale, and import of inefficient products offer the most certain way to encourage manufacturers to shift toward more energy-efficient product lines. This may require coordinated actions on both the demand and supply sides of the market, including:

- creating initial demand within the public sector
- offering loans or loan guarantees to manufacturers who retool to produce efficient products
- providing rebates to manufacturers to reduce the incremental cost of efficient products at the wholesale level
- stimulating competition among manufacturers by identifying the most efficient brands and models (using both labels and product listings)

In developing countries, domestic manufacturers often make products that are less efficient than some imports. In these situations, special programs and attention, such as the phased timing of standards and technical and financial assistance, may be justified to help domestic manufacturers upgrade their product lines.

10.2.3 Influencing Supply, Distribution and Wholesale Purchases

Providing rebates for efficient products can influence wholesale and retail stocking decisions, bring down the first costs of the products, and stimulate buyer interest. Rebate programs targeted at wholesale and retail distributors need to be of long enough duration, perhaps several years, to effect a lasting change in market/consumer behavior. However, it is important to eventually phase out subsidies so that they are not provided longer than needed to transform purchase habits. The criterion for earning a rebate is often defined by an endorsement label or keyed to a standard. Successful rebate programs require advance coordination with distributors and careful planning of timing to avoid problems such as initial supply shortages, which can drive up prices and offset the rebate's intended effect. Educational campaigns specifically targeted at distributors can also play an important role by emphasizing how the sale of efficient products can increase market share and bottom-line profit. Public recognition can be given to distributors who show leadership in offering efficient products, as is done in the U.S. ENERGY STAR Partners program, which gives distributors a marketing advantage while increasing public awareness of efficient products.

10.2.4 Influencing Retail Purchases

At the heart of an energy-efficiency strategy are the choices made by consumers, private firms, and public agencies when they buy products that either use energy directly (e.g., refrigerators, air conditioners, office copiers) or affect its use (e.g., windows). The critical first step in influencing purchases is to provide labels that give buyers information on the energy use and therefore the long-term energy costs of the different product choices. Broad-based marketing and information campaigns can also draw attention to and explain the meaning and significance of energy labels.

Although labels can promote energy-efficient choices, the added first cost of making these choices may be a barrier to buyers. This barrier can be reduced by:

- rebates
- attractive loan financing or leasing
- tax credits
- government purchasing policies

10.2.5 Influencing System Design and Installation

Achieving real energy savings requires more than purchasing a product that performs its primary function efficiently; that product must be properly selected and correctly installed. Too often, efficiency programs have focused only on individual pieces of equipment while ignoring how each component fits into an overall system. A common example is the potential energy savings from office equipment (computers, monitors, printers, and copy machines) that automatically lower their standby power when the equipment is idle (see insert: *Transforming the Office Equipment Market to Reduce Unnecessary Standby Losses with ENERGY STAR and Energie-2000 Labels*). The power management controls built into individual personal computers and other office equipment may not operate properly when connected to an office-wide system unless users or system managers check when the units are installed to see that all the software and hardware settings are properly enabled. Similarly, proper installation of residential heating and cooling systems (including correct equipment sizing and good design of air-distribution ducts) can save even more energy than can be achieved by choosing an efficient air conditioner or furnace.

10.2.6 Influencing Operation and Maintenance

Not only does an efficient product need to be appropriately selected, purchased, and installed in order to actually save energy, it must be properly operated and maintained to perform well throughout its lifetime. Too rarely do efficiency programs focus on operation and maintenance (O&M) needs and practices. As noted in the previous section regarding potential energy savings from automatic standby power, the power-management controls built into individual personal computers and other office equipment have to be set properly when the units are installed; moreover, users or system managers need to regularly check to see that all the software and hardware settings remain enabled. Standards-setting and labeling programs only ensure that appropriate products are in place. Other programs are needed to ensure that they are appropriately used.

10.3 Program and Policy Tools

Program and policy tools that can help ensure positive outcomes from energy labeling and standards programs include: research and development (R&D), energy pricing and metering, financing and incen-

Transforming the Office Equipment Market to Reduce Unnecessary Standby Losses with ENERGY STAR and Energie-2000 Labels

In most offices, PCs, monitors, printers, and copy machines are left on all day (and sometimes even at night), consuming substantial energy when not actually in use. Many of these products use significantly more energy in the standby mode than is necessary for the standby functions. To address this problem, the U.S. EPA worked with equipment manufacturers to develop the ENERGY STAR label for equipment that automatically shifts to a low-power mode (e.g., 30 Watts or fewer for a PC) when not in active use. Manufacturers found that they could use very inexpensive power-management controls to switch equipment to low-power standby. Industry interest in the ENERGY STAR label, limited at first, grew rapidly following an executive order requiring federal government agencies to purchase PCs and other office equipment that qualify for the label. At the same time, utility programs helped raise customer awareness of energy wasted by office equipment in standby mode. As a result, by 2000 about 95-97% of the computer/monitors, 90% of the copiers, and 99% of the faxes sold in the U.S. qualified for the ENERGY STAR label (U.S. EPA 2003, Fanara 1997).

These exceptionally large market shares were achieved because of the rapid rates of technical innovation and product replacement in the electronics industry, the very low cost of incorporating power management when designing a new microchip, and other marketable advantages of power management, such as quieter PCs, reduced internal heat build-up, and lower air-conditioning loads in equipment-intensive offices. As a result of these attractive features, it was relatively easy to convince manufacturers to make power management a standard feature on most or all models. U.S. EPA attributes its success to its focus on creating ENERGY STAR as a well-recognized national brand for energy efficiency, which combines the voluntary participation of a wide range of organizations with U.S. EPA's endorsement and extensive information disseminated to participating organizations and the public. However, despite high market penetration, continued efforts have been needed to make sure that manufacturers ship their products with the power-management features enabled, to educate consumers on the proper use of power management, and to update the ENERGY STAR criteria to keep pace with new technical developments.

The Swiss Federal Office of Energy (SFOE) has also combined voluntary standards, labeling, and government purchasing to promote energy-efficient office equipment. First, SFOE developed fleet-average targets for low-standby-power office equipment and consumer electronics, which were designed to influence manufacturers' choices about which products would be manufactured for sale in Switzerland. If the industry failed to meet these target values by a specified date, SFOE had the statutory right to set mandatory minimum efficiency standards. In addition to establishing target values, SFOE developed the Energie-2000 label to help consumers identify models that are among the 25% most efficient on the market. SFOE also publishes a list of the qualified models each year and encourages large government and private-sector purchasers to buy Energie-2000 labeled products.

tives, regulatory strategies, voluntary activities (e.g., promotional campaigns), government purchasing, energy audits, and consumer education and information. These are discussed in the subsections below.

10.3.1 Research and Development

Government R&D programs are designed to directly stimulate the creation of new technology. On a global basis, they are important for maintaining continuing improvement in, among other features, the energy efficiency of energy-consuming products. Government intervention is warranted for technology improvements that serve a public interest but may have little commercial interest or be too large and risky for private investment. Individual countries may choose to participate in such public-interest R&D or leave it to other countries. Although this R&D is important, it may have little direct interaction with standards-setting and labeling programs in the short term and is therefore not described in further detail here.

10.3.2 Energy Pricing and Metering

Energy prices paid by consumers can affect the outcome of labeling and standards-setting programs in important ways. In fact, energy-pricing policies and metering and billing practices together provide a sound foundation for all energy policy, including energy efficiency standards and labels.

