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# Comparison of Australian and US Cost-Benefit Approaches to MEPS

**by**

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# Executive Summary

The Australian Greenhouse Office contracted with the Collaborative Labeling and Appliance Standards Program (CLASP) for LBNL to compare US and Australian approaches to analyzing costs and benefits of minimum energy performance standards (MEPS). This report compares the approaches for three types of products: household refrigerators and freezers, small electric storage water heaters, and commercial/industrial air conditioners. This report presents the findings of similarities and differences between the approaches of the two countries and suggests changes to consider in the approach taken in Australia.

The purpose of the Australian program is to reduce greenhouse gas emissions, while the US program is intended to increase energy efficiency; each program is thus subject to specific constraints. The market and policy contexts are different, with the USA producing most of its own products and conducting pioneering engineering-economic studies to identify maximum energy efficiency levels that are technologically feasible and economically justified. In contrast, Australia imports a large share of its products and adopts MEPS already in place elsewhere. With these differences in circumstances, Australia's analysis approach could be expected to have less analytical detail and still result in MEPS levels that are appropriate for their policy and market context.

In practice, the analysis required to meet these different objectives is quite similar. To date, Australia's cost-benefit analysis has served the goals and philosophies of the program well and been highly effective in successfully identifying MEPS that are significantly reducing greenhouse gas emissions while providing economic benefits to consumers. In some cases, however, the experience of the USA—using more extensive data sets and more detailed analysis—suggests possible improvements to Australia's cost-benefit analysis.

The principal findings of the comparison are:

1. The Technology and Market Assessments are similar; no changes are recommended.

2. The Australian approach to determining the relationship of price to energy efficiency is based on current market, while the US approach uses prospective estimates. Both approaches may benefit from increased retrospective analysis of impacts of MEPS on appliance and equipment prices. Under some circumstances, Australia may wish to consider analyzing two separate components leading to price impacts: a) changes in

manufacturing costs and b) markups used to convert from manufacturing costs to consumer price.

3. The Life-Cycle Cost methods are similar, but the USA has statistical surveys that permit a more detailed analysis. Australia uses average values, while the US uses full distributions. If data and resources permit, Australia may benefit from greater depth here as well. If implemented, the changes will provide more information about the benefits and costs of the program, in particular identifying who benefits and who bears net costs so that programs can be designed to offset unintended negative consequences, and may assist the government in convincing affected parties of the justification for some MEPS. However, without a detailed and statistically representative national survey, such an approach may not be practical for Australia at this time.

4. The National Benefits and Costs methods are similar prospective estimates of shipments, costs and energy savings, as well as greenhouse gas emissions. Additional sensitivity studies could further illustrate the ranges in these estimates. Consideration of lower discount rates could lead to more stringent MEPS in some cases.

5. Both the Australian and US analyses of impacts on industry, competition, and trade ultimately depend upon sufficient consultation with industry experts. While the Australian analysis of financial impacts on manufacturers is less detailed than that of the US, the Australian treatment of impacts on market shares imported from different regions of the world is more detailed. No change is recommended.

Implementing these changes would increase the depth of analysis, require additional data collection and analysis, and incur associated costs and time. The recommended changes are likely to have incremental rather than dramatic impacts on the substance and implications of the analysis as currently conducted.

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# 1. Objectives

The Australian Greenhouse Office (AGO) established a contract via CLASP with LBNL, comprising the following tasks:

1. Review the cost-benefit approach used in Australia's Regulatory Impact Statements (RIS) for appliance and equipment energy efficiency measures, (using three recent examples as case studies);

2. Compare the Australian approach in these case studies with the approach taken in other countries, principally the USA; and

3. Assess the adequacy of the Australian approach, benchmarked against the approach used in the USA, and make recommendations to improve the approach taken in Australia.

# 2. Case Studies

Three case studies were selected for the comparison between Australian RIS and US cost-benefit analysis for minimum energy performance standards (MEPS):

- Household refrigerators and freezers (RIS, October, 2001)
- Small electric storage water heaters (RIS, August, 2003 and October, 2001)
- Air conditioners (RIS, Draft Report, August 25, 2003).

In each case, the Australian RIS was compared to the most recent US analysis:

- The refrigerator and freezer RIS was compared with the US analysis completed in 1997 for the update to mandatory US standards (effective in 2001). (The documentation is in USDOE, 1995)

- The water heater RIS was compared to the USA analysis completed in 2001, including the update to mandatory US standards that becomes effective in 2006. (USDOE, 2000)

- The air conditioner RIS was compared to the US analysis completed in 2001 for commercial and industrial air space-conditioning equipment, effective in 2003-04. (Federal Register, 2001) (Additional US analysis for commercial unitary air conditioners is underway but was not available in time for this report.)

