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Workshop Proceedings of the

Industrial Building Energy Use

Berkeley, California, November 7, 1988

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Workshop Proceeding

INDUSTRIAL BUILDING ENERGY USE

November 7, 1988

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Sponsored by

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Lawrence Berkeley Laboratory

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INDUSTRIAL BUILDINGS ENERGY USE WORKSHOP

Monday, November 7, 1988

AGENDA

9:30-9:45
Welcome, Carl Blumstein (UERG)

9:45-10:15
Energy Use in Building Services of the Industrial Sector in California: Hashem Akbari and Tom Borgers (LBL)

10:15-10:45
End Use Metering in Pacific Northwest Wood Products Mills: Carey Lee (BPA)

10:45-11:15
Preliminary Survey of SIC 20-39 Industries: Ted Mureau (LADPW)

11:15-11:45
Industrial End-Use Data Collection and Applications: Bill Idzerda (PG&E)

12:00-1:00
Lunch: LBL Cafeteria

1:15-1:45
Industrial End-Use Data for Utility Planning and Forecasting: Raymond Squitieri (EPRI)

1:45-2:15
Data Needs for Modeling and Forecasting: Larry Butler (SCE)

2:15-2:45
Data Needs for the Assembly Industry Model: Leigh Stamets (CEC)

2:45-3:45
Open Discussion and Summary: Hashem Akbari and Tom Borgers (LBL)

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WORKSHOP ON INDUSTRIAL BUILDING ENERGY USE

Editors' Notes

California has a large number of small and medium sized industries which have a major impact on the demand growth of California utilities.† Energy use in building services (lighting, HVAC, office equipment, computers, etc.). These industries constitute an important but largely neglected fraction of the total site energy use. The ratio of energy use in building service to the total site energy use is a function of the industrial activity, its size, and the climate at the site of the facility. Also, energy use in building services is more responsive to weather and occupant schedules than the traditional ''base-load'' industrial process energy.

Industrial energy use is considered as a ''base-load'' by utility companies because it helps to increase the utilities' load factor. To increase this further, utilities often market energy at lower rates to industrial facilities. Presently, the energy use in the building services of the industrial sector is often clubbed together with industrial process load. Data on non-process industrial energy use are not readily available in the literature. In cases where the major portion of the energy is used in the building services (with daily and seasonal load profiles that in fact peak at the same time as systemwide load peaks), the utility may be selling below cost at peak power times. These cases frequently happen with electric utilities.

One estimate of energy use indicates that, nationwide, about 100 GWh, equal to 13.5% of industrial electricity use, is consumed by the building services in the industrial sector. There are indications that this figure may not include all the shaft power for HVAC fans, pumps, and compressors. This fraction is undoubtedly higher in newer (light) industries, with high

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† In northern and central California three industrial groups have been identified as having significant growth in the next 20 years. These industries are:

Food and Related Products (SIC 20),
Plastic (SIC 28,30), and
Computing Equipment and Electronics (SIC 35,36).

Together these industries represented about 40 percent of the regional utility's industrial electricity sales in 1984.

occupancy levels and/or special needs for environmental conditioning -- as is the case for many California industries. Thus, for California industries, which account for about one-third of total California energy use, the industrial building services represent an even larger portion of electricity use (and peak demand).

Recent data indicate that there has been a trend towards increasing use of electricity, and decreasing use of fossil fuels, at the facility site. With lower and nearly stablized fossil fuel prices, this trend is expected to slow down. In fact, if the price of electricity continues to increase relative to that of fossil fuels, more site fuel use could be expected in cogeneration applications wherever air quality and other factors permit.

Industrial buildings are not necessarily as different from other non-residential buildings as commonly thought. For practical reasons, many light industrial buildings are designed and built to be physically similar to retail or office structures. Where occupants are in an enclosed space, they still need to be provided comfort conditioning and lighting levels comparable to commercial buildings. California industrial buildings almost always contain some office workers, and the same structure, over its lifetime, may shift back and forth between industrial and non-industrial uses. On the other hand, compared to other non-residential buildings, industrial buildings may have higher thermal loads, air-change rates, longer operating hours, and greater pollution-control or other environmental conditioning requirements, and therefore higher intensity of energy use for building services.

To study some of the issues posed above, the University-wide Energy Research Group (UERG) and the Lawrence Berkeley Laboratory jointly sponsored a one-day workshop with invited participation from researchers, California Energy Commission (CEC), and California utilities to discuss aspects of data base generation and maintenance, and technology impacts on demand in this area of rapidly changing economic and political environment. The workshop focused attention on energy use in industrial buildings, summarized the existing knowledge in the field, and identified gaps in data for energy and peak forecasting, as well as for analysis of load-shaping and conservation strategies. Thus the three key questions discussed were:

1) What data are needed; of these

2) What data are available (identifying data sources); and

3) What are the gaps in the existing knowledge.

Another integral objective of the workshop was to identify needs for future research and development and to prepare detailed research plans for the California utilities, the California Energy Commission, and the U.S. Department of Energy.

On behalf of the UERG and LBL, we would like to thank the representatives from Pacific Gas and Electric Company, Southern California Edison Company, Electric Power Research Institute, CEC, Los Angeles Department of Water and Power, and Bonneville Power Administration, Seattle City Light, and others for their active and stimulating participation in the workshop. The workshop speeches were recorded, transcribed, and reviewed by the authors. These Proceedings are the collection of edited papers that resulted from this process. Copies of any transparencies shown during the presentation are appended to each paper, in the same order as they were shown.

As the reader will find, in some important areas the workshop raised more questions than it answered. This by itself is a clear indication of lack of knowledge in those important areas. We hope that the contents of these Proceedings would constitute a common basis for the development of further research plan in industrial building energy use, modeling, and assessment of conservation and load-shaping potentials in California industry.

Hashem Akbari

Ashok Gadgil

ENERGY USE IN BUILDING SERVICES OF THE INDUSTRIAL SECTOR IN CALIFORNIA

Hashem Akbari and Tom Borgers (LBL)

(Presented by Tom Borgers)

We started this study about October 1, 1987. Prior to its inception, we had spent little time looking at energy end-use disaggregation with no attention given to industrial buildings. So, in the study, we looked at a variety of data sources and tried to evaluate their pertinence to industrial energy use. In this report, we present our assessment of the quality of the data, discuss some of our major observations, and lastly, formulate some rough conclusions and recommendations based on what we found.

Overall, in terms of the data's availability and its quality, we were guided by two central questions: First, is it possible to make energy forecast predictions from the type of data presently available in the field? Second, how important is building service energy to the total California industrial energy need? If the contribution was found to be significant, our aim was then to explore the feasibility of characterizing the building service end uses, industry by industry. You will see as we go along that there is a great deal of variation among industries with respect to how much of their purchased energy goes toward satisfying the building service or nonprocess requirements.

As an outgrowth of our focal questions, we examined and shall report on here as well the potential importance of conservation measures, dealing especially with the building services, because it appears that several important conservation measures remain untapped. Surprisingly, some of those conservation measures are very fundamental and very rudimentary in nature. It is rather distressing to find that many facilities have not greatly progressed from their 1973 state, so we are convinced there is still a lot of work that needs to be done in the area of conservation.

A number of data sources were examined, varying in their usefulness to our study. The Nonresidential Building Energy Consumption Survey (NBECS), a national effort, was not specific enough in terms of energy end use. The end-use breakdown is not as detailed as we would like. The Industrial Energy Use Data Book is quite outdated. It presents 1977 data and does not fully reflect the changes that have occurred across industries in the United States as a result of the two oil-price impacts of 1973 and 1979. So we think that more recent data are needed, reflecting changes that have occurred since at least 1979. The Energy Analysis and Diagnostic Center (EADC), headquartered in Philadelphia, is composed of thirteen member universities located in states other than California, so information provided in their annual reports is not always pertinent to the state of California.

The Hagler-Bailey Company report, titled "Industrial Buildings Energy Use," was released in 1987, and we use some of their conclusions about industrial building energy use. The published data that the California Energy Commission apparently is using most heavily at the moment, are found in the report titled, "A Characterization of Energy Use in Selected California Industries" (ERC/CEC). I shall refer to this report quite often. Another source that we found most useful is the PG&E Energy Utilization Audit database, which, through the efforts of Gloria Nugent and Bill Idzerda, we were able to examine in some detail.

We also looked at some specific cases, sucl. as the ASHRAE energy efficiency award winners, and we contacted other utilities to see if they had data they would share with use. The people we contacted at Southern California Edison and San Diego Gas & Electric indicated they did not have anything on the scale that PG&E was able to furnish. Thus we were quite pleased to be able to review the information obtained from PG&E. Now, I should tell you a little bit about the differences between the types of data from ERC and those from the PG&E database. Referring to page titled "Purchased, Site, ..." of the handout, I would like to highlight just some of the differences, so that you can appreciate the difficulties of making a one-to-one comparison of data that we might use to assess the consistency of the database. This is all site purchased energy, and when we look at electricity, we see that the end uses are broken down in the two data sources, in a slightly different fashion. The ERC is less specific than the PG&E energy end use breakdown in both the gas and the electricity categories. And, therefore, at times this leads to a quandary when comparisons on a detailed level are made as to what kind of energy we should attribute to which category in order to make one-to-one comparisons. But for lighting, air conditioning, and refrigeration on the electricity side, and for space heat on the fuel side, we can look fairly closely at their agreement or disagreement.

I should also say that the nature of information, not only in this coarse comparison but also on a more detailed level, can be quite different. For example, ERC covers fuels of all types, including fuel oils, natural gas, distillates and so on, whereas the PG&E data are centered on natural gas, so we get a little broader picture with the ERC data. There are also some notable omissions in both databases. Neither data source indicates whether cogeneration is on site, and PG&E does not indicate whether significant use of alternative fuels exists. The point about cogeneration is one that we would like to have data for. And while the PG&E database does indicate whether alternate fuel is available, it does not say whether or how much it was used.

I would like to indicate the degree of data variability for various end uses and, in fact, even in total energy purchases. If we look at NBECS, for example, and focus on what we believe are industrial buildings located in California (we did that by screening the climate zones and the region from which the data originated), we find that there is a great deal of variation in terms of total site-purchased energy. (See Table 3.) Granted that the sample size is very small, but even when the sample size is increased, we find a great deal of variability in the total purchased fuel on a per-square-foot basis, and the ratios of the last column indicate variability of one order of magnitude in the intensity of energy use within various industrial categories. In fairness it should be stated that NBECS is not really meant to be an industrial database. About 620 buildings containing industrial activity were inadvertently included in their initial survey of 5,585 buildings. It appears each industrial category shows very large variation, and in order to determine its basis, we think that more extensive data is needed to at least get an idea of what this variation profile looks like. In the PG&E database we see that if we look at a particular SIC, four digit level, we might expect to see some of this variability disappear, but instead we find that, indeed, there is a wide range of energy use intensities, even within a particular end use. For other examples of data variability, air conditioning use is indicated for two SIC categories, 3674 semiconductors and 3573 computer manufacturing. Air conditioning could vary anywhere from 5% to around 70% of total electricity use in both cases, which indicates again the need to explore why there is a large variability in total energy use for a particular end use, such as air conditioning, even within specific industrial categories.

Our conclusion is that in order to understand this variability, we should examine more data, and better data, which we hope will reflect the real origins of this variability and its distribution. Then we can determine if we can get meaningful predictive tools from it.

Member of Audience: Would a better classification scheme than the SIC code help solve the problem?

TB: That is a good question. One of the problems seems to be that at some plants there is a mix of industrial activity that may overlap various SIC categories, and it is difficult to attribute energy consumption to either one or the other category. It is difficult to unravel the energy end uses, and this is one of the problems that has been mentioned in the literature. Your question is well taken. Maybe SIC is not the only way to look at categorization of energy end uses.

We also wanted to find out how important building services end use was to the overall energy picture, and for that I think the best data that we had in terms of the entire state of California were those of ERC, the Energy Resources Consultants, Inc., of Boulder, Colorado. In their report they estimate that about 15% to 20% of all purchased energy, by industry, ends up in the building energy services. The Hagler-Bailey report and the NBECS data also agree that about 15% to 20% of the total industrial energy purchases were used to heat, light and cool buildings. The HBC report also states that 84% of that 15% is used for space heating, with 8% each for lighting and for air conditioning plus ventilation.

The California industrial mix differs from that found in the heavy-industry regions of the eastern parts of the United States. California industry purchased only about 5% of the energy purchased by industry nationally, even though this state has over 10% of the U.S. population. Petroleum refining, stone-clay-glass and food rank 1, 2, and 3 in California purchases of total energy, whereas chemicals, primary metals, and paper rank 1, 2, and 3 nationally. Estimates from the ERC data of selected California industries are that of the 448 tBtu of site purchased energy, 69 tBtu was for nonprocess use. Approximately 52% of this 69 tBtu, or roughly worth $200 million, represents fuel for space heating, with the remaining representing site-purchased electricity for air-conditioning and ventilation being 21 tBtu or 31%, and for lighting 12 tBtu or 19%. The 33 tBtu purchased electricity for nonprocess use in California represents about 9.7 billion kWh, with a roughly $1 billion annual purchase cost. Various sources, HBC and PG&E EUA data bases among them, indicate that at least 15% to 20% of nonprocess energy could be conserved. If this estimate is applied only to the California industries surveyed by ERC, it could conservatively represent $180 to $240 million annual cost avoidance. Since this represents a savings of approximately $10 per state capita annually, it merits further study.

I would like to look in a little more detail at some of the energy conservation measures that were suggested by both the EADC centers on a national level, and by other authors a little bit closer to home. If we look at the types of energy conservation measures that yielded the highest results in terms of monetary payback and also in terms of Btu reduction (see Table 5, 1984 to 1985 EADC Program Period), we see six numbered measures, which in order are described as follows: number 1 is simply adjust burners of boilers; number 2 is install timers or thermostats for heating and cooling; number 3 is monitor boiler efficiency and improve quality or control capabilities; number 4 is preheat combustion air; number 5 is install insulation on stream lines; and number 6 is eliminate stream leaks. So all of these cogeneration measures are very, very fundamental in nature. If we were to examine California industry, we might see the same sort of situation existing as well.