Market-based Energy Pricing

If electricity and fuel prices are subsidized (through taxes or price controls), this reduces the motivation for consumers to save energy. Below-market electricity or fuel prices decrease the effectiveness of labeling and standards-setting programs by causing life-cycle cost (LCC) analyses to dictate standards levels and other energy efficiency targets below the true economic optimum (see Chapter 6). Below-market energy prices can reduce the effectiveness of energy-efficiency labels by making energy consumption cheaper and thus not sending consumers the message that there is value in saving energy. This discrepancy is often an obstacle in developing countries where average electricity tariffs were less than $0.04/kWh during the first part of the 1990s even though the average cost of supply was around $0.10/kWh (Wohlgemuth and Painuly 1999).

Two possible solutions that are available to policy makers to address subsidized energy prices are to transition to a free market with cost-based energy prices, or, when this is not feasible or during a transition period to cost-based prices, governments can use “shadow prices” (energy prices calculated as if there were no subsidies) to determine economically justified levels for energy-efficiency standards.

Metering and Billing

In some developing countries, billing for electricity and pipeline gas may be infrequent or inaccurate, providing poor market signals to consumers. Reliable metering, frequent meter reading and billing, and reduced “technical losses” (stolen or unbilled energy) are needed to provide an incentive to save energy. In several countries, significant energy savings were achieved simply by installing submeters in previously master-metered apartment buildings and by adding heat meters to individual buildings served by district heat (Philips 2003, Hirschfeld 1998). In some countries, metering and billing may be the most important issues to address in introducing energy-efficiency programs directed at consumers. The cooperation of utility companies is necessary for successful introduction of metering and billing programs.

10.3.3 Financing and Incentives

A range of financing and incentive programs has been used to overcome the barrier of higher first cost that often restricts the purchase of energy-efficient technologies. The most common incentives are consumer rebates or grants, tax credits or accelerated depreciation, loan financing (including shared-savings or performance-based contracting), and equipment leasing. Energy labels and standards are an important foundation for these programs because labels and standards provide a verified baseline for judging enhanced performance and establishing appropriate incentives. Incentive programs can use product listings available from the labeling program to establish which products meet higher efficiency levels and to identify the models qualified to receive incentives.

Rebates, Grants, and Tax Policies

In most cases, either a government agency or a utility sponsor offers financial incentives directly to end users. Sometimes incentives are provided to manufacturers or builders to encourage them to supply more-efficient products with the assumption (or requirement) that at least some of the incentive will be reflected in a lower price to the final buyer.

Two programs that used manufacturer incentives are the Super-Efficiency Refrigerator Program (SERP), a pioneer "Golden Carrot" program initiated through a collaboration of electric utilities, non-governmental organizations (NGOs) and government agencies in the U.S.; and the Polish Efficient Lighting Project (PELP), developed by the International Finance Corporation (IFC) and funded by the Global Environment Facility (GEF). SERP sponsored a competition among manufacturers to develop a super-efficient refrigerator; the winner, Whirlpool, was awarded $30 million in guaranteed purchases of the new refrigerators from a consortium of participating utilities. PELP stimulated manufacturers who were exporting compact fluorescent lamps (CFLs) to produce more, cheaper, and better CFLs and to market them within the country (Ledbetter 1998, Hollomon 2002) (see insert: *Manufacturer Incentives Reduce Electricity Distribution Investments; CFLs Go International* on next page).

Some countries have reduced import duties or sales taxes on energy-efficient equipment, sometimes distinguishing between locally produced and imported products. In Pakistan in 1990, for example, the import duty on CFLs was reduced from 125% to 25%, cutting retail prices almost in half and increasing sales. Because import duties or sales/excise taxes may be an important source of revenue for a country, another approach that should be considered is a "revenue-neutral" tax incentive or "feebate" for efficient products. The idea is to keep the total amount of tax revenue about the same

Manufacturer Incentives Reduce Electricity Distribution Investments; CFLs Go International

The Poland Efficient Lighting Project (PELP), developed by IFC and funded by the GEF, was developed in 1995 to demonstrate to the Polish electric utility industry the benefits of using efficient lighting to reduce peak-power loads in geographic areas with inadequate distribution-grid capacity to meet existing or projected loads.

One major component of the program was an incentive payment to CFL manufacturers, which reduced wholesale prices by about US$2 per CFL. During a two-year period, the project subsidized the sale of more than 1.2 million CFLs. An aggressive CFL discount coupon/promotion program in three Polish cities led to very high CFL installation levels (two to nine CFLs per household) in the target neighborhoods and 15% peak demand reductions for substations serving purely residential loads; there was no adverse impact on power quality as a result of the CFL ballasts. The program was also highly cost effective for the utility compared with traditional approaches to upgrading grid capacity; residential peak demand savings averaged 50% over five years and 20% over 10 years.

PELP was an early demonstration that private-sector energy-efficiency projects are often more cost effective than supply-side investments. Other countries contacted IFC, so it asked GEF to support a $15-million Efficient Lighting Initiative (ELI) in seven countries: Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines, and South Africa. GEF approved the request in 1998. ELI has accelerated the deployment of efficient lighting by working with manufacturers, electric utilities, government and education institutions, and NGOs. In 2003–2004, ELI worked with its international partners to make the transition to a self-sustaining lighting-product quality-certification program. The program is built around the ELI logo, which is already carried by more than 150 products (see Figure 5-1).

Sources: Ledbetter et al. 1998, Ledbetter et al. 1999, International Finance Corporation 2004, Efficient Lighting Initiative 2004.

but to vary the tax rate so that the import or excise tax is lower on an efficient product and higher on a less-efficient one. The performance testing and rating information developed for product energy labels can provide the basis for these differential tax policies. The Netherlands applied this strategy in its Energy Premium Scheme (EPR), which raised money from households through an energy tax to use for rebates on energy-efficient appliances, building facilities, and renewable energy production. EPR offered rebates for appliances with an "A" label or better (see insert: *Netherlands Rebate Scheme for A-Rated Appliances*). Started in 2000, the EPR helped transform the market. The sales of A-labeled appliances increased by about 70% in 2001 and even more in 2002 (Siderius 2003).

Financing of Energy-Efficiency Investments: Loans, Leases, Performance Contracts, Vendor Financing, and Utility Financing

Providing financing for both the manufacture and purchase of energy-efficient equipment overcomes the barrier of lack of capital by spreading the initial costs over time. This financing can come in several forms.

Loans. Although development banks have historically been a major source of funds for energy-efficiency investments in developing countries, commercial banks and other lenders are an important and largely untapped funding source. Commercial financing includes loans and lines of credit, leasing, trade finance, consumer credit, vendor finance, mortgage finance, and project finance (Hagler-Bailly 1996).

Netherlands Rebate Scheme for A-Rated Appliances

In the Netherlands, E.U. energy labeling, introduced in the 1990s to improve the energy efficiency of appliances, was perceived as not sufficient by itself to substantially transform the market. One reason was that A-labeled appliances were more expensive than appliances in other label categories. Therefore, a financial incentive was thought to be necessary to induce consumers to buy energy-efficient appliances. This financial incentive started in January 2000 and was called the "energiepremie" (energy rebate); the program was called "Energiepremieregeling (EPR)" (Energy Premium Scheme).

In practice, the EPR works as follows: The consumer buys an energy-efficient product (an appliance or a building upgrade) in a shop or by mail order. In the shop, the consumer can get a form (or order the form from a utility), which, when completed and sent in with a proof of purchase, results in a rebate payment by the utility. The rebate for appliances was set at €45–50 for most A-rated appliances and €100 for better than A-rated appliances, with the exception of A-rated clothes dryers and washer-dryers, for which a higher rebate applied.