# 3. Policy and Market Contexts

The purpose of the Australian program is to reduce greenhouse gas emissions, while the US program is intended to increase energy efficiency; each program is thus subject to specific constraints. In practice, the analysis required to meet these different objectives is quite similar.

In Australia, secondary criteria for setting acceptable MEPS levels include:

- addressing market failures so that life-cycle cost is reduced;
- minimizing negative impacts on product quality and function;
- minimizing negative impacts on manufacturers and suppliers; and
- ensuring consistency with other national policy objectives (e.g., reducing emissions of ozone-depleting substances and matching "world best practice" standards).

In the USA, factors specified for determining economic justification of proposed MEPS levels include:

- economic impact on manufacturers and consumers;
- lifetime operating cost savings compared to increased price;
- total projected energy savings;
- lessening of utility or performance;
- impact of any lessening of competition;
- need for national energy conservation; and
- other factors the Secretary of Energy considers relevant.

In the USA, MEPS levels can be relatively stringent, since they are based on engineering-economic studies that may lead to standards that require new combinations of existing technologies. In most cases, US MEPS have been set in advance of Australia's MEPS and, in many cases, USA efficiency levels are the most stringent in the world. In the USA, most products of interest are produced domestically, comprehensive detail usually exists from national energy surveys and product directories, and extensive analysis is conducted. In Australia's appliance market, most products are imported, the available data are sometimes (but not always) less detailed and comprehensive, and the MEPS levels are for technologies that are apparently feasible, since the levels are those that have been in force elsewhere. Australia's MEPS are intended to match "world's best practice."

With these differences in circumstances, Australia's analysis approach could be expected to have less analytical detail and still result in MEPS levels that are appropriate for their policy and market context.

# 4. Cost-Benefit Analysis

The steps for analyzing and setting MEPS are similar in Australia and the USA, Table 1 compares the major analysis elements in the two approaches. Each of the analysis elements is discussed below.

**Table 1 Major analysis elements for establishing minimum energy performance standards (MEPS) in Australia and the USA**

| ANALYSIS | AUSTRALIA | USA |
|---|---|---|
| Technology Assessment | Statistical analysis and engineering estimates | Engineering estimates |
| Market Assessment | Shipments projections | Shipments projections |
| Price-Efficiency Relationship | Based on current market | Prospective cost estimates calibrated to tear-downs of selected current products |
| Candidate MEPS Levels | Intended to reflect "world's best practice." Based on technology and market assessment and on current MEPS worldwide | Maximum efficiency that is technologically feasible and economically justified. Based on engineering-economic analysis |
| Life-Cycle Costs | Change in average equipment costs, and operating costs due to MEPS | Distribution of changes in equipment costs and operating costs due to MEPS |
| National Benefits and Costs | Projected national shipments, energy savings and equipment costs | Projected national shipments, energy savings, and equipment costs |
| Industry, Competition, and Trade Issues | Market composition and trends. Compatibility with trade agreements. | Financial analysis of manufacturer impacts and industry net present value. Determination regarding competitive impact. |
| Consultation | Working groups include stakeholders, public meetings | Open process with stakeholders, public workshops |
| Evaluation and Recommendations | Included in analysis | Separate from analysis, included in Federal Register Notices |
| Review | Implemented as State and Territory regulations | Implemented as Federal regulations, preempting States |

## 4.1 Technology Assessment

The technology assessment defines the current product and identifies possible technological changes that could reduce greenhouse gas emissions or improve energy efficiency.

For refrigerators and freezers, Australia relied more on detailed data about models available for sale in the current market than did the USA, which typically does not use such comprehensive market data. On the other hand, the USA conducted more engineering studies using computer models to simulate alternative design changes and their expected impacts on energy consumption. Australia's analysis had a good balance of detailed market data, awareness of engineering simulation studies done elsewhere, and limited simulations in Australia.

For water heaters, Australia described the range of technologies by fuel type (electric, gas, solar) and technology (storage, instantaneous), then used computer simulation to identify options for reducing heat losses. The USA used a generally similar approach, with some differences. In addition to options for reducing heat losses, the USA considered other possible design changes to save energy. The USA did not consider solar technologies.

For air conditioners, Australia utilized information about current models registered with the AGO. The USA gathered information about available models, but conducted computer simulations to identify a range of possible efficiency increases.

## 4.2 Market Assessment

The market assessment identifies the manufacturers, market shares, importers, and distribution channels of the product being analyzed.

The USA produces most of its products domestically, while Australia is significantly more dependent on imports. As a consequence, the analyses differ. Australia characterizes the market shares from different regions of the world, while the USA is primarily focused on domestic producers.

Australia and the USA considered a similar set of factors regarding different categories or classes of products (e.g., distinguishing types of refrigerator-freezers). Both produced projections of future shipments based on demographic projections, ownership trends, changing market shares among categories, and product lifetime. For some products (e.g., clothes washers) the USA had further disaggregated the market to account for repair-or-replace decisions that may occur differently in the standards scenario than in the base (no new standards) case. The additional level of detail used in the clothes washer analysis addressed the concerns of some stakeholders and required additional survey data, but did

not significantly change the projections, so there is no clear need for Australia to pursue a similar refinement.