Using the PG&E EUA data, we selected five industries because of (1) their diversity, (2) their importance to California's economy, and (3) their rapid growth in California. We wanted to get an idea of how widely differing their energy end uses were, and also to get an idea of what the PG&E auditors estimated could be saved on an economic basis, that is, with reasonably short paybacks. So, if you look at Fig. 8, the first category is instrument manufactures, SIC 3800-3900; the second category is electronics, SIC 3670-3680; the third is frozen fruits, SIC 2037-2038; the fourth is meat packing, from SIC 200-2016; and the fifth is motor vehicles, from SIC 3700-3730. Thus, we have selected very narrow segments of the industrial complex for examination. In Fig. 8, the first of the three bars for each industry represents the percentage of the total purchased electricity in this case that is used for lighting. The second bar represents the percentage by which the auditors judged that lighting electricity could be conserved. And the third bar represents the percentage by which that electricity was actually conserved via lighting conservation measures. So, if you look at, for example, instruments, you see that approximately 29% of the entire electricity bill goes to light the facilities on the average and that approximately 32% of that energy could be conserved, representing about a 9% reduction of overall electricity purchased. But if you look at the 3.5% that was saved, it only represents about a 1% overall reduction in purchased electricity. And you can draw similar conclusions for the remaining four industrial categories, except for frozen fruits, where apparently lighting conservation was taken seriously. They conserved about two thirds of what the auditors felt could be conserved.

Jeff Harris: Tom, can you clarify one thing? The percentages all apply to different bases, is that right?

TB: The first represents the percentage of the total electricity that is used for lighting (e.g., 29%

for instrument manufacturers, in Fig. 8), thus giving an idea of how important this end use is; the second bar represents the percentage by which electricity for lighting could be reduced through conservation measures, and you can see it's about 32% for instrument manufacturers; and the third bar (e.g., about 3% for instrument manufacturers, in Fig. 8) represents the estimated percentage by which the electricity used for lighting was decreased through conservation efforts. The response to conservation opportunities is measured by the magnitude of the third bar to that of the second bar.

Member of Audience: So, the second and third bars represent percentages with the same base?

TB: Correct.

Member of Audience: And that base is the first column?

TB: Yes it is, yes. So 3% of 29% represents about a 1% overall purchase reduction. Okay?

Then let's just for example turn over to air conditioning (see Fig. 10) and do the same for that end use. We see that the same sort of results are apparent, and again, instruments, being the first category, you will see that a great deal of potential for conservation exists, approximately 26%, whereas a fairly insignificant amount has actually been realized, approximately 2.5% of that 26%, even though 35% of the total purchased electricity is used for air conditioning.

I should say a little bit about how these numbers were estimated. PG&E spent a great deal of effort sending out trained auditors and collecting this information, and the numbers are largely the perceptions and estimates made by the auditors. As far as I know, there was no hard, metered data collected.

Member of Audience: Are these five industries the highest energy using industries in California?

TB: Not by any means. Motor vehicles is a fairly large-users category, and electronics are fairly large-user categories. And, of course, various segments of the food industry are important contributors, since the food industry is one of the largest industries in California.

Member of Audience: How about their growth rates?

TB: The first two categories, the instrument manufacturers and electronics, are among the most rapidly growing industries in the state of California.

I forgot to mention that there may be reasons why the lighting conservation has not really taken on its full measure, and one might be that the most efficient lighting might not allow the workers to distinguish colors rapidly enough. There are some accounts of industrial accidents resulting from inadequate color rendition with sodium yellow in particular, where perhaps you have an assembly line of fast moving objects.

Member of Audience: Are these potential energy conservation percentages limited to cost effective measures?

TB: Yes. In the auditors' estimates there were cost effective conservation measures that should be applied.

HA: These have payback periods of only two years or less.

TB: I would like you to glance at gas use for space heat (see Fig. 14) as an example of the apparent fuel-conservation opportunities that exist. You can draw the same conclusions regarding gas use for space heat as we observed for electricity use in lighting and air conditioning.

Member of Audience: In the meat packing category, the actual energy savings are more than those predicted by the auditors!

TB: Yes, yes. Perhaps they took something seriously, or whatever changes they made greatly exceeded expectations. But one would have to look in detail at the data, site by site to find out the origin of that, which we did not have time to do.

Member of Audience: Did they achieve the conservation through some kind of program? How was it managed?

TB: That I am sure you can ask Bill Idzerda, who will also present a perhaps more inside view of the database from the PG&E perspective.

BI: We have offered a lot of rebates for lighting, energy management systems and conservation in general along the way.

Member of Audience: So this is PG&E's program?

TB: Yes, and this is all PG&E data.

BI: And I think a lot of times the conservation opportunities that were available have been taken advantage of since the database was formed, but it is a relatively old database. It was about five or six years ago when a lot of the audits were conducted.

TB: I saw references to 1984 in the database.

Member of Audience: Is this the most recent database that is available, or do you have a more updated one?

BI: We have an updated database, but we have not updated this one. It is updated in a different location. So even today to determine which conservation measures affect each particular location would be very difficult. I think the interest is not there either necessarily, to get accurate statistics in this area, in conservation, as there was just a couple of years ago.

I am not going to discuss this database in my presentation, we do not even do energy audits any more, for example. Instead, I shall talk about the type of information we do get from customers and how we get it.

TB: One thing I wanted to do was also give you an idea of the power of the database to give you an overall glimpse, you might say, of a breakdown of how perhaps electricity might be used. Fig. 1 shows the same five industrial categories selected and the six electricity end uses that are listed in order from the bottom up are lights, air conditioning, refrigeration, process heat, motors, and at the top, miscellaneous. For electricity you can see that the importance of the various end uses changes quite noticeably as we go from one industrial category to another.

Member of Audience: These are annual, total end-use lists, to match the bill through simulation?

TB: Neither we nor PG&E performed any simulations.

Member of Audience: How were these end uses obtained then?

TB: Bill, do you want --

BI: These are the auditor estimates. They did a plant walk through and said, "well, that looks like 20%, that's 25%." I guess they are trained to determine how to estimate.

Member of Audience: Was there a nameplate rating survey? There was no utilization factor that was measured so as to apply some estimate other than the best guess by the auditor?

BI: Oh, yeah, well they could walk and read the nameplate ratings, for example, on motors, and get information about the air conditioning system, but there was no sophisticated analysis. The reason for doing the energy audit was specifically to target conservation opportunities. And I have read these reports, some of which got up to forty pages long, with diagrams about what to actually do and where to install insulation, for example, and what I found out looking through them is that they basically address how to reduce lighting requirements and how to make the air conditioning, the HVAC systems, use less energy --

Member of Audience: We have seen audits that were calibrated to energy bills, that were still off on end-use lists by over 100%, based on metered end-use data.

Member of Audience: And there were no metered end-use data at all, not at all?

Member of Audience: This is not even as good as the calibrated simulation. This is just pure guess.

HA: I think that there was an attempt by the auditors to reconcile their estimates with the utility bill.

BI: Yes.

HA: So that was done. But there were no submetered data, anyway.

Member of Audience: But percentagewise there is no way to verify that it is within 10% of the actual, or a lot more or a lot less.

TB: I still think qualitatively this gives at least a relative importance of various end-use categories; as you scan across industries, you would be very surprised if you saw refrigeration extremely important in, for example, motor vehicle manufacturing.

Member of Audience: That's right.

TB: So I think qualitatively it presents a pretty good picture of what one might expect.

HA: One other point to mention here is that these are averages of many, many facilities. So even though on one particular instance of your samples your results might be off by a factor of 2, even 3, still on the average I expect that the data really show some truth.

Member of Audience: What is the sample size of the five categories?

TB: It varies dramatically for each industrial segment selected. I do not have those numbers right handy, but I could certainly get them to you.

Member of Audience: Dozens?

TB: Yeah, dozens.

HA: On the order of several hundred.

BI: Yeah, generally, we covered about 80% or so of the energy use within the categories, so certainly all the large users were audited.

TB: Again, if we look at the same sort of display of natural gas use in Fig. 2, we can see wide ranges in the various end uses. The order is as follows: space heat, hot water, boiler generated heat from gas, gas boiler process, gas processed heat directly, and cooking. The small bands left up at the top are for very small categories of miscellanea. The software had limitations as to how many categories one could plot.

I think from an energy-planning perspective it would be valuable if we had data that would give an idea of how intensively energy is used. The first of the two bars on Fig. 3 represents the summing of all of the industries in instruments, calculating the kWhs, and dividing it by the total square footage in order to obtain __ for what might be one single plant of great magnitude __ a kWh figure per square foot on an annual basis. The second bar for each industrial category represents the statistical mean. So you can see that the agreements are not that terrible, except when we get to motor vehicles where several large plants dominate this entire industrial sector. But you can see that from, let's say, an energy-demand forecasting standpoint, such data (giving kWhs per square foot for each industrial category) would be exceedingly useful. And I think that since lighting is not really seasonally changing, we can at least get an estimate of what the lighting demand should be from data of this nature. >From Fig. 7 it is seen, as expected, that one does not really need intense lighting in such industries as frozen fruits and meat packing. One might be able to conclude that instrumentation needs about 2 watts per square foot for adequate lighting, and electronics about the same, or a little higher; frozen fruits need on the order of maybe 0.7 to 0.8 watts per square foot; meat packing on the order of 1.2 or 1.3 watts per square foot; and motor vehicles surprisingly up in the range of 2 watts per square foot for proper illumination.

I hope that this presentation gives you an idea of the type of data that we were looking at and an idea of the importance of the conclusions one might be able to draw from a reliable, current database. Remember, these figures originate from PG&E regional data. We do not have good numbers for the entire state of California. But again, let me just summarize a few things. Unquestionably, the data are rather sparse, the reason being the difficulty and expense of data collection. The area of industrial buildings has been neglected for some time, and from a conservation standpoint it is obvious that at least $200 million a year could be avoided in purchase costs through conservation measures that have reasonably short paybacks.

The studies that we have been able to access are really quite fragmented. Some emphasize one aspect of energy use, others emphasize another aspect or aspects, and it is difficult to put these fragmented data sources together and get a coherent picture. We believe we need a serious effort, at least in the state, and more importantly, across the nation, to establish a useful database from which energy planners and utility providers can plan our nation's future energy use in a constructive way. The overbuilding, underbuilding, economic-crisis rollercoaster that the United States has been on could be greatly reduced if such data were available and used.

Overview

1. Identified Data Sources
2. Data Quality Assessment
3. Major Observations
4. Conclusions and Recommendations

PURPOSES OF OUR STUDY

- EXAMINE AVAILABLE DATA TO DETERMINE IF IT IS OF SUFFICIENT QUANTITY AND QUALITY TO MAKE MEANINGFUL OBSERVATIONS ABOUT THE ENERGY NEEDS OF CALIFORNIA INDUSTRY AND WHETHER IT COULD ASSIST IN ENERGY DEMAND FORECASTING STUDIES.

- ESTIMATE THE IMPORTANCE OF BUILDING SERVICE ENERGY USE TO THE TOTAL CALIFORNIA INDUSTRIAL ENERGY REQUIREMENTS.

- EXPLORE FEASIBILITY OF CHARACTERIZING THE BUILDING SERVICE END USES INDUSTRY BY INDUSTRY.

- ESTIMATE THE IMPORTANCE OF ENERGY CONSERVATION MEASURES AND LOAD SHAPING OPPORTUNITIES IN THE BUILDING SERVICES, INDUSTRY BY INDUSTRY.

Data Sources

1. Nonresidential Buildings Energy Consumption Survey (NBECS)
2. Industrial Energy Use Data Book (Oak Ridge Assoc. U. 1977)
3. Industrial Buildings Energy Use (HBC, 1987)
4. A Characterization of Energy Use in Selected CA Industries (ERC/CEC)
5. Energy Analysis and Diagnostics Centers (EADC) reports
6. PG&E Energy Utilization Audit (EUA) Data Base
7. ASHRAE Award Winners

Others

8. SCE Industrial Data Base?
9. SDG&E Industrial Data Base?

PURCHASED, SITE, IDENTIFIED ENERGY END USES

	PG&E EUA DATA BASE	ERC, INC.
ELECTRICITY		
LIGHTING	X	X
AIR CONDITIONING	X	X
REFRIGERATION	X	X
PROCESS HEAT	X	X
SPACE HEAT	X	
ELECTRIC MOTORS	X	X
HOT WATER	X	
MISCELLANEOUS	X	X
FUEL	PG&E (GAS ONLY)	
SPACE HEAT	X	X
HOT WATER	X	
BOILER SUPPLIED SPACE HEAT	X	
BOILER PROCESS HEAT	X	X
PROCESS HEAT	X	X
COOKING	X	
MISCELLANEOUS	X	X

Averages and Ranges of Total Site Energy Demand
Reported Within NBECS Industrial Categories

		Total(Btu/hr)/ft^2				
Category	Sample Size	Low	High	Average	Median	(High/Low)
Industrial	9	5.48	102.04	48.0	53.8	18.6
Leather, Textile	2	4.72	84.93	44.8	44.8	18.0
Light Assembly	11	1.76	96.20	24.3	49.0	54.6
Heavy Assembly	3	19.35	160.46	71.8	89.9	83
Paper, Chemicals, Rubber	2	47.88	412.52	230.2	230.2	8.6
Metal, Glass	5	6.09	174.10	58.5	90.1	28.6
Printing, Publishing	2	12.56	42.87	27.7	27.7	3.4
Mfg. of non-food, Storage	4	0.93	37.28	20.5	19.1	41.2

Other Examples of Data Variability

PG&E EUA shows that end use varies widely:
The % of total purchased electricity used for A/C in

- SIC 3674, Semiconductor industry, varies from 5 to 70%
- SIC 3573, Computer manufacturing, varies from 0 to >70%