An extensive campaign was set up to communicate the EPR message to consumers, including a TV show, advertisements in national newspapers and magazines, and information on local media (radio, TV, newspapers, magazines). At the beginning of the campaign (in early 2000), 40% of consumers knew about EPR; in November 2001, this percentage had doubled to 82%. In addition, 76% of the people who had not used the EPR as of November 2001 were aware of the program. About one third of consumers knew how the EPR was financed (i.e., through the energy tax), 80% had a positive opinion of this way of financing, 10% had a negative opinion, and 10% had no opinion.

The effects were impressive. In 2000 (the first year of the scheme), more than 50% of washing machines and dishwashers sold were A-rated products. This statistic increased further in 2001, when the market share for A-rated washing machines rose to 88%.

The EPR has been a huge success in transforming the market for household appliances (not including dryers) in the Netherlands. Today it is difficult not to buy an A-labeled appliance in a shop in the Netherlands. However, the EPR was very costly, more than €50 million per annum at its height, which has led to a critical investigation into the program's overhead costs.

Source: Siderius 2003

Leasing. Leasing of energy-efficient equipment allows the user (lessee) to avoid expending capital up front to acquire an asset. To date, leasing has been used for purchasing energy-efficient products, particularly office equipment and automobiles, primarily in industrialized nations.

Performance contracting. Performance contracting (or third-party financing) has been widely used to finance energy-efficiency projects in the U.S. and Europe. In performance contracting, an end user obtains efficient equipment or other facility upgrades from an energy service company (ESCO). The ESCO pays for the improvements and receives a share of the savings as a performance-based incentive fee. There are two common models of performance contracting: guaranteed savings (where an ESCO or other partner guarantees the customer a minimum level of energy or cost savings) and shared savings (where the ESCO and customer agree beforehand on a formula for sharing whatever savings are realized). Variants and combinations of these basic approaches are also common. Performance contracting through an ESCO transfers some technology and management risks from the end user to the ESCO. It also minimizes or eliminates the requirement for an initial cash outlay by the customer and reduces other transaction costs and demands on staff. In the U.S., transaction costs of performance contracting are high at 20–40% of total project costs; therefore, ESCOs are only interested in large projects (one-half million to several million U.S. dollars) (Lin 2004).

Vendor financing. Vendor financing often targets energy-efficient products that are newly introduced or at least new to a market segment in a country or region. Vendor financing is typically used for sales of common equipment with large numbers of end users (e.g., industrial motors, commercial lighting).

Utility financing programs. Utilities can be allies or barriers to energy-efficiency programs. They have the potential to be strong allies because of their regular contact with their customers, their reservoir of trained energy specialists, and their potential to aggregate the consumer market and reduce acquisition costs. However, to become allies, they must embrace corporate values that are consistent with the goal of energy efficiency. In the past, the goal of utilities has been to promote sales as profits were linked to sales. For this linkage to change, regulators must award utilities for their performance in delivering the least-cost mix of supply- and demand-side programs. And, for these programs to be effective, utility executives must show the same dedication to energy efficiency that they have shown in the past to increasing energy supplies.

If utilities embrace this change, they can assume one of three roles in financing energy efficiency: facilitator, collection agent, or direct provider of financial services. In all cases, the utility's role needs to be approved by the applicable regulatory authority or governing body. The financing role could also be delegated to an unregulated subsidiary in countries where deregulation or utility restructuring is under way.

- *Facilitator.* As a facilitator of loan financing, the utility is a broker, helping bring together end users (its customers), energy-efficiency businesses, and lenders.
- *Collection agent.* If a utility collects customer loan payments through its regular monthly bills, this can help reduce transaction costs (especially for smaller projects) and also lower credit risk.
- *Direct provider.* Utilities can be direct providers of financial services (e.g., direct loans, equipment leases), using the market advantages of their customer relationships, access to capital, and existing billing systems.

The links between utility financing programs and labels and standards may be stronger than when financing is offered by other institutions. Utilities generally have a more direct interest in the outcome: cost-effective energy savings, improved customer relations, customer retention in an increasingly competitive market, satisfied regulators, and a future energy demand that is consistent with their energy supply plans.

10.3.4 Regulatory Programs

Four main types of regulatory programs can influence appliance and equipment energy efficiency:

- mandatory energy labels (or manufacturer declarations of energy performance even without a physical label on the product)
- efficiency standards for appliances and equipment (either at a minimum required level or as a class average for all products sold)
- energy-efficiency requirements in building codes
- government requirements that private utilities offer energy-efficiency programs

The first two programs are the subjects of previous chapters. The third, energy-efficient building codes, is an important means of assuring efficiency in both new construction and major renovation. Building energy codes, common in the U.S., Europe, Southeast Asia, and several other countries, usually specify performance levels for the building envelope and heating and cooling equipment and also specify overall lighting levels. Codes generally do not set standards for plug-in appliances or for replacement equipment in existing buildings. Code requirements are typically expressed either in energy-performance terms (e.g., maximum lighting power, in W/m2, to deliver a specified level of illumination) or as prescriptive requirements (e.g., ceiling and wall insulation of a certain thickness or R-value). Efficiency labels on heating and cooling equipment and performance labels for windows can make it easy for building inspectors to check for compliance with energy codes.

Some countries, including the U.S., have both mandatory equipment-efficiency standards and mandatory building-energy codes that cover some of the same products. In this situation, the credibility and effectiveness of both programs depend on effective coordination between those responsible for equipment standards and those responsible for the building code.

The fourth type of regulatory program, prominent in the U.S. during the 1980s, is quite different from the previous three. It requires private electric and natural gas utility companies to conduct demand-side management (DSM) programs to help their customers use energy more efficiently and to better manage peak loads. Many government-run public utilities also have undertaken DSM programs. As will be discussed in Section 10.4, more comprehensive market-transformation programs are now replacing utility DSM programs in the U.S.

10.3.5 Voluntary Programs: Quality Marks, Targets, and Promotional Campaigns

Voluntary programs, led by both government and industry, encourage manufacturers, distributors, installers, and customers to produce, promote, or purchase energy-efficient products and services. These programs may include:

- quality marks or labels that distinguish products based on superior energy and environmental performance (see Chapter 5)

- voluntary targets that set guidelines for an industry to strive for
- marketing and promotional campaigns (see Chapter 7)

Quality marks or labels are part of the labeling and standards-setting activities that are the primary focus of this guidebook. So are marketing and promotional campaigns that are targeted at standards and labels. Industrial programs that set voluntary targets are closely aligned to the labeling and standards-setting activities, as are marketing and promotional campaigns that target programs other than standards and labels. They often have exactly the same objectives as efficiency standards and labels programs—communicating information to consumers and setting performance goals—and rely on similar information and analyses.

Voluntary programs often enlist private firms as partners with the sponsoring government agency. The U.S. ENERGY STAR program, for example, introduced by the U.S. Environmental Protection Agency (EPA) in 1992 and addressed in more detail in Chapter 5, illustrates how such partnerships can help these programs grow in their coverage of products, numbers of partners, and national and international impact. An entire industry sector may also establish voluntary targets for energy-using products or processes—to promote best practices and increase competitiveness and profitability within the industry, to gain public relations benefits, or to anticipate regulatory pressures and minimize the likelihood of future regulation. Such voluntary targets can be based on either a single target value for efficiency that everyone must meet or a fleet-average efficiency for all products sold by each firm or by the industry as a whole. The success of a voluntary program for office equipment and consumer electronics in Switzerland shows the importance of both government leadership and active involvement from manufacturers (see insert: *Transforming the Office Equipment Market to Reduce Unnecessary Standby Losses with Energy Star and Energie-2000 Labels* on page 259).