For refrigerators, Australia had detailed sales data by model, lacking in the US analysis. Interpreting such data (e.g., to classify imports) involves issues including:

- different models of the same brand may originate from different countries;
- the country of origin for a model may change over time;
- some models are sold under different (multiple) brand names; and
- licensing arrangements for brands vary (e.g., different companies hold the license for the "Frigidaire" brand in different regions of the world).

Analyzing annual data over a period of several years increased confidence in the interpretation of the data and provided information about trends that was useful as a basis for projections of trends in Australia.

## 4.3 Price-Efficiency Relationship

The relationship between product price and energy efficiency (or consumption) is established based either on statistics of the price and efficiency of current products, or on engineering analysis of new combinations of technologies.

Australia derived the statistical relationship between price and product characteristics (e.g., for refrigerators, capacity and energy). The analysis also examined the price-efficiency relationships reported in European and US studies. The projected price-efficiency relationships for refrigerators accounted for those product groups where price is not increasing with efficiency.

For most products[1], the USA does less statistical analysis, but instead performs a more-extensive engineering analysis to identify technological changes that increase energy efficiency and the expected prices of such technologies. The engineering analysis includes determining the maximum technologically achievable efficiency, identifying potential technologies or design options or efficiency levels, and using computer simulation models or spreadsheets to quantify energy savings. The manufacturing costs are determined by cross-checking two methods: (1) "tearing down" selected existing products representing a range of efficiency, and (2) eliciting input from manufacturers about expected manufacturing costs. The cost estimates are intended to account for changes in production practice and volume from current production to those

[1] Exceptions include products where the full range of efficiencies under consideration is available in the current market, for example, magnetic and electronic fluorescent lamp ballasts. For other products, where the proposed MEPS level is not commonly available on the market, the US analysis relies on engineering-based estimates of specific design changes that would achieve the target efficiency level.

expected after new MEPS take effect. The USA conducts analysis of the relationship between consumer prices and manufacturer costs to develop scaling factors ("markups") to convert from the change in manufacturer costs required to increase energy efficiency to the resulting change expected in consumer prices. In addition to manufacturers, intermediaries including wholesalers, distributors, retailers, contractors, and home builders (depending on the product) influence the price that consumers pay.

## 4.4 Candidate MEPS Levels

Analysts select a small number of candidate standard levels for analysis of impacts. Australia's proposed MEPS levels are based on best practice in other countries. The RIS's reviewed here included detailed analyses at three MEPS levels each for refrigerators, water heaters, and air conditioners.

The USA's candidate MEPS are based on engineering-economic analysis (described below). The US process considers an extensive list of technological possibilities for increasing energy efficiency, then screens out some designs from further analysis for reasons of technological feasibility; practicability to manufacture, install and service; impacts on product utility or availability; or impacts on health or safety. Using the remaining design options, the USA analyzes several possible levels of efficiency, and then proposes one level before reaching a final decision. The number of candidate standard levels—typically around five, ranging from least-stringent to maximum technologically feasible—has varied from product to product and over time.

## 4.5 Life-Cycle Costs (LCC)

Australia calculates LCC as one estimate of national benefits and costs. The USA considers this calculation as representative of a cross-section of consumer impacts as distinct from a calculation of national impacts, in which fuel-switching and the time dynamics of equipment purchases are considered (see National Benefits and Costs, below). While Australia considers the national average price of equipment and of energy, the USA considers distributions intended to capture the variability in all the inputs, permitting an estimation of the fraction of product applications for which the MEPS will have net LCC savings or net LCC costs. The disadvantage of the US approach is that it requires more-detailed data inputs; the effort to collect those data is not justified by the MEPS program alone, but serves other national purposes. The advantages are: explicit consideration of differences among product applications (e.g., in energy prices, climate, usage); appropriate weighting of combinations of those factors (e.g., most correlations between inputs are captured by using household-specific data from a comprehensive national survey), and the ability to answer policy questions at a higher level of detail (e.g., which subpopulations are advantaged or disadvantaged by the proposed MEPS or the range of net costs or savings per household).

Australia should consider the possible benefits of using more detailed data, subject to its availability. For example, for Australian electric water heaters, the lifetime is assumed to be concentrated around nine years, with one-third retiring after eight years, one-third after nine years, and one-third after ten years. A refinement to the shipments projections would be achieved if more data on the details of the retirements as a function of age could be obtained.

## 4.6 National Benefits and Costs

National energy savings and equipment costs are calculated similarly in the Australian and US analyses. Both countries use marginal energy prices to value the energy savings. The USA produces more sensitivity analyses to test the robustness of the results.