Conclusion

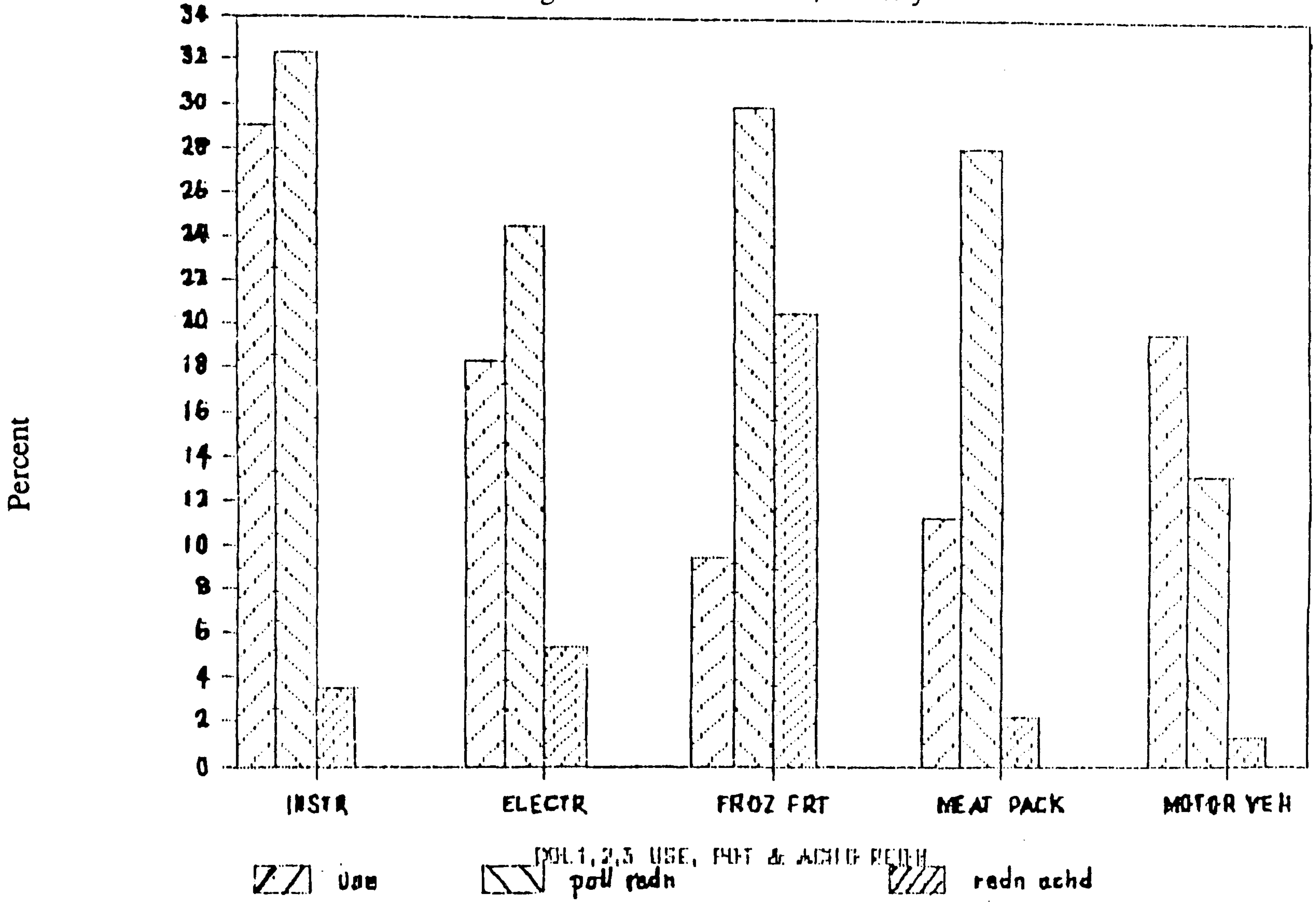
Data variability must be better characterized for end uses at the 4 digit SIC resolution. The data appear to reflect genuine variation at each site, but more data need to be collected to characterize these variations.

1984-85 EADC Program Period: The Estimated Contribution to Overall Industrial Energy Conservation by Measures Appropriate to the Building Services.

Number	Conservation Implemented Million Btu/yr	% of Total Implemented Conservation	Conservation Recommended Million Btu/yr	% Implemented Recommendations
1	122,400	15.6	361,100	33.9
2	96,800	12.4	113,200	85.6
3	51,200	6.5	221,000	23.2
4	24,200	3.1	42,900	56.4
5	24,100	3.1	29,900	80.6
6	22,100	2.8	27,500	80.2
Totals	340,900	43.6	795,700	42.8
All ECOs	782,087	100.0	1,627,212	48.06

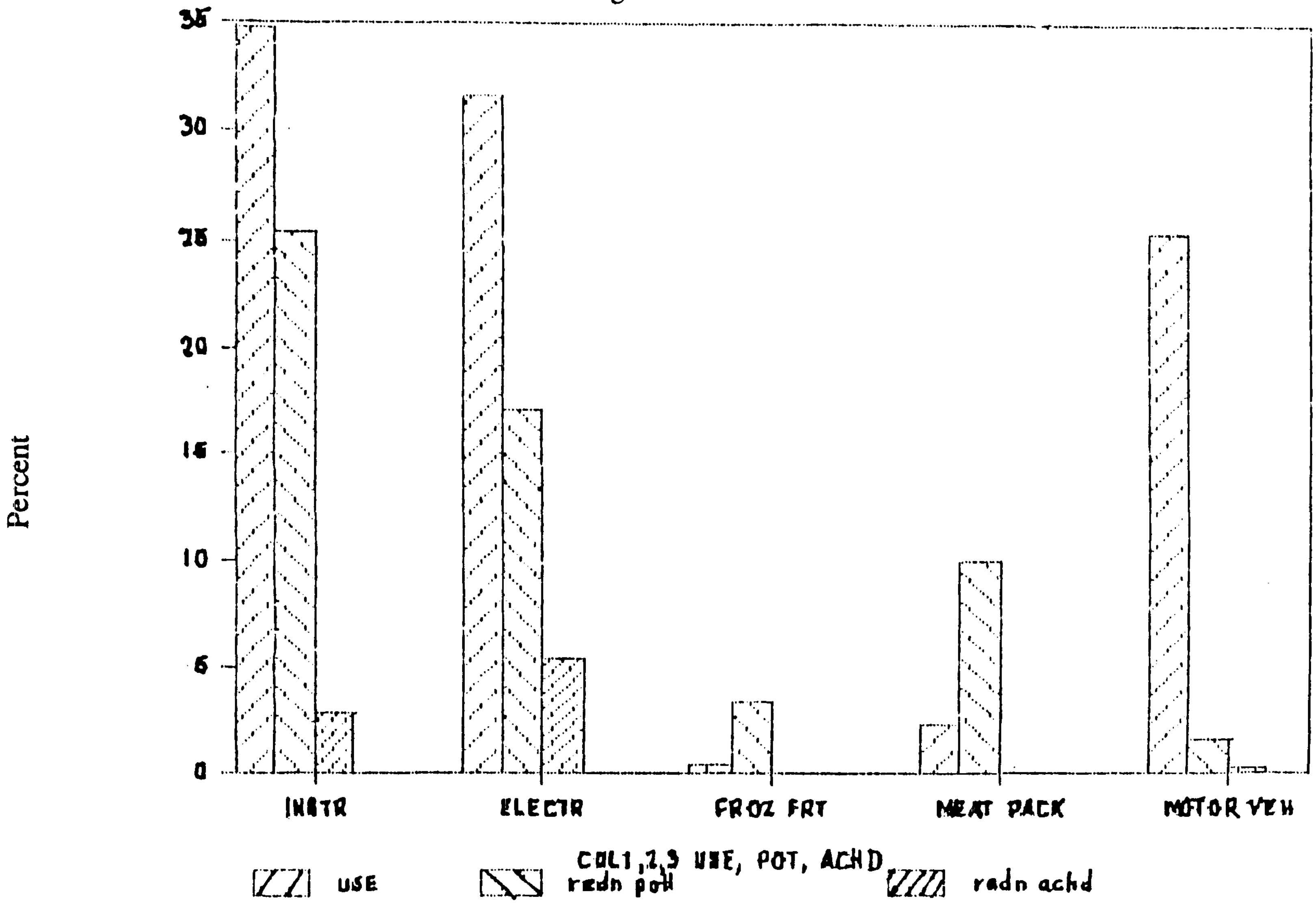
Lighting Use, Potential for Reduction, and Achieved Reduction for 5 Industries

Average Values of all Cases/Industry



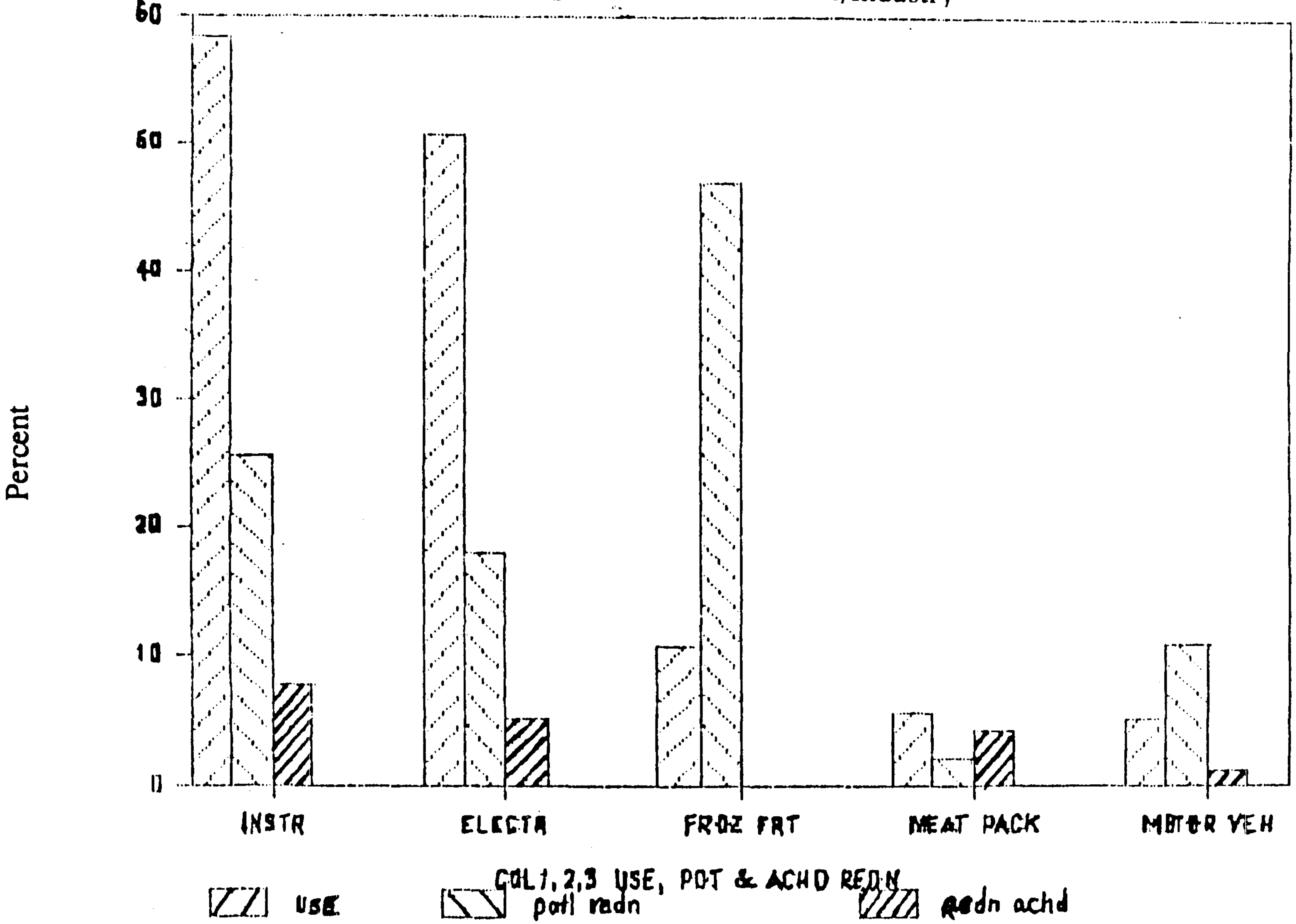
Air Conditioning Use, Conservation Potential and Achieved Reduction for 5 Industries

Average values of all Cases/Industry



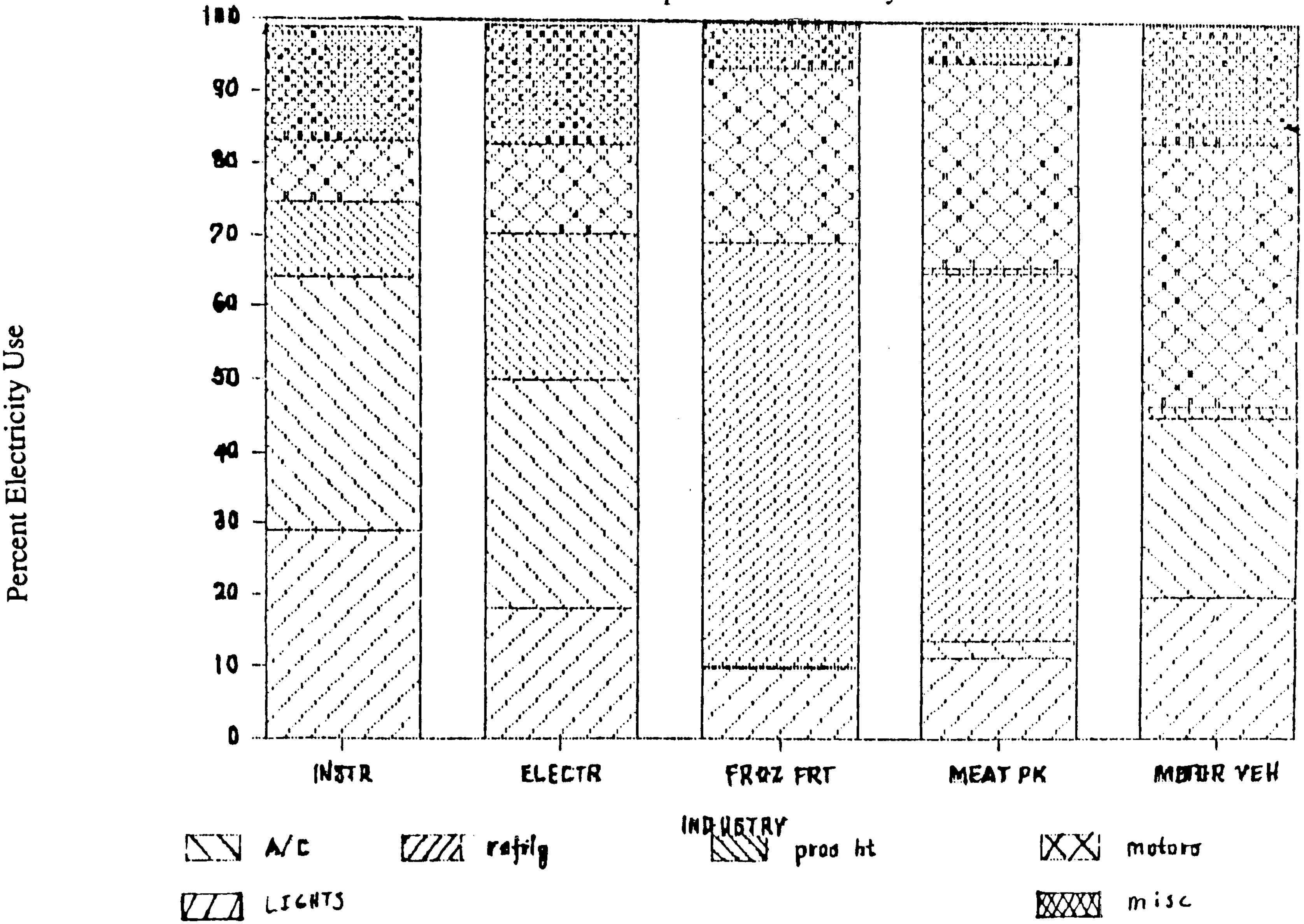
Gas Fired Space Heating Use, Potential for Reduction and Achieved Reduction for 5 Industries