10.3.6 Government Purchasing

Government purchasing power can have enormous influence in stimulating the diffusion of energy-efficient products. In their day-to-day activities, public agencies purchase large numbers of energy-using appliances and equipment for use in government offices, public schools, universities, hospitals, street lighting, water and other utilities, military/defense facilities, and state-owned enterprises. Harnessing the power of routine purchasing by government and other institutional buyers can be a powerful way to stimulate the market for energy-efficient products while setting an example for corporate buyers and individual consumers. This strategy also bypasses much of the need to raise new capital for energy-efficiency investments, making use of funds already budgeted to purchase or replace equipment and directing this spending toward energy-efficient products. The government's influence also can be exercised through "indirect purchasing," requiring contractors who provide design, construction and maintenance services to offer energy-efficient equipment and follow energy-efficient practices.

The U.S., led by DOE and EPA, was an early promoter of energy-efficient purchasing at all three levels of government: federal, state, and local (www.eere.energy.gov/femp/program/equip_procurement.cfm and www.energystar.gov/index.cfm?c=government.bus_government). The U.S. federal government by itself is the world's largest single buyer of energy-using products, spending more than US$10 billion on such purchases each year (McKane and Harris 1996). Including purchases by state and local government agencies, the public sector represents at least one of every 10 dollars spent in the U.S. on energy-using products.

The program was strengthened by a 1999 Executive Order directing that all federal agencies purchase energy-using products that are life-cycle cost-effective, including products with ENERGY STAR labels or, where the label is not available, products in the upper 25 percent of energy efficiency in their product class. In addition, to defang what he called "energy vampires," President Bush issued a 2001 Executive Order directing all federal agencies to buy products with low standby power requirements (1 watt or less where possible) (Harris et al. 2003).

A recent review of U.S. state and local government purchasing policies identified a growing number of jurisdictions that are adopting purchasing requirements based on the same federal efficiency criteria, i.e., ENERGY STAR-labeled products or those in the top 25th percentile of efficiency (Harris et al. 2004). The study concludes that: "Aggregating public sector demand sends a powerful market signal to manufacturers and vendors that some of their largest customers are looking for suppliers who offer good prices and overall value for products that meet a well-defined efficiency target."

An international review performed in 1997 found that, although a few countries had recently instituted energy-efficient purchasing programs, the potential for such programs was largely ignored (Borg et al. 1997). A more recent survey in 2002 reached the same conclusion, estimating, based on the government-sector share of GDP or employment, that governments represent 10-25% of the energy market in industrial, developing, and transition countries alike. Although the study found that a few additional countries had initiated energy-saving programs in government buildings since the previous study, the potential for government purchasing power to lead and transform markets was still rarely recognized (Van Wie McGrory et al. 2002).

Some countries are, however, starting to link the government's purchasing power with energy-efficiency standards and labeling programs. Developing and transition countries have an enormous potential to use standards and labels as a guide to save energy and money in their own government-sector purchases and to stimulate savings throughout their economies. Although many countries have been slow to grasp this potential, there are a few important exceptions, in addition to the U.S. These include Europe, Denmark, Japan, Korea, China, and Mexico, as detailed below.

Europe has recognized the power of the public purse to promote energy efficiency. Europe's public sector could save €12 billion /year in energy costs, according to a recent multi-country study by the European Commission's SAVE program (www.eceee.org/library_links/prost.lasso). The study, "PROST—Public Procurement of Energy Saving Technologies in Europe," found that: "If the public sector all over Europe were to systematically procure energy-efficient products and buildings using very much the same performance criteria, the market transformation towards more efficient and sustainable products and building practices of the whole market beyond the public sector would be boosted significantly" (Borg et al. 2003). The study's recommendations included energy efficiency A-class appliances and ENERGY STAR office equipment. The study found no significant legal barriers to procuring energy-efficient products. The major barriers were lack of political priorities and policies, lack of motivation or incentives, and outmoded routines that failed to reflect energy and environmental priorities.

The Danish Electricity Savings Trust (DEST), a governmental agency created in 1996, organized a group of large institutional buyers, including social housing companies and local governments, to jointly procure—at a very favorable bulk-purchase price—up to 10,000 energy-efficient refrigerators that qualified for the top efficiency rating (A) on the E.U. appliance label. DEST has expanded its program to other volume purchases for high-efficiency appliances, consumer electronics, office equipment, and CFLs (Karbo 1999).

In Japan, the "Basic Policy on Promoting Green Purchasing" contains specific provisions for government procurement of energy-efficient and environmentally preferable products, including the use of ENERGY STAR labeling criteria for office equipment (www.env.go.jp/en/lar/green/2.pdf). In Korea, there is a similar government policy favoring purchases of energy-efficient appliances and equipment that are above the minimum energy performance standards (MEPS) (www.pepsonline.org/workshop/downloads/Byun%20Chun%20Suk%20presentation.pdf).

Projects currently under development in China and Mexico are creating government purchasing policies linked to energy-efficiency endorsement ("seal of approval") labels: in Mexico the Sello FIDE and ENERGY STAR labels, and, in China, the certification label issued by the China Certification Center for Energy Efficiency Products (CECP).

By adopting energy-efficiency criteria to guide their own purchasing, government agencies save energy and money, set an example for other buyers to follow, and send a strong market signal to product suppliers and manufacturers. Energy testing and rating systems already in place to support efficiency labels and standards provide a baseline for establishing these energy-efficient purchasing criteria.

10.3.7 Energy-Audit Programs

Many end users do not have the time, expertise, or resources to hire experts to recommend energy efficiency improvements and strategies to reduce energy costs. Free or subsidized energy audits can help end users identify and prioritize energy-saving opportunities. In many countries, energy audits are a central element of efficiency programs in the industrial sector and in the building sector for homes, commercial buildings, and public facilities.

Audits typically identify generic energy-saving options, including O&M improvements, as well as site-specific options for capital investments in efficient equipment and systems. Some programs offer in-depth energy audits conducted by experts skilled in a particular industrial process or building type and may address industrial waste-reduction or other environmental measures as well as energy efficiency. Standards-setting and labeling programs can complement auditing programs by providing reliable performance and cost information on major elements of the audits. For building audits, these elements include window systems and heating, cooling, lighting, and other energy-using equipment. In industrial audits, electric motor improvements are an attractive target, including improved efficiencies and correct sizing and controls.

In recent years, a number of developing and transition countries have adopted or are considering mandatory audits for all facilities whose energy consumption is greater than a defined threshold. Experience with these programs has shown mixed results. A requirement for mandatory audits by themselves has led to perfunctory, low-quality audits performed just to meet the legislative requirement. Auditors may avoid recommending any measures that would require mandatory investments. Experience shows that it does little good to provide energy audit recommendations without some way to assure the customer will implement the recommended measures, and that the measures will often require some form of financial assistance (World Bank 2004).

An early example of combining audits and financing is the Technology Transfer for Energy Management (TTEM) program in the Philippines (Rumsey and Flanigan 1995). This program, sponsored by a grant from U.S. AID, addressed two major constraints: a lack of reliable information on energy-efficient technologies and reluctance on the part of industrial managers and lenders to fund efficiency upgrades. Through a Demonstration Loan Fund, accredited banks made five-year loans for energy-efficiency upgrades at below-market rates. Loan financing for 16 demonstration projects produced energy savings with an average 41% internal rate of return. TTEM also provided free technical assistance to more than 120 companies, seminars for 1,100 attendees from private firms and financial institutions, and technical training for the staff of the Philippines Office of Energy Affairs (OEA). Program staff believed that technical assistance, even more than financing, was the key to the program's success.