Australia used marginal electricity rates and accounted for both residential and business applications (e.g., for small electric water heaters). Demand charges were not included in the calculation. If the MEPS impact demand, and if business tariffs include demand charges, the value of savings may be underestimated (e.g., for commercial/industrial air conditioners).

Australia used a 10% (real) discount rate to discount future costs and savings to the present, with sensitivity at 5% in the analysis of water heaters. The USA used different discount rates for the LCC analysis and the national impacts analysis. For US national impacts, the discount rate was fixed at 7% real (with a sensitivity at 3% real). However, the discount rates for the LCC analysis—with average values near 6% real, but varying by product type—were based on a distribution of purchase mechanisms and opportunity costs for buyers of that product. The product-specific values, expressed as a probability distribution, accounted for whether the purchasers are commercial entities or households, and whether the mechanisms of purchase were cash or some form of loan (e.g., mortgage, home equity loan, credit card) with a corresponding interest rate. The probability distributions also accounted for the opportunity costs represented by returns on investment from savings accounts, stocks, or other investments.

Australia and the USA both estimate impacts of MEPS on greenhouse gas emissions by applying emission factors to energy savings. The emission factors account for marginal intensity and projected changes over time in the mix of technologies for generating electricity.

## 4.7 Industry, Competition, and Trade Issues

The analysis of impacts on the manufacturing industry is performed differently in Australia and USA. The Australian analysis considers the number of domestic manufacturers and the number of imported models, as well as market share information. In determining whether industry will be able to meet proposed

MEPS, Australia considers manufacturers' resources and technical capacity, availability of technologies (e.g., suppliers of refrigerator compressors), and consistency with global trends, against the background rate of efficiency improvements.

The US Manufacturer Impact Analysis (MIA) uses a spreadsheet model applicable to individual manufacturers for estimating the financial impact of MEPS. The results for manufacturers are aggregated to produce industry impacts, including industry net present value. The industry cash flow analysis requires detailed data and accounts for the impacts of standards, including: (1) the need for additional investments, (2) changes to production costs, and (3) revenue effects, possibly including higher prices and lower sales. The MIA also calculates the impacts of MEPS on competition, employment, and manufacturing capacity. The results are provided to the US Attorney General, who is responsible for determining impacts of any lessening of competition from a proposed MEPS.

While the Australian analysis is less detailed than the US analysis, in either case, the results are only credible if there is sufficient consultation with and review by industry experts. A high level of cooperation between government and industry analysts can be an effective substitute for increasing the level of detail of analysis by the government. The levels of such cooperation achieved in Australia and the USA are discussed in the next section.

## 4.8 Consultation

While the details differ, both Australia and the USA embrace processes intended to include consultation with parties affected by MEPS, including manufacturers, importers, and consumers. Australia uses consultative bodies (e.g., the Refrigerator Standards Working Group) during the development of MEPS levels. The USA in 1996 adopted procedures that, when considering new standards, provide for "greatly enhanced opportunities for public input, improved analytical approaches, and encouragement of consensus-based standards." (Federal Register, 1996) These procedures established a more open process in which stakeholders have increased opportunities to provide input to the analysis and the analysis is more open and accessible. Both Australia and the USA have public meetings over a period of months to years to receive input and discuss intermediate results prior to determining the binding MEPS. In both processes, requests for public comments elicit information that is then incorporated into subsequent analyses and interpretations.

## 4.9 Evaluation and Recommendations

After the analysis, Australia and the USA evaluate and interpret the options for MEPS levels, in their own policy contexts. Both processes have in common a weighing of the costs and benefits of each considered level. In Australia, this

activity is included in the RIS. In the USA, the analysts provide a Technical Support Document that describes the options and their impacts, but does not include a recommendation. US Department of Energy staff, with support from the analysts upon request, make recommendations and compose Federal Register Notices that include the evaluation of the options and the selection of the MEPS from among them. The Secretary of Energy selects the MEPS to be published in the Notices. The US Department of Energy process is beyond the scope of this report, which focuses on the analysis elements.

### 4.10 Review

Australia implements MEPS under State and Territory regulations, while the US regulations are Federal and preempt State regulations on products covered by the regulations. This report does not address further the differences in the legal approaches.

Both Australia and the USA recognize the benefits of principles such as: (1) standards should remain unchanged for some years (typically 4-5 years in Australia and at least 3-5 years for most products in the USA), and (2) changes should be based on an analysis of costs and benefits.

## 5. Recommendations

The comparison of the approaches for setting MEPS in Australia and the USA shows many similarities and some differences. The following recommendations, which are presented separately for each step in the process, stem from an analysis of the differences between the two approaches.