Average Values of All Cases/Industry

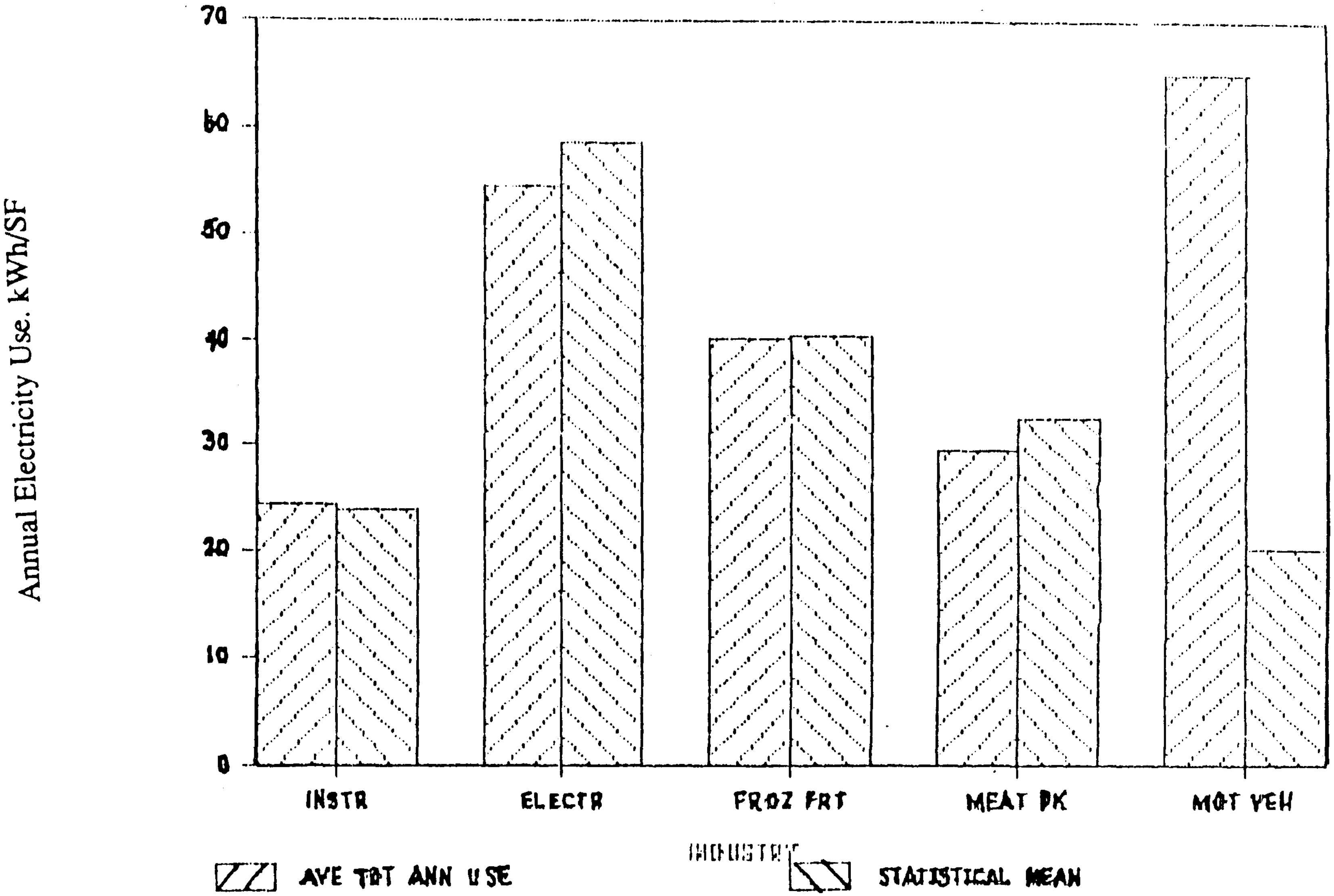


Electricity End Use Comparison for 5 Industries (Percentages)

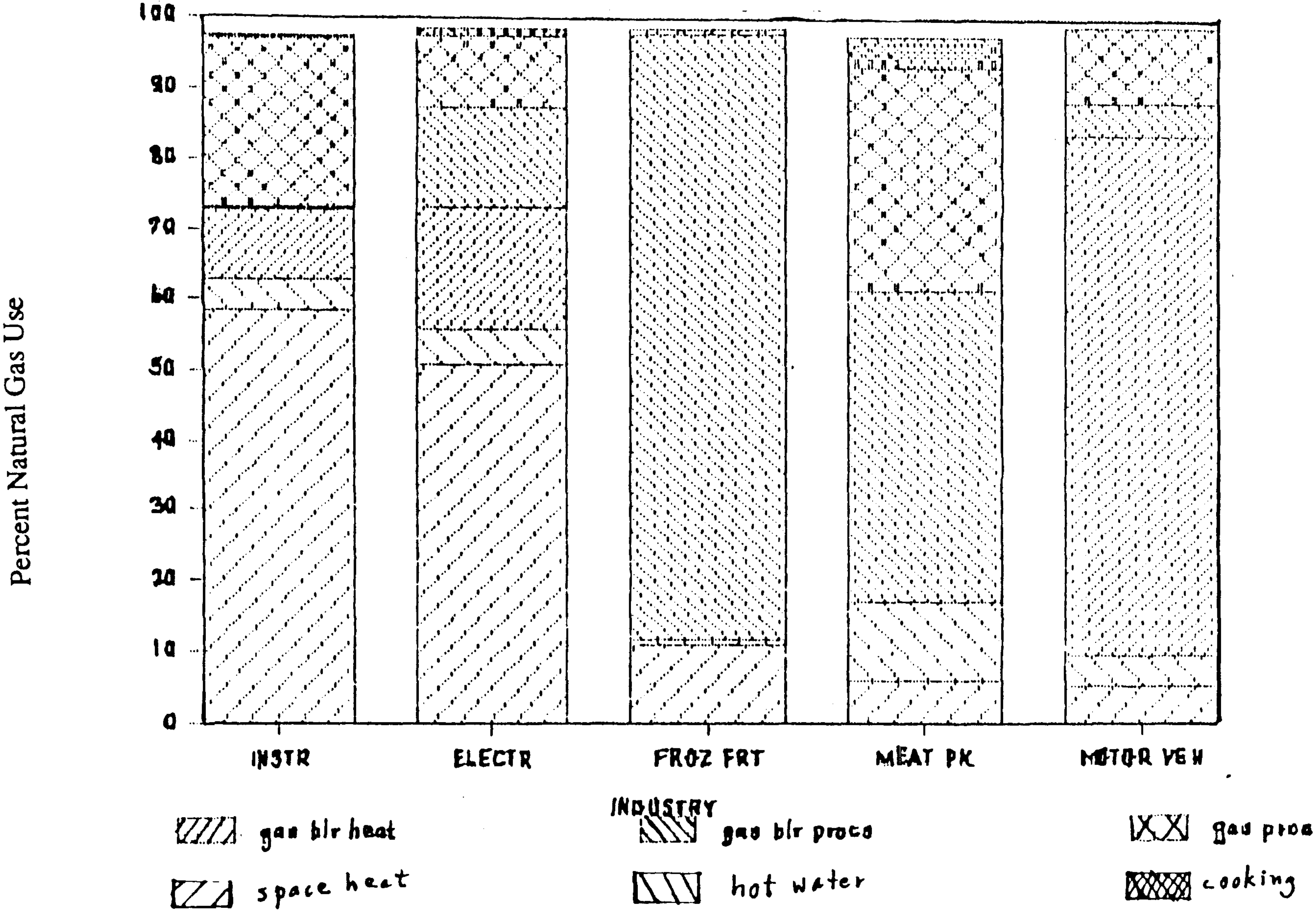
Data Computed from Industry Sums



Total Annual Electricity Use Intensity (kWh/sq. ft.) for 5 Industries

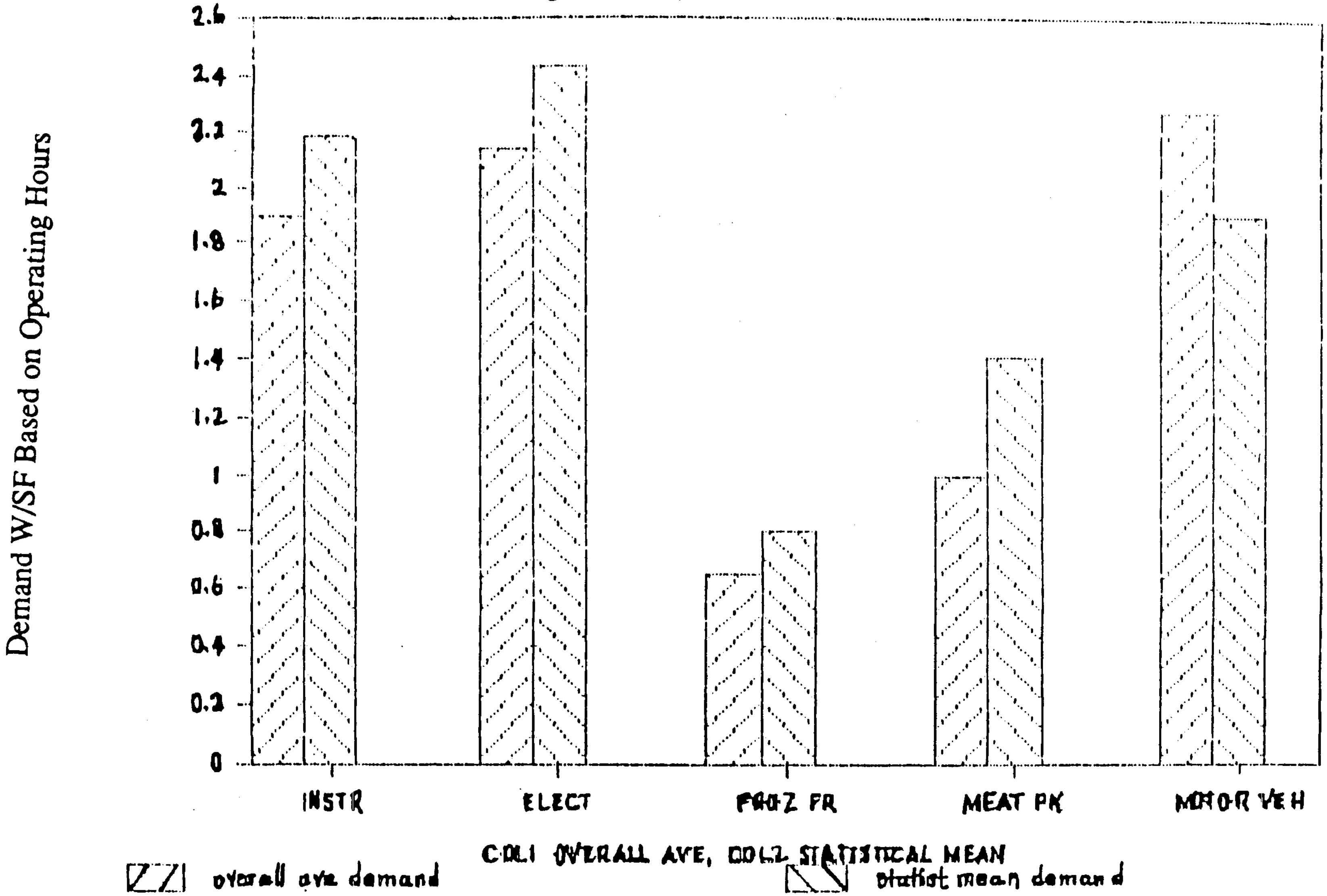


Natural Gas End Use: Comparison of 5 Industries (Percentages)



Lighting Demand Comparison for 5 Industries

Using the Computed Values/Industry



Conclusions and Recommendations

- Data is sparse
- Industrial buildings are important but neglected energy use sectors
- At least $200 M per year in California industrial building services energy could be avoided through conservation
- Current studies are not consistent and are too fragmented to form a solid basis for energy and peak demand forecasting
- A serious effort is required to establish a useful data base for California

END-USE METERING OF PNW LUMBER AND WOOD PRODUCTS MILLS

Carey Lee (BPA)

Background

The industrial sector in the Pacific Northwest (PNW) region, excluding the industrial customers directly served by the Bonneville Power Administration (BPA) accounts for about 30% of the total firm electricity sales in the region. Of this amount, about 9% was consumed by the lumber and wood products industry (Standard Industrial Classification or SIC 24). This industry is the second largest industrial consumer of electricity next to the pulp and paper industry and is expected to remain in this position through the year 2010. Because of this fact, the lumber and wood products industry has been the subject of much analysis at BPA.

BPA is a power wholesaler, marketing electricity to regional and extra-regional utilities and to several directly served industries. This situation makes it difficult for BPA to directly contact or access data from industrial consumers. BPA must work through the retail utilities in order to collect data from industrial consumers. BPA has contractual arrangements with the utilities and not with the industrial consumers.

In addition to wholesaling power, BPA provides conservation and marketing-program support for its retail utility customers. Hence, any data collection efforts BPA undertakes provide the underpinnings for the design of conservation and marketing programs offered to its retail utility customers for implementation. Because PNW mills have many similarities in their operations, it is economic to conduct such regional-level research, as opposed to conducting numerous independent studies at the utility service-area level.

BPA has acquired electric load recording and translation equipment to embark on load research projects, but most of the activity centered on residential and commercial establishments. This project presented an opportunity to collect load shape and electric end-use data from industrial consumers.

Purpose of the Project

The purpose of this study was to collect hourly electricity load data for a period of twelve months, and electricity end-use data from thirty-five PNW regional lumber and wood products mills. This data are used for forecasting annual and hourly electricity load from the lumber and wood products industry and provide a basis for BPA's conservation and marketing programs.

Site Selection Process

The project budget allowed for data collection at thirty-five regional mill sites. Based on historical industry employment and electric consumption data, six subgroups were targeted for this study. The number of mill sites selected for each subgroup was intended to reflect its importance with respect to its size, in terms of both employment level and electricity consumption. For example, twenty-one sawmills were selected for this study, since sawmills account for a major portion of the employment created and electricity consumed by the lumber and wood products industry in the PNW region. The following groups were targeted for analysis:

SIC 2421 Large sawmills (greater than 100,000 board feet per shift)

SIC 2422 Small sawmills (less than 100,000 board feet per shift)

SIC 2431 Millwork

SIC 2436 Plywood mills

SIC 2492 Composite board plants

SIC 2499 Wood treating, laminated board

The candidate mills were rated according to three screening criteria. The first criterion was whether the mill was served by a public utility that purchased electricity from BPA, as opposed to an investor-owned utility that was not dependent on BPA for its electricity supply. Preference was given to mills served by public utilities in order to have the sample represent the mills whose load BPA had the obligation to serve. The second criterion was whether the mill site was representative of a typical plant in its industry subgroup. Mills that were judged to be typical of their industry segment were given preference over mills that were exceptional. For instance, a mill that used radically different or unconventional machinery was not selected since the mill would not be representative of the population in its SIC subgroup. The last criterion was whether the mill management had a cooperative attitude. Previous data-collection efforts indicated that this element was critical to the success of the project.