10.3.8 Consumer Education and Information

In the long run, developing and maintaining an energy-efficient economy requires that private citizens, corporate managers, government officials, professionals, and retail outlets all share at least a basic understanding of how energy is used, the economic and other (environmental, social) costs of energy production and use, and the main opportunities to improve energy efficiency. This basic "energy literacy" must begin with elementary and secondary schooling and continue as part of professional and technical training for those whose jobs will involve energy-related decisions. Consumers need access to information about how their homes or businesses use energy, what energy-saving opportunities are open to them, and which products are energy-efficient and cost-effective choices.

Energy-efficiency labels can play an important role in this consumer education. As described in Chapters 5 and 7, surveys and focus groups to help design energy-efficiency labels provide important information about consumer motivation. Subsequent training and educational campaigns to support the energy labels target not only the final consumer but also those who have direct contact with customers, including retail sales staff, contractors/installers, and maintenance/service personnel, all of whom should understand the benefits of efficient products and can personally profit from promoting these products to end users. The growing number of websites addressing standards and labels and presenting an increasing depth of information is making a significant contribution to the education of consumers (See insert: *Information and Education Websites*).

As emphasized in Chapter 7, governments typically engage in consumer education campaigns that go beyond those focused on endorsement labels and other aspects of standards and labels programs. Coordination among parallel education programs is necessary so all programs communicate a uniform message and are thus most effective.

Information and Education Websites

Central and Eastern European Countries Appliance Policy (CEECAP): Information on extension of standards and labeling systems into Central and Eastern European countries. www.ceecap.org

Collaborative Labeling and Appliance Standards Program (CLASP): Standards and labels information clearinghouse. www.clasponline.org

Consortium for Energy Efficiency (CEE): Information on residential, commercial, and industrial programs; evaluation and research; and government, multi-family housing and gas programs. www.cee1.org

Efficient Lighting Initiative (ELI): Information on international lighting program funded by GEF and managed by IFC. www.efficientlighting.net

Energy Standards Information System (ESIS): Website developed by APEC and co-sponsored by CLASP serves as a clearinghouse for information on energy-efficiency standards in APEC economies and beyond, including access to standards in place, e-mail notification of new proposed standards, a list of experts and key contacts, links to related websites, and dynamic comparisons and benchmarking. www.apec-esis.org

ENERGY STAR: Website sponsored by the U.S. EPA and U.S. DOE; includes products, home improvement, new homes, business improvement, partner resources, news, and links to other sites. www.energystar.gov

European Union Energy Efficiency Action plan: europa.eu.int/scadplus/leg/en/lvb/l27033.htm Energy labeling of household appliances. europa.eu.int/scadplus/leg/en/lvb/l32004.htm

Homespeed: Pan-European database for energy-efficient appliances for household equipment (white goods), consumer electronics, and office equipment. www.homespeed.org

U.S. Department of Energy: Website provides information on energy efficiency, ENERGY STAR, and the Building Technologies Program's Appliance and Commercial Equipment Standards. www.doe.gov

10.4 New Strategies to Transform Markets

Governments can invite, coax, require, or directly sponsor any of the program and policy tools described in Section 10.3. As mentioned previously, in many parts of the world the design of energy-efficiency programs is changing—largely in response to electric utility industry deregulation and the related move toward cost-based energy prices to focus more on lasting transformation of markets.

Until recently, energy-efficiency programs and policies were most often independently conducted by government agencies, utility companies, private consultants, and large building owners or industrial firms themselves. However, these programs typically targeted efficiency improvements at a specific site or for a given type of energy-using equipment. Market-transformation strategies focus more broadly on how products are manufactured and flow through markets to consumers. These approaches change the behavior of market participants in a lasting way to increase the adoption of energy-efficient technologies and services (Suozzo and Nadel 1996, Suozzo and Thorne 1999).

A coordinated strategy for market transformation might focus on a single technology, energy end use, or a well-defined market segment. Like any well-designed energy-efficiency program, this strategy should include a careful analysis of market conditions to identify specific barriers to development, introduction, purchase, and use of the energy-saving measure. The market-transformation strategy will use that information to prepare a clear statement of the specific objectives for each market segment and a practical plan for transitioning from intensive interventions toward a largely self-sustaining market process—i.e., an exit strategy.

10.4.1 National Market Transformation Programs

China's CFC-Free Energy-Efficient Refrigerator Project is a good example of a market transformation program (see insert: *China Comprehensively Reforms Refrigerator Market* on next page). Coordinated strategies also have been used to move high-efficiency products into the light commercial air-conditioner market (Lowinger et al. 2002).

The United Kingdom's (U.K.) Market Transformation Programme (MTP) supports a structured, public-domain sector-review process, conducted in partnership with businesses, consumers, experts, and others. It focuses on improving the delivered energy performance of domestic and non-domestic energy-consuming appliances, equipment, and components. The program is broad, with reviews in 12 major sectors, covering 27 product types and representing 75% of U.K. electricity consumption, including all major domestic energy-consuming appliances and traded goods in the commercial sector. It uses the internet to provide information and encourage public awareness and scrutiny of current policy thinking, promoting openness, and transparency. A key feature of MTP is the use of market projections and policy scenarios to help "reality test" explicit market-transformation policy rationales against consumer expectations and industry's own business plans. MTP supports the U.K.'s work in all aspects of its energy-efficiency portfolio, including Eco-labeling, buyers' guides, standards, and green procurement.

China Comprehensively Reforms Refrigerator Market

The CFC-Free Energy-Efficient Refrigerator Project, China's first comprehensive market-transformation project, improved the efficiency of a common consumer product and pioneered the introduction of standards and labels with a huge, rapidly growing domestic appliance market. The project originated in 1989 as a joint effort by the U.S. EPA and China's National Environmental Protection Agency (NEPA—now SEPA, the State Environmental Protection Administration). The project took advantage of the planned phase-out of CFC refrigerants to also increase the energy efficiency of Chinese refrigerators, achieving both environmental goals with a single retooling of manufacturing plants. The participating agencies worked with industry to incorporate non-proprietary technologies in a prototype CFC-free refrigerator that used 45% less energy and had design features appropriate for wide application in China (Fine et al. 1997).

The next step was to focus on manufacturing, distribution, and sales, to ensure that manufacturers would produce and dealers would stock and promote the new, efficient refrigerator models and that consumers would buy them. GEF sponsored research on consumer attitudes, market trends, efficiency standards, sales channels, pricing, compressor efficiency, and other topics in order to develop a comprehensive approach to market barriers. The GEF-funded market-transformation project included revised efficiency standards, a mandatory appliance energy label, dealer training and consumer education, manufacturer training in refrigerator design and modeling, and a manufacturer incentive program.

The project unfolded against a background of monumental growth in appliance ownership and production in China. In 1981, fewer than 1% of urban Chinese households owned refrigerators; by 1998, that number had increased to more than 75%. Similar increases have occurred for television sets, clothes washers, and air conditioners. Since 1980, China's infant appliance industry has grown to become one of the largest in the world, surpassing US$14.4 billion in 2000 (Lin et al. 2002).

This project exemplifies a multi-staged approach to a comprehensive market-transformation project. China's first set of minimum efficiency standards, initiated in 1989, was strengthened by the Energy Conservation Law in 1997, which put end-use energy efficiency and standards and labels at the center of its new energy-conservation strategy. To further enhance savings, China developed endorsement labels, including a refrigerator label for products that are 30% more efficient than the mandatory standard. Manufacturers responded quickly, and a majority of the refrigerators qualified for the label in 2000. China currently is strengthening its standards and label requirements. The program is achieving a substantial increase in refrigerator efficiency, saving money for consumers, easing power loads on an already strained electricity grid, and significantly reducing emissions of CFCs, CO_2, and other air pollutants.

Outreach activities go beyond national borders and include, for example, a collaborative project with the Dutch Ministry of Economic Affairs (www.mtprog.com).