### 5.1 Technology Assessment

Restricting attention to products already on the market risks overlooking new combinations of existing technologies that could achieve significant energy savings and emission reductions. However, computer simulations require time and effort, in part because they are credible only if the simulations are calibrated against test (and sometimes field) data. Australia uses a good balance of techniques, based on gathering information about current products, supplemented by targeted computer simulations of likely efficiency improvements from possible design changes. Australia's tracking of sales by model, as done for refrigerators, is perhaps the most extensive such analysis conducted in the world to date.

**Recommendation:**

No change is recommended in the analysis process for technology assessment.

## 5.2 Market Assessment

Identifying the manufacturers, products, and distribution channels (including imports by originating region) is a well-defined process. Australian and US analyses of domestic supplies are similar; Australia's analysis of imports is more detailed than the US's.

Projecting future shipments is difficult for practitioners in the private sector as well as for government analysts. Australia's current methods make good use of historical time series data and are comparable to methods elsewhere. The natural variability in annual shipments due to changes in the economy unrelated to MEPS is much larger than the expected increase in accuracy from more time-intensive analysis.

**Recommendation:**

No change is recommended in the analysis process for market assessment.

## 5.3 Price-Efficiency Relationships

Australia relies primarily on the current relationship between price and efficiency, then accounts for trends in estimating future prices, while the USA builds up the price from detailed analysis of manufacturer costs and markups applied by intermediaries between manufacturers and consumers. Estimating in advance the future prices of products is perhaps the most difficult of all the critical analysis tasks. Both approaches have identified cases where price increases due to MEPS are less than expected based on simple extrapolation. Both Australia and the USA may benefit from increased attention to retrospective analysis of price changes after MEPS.

While the USA approach is more comprehensive (with associated heavier requirements in effort and time), two factors suggest that adopting the US approach may not be an appropriate change for Australia: (1) This level of analysis will require dedicated cooperation from a representative set of manufacturers and may not be achievable where most production is non-domestic; and (2) Australia's more conservative analysis is consistent with the intention to adopt MEPS already in place somewhere else in the world.

**Recommendations:**

1. Conduct retrospective analysis of price changes after MEPS to better inform future projections of impacts on product prices from future updates to MEPS.

2. If a situation arises for a product where production is primarily domestic and more aggressive MEPS levels are desirable, consider analyzing price impacts

in two stages: impacts on manufacturing costs from specific design changes, and impacts on consumer prices based on markups.

## 5.4 Life-Cycle Costs

The current Australian approach is consistent with the historical US approach, but simpler than current practice in the USA. In recent years, the USA has used statistically representative national surveys to provide the necessary inputs for the more-detailed analysis of impacts on a sample of the affected population. The most significant benefits are: (a) more complete characterization of the impacts of proposed MEPS, including the fraction of consumers having net benefits or net costs, and identification of those subpopulations that are most impacted; and (b) ability to identify those inputs whose uncertainty contributes the most to uncertainty in the result. Without a detailed and statistically representative national survey, such an approach may not be practical for Australia at this time.

### Recommendation:

Consider expanding the inputs to the LCC model to full distributions, if data sources and resources permit. (This recommendation may not be practical in the absence of national statistical surveys.)

## 5.5 National Benefits and Costs

The current approaches are similar, with both Australia and the USA prospectively estimating shipments, national costs and savings, energy savings, and emissions reductions. The principal differences in the economic impacts are: (1) the USA conducts more extensive sensitivity analysis, e.g., a range of scenarios of future energy prices and other critical variables; and (2) the two countries use different discount rates for obtaining a present value from a time series of costs and savings. The US approach also uses different values of discount rates for calculating consumer life-cycle cost from the values used for calculating the national net present benefit. On the other hand, sensitivity analysis indicates that, in some cases, changing the discount rate within a reasonable range is unlikely to change the selection of MEPS.

### Recommendations:

1. No change is recommended in Australia's calculation of shipments, energy savings, emissions, and annual economic impacts.

2. Conduct sensitivity analysis of national savings to alternative projections of future energy prices and other critical inputs.

3. Conduct sensitivity analysis using different discount rates (lower than 10% real) to determine if the resulting MEPS levels would differ. If significant,

consider revisiting the basis for discount rates. Consideration of lower discount rates could lead to more stringent MEPS in some cases.

## 5.6 Industry, Competition, and Trade Issues

The Australian analysis is less detailed than the US's. Both are dependent on sufficient consultation with industry to validate the results. As discussed above (see Recommendations, Price-Efficiency Relationships), the contexts are different and the additional analytical burden of the more detailed US analysis may not be appropriate or beneficial for Australia.

**Recommendation:**

No change is recommended in the analysis process for industry, competition, and trade issues.

## 5.7 Consultation

Both Australia and the USA have processes for consulting affected parties during the analysis, conducting public meetings, and eliciting and responding to comments.

**Recommendation:**

No change is recommended in the consultation process.

## 5.8 Evaluation and Recommendations

This report makes no recommendations in the area of Evaluation and Recommendations, since it occurs after the analysis and is outside the scope of this report.