In order to provide an incentive for mills to volunteer for this project, BPA offered to reward the participating mills with individual reports about their electricity use.

Data-Collection Process

Each participating mill was equipped with a BPA-furnished Westinghouse Model EWR-84R demand recorder. This instrument recorded electronic pulses originating at the utility demand meter onto a removable 256-bit nonvolatile magnetic bubble memory cartridge. Each cartridge had adequate memory for 110 days of data on each of four channels. Electronic pulses were recorded at thirty minute intervals for one to two months on each cartridge.

Each mill was asked to supply various background material, including five years of monthly electric peak kilowatt and average kilowatt-hour consumption data, five years of annual production data, some monthly billing records, an electrical one-line diagram of the mill's system, and a list of motors that were 20 horsepower and larger. This information was used to validate the metered load data and to select specific pieces of equipment that would be monitored for a two to three week period on a Dranetz portable meter.

The contractors installed a recorder at each participating site. In some cases, the demand meter used by the utility was not compatible with the recorder, and hardware changes were necessary. After the recorders were installed, the bubble memory cartridges were inserted. The cartridges were then removed and sent to the contractors for processing within one week. The load data contained on each cartridge were quickly downloaded and translated so that any major equipment failures or problems could be detected early on. After this initial changeout, the cartridges were left in the recorders for a month at a time.

Utility personnel were relied upon for cartridge changeout and for mailing the loaded cartridge to the contractors for processing. Translation of the electricity load data contained on each cartridge was done at BPA, using a Westinghouse translating deck and software developed by Process Systems, Incorporated. The translating deck was attached to an IBM-XT compatible personal computer, which facilitated the downloading of the data into an ASCII file, which could then be imported into a spreadsheet program for analysis.

As can be expected, numerous problems arose during the data-collection phase of the project. Several recorders and bubble memory cartridges failed to function, in spite of being checked before installation. On occasion, the incorrect meter multiplier was supplied by the utility, which produced incorrect kilowatt readings form the pulses recorded on the cartridges. In another instance, the utility personnel mistakenly inserted the same cartridge into the recorder instead of a new cartridge, in which case a month or more of data were lost. Fortunately, these problems were not widespread, and many of the problems were overcome once the lags in data translation were shortened and one-week recorder and cartridge-initialization routines were instituted.

Data Analysis

After the data were collected, analysis was conducted at the individual mill level. An average workday demand curve was constructed for each mill site. This curve was computed by averaging all hourly load data collected for each workday over the twelve-month period of observation. Next, a spreadsheet model of the mill was constructed, based on the load data recorded for each major piece of equipment. This model produced a load profile for a typical workday, which was then compared to the actual data represented in the average workday demand curve. This model was adjusted if the load profile it produced did not achieve a close fit with the average workday demand curve. Such adjustments were made by changing assumptions regarding the timing or level of subloads if interviews of mill personnel indicated that operational or structural changes occurred subsequent to subload metering. When the modeled mill curve came within 5% to 10% of the average workday demand curve, the model was deemed to be acceptable for various types of mill-specific analyses. With this model, one could estimate what the impact would be on a specific mill's electricity consumption pattern if the mill expanded production capacity, implemented efficiency improvement measures, or instituted other changes. Figure 1 displays a modeled mill curve overlaid on the mill's actual workday demand curve.

The data collected in this study were also organized and presented so that characteristics of the various SIC subgroups could be observed. Average workday demand curves were constructed for green finish sawmills, dry finish sawmills, softwood plywood mills, and waterboard mills. An average workday demand curve for a rough green sawmill is displayed in Fig. 2.

The data were compiled to display end-use characteristics of each SIC subgroup. Figure 3 includes a pie charge displaying the percentages of electricity attributed to five end-uses for rough green lumber mills.

Historical data on production levels and electricity use per unit of output were displayed on scattergrams with a fitted curve to illustrate the fact that as production increases, electricity use per unit of output declines. A scattergram for mills producing rough green lumber is displayed in Fig. 4.

Conclusions

The data collected in conjunction with this project will be useful to BPA in several ways. First, recent empirical PNW regional data were collected. This data can be used for identifying and quantifying various demand-side management and marketing opportunities in the lumber and wood products industry, such as load shifting or the installation of electrotechnologies. This data can also be used to validate existing nationally based references, such as the Dun & Bradstreet data base. Second, through this project, BPA gained much experience in conducting load research on a specific industrial sector. An infrastructure for translating and downloading data has been built, and future projects of this nature will deal more effectively with problems that have arisen in the past.

This paper is a shortened version of a report that is available on request from Carey Lee, Bonneville Power Administration: (503) 230-3660.

Figure 1

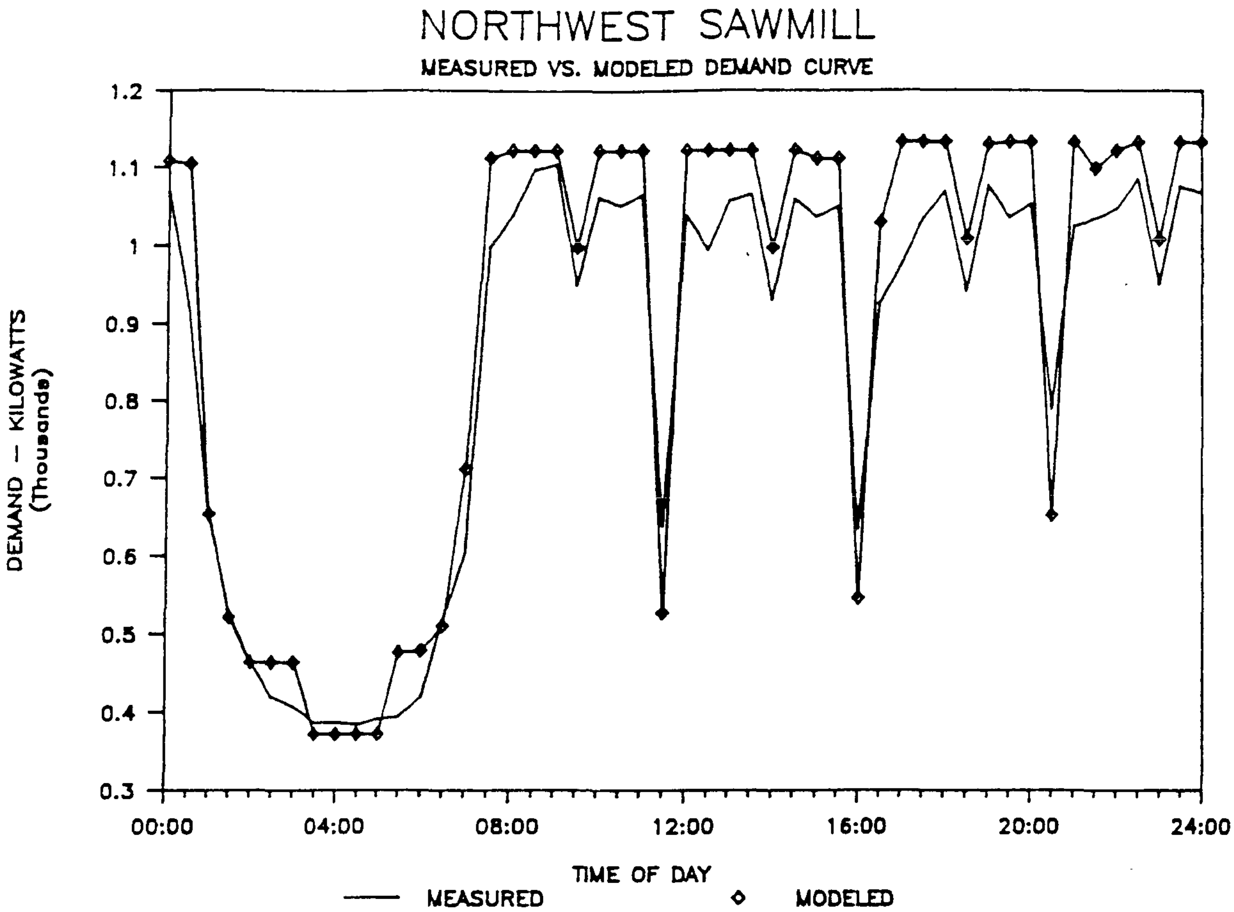


Figure 2

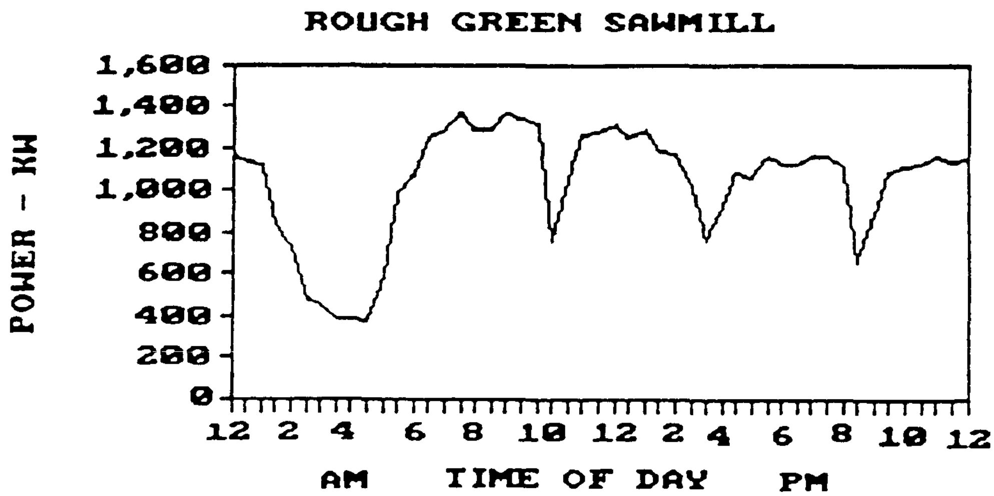


Figure 3

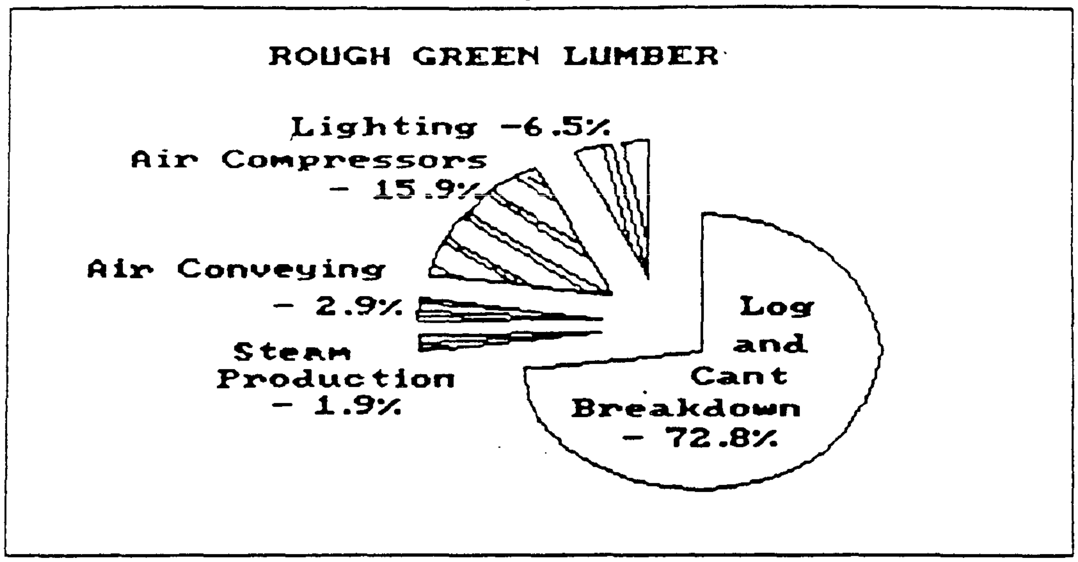
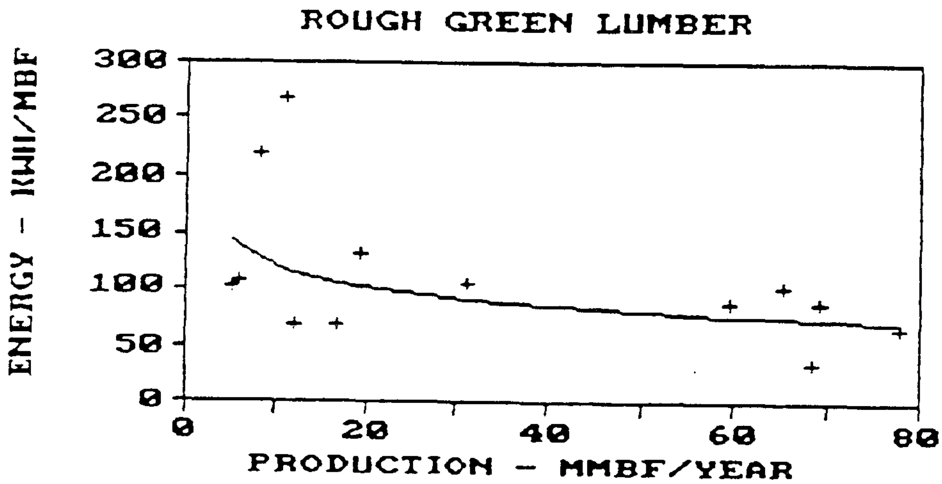


Figure 4



PRELIMINARY SURVEY OF SIC 20-39 INDUSTRIES

Ted Mureau (LADWP)

Let me introduce myself; my name is Ted Mureau. I am with the Los Angeles Department of Water and Power, and I am the supervisor of load forecasting. Over the last ten years we have been developing various end-use models with which to predict our loads. Probably the most neglected sector has been the industrial sector. After about a year of discussion, I was able to persuade some likeminded people in our energy-services marketing group that we should do some kind of industrial survey, and what we came up with was a mail-out survey. So, beginning in September 1987, we mailed this survey to our industrial customers and asked them to complete and return it to us. There were two mailings. We have approximately thirteen thousand industrial accounts: how many industrial customers it represents, we are not precisely sure. By aggregating the accounts by address we come up with approximately seven thousand industrial customers. The reason for the difference between the number of accounts and customers is that an industrial customer may have multiple accounts. They may have a single account for a process and then a smaller account for their lighting or their office facility. Some of our big customers only have one. And the accounts correspond roughly to meters.

Prior to the mailing of the questionnaire, we notified all of our industrial customers about the survey through our newsletter and requested their cooperation. In addition, our energy-service representatives contacted the larger customers to ensure that knowledgeable respondents answered the questionnaire.

About 7,000 questionnaires were mailed. The total responses have been about 795, which is not too bad.