Market transformation typically includes activities designed to:

- eliminate the availability of energy-wasting products through mandatory standards
- stimulate the development and market introduction of new, energy-efficient models
- ensure that energy labels are in place to provide the information consumers need to make well-informed choice
- raise the awareness by all participants in the product-distribution chain regarding new products and relevant information
- change consumer purchasing practices to increase market penetration of efficient products so that these products become well established in the market
- stimulate accelerated replacement and early retirement of existing products

The appropriate tools for market transformation depend in part on how mature a technology or practice is (Nadel 2002, Hinnells and McMahon 1997, Suozzo and Nadel 1996). For example, demonstration projects and technology procurement efforts may be employed in the early stages to stimulate the introduction of new, energy-efficient technologies. Rebates/loans and volume purchasing by large buyers, along with consumer education and labeling and marketing campaigns, may be used to increase market penetration. Where feasible, building codes and minimum efficiency standards are used to complete the transformation process by removing inefficient products and practices from the market. As part of a market-transformation effort, energy-efficiency standards-setting is a dynamic process with periodic updates to ensure continuing progress in saving energy (see insert: *How Market Transformation Makes New Technologies Available: Resource-Efficient Clothes Washers* on next page). Market transformation has little hope of being successful if it employs just one approach. Using a market-transformation approach, several program and policy tools are combined to achieve permanent changes in the market. Labeling and standards-setting programs are an essential part of most market-transformation strategies.

10.4.2 Multinational Trends

The energy and environmental benefits of standards and labels, combined with the growth in the global economy, have led to an increasing number of new, multinational approaches.

The North American Energy Working Group (NAEWG) was established in 2001 by the governments of Canada, Mexico, and the U.S. to advance their common interests on energy-related issues. Although electricity and gas interconnections were a driving force, NAEWG also gave a high priority to the harmonization of standards and labels in North America. The Lawrence Berkeley National Laboratory, representing CLASP, was funded by the U.S. DOE to analyze the standards, labels, and test procedures of the three countries. The report identified 46 energy-using products. Three of them—refrigerator/

How Market Transformation Makes New Technologies Available: Resource-Efficient Clothes Washers

Clothes washers offer major energy-savings opportunities. More than 70% of American homes have clothes washers, which use significant amounts of electricity or gas for water heating and drying and smaller amounts for motors. In 1991, the savings potential from clothes washers drew attention when U.S. DOE conducted a standards rulemaking under the National Appliance Energy Conservation Act (NAECA) and set a standard requiring only a modest efficiency gain of 10%. That decision continued U.S. reliance on vertical-axis, agitator-based models and marginalized the potential for horizontal-axis clothes washers, such as those commonly sold in Europe and Japan, which use about half the water and one-third the energy of conventional U.S. models.

U.S. DOE's 1991 decision drew serious attention from utilities, NGOs, federal agencies, states, manufacturers, and retailers. In particular, U.S. DOE caught the attention of manufacturers by saying that it would consider horizontal-axis machines in its next rulemaking. Utility groups in the western states and New England discussed strategies for supporting advanced clothes-washer designs, and NGOs joined the effort. The newly formed Consortium for Energy Efficiency (CEE), a utility-based group, was asked to play a coordinating role. CEE prepared draft specifications for a highly efficient clothes washer, prepared a program description, solicited participation by utilities through subsidies and/or marketing campaigns, and met with manufacturers to seek their participation. Manufacturer support was gained through specifications that did not prescribe any specific feature, such as horizontal-axis drums, but were performance-based, which gave manufacturers freedom in creating designs to meet the imminent, stringent new requirements. The U.S. DOE/EPA ENERGY STAR program reinforced the CEE specifications by adopting the same criteria for its clothes-washer labels. In 2000, U.S. DOE announced that an agreement had been reached to increase the federal minimum standards for residential clothes washers, to take effect in 2004 and 2007, by 22% and 35% above the current standard, respectively.

Despite a premium price, the new models have captured 6% of the national market and nearly 20% of the sales in regions with active programs. When the initiative was launched in 1995, it had commitments of support from 27 participating utilities and energy organizations. Now that number has grown to more than 240. When the initiative began, high-efficiency clothes washers were a niche market and were available only from foreign manufacturers. Now the U.S. market has 21 different brands, including at least one from every major domestic manufacturer, and more than 80 different models.

Sources: CEE 2001, Suozzo and Thorne 1999, Gordon et al

freezers, room air conditioners, and three-phase electric motors—have identical MEPS and test procedures. Ten other products exhibit some differences in MEPS and test procedures but are early candidates for harmonization. NAEWG is planning further harmonization of test procedures, mutual recognition of test results, and perhaps extending the ENERGY STAR program to Mexico (Wiel et. al. 2002).

The extension of energy standard and label programs into central and eastern Europe is the goal of an initiative launched in 2002. The IEA's Climate Technology Initiative (CTI) laid the groundwork for the extension project with a report on the status of appliance policies in central and eastern European countries and their inherent barriers and opportunities. The IEA and the Dutch government provided initial funding for the Central and Eastern European Countries Appliance Policy (CEECAP) project in anticipation of future support from the E.U.'s Intelligent Energy for Europe (IEE) program. A driving force for the initiative is the E.U.'s interest in the effective implementation of its appliance policies in new member states and the accession countries with spillover impacts on other central and eastern European countries. The project moved into a new phase in 2004, with expert training and in-country assistance in the new member states (CEECAP 2004).

The Asia-Pacific Economic Cooperation (APEC) forum is a vehicle for advancing discussion of energy efficiency among the Pacific Rim countries, with special emphasis on incorporating standards and labels in each economy's energy efficiency portfolio and harmonizing members' efficiency policies. APEC operates on the basis of dialogue and non-binding commitments, so its role would not be to create a program, but to create conditions that advance inter-governmental actions. The 21 members of APEC represent about 60% of world GDP, so this role can be significant. In 2000, an APEC report, "Cooperation on Energy Standards in APEC," provided useful baseline information, particularly on the importance of common test procedures, laboratory capacity, and transparency to support standards and labels (APEC 2000). For more than a decade, the Experts Group for Energy Efficiency & Conservation (EGEE&C) of APEC's Energy Working Group (EWG) has placed major focus on energy-efficiency standards and labels. It has conducted workshops on both, and has developed an Energy Standards Information System interactive database, called APEC-ESIS, to track and update information on energy-efficiency performance standards that are either in use or under development (www.apec-esis.org). APEC-ESIS, now co-sponsored by CLASP, includes a Standards Notification Procedure for informing energy policy officials, manufacturers, and other interested parties about new energy standards and regulations being developed or revised in APEC economies.

The 10-member Association of South East Asian Nations (ASEAN) adopted a Plan of Action for Energy Cooperation 1999-2004 that identifies Energy Efficiency and Conservation Promotion as one of its key programs. The implementing body of this program is the Energy Efficiency and Conservation Subsector Network (EE&C-SSN). The activities of the EE&C-SSN are facilitated and coordinated by the ASEAN Center for Energy (ACE), an intergovernmental organization established by the ASEAN member countries. The activities of the program include exploring development of a harmonized ASEAN energy-labeling system.

These multinational efforts have a theme that is similar to their parallel bilateral and national efforts. All of the activities described in this chapter target the development of a long-term, sustainable global energy sector that stimulates socio-economic growth and the accompanying improvement in living conditions with reduced environmental harm worldwide. All of the activities described in this chapter have their place, along with energy-efficiency standards and labels as the flagship program, in every country's portfolio of energy-efficiency programs. The people responsible for the standards and labels program will maximize their country's achievements by coordinating closely and cooperatively with their counterparts in the other energy-efficiency programs.