## 5.9 Review

This report makes no recommendations in the area of Review of MEPS, since it occurs after the analysis and is outside the scope of this report.

## 5.10 Summary of Recommendations

Table 2 shows recommendations for changes to the various analysis elements.

**Table 2. Recommendations for changes to analysis of Australia MEPS**

| ANALYSIS | RECOMMENDATION |
|---|---|
| Technology Assessment | No change |
| Market Assessment | No change |
| Price-Efficiency Relationship | 1. Retrospective analysis of impacts of MEPS on equipment prices.<br>2. Where appropriate, consider increased analysis of manufacturing costs and the relationship of consumer prices to manufacturing costs |
| Life-Cycle Costs | Consider expanding the inputs to the LCC model to full distributions, if data sources and resources permit |
| National Benefits and Costs | 1. Add sensitivity analysis (e.g., alternative future energy prices and other critical variables)<br>2. Additional sensitivity analysis to choice of discount rate |
| Industry, Competition and Trade Issues | No change |
| Consultation | No change |
| Evaluation and Recommendations | No recommendations |
| Review | No recommendations |

## Suggested Reading

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. / Illuminating Engineering Society of North America, ANSI/IESNA Standard 90.1-1999, Energy Standard for Buildings Except Low-Rise Residential Buildings, 1999. Atlanta, Georgia.

Federal Register, Vol. 66, No. 9, Friday, January 12, 2001
Energy Efficiency Program for Commercial and Industrial Equipment: Efficiency Standards for Commercial Heating, Air Conditioning and Water Heating Equipment; Final Rule.

Federal Register, Vol. 61, No. 136, Monday July 15, 1996, p. 36974. Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products; Final Rule.

George Wilkenfeld and Associates Pty Ltd, Draft Regulatory Impact Statement: Revised Minimum Energy Performance Standards and Alternative Strategies for Small Electric Storage Water Heaters, Report No 2003/09, Prepared for the Australian Greenhouse Office, August, 2003.

George Wilkenfeld and Associates Pty Ltd, Final Regulatory Impact Statement: Revised Minimum Energy Performance Standards and Alternative Strategies for Small Electric Storage Water Heaters, Prepared for the Australian Greenhouse Office, October, 2001.

George Wilkenfeld and Associates with Energy Efficient Strategies, Final Regulatory Impact Statement: Revised Minimum Energy Performance Standards for Household Refrigerators and Freezers, Prepared for the Australian Greenhouse Office, October, 2001.

Syneca Consulting, "Minimum Energy Performance Standards for Airconditioners: Regulatory Impact Statement," Draft Report – August 25, 2003, Report No. 2003/08 prepared for the Australian Greenhouse Office.

USDOE. U.S. Department of Energy, 2000. Technical Support Document: Energy Efficiency Standards for Consumer Products: Residential Water Heaters, December. LBNL-47419.

USDOE. U.S. Department of Energy, 1995. Technical Support Document: Energy Efficiency Standards for Consumer Products: Refrigerators, Refrigerator-Freezers, & Freezers. DOE/EE-0064, July.

# A. Appendix A: Household Refrigerators and Freezers

Comments on the "Final Regulatory Impact Statement: Revised Minimum Energy Performance Standards for Household Refrigerators and Freezers", prepared for the Australian Greenhouse Office by George Wilkenfeld and Associates, October 2001.

## A.1 Detailed sales data

Australia relied on detailed sales data by model available for sale in the current market. The US did not use such comprehensive market data. In this area, the Australian data appears superior to that used in the US.

On the other hand, the US conducted more engineering studies using computer models to simulate alternative design changes and their expected impacts on energy consumption. While these are speculative, models based on sound physical principles and calibrated to measured data for several designs over a range of efficiencies can provide a strong basis for exploring combinations of components or new designs not currently available for purchase in the market.

In all, Australia's analysis had a good balance of detailed market data, awareness of engineering simulation studies done elsewhere and limited simulations in Australia.

## A.2 Price-efficiency relationship

Retrospective studies of the actual price impacts from MEPS may be useful to guide future assumptions. Some studies in the US have found that actual price increases were less than expected.

Australia derived the statistical relationship between price and product characteristics (e.g., capacity and energy). The US typically conducts less statistical analysis and more extensive engineering analysis. The US determines manufacturing costs by cross-checking "tear-down" analysis with input from manufacturers about expected production costs. The cost estimates are intended to account for changes in production practice and volume from current production to those expected after new MEPS take effect.

The US conducts analysis of the relationship between consumer prices and manufacturer costs to develop scaling factors (called “markups”) to convert from the change in manufacturer costs required to increase energy efficiency to the resulting change expected in consumer prices. In addition to manufacturers, intermediaries including wholesalers, distributors, retailers, contractors and home builders (depending on the product) influence the prices that consumers pay. Australia may wish to conduct some exploratory research of these details, to examine whether the additional effort required to increase the level of detail of the analysis appears justified.