Before I go on and show you some of the preliminary results, let's look at our industrial sector, just to get a feel for it. In 1977 we sold about 3,900 gigawatt-hours of electricity to our industrial customers. Our sales to our industrial customers peaked in about 1980, and they have declined slowly since then. We expect sales to decline through the early 1990s and maybe pick up after 1995. The reason for the pickup is that the South Coast Air Quality Management District is preparing a plan that calls for increased electrification of all industrial processes. There is considerable debate as to what impact that plan will have on our industrial sector. There are any number of measures under consideration, including the electrification of all heating processes. If you have a natural gas heating process, you may be required to switch to electricity. Now, whether that load will be converted into electrical load, we do not know. The participants may respond in other ways: they can always shut down, move across the border into the next air quality district, or electrify. However, the air quality district has not made its final determination yet, and the issue will be resolved later.

Prior to the complete transcription of the survey results, I was getting a little anxious and wanted to do some preliminary work. It took a lot longer to code the data than I expected, owing to preliminary checks of data, attaching the billing histories, etc. After about 500 responses were transcribed into the system, I decided to do some preliminary review just to get a feel for what the data were going to be like. And here I present the results of that preliminary analysis.

The first thing I wanted to do was look at the SIC code not only to see how well we had identified the customer by SIC (Standard Industrial Classification) code and how well the customer identified their SIC code but also to match the SIC code to what each customer says their product is. The percentage error on the SIC code varied from a very low 3.3% in SIC code 20, to a very high 35% in SIC code 25. This is a cross-match between what the firm says they are, what we say they are, and what they describe their business as. So, there are three kinds of errors you can have: we are wrong, they are wrong, or we are both wrong.

Member of Audience: I do not see how the respondents can be wrong.

TM: I shall show you an instance where the respondent can be wrong.

Member of Audience: You mean not knowing what business they are in?

TM: No, I assume that they know what business they are in when they describe it, but their attachment of an SIC code to it is wrong, and I have a more detailed chart here. Now again, the errors vary. The purpose of doing this is to determine how we are going to use this information, how we are going to weigh it, and how we are going to translate it into input assumptions that we can put into our forecasting models.

Okay, our largest industrial customer block still remains refining. That is SIC code 29. And it is also our most accurate SIC code. There were five respondents in refining and two of the largest respondents, Union Oil and Texaco, consume about 75% of the energy in this SIC code. Then there was a roofing business. They produce roofing materials. Finally, there were an asphalt production company and a metal-cutting oils producer, so they were actually accurately coded.

The next largest category is transportation. That is SIC code 37. Again, no errors, based on our preliminary look. But this one does not include General Motors, which is the largest customer in that SIC category. They consume about 300 gigawatt-hours per year. The third largest category (in terms of energy consumed) is food processing, which has a low error rate. The fastest growing with the largest number of customers is the apparel industry, SIC code 23, and they have a fairly low error rate with a large number of respondents. Now, let's look at some of the individual responses.

HA: My understanding about mail surveys is that they usually have a respondent rate of about 20% to 30%. Here the respondent rate is below 10%. Is there any particular reason for such a low response rate?

TM: I really do not know of one. I cannot tell you why.

HA: Let me ask you another question. How many questions did you have in your questionnaire?

TM: It is a huge questionnaire and I want to address that point in the conclusion.

JH: I think you may be misinterpreting the numbers. If I recall just a moment ago, there were 2,000 questionnaires sent out.

TM: 7,000.

Okay, this kind of gets to the detail, this is the anecdotal part. The Space Time Machine Companies, Member of Audience: Were you only looking at two-digit SIC codes?

TM: Yes, I never look at anything below two digits because to do so is really asking for problems. Let me tell you three kinds of errors. The first kind of error is our SIC code here, the SIC code from the master file is wrong. The second kind of error is the customer's SIC code is wrong. Then, what we assume to be infallible information is the customer's description of what the business is, so the third kind of error is the customer is wrong on the SIC code and we are wrong on the SIC code. The Space Time Machine Company—fabricated parts—that does not sound like an apparel manufacturer. So we gave that a 1. The same thing with sheet metal. That is clearly not apparel (laughter). Nor are radial aircraft engines (more laughter). It does not make sense. Okay, sails for sailboats. This is where the customer made a mistake. If, in fact, they make sails, and it looks like they do, T & A Sails should not be a SIC 37. They are not in the transportation industry, or a transportation manufacturer, they are, in fact in apparel (laughter). They are SIC code 2392. So this is the one instance where we have a number 2 on this list.

Member of Audience: What if they make sails and rigging? I mean, there are some interesting choices.

TM: Oh, there are. That is why I never look at the four-digit SICs. It is foolhardy to start to look at the four digits, three digits, too, I mean, stick to the two digit and you are going to get in less trouble and you are going to have more data. And you just hope the errors cancel each other.

Member of Audience: What was the question asked, though, was it "What is the majority of your sales?"

TM: I am not sure. I have the questionnaire and I can go back to it. I think they asked, "What do you do and please describe it." We put this in there so that we could make some kind of judgment as the the accuracy of how they responded. It is quite possible that they do a variety of things, especially some of the smaller manufacturers. They are not going to be in one SIC code, especially when you get into anything with metal. They may have some kind of mill, or some kind of furnace in their operation, so when they melt down the metal and then fabricate it, you can get a SIC 33 or SIC 34 quite easily.

HA: Let me make an observation. I was visiting an exhibition that was put up by ASHRAE, and I was asking a specific question to the people who were exhibitors: what business are you in? And about 60% of them answered that they are in the business of making money.

TM: That is right.

HA: And one good example of that was a very predominant manufacturer of air-conditioning pumps and compressors. In the last five years about 50% of their earnings came from renting out security guards. They actually go and train the personnel for security, and they also have a gun for hire. All these kinds of errors that are there. Businesses change so rapidly. What do you think?

TM: Yes, I am positive that we assign these customers the SIC codes when they call in to establish an account. When they change business, they do not necessarily call us and tell us, and we are the last people to learn. And we are just happy as clams thinking that Space Time Machine Company is manufacturing clothes. Now, you say, are there any "third" type errors where both we and the customer are wrong in attaching SIC code. The answer is yes—silkscreening. He said he was in SIC 35, we said he was in SIC 23. And we were closer to the truth. If you look at the definition, depending on the type of materials you use in silkscreening, that is how you assign the SIC code. You can interpret that to mean that that SIC code could be a 22, which is much closer to 23 than it is to 35, but Mr. Rosenblatt may be in some other kind of business. Judging by what he says here, we believe that he's in shirt manufacturing. Now, in fact, he may manufacture silkscreen materials or machinery.

Now the purpose of this meeting is not to talk about SIC coding, but to look at building shell. Well, the last page of the questionnaire, page 8, is where we requested information on building envelope. The energy services people were interested in motors and process. I was interested in building shell. I lost. I am on the eighth page. These are the kinds of questions that were asked and you see a typical response here. What are my conclusions.

Member of Audience: Can you please read out the questions?

TM: This is the original questionnaire. As you can see it is quite long, quite forbidding, and to a manufacturer who has deadlines to meet, it is a very long questionnaire.

Member of Audience: We have one we do for the CEC for commercial customers every other year, and it is much longer than this.

TM: I shall not address that question. We also use that long questionnaire. They can be time consuming and the response rates reflect this.

The first question, "what is the square footage of your facility?" Second, "what percentage of the following areas in your facility are air conditioned? What is the kW rating of your air conditioning system? Is your facility refrigerated? Please estimate the percentage of your floor space that is lighted and give the type of lighting, hours." These are kind of typical questions that you would ask. Now in terms of motors and processing, there is a page devoted to each, depending on whether you are in manufacturing, food processing, clothing, or whatever. What have we found so far? Talking to the people that conducted the survey, they said our industrial sector and our industrial customers are very heterogeneous. Within SIC codes, the processes are very different. Between SIC codes, there is a whole universe of difference. One questionnaire just does not get at the answers. You have to target the questionnaires to the industrial customers. It is required that the surveyor know something about the industrial sector. As I told you, on the eighth page were the building envelope questions. And these are the best data we got. The people in energy services, going through the responses on motors and processes, said that the information is just not very good. The recommendation, let me repeat, is for more focused surveys and less reliance on the customer to fill it out. That indicates to me some kind of on-site audit might be better, something where you are able to make contact, where you are able to control the quality of the responses. If there are any other questions, I shall be happy to answer them.

CL: Did you conduct the survey yourself, or did you have assistance by a contractor?

TM: This is done in-house by our energy-service people. They had a lull in their activity and they agreed to do it.

JH: I was interested in your comments, and maybe other people had them too, going back to what you said a moment ago, that there is a great deal of variance within SIC and then even more among SICs. It is the second part of that statement I am interested in. I have some doubts about whether SICs are a particularly useful way of categorizing the industrial sector because of the inverse of your second statement, that there may be a lot in common across SICs. That makes sense for your forecasting demand or for understanding whether there are any opportunities for conservation in the industrial sector in similar process operations. This brings us back to your statement. There are similarities in terms of the amount of motor drive, compressors. And going back to Carey's statement, compressors are a big load and they are doing things that involve mechanical manipulation, I presume. And there are a lot of other SICs where compressors are apt to do the same thing, so one could look at opportunities for variable speed drives, such as those for compressors, and so forth. And a lot of those things are masked if we think in terms of SICs, so I am interested in your comment about the importance of and the degree of similarity across SICs and whether there are other ways of thinking, categorically, about this large complicated thing called industrial end use.

TM: I really do not have a specific answer to that, but let me respond. People come back and tell me, a single questionnaire for SIC codes 20-39 is not the way to go. And now you are saying, even within an SIC code, one questionnaire may not be appropriate. So your suggestion is there may be something else that is a better way to aggregate these data rather than SIC codes. What is that?

JH: For the sake of argument, then, there may be a particular way of thinking about and categorizing energy use that applies to large facilities that are dominated by treating, moving, and heating and cooling liquids or liquid chemicals. Another categorization has to do with cases where there are a lot of important applications of liquid, let us say, to solids, and then drying the liquids. There is fabric, there is coating of metals, there is painting of nonmetallic surfaces, and so forth. For another category, one of particular interest to me and to Hashem and Tom, for example, where what is really important is the comfort conditioning. Space, conditioning, and lighting are dominant because it is really people working in the space, and the machines are kind of incidental to help people do their industrial jobs, and so forth. These are really different categories, and they do not match SICs very well or other categories.

TM: I am not sure I agree with your hypothesis that they do not match SICs, I mean, an automobile assembly plant is not unlike aircraft assembly, and they are in the same SIC code.

Member of Audience: But the subcontractor that puts together electronic pieces of dashboards may be very different and yet that would, I suspect, be in the category at the two-digit level, at the same SIC.

TM: Yes, but again, you are still using SIC codes as your reference. You know that they are in this category and this is kind of what they do, so you have not completely escaped using SIC codes.

Member of Audience: Let's take that example. It seems to me that you would look at small-scale assembly and testing of electronic components for calculators, for the controls of dishwashers, for the dashboards of automobiles, you name it, for complicated sewing machines. And say that those are similar activities, they have similar facilities. The industrial energy use, and what you can do about them, and where the technology opportunities are, is probably very similar for all those categories. But they are wildly different SICs.

TM: But, again, what you are suggesting is just a new way of --

Member of Audience: This is not going to lead us anywhere until you have some scheme for finding categorywise the employment data, and all the economic data, which is essential for building the forecasting picture.

Member of Audience: Yes, a label is a label.

Member of Audience: And where are you going to find it? The data organization is so driven by the existing census organization of the data information, the whole world is divided that way. And you look at it and you say, Jesus, that is not the best division for my purposes. But we are the tail, and we are not going to wag this dog.

TM: And, remember, you are talking about your initial source, which is utilities, and they collect this data by SIC code. So in a way you are handicapped by having to depend on it. Now if, as an individual or a private consultant contractor you can think of something else as a substitute, you may in fact very well resolve your problem. But the rest of us, or at least those of us in the utility business or the utility regulatory business, are still going to be stuck to SIC codes in the long term. I mean, we are trying to come to grips with the problem of going from the 1972 SIC code classifications to the 1988 SIC codes, I mean, Jesus, how are we going to do that. We have got to go backdate a lot of that information.

Member of Audience: It is not just limited to industrial categories either, I mean, there are SIC coding problems related to commercial activities.

Member of Audience: It also seems extremely likely that the SIC coding mechanism, as far as getting an overall intensity of electricity use, or energy use in general, is probably a much more accurate device than anything else one can come up with as a single cut. As a first cut it is perhaps okay, and that requires at least some judgment. Now it may not be, if you bring it down to building codes, if you cut out the manufacturing process itself, an appropriate thing to use. But who wants to throw out that baby.

Member of Audience: I may be wrong, Larry, but it seems to me the SIC model stems from a time, an era, when the perspective was that making something meant raw materials in, finished product out. That is no longer a very good description of a lot of our industrial sector. Let's consider an electronic product. If you make an electronic product, that means one thing if you are producing the silicon or taking it and turning it into chips. It means another thing, and quite a different kind of use of energy in terms of job predictions and in terms of overall growth, as we have seen to our pain in the last two years, if you are simply assembling finished products. Those are really different activities, both in terms of what the value added is and what the electricity use is.

Member of Audience: Well, if you have made a cut according to some sort of energy-use categorization and asked yourself the question of whether you are trying to allot a different SIC code among people who use such and such a quantity of electricity per employee, the answer is yes. But I doubt if that would be a better characterization.

TM: Let me ask you two questions. I have heard all kinds of things about the GM plant in Fremont, how automated it is. Would you put it in the same category as the GM plant in Van Nuys, a much older plant that is not automated; in fact, it has fairly old technology and it is cost of producing cars is much higher?

HA: That depends on how we are looking at it. If we are looking from the production-planning view, we put it in the same SIC category. If we are looking at it in terms of energy-use intensity, probably not. What we are talking about --

TM: Okay, but then you come to my second point which is the guy that puts this on, the customer who puts this on and the customer who describes this, how do you get them to account for those differences? I mean, you have to solve the easy ones first, and that is correctly identifying these guys, so with that --

HA: We are talking about these issues for the purpose of modeling and hopefully will be able to summarize some of these in the afternoon discussion, for which we have identified one topic, and the topic we discuss is, of course, modeling purposes.

The fourth speaker of today will be Bill Idzerda who will be talking about industrial end-use data collection and application. I am especially thankful to Bill, who has provided us with a lot of data and inspiration for today's workshop.

Thank you, Ted.

Partners in
PROGRESS

Los Angeles Department of Water and Power

INDUSTRIAL ENERGY END-USE SURVEY

As one of our industrial customers, your company is very important to us. To help you stay competitive, and to help us provide better service, DWP is investigating a wide variety of industrial process technologies which can substantially improve productivity.

In order to best serve you, it is important to have more information on how you operate and especially how you use energy. Therefore, we respectfully ask your indulgence in completing the attached questionnaire.