Acronyms

AB	Accreditation body
ACE	ASEAN Center for Energy
ACEEE	American Council for an Energy-Efficient Economy
ADB	Asian Development Bank
ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie (French Agency for the Environment and Energy Management)
AGO	Australian Greenhouse Office
AHAM	Association of Home Appliance Manufacturers
ANER	Tunisian Agency for Renewable Energy
ANSI	American National Standards Institute
ANOPR	advance notice of proposed rulemaking
APEC	Asia-Pacific Economic Cooperation
ARI	Air-conditioning and Refrigeration Institute
ASEAN	Association of Southeast Asian Nations
ASHRAE	American Society of Heating, Refrigerating, and Air-conditioning Engineers
AV	adjusted volume
BRS	Building Research and Standards Office (U.S. DOE)
Btu	British Thermal Unit
CACPK	Citizens Alliance for Consumer Protection of Korea
CANENA	Council for the Harmonization of Electro-technical Standards of the Nations of the Americas
CCE	cost of conserved energy
CECED	European Committee of Domestic Equipment Manufacturers
CECP	Center for the Certification of Energy Conservation Products (China)
CEE	Consortium for Energy Efficiency
CEECAP	Central and Eastern European Countries Appliance Policy
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CFC	chlorofluorocarbon
CFL	compact fluorescent lamp
CFR	Code of Federal Regulations
CLASP	Collaborative Labeling and Appliance Standards Program
CM	compliance monitoring
CNIS	China National Institute of Standardization
CO	certification organization
CO_2	carbon dioxide
CONAE	Comision Nacional para el Ahorro de Energia (Mexican government energy-efficiency agency)
COP	coefficient of performance
COPANT	Pan American Standards Commission
CSA	Canadian Standards Association
CTI	Climate Technology Initiative (of the IEA)
DG TREN	European Commission Directorate General for Transport and Energy
DSM	demand-side management
EE	energy efficiency
EE&C-SSN	Energy Efficiency and Conservation Subsector Network (ASEAN)

EEA	European Economic Area
EER	energy-efficiency ratio
EGAT	Electricity Generating Authority of Thailand
EGEE&C	Experts Group on Energy Efficiency and Conservation (APEC)
EIA	Energy Information Administration (U.S. DOE)
EJ	exajoule
ELAR	Energy-efficiency Labeling of Large Household Appliances (Czech Republic)
ELRC	Energy Labeling Regulatory Committee (E.U.)
ELI	Efficient Lighting Initiative
EPR	Energy Premium Scheme (Netherlands)
ESCO	energy service company
ESIS	Energy Standards Information System
E.U.	European Union
EWG	Energy Working Group (APEC)
FTC	Federal Trade Commission (U.S.)
GDP	gross domestic product
GEA	Group for Efficient Appliances
GEF	Global Environmental Facility
GHG	greenhouse gas
GRIM	government regulatory impact model
GSA	Government Service Agency (U.S.)
GWh	gigawatt hour
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
HPWH	heat-pump water heater
HVAC	heating, ventilation, and air conditioning
IDB	Interamerican Development Bank
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEE	Intelligent Energy for Europe
IEEE	Institute of Electrical and Electronics Engineers
IFC	International Finance Corporation
IIEC	International Institute for Energy Conservation
ILAC	International Laboratory Accreditation Cooperation
ISO	International Organization for Standardization
JIS	Japan Industrial Standards Association
kCal/hr	kiloCalories per hour
KSA	Korean Standards Association
kWh	kilowatt hour
LBNL	Lawrence Berkeley National Laboratory
LCC	life-cycle cost
LCIE	Le Laboratoire Central des Industries Electriques (Central Electricity Industry Laboratory, France)
LED	light-emitting diode
LFA	logical framework approach
LNE	Laboratoire National d'Essais (French National Testing Laboratory)
MEPS	minimum energy performance standards
MITI	Ministry of International Trade and Industry (Japan)
MOU	memorandum of understanding
MRA	mutual recognition agreement
MTP	Market Transformation Programme (U.K.)
MW	megawatt
NABL	National Accreditation Board for Testing and Calibration Labs (India)

NAECA	National Appliance Energy Conservation Act (U.S.)
NAEEEP	National Appliance & Equipment Energy-Efficiency Program (Australia)
NAEWG	North American Energy Working Group
NEMA	National Electrical Manufacturers Association
NEMS	National Energy Modeling System
NEPA	National Environmental Protection Agency (China)
NGO	non-governmental organization
NOPR	notice of proposed rule making
NPV	net present value
NUTEK	Swedish National Board for Industrial and Technical Development
O & M	operation and maintenance
OECD	Organization for Economic Cooperation and Development
PADE	Pan European Database of Energy-Efficient Appliances
PAMS	Policy Analysis Modeling System
PELP	Poland Efficient Lighting Project
R&D	research and development
SARI/E	South Asia Regional Initiative for Energy Cooperation and Development
SEER	seasonal energy-efficiency ratio
SEPA	State Environmental Protection Administration (China)
SERP	Super-Efficient Refrigerator Program
SFOE	Swiss Federal Office of Energy
SI	Système Internationale d'Unités (International System of Units)
STEM	Statens Energimyndighet (Swedish National Energy Administration)
TESAW	Top Energy Saver Award (Australia)
TRC	total resource cost
TREAM	Transforming the Market for Energy-Efficient Appliances and Products through the Use of Appliance Information Systems (Czech Republic)
TSD	technical support document
TTEM	Technology Transfer for Energy Management (Philippines)
TWh	terawatt hour
UEC	unit energy consumption
U.K.	United Kingdom
UN DESA	United Nations Department of Economic and Social Affairs
UN ECE	United Nations Economic Commission for Europe
UN ECLAC	United Nations Economic Commission for Latin America and the Caribbean
UN ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
UNF	United Nations Foundation
U.S. AID	United States Agency for International Development
U.S. DOE	United States Department of Energy
U.S. EPA	United States Environmental Protection Agency
VCRs	videocassette recorders
VECP	Vietnam Energy Conservation and Efficiency Program
VINASTAS	Vietnam Consumers Organization
WSSN	World Standards Services Network

GLOSSARY

Accreditation: Conformity certification process by which the government ensures that testing facilities perform tests correctly with properly calibrated equipment.

Achievable potential: Practical and sustainable energy-savings potential, given market barriers and competing policies.

Adjusted volume: Accounts for the different temperatures in the fresh-food and freezer compartments of refrigerators, refrigerator-freezers, and freezers.

Alignment: The unilateral adoption of the same test procedure or performance standard level or energy labeling criteria or design as that of an international organization or trading partner for a particular appliance.

Baseline: Represents the energy performance of a typical model for a given product or a description of what would have happened to a produc's energy use if labels and/or standards had not been implemented

Carbon Dioxide (CO_2): Colorless, odorless noncombustible gas with the formula CO_2 that is present in the atmosphere. It is formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass); by respiration, which is a slow combustion in animals and plants; and by the gradual oxidation of organic matter in the soil.

Certification: Process for meeting labeling or standards requirements, ensuring consistency, and giving credibility to government and manufacturer claims about energy efficiency. Protects manufacturers by making willful non-compliance unacceptable.

Chlorofluorocarbons (CFCs): Family of chemicals composed primarily of carbon, hydrogen, chlorine, and fluorine whose principal applications are as refrigerants and industrial cleansers and whose principal drawback is their destructive effect on the Earth's protective ozone layer. They include CFC-11, CFC-12, and CFC-113.

Class-average standards: Standards that specify the average efficiency of a manufactured product over a specific time period, allowing each manufacturer to select the level of efficiency to design into each model in order to achieve the overall average.

Compact fluorescent lamps (CFLs): Smaller version of standard fluorescent lamps that can directly replace standard incandescent lights. These lights consist of a gas-filled tube and a magnetic or electronic ballast.