## A.3 Sensitivity analysis

Australia currently conducts analysis of impacts by State, while the US analyzes a statistical distribution (typically a sample of 10,000) to account for the broad range of applications. Australia lacks detailed national surveys of energy consumption like the US Residential Energy Consumption Survey (RECS). But the costs of developing, implementing and maintaining such a national survey at regular intervals is high, and not justified by the MEPS program alone. Australia may wish to consider conducting additional sensitivity analyses to address more fully the variability in current applications and uncertainties about the future (e.g., alternative future energy prices, discount rates and other critical variables).

# B. Appendix B: Small electric storage water heaters

Comments on the draft "Revised Regulatory Impact Statement: Revised Minimum Energy Performance Standards and Alternative Strategies for Small Electric Storage Water Heaters", by George Wilkenfeld and Associates, August 2003.

## B.1 Product differences

The main difficulty in comparing Australian to US standards is that the U.S. standards don't apply to water heaters that small. The market share in the US for water heaters with volumes less than 20 gallons apparently is much smaller than in Australia. Australia also has low pressure classes of water heaters that don't exist in the US.

## B.2 Test procedures

The Australian (and related, but not identical New Zealand) test procedure for electric water heaters is a standby loss test, which in some ways is better than the US test. There are no draws in the Australian test procedure. Because recovery efficiency with electric resistance heaters is 98%-100% efficient, nearly all of the losses are standby. A standby only test will be able to measure those directly, and is easier to do. However the Australian test is done with the water pipes disconnected from the water heater. This means the major heat losses from convective losses in the pipes are not counted. It also means that the savings from heat traps are not captured at all.

Some of the differences between the New Zealand and Australian test procedures point to some differences from the US standards. The Australian MEPS are based on delivery capacity. The US standards are based on 'rated' volume. The Australian MEPS use an "absolute" approach, which means that every single water heater must meet or exceed the standard. The US uses a "mean" approach, which means that individual water heaters may not meet the standard, but some statistical average does meet the minimum standard.

## B.3 Costs of insulation and blowing agents

The Wilkenfeld report may overstate the risks, both safety and reduced efficiency, from hydrocarbon blowing agents for the foam insulation. The R value of foams blown with cyclopentane is slightly worse than that blown with HCFCs but about

the same as that blown with the best HFCs. Based on anecdotal evidence, it appears that water heater manufacturers in the US shifted over from HCFC blowing agents to cyclopentane. This seems to have been accomplished more easily that was anticipated in the water heater TSD. In addition, the refrigerator industry in Europe and India appears to have converted almost entirely to using hydrocarbon blowing agents. Australia may wish to reexamine the costs based on the experience of the US and Europe at adopting hydrocarbon-based blowing agents.

## B.4 Equipment lifetimes

The distribution of water heater lifetimes seems too narrow, with one-third assumed to retire one year before the average lifetime, one-third at the average lifetime, and one-third retiring one year after the average lifetime.

# C. Appendix C: Air conditioners

Comments on Minimum Energy Performance Standards for Airconditioners, Regulator Impact Statement (RIS), Draft Report – August 25, 2003

The most significant comments on the airconditioner RIS pertain to the following two issues: (1) reference to USA standards for three-phase airconditioners and (2) estimation of manufacturing cost and consumer price increases due to MEPS for single-phase and three-phase airconditioners. Minor comments pertaining to redesign costs and equipment lifetime are presented after the discussion of the above two issues.

## C.1 USA standards for three-phase airconditioners

The RIS states that new MEPS for three-phase airconditioners (which are to become effective in 2007) will be equivalent to those standards in the USA that will take effect in 2003 for smaller commercial units and 2004 for larger commercial units. But the US Department of Energy's (USDOE) January 12, 2001 Final Rule establishing new MEPS for commercial and industrial space-conditioning and water-heating equipment does not finalize new MEPS for the three-phase airconditioning products covered in the RIS. On page 6 of the RIS it states that USA MEPS will be the basis of the new Australian MEPS:

> "NAEEC's proposal for July 2007 [for three-phase airconditioners] is to adopt MEPS levels that will apply in the USA from October 2003 for smaller commercial units and from October 2004 for larger commercial units."

But on page 4, the RIS excludes the only three-phase airconditioning products that are actually covered by the USA in the US Department of Energy's January 12, 2001 Final Rule:

> "In the commercial sector, the proposed MEPS will not apply to the purpose built installations that serve larger buildings, generally incorporating central cooling towers."