While it may appear to be long and involved, please note that you will only have to complete the first two pages (Sections I and II), one (or possibly two) of the process sections, and the last three pages (Sections X, XI and XII).

The information you provide will be kept **completely confidential.** It will only be used in an aggregate condition for purposes of determining demographic and energy end-use information for industrial program development and energy forecasting purposes.

Those companies which participate in the survey will receive a complete report of the summarized results.

If you have any questions regarding the questionnaire, please call:

DWP HOTLINE
(213) 481-5800 • (818) 984-3303

We have enclosed a postage-paid envelope for your convenience in returning the completed questionnaire. Please return the completed questionnaire WITHIN TWO WEEKS to:

DWP Industrial Programs
977 North Broadway, Suite 500
P.O. Box 111
Los Angeles, CA 90051-9958

We thank you for your cooperation and assistance.

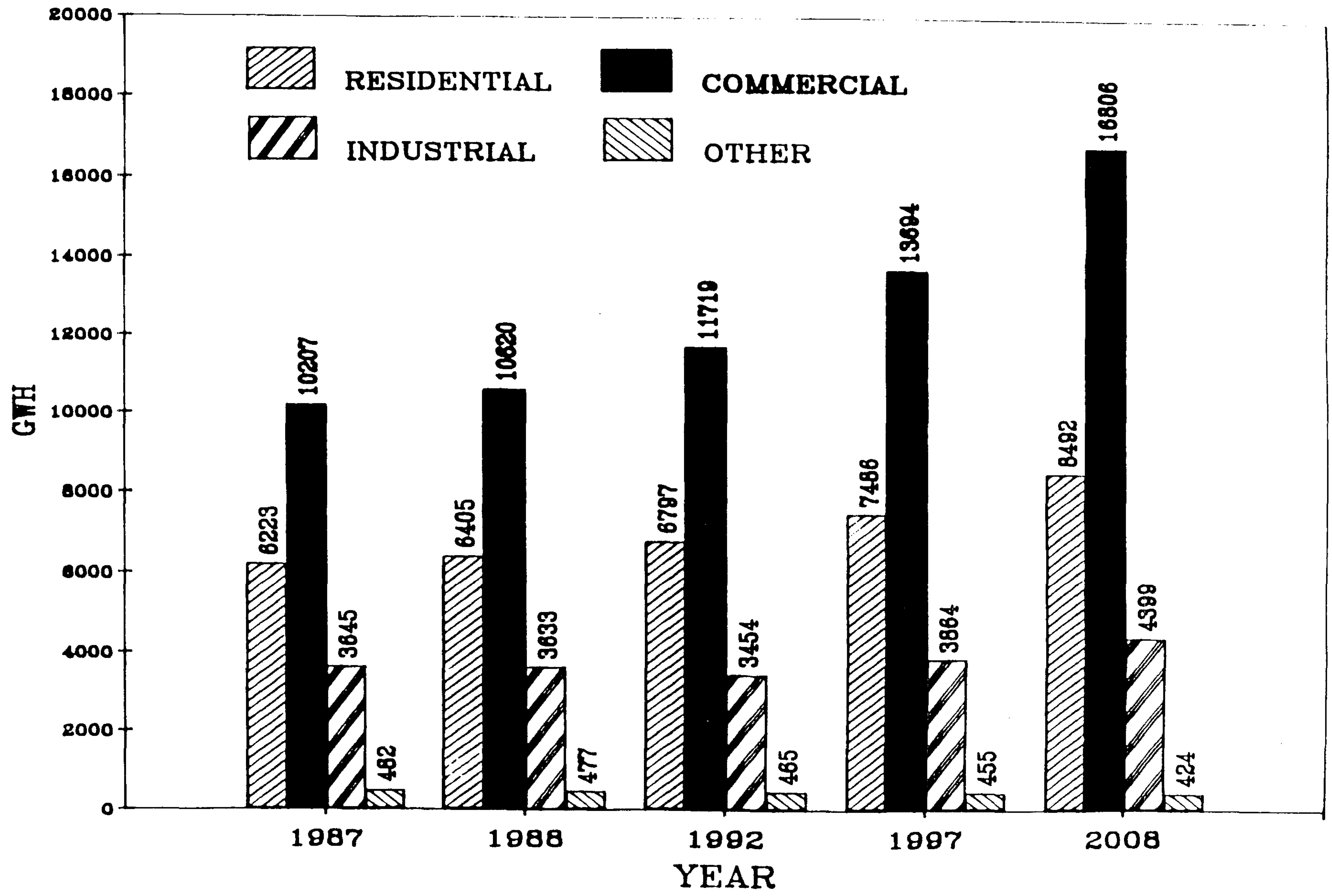
INDUSTRIAL USER SURVEY
AS OF 2/22/88

SIC CODE MASTER	SIC CODE SURVEY	ACCOUNT NUMBER	CUSTOMER NAME	PRODUCT
23	23	3348917711860000000301	THE DRAPERY HOUSE	DRAPERIES
		3594993108216000007401	ERICA COESLER WEDDING AC	WEDDING MILLINERY
		3638020907026009001001	SUN UNLIMITED, INC	T-SHIRT PRINTING
		3638649407444000000401	LAURENT CREATIONS OF CA, INC	UNIFORMS/CLOTHING
		4507809602254050000001	GALANOS ORIGINALS	WOMEN'S CLOTHING
	34	1018941702255000000001	L & L MFG CO	KIDS/WOMENS SPORTSWEAR
		2079629701418000000401	SPACETIME MACHINE CO	FABRICATED PARTS
		3067715613110000004301	JON L. DUNCAN	SHEET METAL
	35	1016881200501000000501	HARRY ROSENBLATT & SONS	SILKSCREEN PRINTING
	37	1472622102940000000001	AERO-ENGINE, INC	RADIAL AIRCRAFT ENGINES
		2372393300222009001001	T & A SAILS, INC	SAILS FOR SAILBOATS
		3416261018757000000701	THE SPORTSMAN SHOP, INC	MACHINED PRODUCTS
	39	1019782400308000400301	FRED A. GRANICH	COVERED BUTTONS/TRIMMINGS
		1635393900533009003001	OUTDOOR PRODUCTS	CAMPING SOFTGOODS
	56	1438972201201009003301	KOOS MFG, INC.	CLOTHING MFG
		1457623503500000000401	MARA J JRS., INC	GARMENTS
24		1539775800530000000001	SEATTING PROD IND, INC	WOOD MFG
		2126043500793000000601	HARTMARK WOOD DESIGN	FURNITURE ACCESSORIES
		3401412519428000000801	HARRY COLIEN CABINET CO	CABINET MAKING
		3432467008321000000701	DANMER, INC	WOOD SHUTTERS
		3501545509950000001501	ROYAL KITCHENS OF CA, INC	CABINETS
	23	3168181821521000000301	FRANK RIEMER	WOOD CABINETS
		3307717005446000001701	SHANNON MFG CORP	MATERNITY UNDERGARMENTS
	24	1259046806020009001301	CENTINELA CABINET CO	CABINETRY
		1559400402250000000101	RAYMOND VARELA	WOOD PARTS
		3047809308544000003801	ECLECTICS	CABINETRY/FURNITURE
		3081545509916000000301	CC CUSTOM CARTS, INC	CABINETS
		3084528120954000000601	JOHN MAYBALIAN	STAIR BALUSTERS
		3085489909612000011001	CHRISTOPHER VOORHEES DESIGN	WOOD ENTRY DOORS
		3176833111053000003301	P & M FRAMING	POSTER FRAMING
		3327590412354000001301	VISTA ENT	
		3344098011606009001501	G.B.I., INC	SLIDING FRENCH DOORS
		3451223012111500002701	ATLAS BOX CO	CORRUGATED SHIP CTNS
		3577888511260009001701	ALPHA-OMEGA CABINETRY	KITCHEN CABINETS
		3619264107569000000301	TIMBERCRAFT, INC	WOOD SPECIALTY ITEMS
		3632636107646009002501	HAROLD H PEASE	CABINETS
	25	3081545509916000000301	CC CUSTOM CABINETS, INC	CABINETS
		3126993320201000007501	MAJESTIC CABINETS	KITCHEN CABINETS
		3416752419025000113201	BUILTWELL FIXTURES & CABINETRY	STORE FIXTURES
	34	3456099612155000000301	ROLLEZE, INC	ALUM SLIDING DOORS/WINDOWS
	36	3548717810821000000301	E-J ASSOCIATES	WOOD SHIPPING BOXES
	37	3558717811245009002801	FRAIZER AVIATION	AIRCRAFT SPARE PARTS
	39	1452492301408000000001	JOSE IGNACIO VEGA	AUTOMATION SYSTEMS
		3437407716641000000001	VOMAR PRODUCTS, INC	SIGNAGE
25		12879804014540[illegible]	F[illegible] PLASTIC, INC	FORMICA COUNTERS/CABINETS

LOS ANGELES DEPARTMENT OF WATER & POWER INDUSTRIAL SURVEY RESULTS

SIC CODE	NUMBER OF RESPONDENTS		PERCENT ERROR	NUMBER OF CUSTOMERS
	ERROR	TOTAL		
20	1	30	3.3	572
22	1	6	16	218
23	10	71	14.1	2,319
24	6	28	21.4	781
25	5	14	35.7	590
26	0	2	0	116
27	4	84	4.8	1,599
28	3	16	18.8	334
29	0	5	0	79
30	2	22	9.1	320
31	0	2	0	116
32	2	11	18.2	324
33	2	9	22.2	190
34	10	54	18.5	1,114
35	20	104	19.2	1,720
36	8	39	20.5	1,002
37	0	13	0	510
38	4	12	33.3	303
39	3	17	17.6	504
TOTAL	81	539		

LOS ANGELES DEPARTMENT OF WATER AND POWER
ELECTRICITY SALES



INDUSTRIAL END-USE DATA COLLECTION AND APPLICATIONS

Bill Idzerda (PG&E)

Pacific Gas & Electric Company's industrial marketing-research program is focused on developing marketing programs and service options that are targeted to specific market segments and to important individual customers. This focus requires that we understand how our customers use energy, so we can help them to be more productive and more competitive. Based on this knowledge, we are positioned to retain existing customers and attract new customers. This market research program is a four-pronged approach.

The first type of program is to conduct distinct industrial market-segment studies. We divided our entire industrial customer class into forty industrial markets based on four-digit, and sometimes two-digit, SIC codes. Market analysts, such as myself, have produced reports about thirty to one hundred pages in length on each of these forty segments. We focus on industry sales, product sales trends, market drivers, for whom the competition is both within the United States and overseas, energy use characteristics, alternative-energy technology awareness and options, and marketing threats and opportunities. Key PG&E customers are identified. Then we try to customize programs targeted toward those customers or to the market in general. In some cases, consulting firms conducted these studies.

The second type of program is to conduct custom-made studies for our regions and our division. PG&E's service territory is divided into six regions, which are subdivided into twenty-eight divisions. Our field personnel are located in the division offices in the Market Planning and Research Department. They come to us and tell us about a threat or opportunity they would like evaluated, or about a potential program they would like assessed. Power quality and area development receive a lot of attention. For example, after conducting a study, we may recommend specific market segments that a particular division should target.

The third type of program that we get involved in is ad hoc custom-made studies for the regions and divisions that are targeted to specific customers. Once again, our market research focuses on retaining existing customers and attracting new customers. Examples of threats are that a customer may relocate out of our service territory or might install cogeneration facilities. What are the customer's operating characteristics, financial situation, and options? What can we do to help him stay in business? What can we help him do to remain in his current location?

The fourth type of program involves the different types of in-house, user-friendly databases that we use at PG&E. I shall particularly focus on databases that have information about customers' end-use characteristics.

The first type of industrial market-research program we have is to conduct industrial market-segment studies. For example, computer and disk drive manufacturers—SIC code 3573— are a market segment. Who are the largest customers? Where are their sales in the United States? How important are exports? What is the competition? For our major customers, what are the revenues that we derive from them? How much is from electricity, and how much is from natural gas? How much electricity is produced by a customer's cogeneration facility? How much of the customer's natural gas use is susceptible to fuel switching between oil, residual fuels, and perhaps waste products? These are the types of questions we answer.

We especially consider competition from Japan, our major customers' involvements in acquisitions and merger activity, and availability of venture capital. We access several data sources to learn whatever we can about these market segments and produce reports of up to one hundred pages in length. Some of these are done by myself and other analysts. We have also hired some consultants to produce the studies for us.

We get customer-specific information from our major account representatives in the field. Major account representatives are assigned to all customers with an annual PG&E bill exceeding $100,000. They are familiar with customers' production facilities and can determine whether there are any opportunities for installing new electrotechnologies, for improving the customer's productivity, and for making him more competitive. This is really the focus of our marketing programs. Data collection efforts are not primarily intended for energy-forecasting uses but rather for developing better-targeted marketing programs that mutually benefit the customer and PG&E.

We have established customer rebate programs. One is a customized rebate program whereby any customer who wants to increase productivity can install energy efficient equipment and receive a rebate from PG&E. We have targeted programs that provide rebates for thermal energy storage and architectural lighting. Advanced technology rebates are available. Several emerging technologies are commercially available. If the customer is willing to try them out, we will help install them, we will help fund them, and we will give rebates. Our process-management program offers cash rebates to PG&E industrial customers who expand, modernize, or build new manufacturing facilities <u>and</u> who use processing technologies and scheduling practices that shift new electric demand to nonpeak periods.

Member of Audience: How large of a rebate on average?

BI: I do not know the average amount, but the maximum rebate is $200,000 per facility through our process-management project.

Member of Audience: So, isn't there a comparable gas program?

BI: Yes, we have what is called a customized gas rebate program, which pays commercial, industrial, and agricultural customers up to $100,000 to install equipment that saves natural gas.

Member of Audience: Do you conduct commercial market segment studies too?

BI: Yes, we identified about fifteen commercial market segments and have produced reports for most of these.

Member of Audience: How many industrial segments?

BI: About forty industrial market segments. In the food industry alone we have ten distinct segments. We prioritize the forty segments. The most important ones are semiconductors, the computer industry, scientific instruments, and saw mills. We consider how fast a segment is growing and how profitable it is to PG&E.

The second type of market-research program is custom-made studies for the regions and divisions that focus on services or programs that are considering an offering. An example of a state-of-the-art program that we are examining is "premium electric service industrial parks." There are none in the country yet. PG&E and a developer would build an industrial park next to a substation and include equipment that would virtually eliminate problems with power reliability and power quality, such as power surges, harmonic distortion, voltage sags, and power outages. We are conducting a study that includes telephone interviews, with some on-site follow up, of customers in several industries, including biotechnology, electronics, printing and publishing, chemicals, and a few others. Issues we are addressing are as follows: What does power quality mean to a customer? How important is it to him in terms of down time? Compared with other needs, how important is power quality? Which customer segments value power quality the most?