Comparative labels: Labels that present information that allows consumers to compare performance among similar products, either using discrete categories of performance or a continuous scale.

Compliance: Method to ensure that errors are found and corrected and violations of requirements are returned to the permitted range or, if necessary, punished. It protects manufacturers by making willful non-compliance unacceptable.

Consumer Analysis: Analysis that establishes the economic impacts on individual consumers of any standard being considered.

"Declared" energy consumption: A manufacturer's claimed energy performance for an entire production run of a given appliance.

Demand-side management (DSM): Programs by electricity and natural gas utilities to help customers use energy more efficiently and better manage peak loads.

Economic potential: Optimum economic energy savings from a product user's (consumer's) perspective.

Endorsement labels: "Seals of approval" given according to a specified set of criteria.

Energy-efficiency labels: Informative labels affixed to manufactured products indicating a energy performance (usually in the form of energy use, efficiency, and/or energy cost) that provide consumers with the data necessary for making informed purchases.

Energy-efficiency ratio (EER): Measure of the instantaneous energy efficiency of room air conditioners: the cooling capacity in Btu/hr divided by the watts of power consumed at a specific outdoor temperature (usually 95 degrees Fahrenheit).

Energy-efficiency standards: Set of procedures and regulations that prescribe the energy performance of manufactured products, usaually prohibiting the sale of products that are less energy-efficient than a minimum standard; also known as "norms."

Energy service company (ESCO): Company that specializes in undertaking energy-efficiency measures under a contractual arrangement in which the ESCO shares the value of energy savings with its customers.

Energy test procedure: Agreed-upon method of measuring the energy performance of an appliance; may be expressed as an efficiency, efficacy (for lighting products), annual energy use, or energy consumption for a specified cycle, depending on the appliance being tested; used to rank similar products by their energy performance and to evaluate new technologies and to forecast their energy performance; also known as a "test standard."

Enforcement: All activities used to deal with manufacturers, distributors, and retailers that are not in compliance with the regulations.

Engineering analysis: Analysis that assesses the energy performance of products currently being purchased in the country and establishes the technical feasibility and cost of each technology option that might improve a product's energy efficiency and each option's impact on overall product performance.

Engineering data: Data on technical and energy characteristics of individual product models available on the market.

Greenhouse gas (GHG): Gas, such as water vapor, carbon dioxide, tropospheric ozone, methane, and low-level ozone, that is transparent to solar radiation but opaque to long-wave radiation and that contributes to the greenhouse effect by absorbing infrared radiation in the atmosphere.

Harmonization: The adoption of the same test procedure or performance standard level or energy labeling criteria or design as that of an international organization or trading partner or the mutual recognition of test results for a particular appliance through a multilateral forum or compact.

Heat-pump water heater (HPWH): Water heater that uses electricity to move heat from one place to another instead of generating heat directly.

Impact evaluation: Used to determine the energy and environmental impacts of a labeling program. Can be used to determine cost effectiveness and can also assist in stock modeling and end-use (bottom up) forecasting of future trends. Impact elements include influence of an efficiency label on purchase decisions, tracking of sales-weighted efficiency trends, energy and demand saving, pollutant emission reductions, and related effects.

Information-only labels: Labels that provide data only on a product's performance.

Kilowatt hour (kWh): Unit or measure of electricity supply or consumption; equal to 1,000 Watts over the period of one hour; equivalent to 3,412 Btu.

Life-cycle cost (LCC): The sum of purchase cost and annual operating cost discounted over the lifetime of the appliance; includes consideration of lifetime of the appliance and consumer discount rate.

Manufacturing analysis: Analysis that predicts the impact of any standard being considered on international and domestic manufacturers and their suppliers and importers. It assesses the resulting profitability, growth, and competitiveness of the industry and predicts changes in employment. Depending on the local situation, this analysis may be expanded to include distributors and retailers.

Market penetration: Level of ownership, i.e., the percentage of households that own and use the product or equipment in question.

Market transformation: Permanent shift in the market toward greater energy efficiency, accomplished by specific interventions for a limited period of time.

Market-transformation perspective: Evaluation focus on whether sustainable changes in the marketplace have occurred as a result of labels and standards programs.

Minimum LCC: The level at which the consumer incurs the lowest total cost and therefore receives the most benefit.

Mutual recognition agreements (MRAs): Bilateral or multilateral arrangements to recognize or accept some or all aspects of another's conformity test procedures (e.g., test results and certification).

National impact analysis: Assesses the societal costs and benefits of any proposed standard; the impacts on gas and electric utilities and future gas and electricity prices that would result from reduced energy consumption; and the environmental effects in terms of changes of emissions of pollutants such as carbon dioxide, sulfur oxides, and nitrogen oxides that would occur in both homes and power plants resulting from reduced energy consumption.

Net present value (NPV): Value of a personal portfolio, product, or investment after depreciation and interest on debt capital are subtracted from operating income. NPV can also be thought of as the equivalent worth of all cash flows relative to a base point called the present.

Payback period: The amount of time needed to recover, through lower operating costs, the additional consumer investment in efficient equipment; the ratio of the increase in purchase price and installation cost to the decrease in annual operating expenses.

Performance standards: Prescriptions of minimum efficiencies (or maximum energy consumption) that manufacturers must achieve in each product, specifying the energy performance, but not the technology or design specifications, of that product.

Prescriptive standards: Standards that require a particular feature or device to be installed in all new products.

Process evaluation: Measures how well a program is functioning. Process elements include assessing consumer priorities in purchasing an appliance, tracking consumer awareness levels, monitoring correct display of labels by retailers, measuring administrative efficiency, and maintaining program credibility.

Qualitative primary research: Includes the focus-group technique, where a small number of people with certain characteristics (e.g., recent buyers of refrigerators) are recruited to participate in a facilitated discussion about a particular topic in order to get the in-depth and subjective views of key audiences. Results cannot be statistically generalized to the greater population.

Quantitative primary research: Uses survey approaches with randomly selected samples of a particular population. Results are then projected to the whole population from which the sample is drawn.

Regulatory standard: Establishes a level of minimum energy efficiency. Typically references the appropriate test procedures.

Resource-acquisition perspective: Evaluation focus on the calculation of energy and demand savings and greenhouse gas emissions reductions from labeling programs and standards.

Secondary research: Analyzes and applies the results of past research to the current situation.

Seasonal energy efficiency ratio (SEER): Measure of seasonal or annual efficiency of a central air conditioner or air-conditioning heat pump and takes into account the variations in temperature that can occur within a season. It is expressed as average number of Btu of cooling delivered for every watt-hour of electricity used over a cooling season.

Self-certification: Certification in which manufacturers formally test their own products and, in practice, also test each other's products and force compliance. It is practiced in the U.S., Japan, and most European countries.

Stakeholder: Any party who may have an interest. Stakeholders typically include representatives of manufacturers, consumers, utilities, local governments, and environmental or energy-efficiency interest groups; also representatives of importers and international organizations where applicable.

Technical MRAs: Establish technical equivalency between bodies in different countries. They can cover laboratory accreditation agencies, inspection accreditation, and testing certification bodies. They facilitate testing by a manufacturer because they can eliminate the need for retesting a product in a foreign country.

Technical potential: The maximum energy savings that could be achieved by using the best technology available, regardless of cost.

Test protocol: Specifications for testing a product.

Theory Evaluation: Approach that tests hypotheses such as: "most/some/all consumers will use labels as part of their purchase decisions" or "labels will encourage manufacturers to improve the energy performance of their products."

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Chapter 10

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Index

A

D

E

F

M

N

V

W

Back Cover

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