For the three-phase airconditioning products of concern to the RIS (air-cooled units with cooling capacities up to 65 kW) the RIS should reference the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) and Illuminating Engineering Society of North America (IESNA)

Standard 90.1-1999. It is ASHRAE/IESNA Standard 90.1-1999 that provides new minimum efficiency requirements for the three-phase airconditioners of concern to the RIS. The USDOE's January 12, 2001 Final Rule explicitly called out for further evaluation as to whether new MEPS for air-cooled airconditioners with cooling capacities up to 65 kW should be set equal to or greater than the minimum efficiency requirements in ASHRAE/IESNA Standard 90.1-1999 for these products. Thus, the RIS should reference ASHRAE/IESNA 90.1-1999, not the USA, as the basis for the new MEPS for three-phase airconditioners.

## C.2 Ongoing manufacturing costs

*Manufacturing cost for three-phase units*

The RIS references two USDOE documents and a USDOE spreadsheet in establishing manufacturing cost estimates as a function of efficiency for single-phase and three-phase airconditioners. This practice is reasonable for establishing the manufacturing cost vs. efficiency relationship for Australian airconditioners. But on page 23 of the RIS the following statement regarding cost improvements for three-phase unit seems to be incorrect:

> "…the cost of improving three-phase units in the 20-30kW range is put at zero."

Presumably this statement is based on estimates provided in the USDOE's National Energy Savings (NES) Spreadsheet for Commercial Unitary Air Conditioners and Heat Pumps. If this is true, than the manufacturing cost vs. efficiency data in the spreadsheet seems to have been misinterpreted by the RIS as the cost of improving three-phase units is not zero. Further explanation is needed by the RIS to clarify how a zero cost for improving three-phase units was established.

*Cost reductions to account for input power reductions*

The RIS makes the following statement on page 24 with regard to cost reductions achievable through reductions in input power:

> "…airconditioner prices are little affected by an increase in energy efficiency *if matched with an offsetting reduction in input power that leaves the cooling capacity unchanged*."

The above statement is not necessarily correct. Although it might seem that manufacturing costs can be reduced to offset gains in output capacity, the cost associated with design changes that are necessary to increase efficiency (and capacity) cannot necessarily be reduced by incorporating other design changes

that lower input power. There simply is not a one-to-one trade off in cost for designs that improve efficiency with designs that reduce input power.

Presumably the RIS' conclusion that cost reductions can be realized through input power reductions is based on the cost vs. efficiency curves provided in the USDOE's Technical Support Document (TSD) for Room Air Conditioners. It is in this TSD that design options are utilized to increase efficiency as well as output capacity. The other USDOE TSD for Residential Central Air Conditioners and Heat Pumps as well as the USDOE's NES spreadsheet for Commercial Unitary Air Conditioners and Heat Pumps do not present cost vs. efficiency curves which show output capacity increasing with efficiency. Thus, it is somewhat spurious to claim that cost reductions can be realized through the use of USDOE analyses when only the TSD for Room Air Conditioners provides data demonstrating that output capacity increases with efficiency.

Since the basis of the 1.5% change in purchase price due to MEPS is heavily predicated on the assumption that manufacturing costs can be reduced to account for reductions in input power, it is strongly suggested that the percent change in purchase price increase be revised upward. As the RIS stands, purchase price increases due to MEPS are under estimated by the RIS. As highlighted on page 25 of the RIS, the benefit/cost ratio for residential airconditioner MEPS is highly sensitive to the purchase price increase. Thus, it is extremely important to more accurately estimate the purchase price increase due to MEPS.

## C.3 Costs of redesign and testing

On page 21 of the RIS, redesign cost estimates of $100,000/model and $25,000/model are provided for three-phase and single-phase air units, respectively. What is the basis for the lower redesign estimate of $25,000/model for single-phase units? Since redesign costs for single-phase and three-phase units generally involve the same research and development staff, the cost of redesign should not be significantly different. That is, the redesign costs are not typically a function of unit output capacity. Unless there is defensible reason for retaining the lower cost estimate for single-phase units (other than industry consultations), it is suggested that a higher redesign cost estimate be used for single-phase units.

## C.4 Equipment Lifetime

On page 24 of the RIS, commercial unit lifetimes are stated to be longer than those for residential units. Even though the RIS states the following:

> "Commercial units are used much more intensively than residential units."

By all accounts, if commercial units are being used more intensively than residential units, the lifetime of the residential units should be longer. But Appendix 2 of the RIS uses an average life of 10 years for residential units and 15 years for three-phase (commercial) units. The USDOE TSD on Room Air Conditioners uses an average lifetime of 12.5 years. The USDOE TSD on Residential Central Air Conditioners and Heat Pumps uses an average lifetime of 18.4 years. And finally, the USDOE NES spreadsheet for Commercial Unitary Air Conditioners and Heat Pumps uses an average lifetime of 15 years. Thus, based on USDOE analyses, commercial unit lifetimes are not necessarily longer than residential lifetimes. It is suggested that the RIS use a residential unit lifetime that is at least equal to the lifetime for commercial units.