The Electric Power Research Institute has published several background reports about power reliability. Battelle has a Center for Materials Fabrication, which has a lot of information about emerging technologies. Tech commentaries are published, which provide examples of where these technologies have been installed, how they have functioned, and how they have been integrated into the customers' processes.

For area development purposes, Synergistic Resources Corporation published the report Business and Industry Expansion and Migration Study, which is very good. So we get involved in syndicated studies and "multi-utility" studies as well as conduct our own studies.

A third area of activity is customer-specific studies for our regions and divisions, particularly to address competitive situations. One of our customers in the dehydrated fruits industry was saying that they might consider moving to Washington and also was seeking ways to be more productive and more competitive. We completed a competitive study to determine the advantages of the PG&E service territory and to identify what we could do to help the customer stay here. Cogeneration is another serious threat to PG&E's electric sales that we have examined in numerous studies. Sometimes, we conduct on-site audits to take a careful look at the customer's equipment and thermal loads and to assess whether it really is a competitive threat. This is important to know because we go to the table and negotiate prices individually with our largest customers. We want to know the options that really are cost effective for the customer, especially using alternative fuels or going to cogen. What is it going to cost them and what is their expected rate of return going to be?

We will also take a look at some of the electrotechnologies that might increase a customer's productivity. One of the major reasons that corporate executives decide to move their production facilities is that there are new markets to address. Second, the productivity at the existing plant may be so low that the cost of manufacturing products is not competitive. As a result, it might be just as easy to build a new plant where circumstances are more favorable than to upgrade the existing plant.

A source of information about a specific plant's energy-use characteristics is Dun & Bradstreet's MIPD, or Major Industrial Plant Database. The information is in a user-friendly database, and they can produce for us plant profiles and cogeneration reports, which determine the different types of cogen technologies that can be located in a plant and get a high economic rate of return, and which also size the plant and size the cogen facilities for a particular plant. I shall discuss more about the major industrial plant database later.

Member of Audience: One other fact is that once the customers go to gas they often have the option of bypassing the utility altogether and buying their own gas, and then the utility does not make any money at all.

BI: And once that cogen facility is in place, it is there to stay. As a result, electricity sales to the customer are lost for quite some time.

In-house user-friendly databases are a fourth source of information. PG&E has an accounting system for collecting detailed monthly customer-billing information on our one thousand largest customers. It is called a marketing-decision support system. In it, all customer gas and electric accounts are aggregated to premises, and all of our premises are aggregated to corporations. We can get a print out on energy sales going back five years for each premise or corporation. It is a sophisticated system. In addition, our major account representatives, who are our customer field representatives, furnish information related to threats and opportunities, which is included in this database.

Another database, the "California Database" offered by Economic Sciences Corporation, contains time series data on several subject categories, such as population, employment, finance, income, consumer prices, trade, building and real estate, transportation, and agriculture. Data are available from 1950 and projections through the year 2000 are provided. Most data are supplied down to the county level.

In November 1987, PG&E conducted a telephone survey of six hundred medium and large "assembly industries" customers. Topics included energy forecasting, presence of manufacturing processes, use of conventional versus emerging technologies (especially electrotechnologies), energy use characteristics, and plant operating characteristics. The "Datext" database contains detailed financial information for all publicly held companies in the United States. Data generally go back four years. Also, articles for the past two years are summarized. In summary, we use our studies of industrial customers and the in-house databases to plan and develop marketing programs and pricing strategies. End-use information is one of many ingredients.

BETTER DATA FOR INDUSTRIAL-SECTOR ANALYSIS

Ray Squitieri (EPRI)

In this talk, I shall describe an EPRI research project in its early stages. The project will gather, organize, and make available in various forms detailed data for industrial-sector forecasting, demand-side planning, and marketing.

Utility analysis must now use industrial-sector data from many independent sources, in different formats, that are often inconsistent and incomplete. EPRI has taken a first step toward remedying this deficiency in reports such as the Industrial Technical Assessment Guide. Unfortunately, these efforts lack the detail necessary for most uses and come only in print, not in electronic databases. This means the information, even when it exists, is not convenient.

For more than a decade, we have had all manner of fancy computer models for industrial-sector analysis. These models have pushed deeper and deeper into uncharted territory and have now outrun their supply lines: the data needed to run them. To use another analogy, it is as if you intended to prepare dinner from a complicated French recipe calling for sturgeon, escarole, pine nuts, capers, special olive oil, and three herbs you have never heard of. But when you get home from work, you find in the cupboard only tuna fish, frozen vegetables, salad oil, salt and pepper—and that is all you have so you use them anyway.

Figure 1 shows some of the industrial assessment tools developed by EPRI. The data project will, among other things, feed data to these models.

INDEPTH (Industrial End-use Planning Methodology) serves utility forecasters and market planners, producing forecasts and other information for a particular service territory, at the two- to four-digit SIC level. While INDEPTH is much easier to use than earlier models, it nonetheless requires a lot of data. The Department of Commerce lists 454 four-digit industries; multiply that by say five processes and ten equipment types for each industry, five to twenty years for each data series, add a few subjective estimates of, for example, market penetration potential, and I think you will agree, we are looking at a lot of data. Further, most of these data are not found in the Annual Survey of Manufacturers or similar public sources. IMIS (Industrial Market Information System) serves market planners and marketers and focuses at the four-digit level. IMIS too has a hearty appetite for data.

The next series of slides shows the project at a glance. Fig. 2 shows ho·v project data and other resources feed in through the user interface to meet user needs. Fig. 3 expands on user needs, listing the various constituent groups served by the data project.

Different users ask different questions and thus need different types of data. Consider a utility program to promote thermal energy storage. Forecasters ask, "What's the likely impact on peak in ten years?" The rates department wants to know, "What would happen if we offered a special rate for this use?" Customer Service representatives ask, "What does it take to get Customer X to sign up?" and "How much would that customer add to my sales goal?"

Fig. 4 shows project data, which come at different levels of aggregation, from different sources, and are designed for different purposes. One task of the data project will be to align data from the various sources so that they all march in the same direction, if not in step. Other resources incorporated into the database by a particular utility could be internal or external to the utility. Its own customer files are internal; a subscription data service is external.

Fig. 5 shows the user interface, including two major categories of output: hardcopy and electronic. The hardcopy guidebooks will appear by two-digit industry and occasionally by process, such as motor drive. Electronic output will appear as databases, at various levels of sophistication. A sample question is "give me all the information for one process: all the customers using that process, technical information on that process, and technical alternatives to the current process." At the most elegant level, you could type in one command, such as "Tell me everything I need to know about making my paper industry costumers more efficient." I doubt we will reach that level here, but we do plan to incorporate some sort of expert system into the database. Fig. 6 summarizes the capabilities of different levels now planned.

Who will use the different products? Fig. 7 indicates the audience for the guidebooks, the database management system, and the more advanced decision support/expert system. All the target audiences will, we hope, find the guidebooks useful. Forecasters and market planners especially will find the databases useful.

When will this be done? Guidebooks will begin appearing in 1989 and continue through 1991. The electronic products will appear in an early form late in 1989 and grow more complete and more sophisticated over the next three years. We plan various interim publications, workshops, etc., as the project progresses.

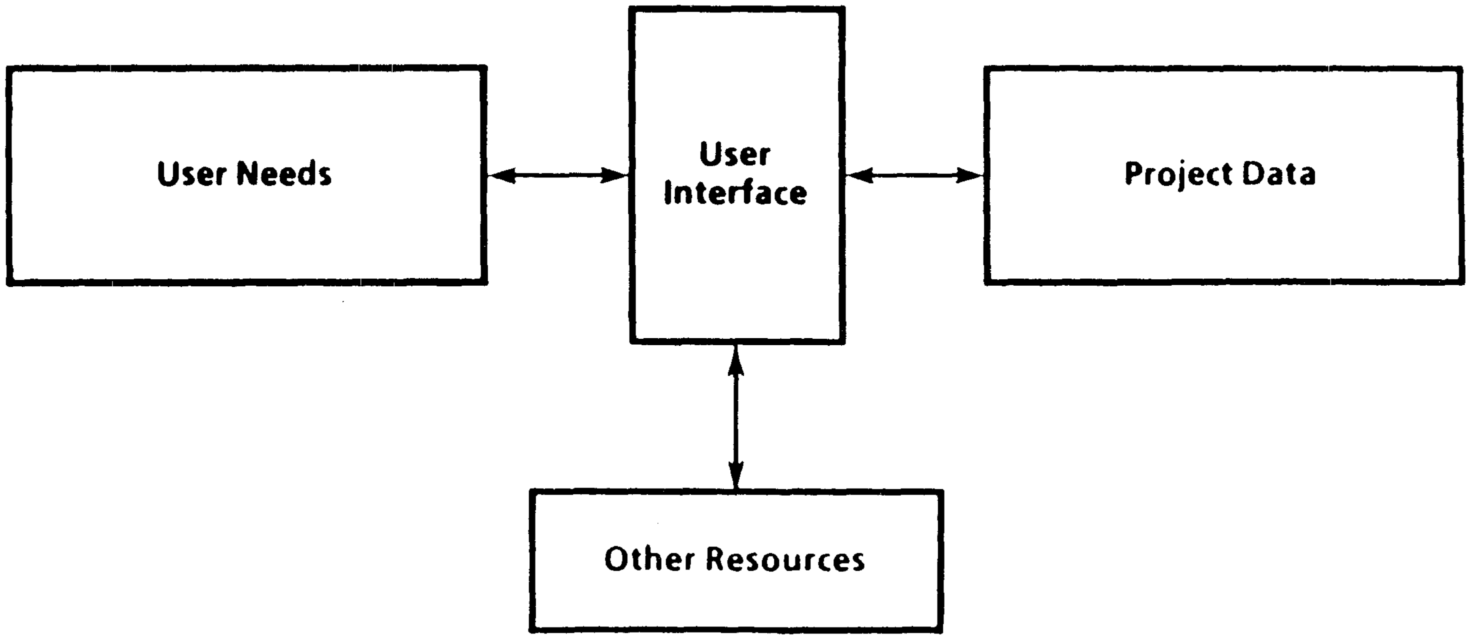
Member of Audience: What level of activity are you talking about for all this? Because the way I understood it, the cost could be anywhere between $1 million and $10 million.

RS: It began at about $1.5 million and may shrink to $1 million. I described a project more ambitious than what we will actually deliver. Some of the detail and some embellishments will be sacrificed as the project goes along. Like most utility companies, we have seen our project budgets shrink. So we are seeking other ways to stretch our dollars. We already have outside money pledged from utilities in Michigan, for work on industries of particular interest in Michigan. And we are seeking cofunding from other utilities and state agencies, including those in California. I would not say we are running this project on a shoestring, but we are doing everything possible to stretch our dollars.

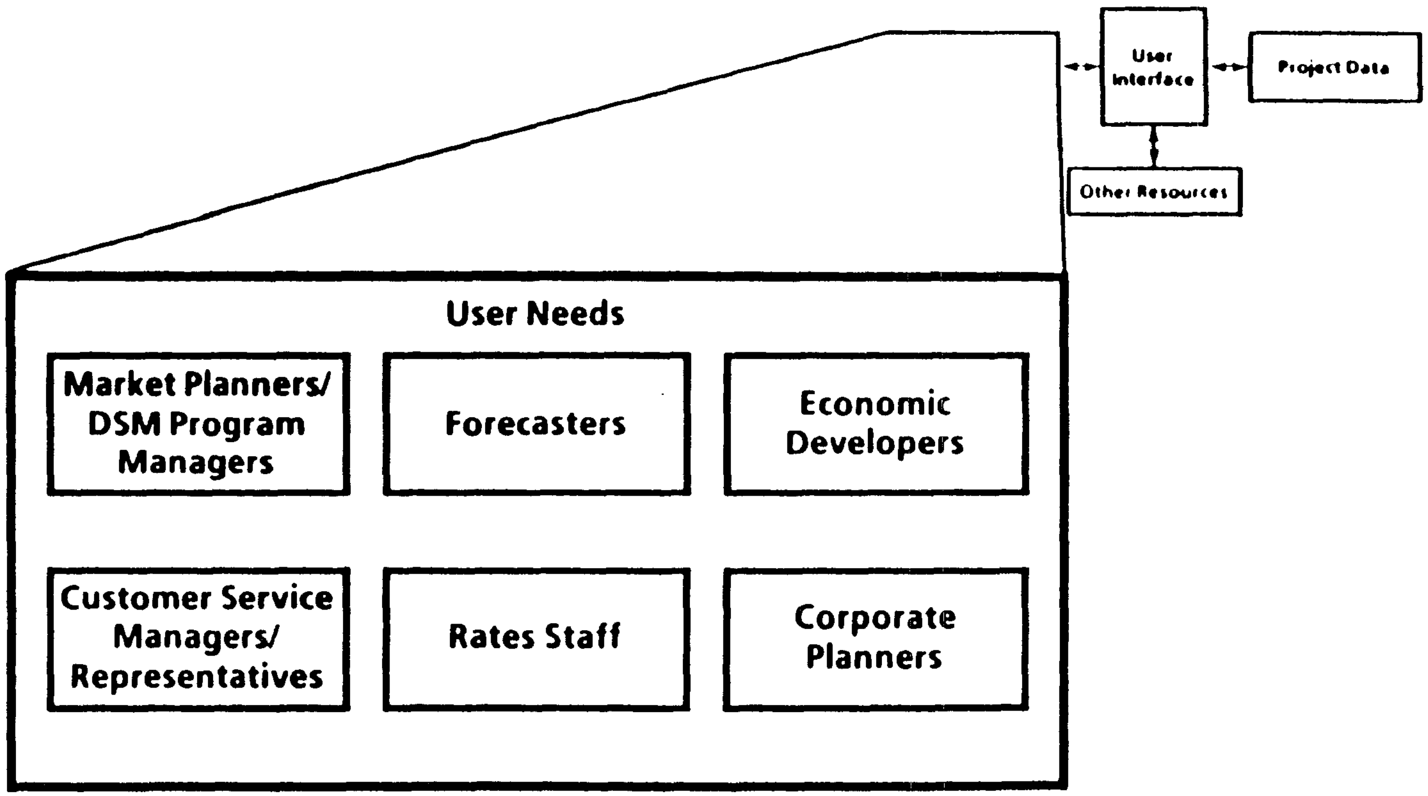
Comparisons of Related Industrial Assessment Tools

	Audience	Industry Disaggregation	Technology Disaggregation	Economic Evaluation
INDEPTH	Forecasters	2-Digit	25 Elec and and Competing Technologies	Life Cycle Costs
ISTUM/ INDEPTH	Market Planners/ Forecasters	3-4 Digit	40 Elec and Competing Technologies	Life Cycle Costs
IMSS	Customer Service/ Market Planners	3-4 Digit	20 Electro-Technologies	Ratings

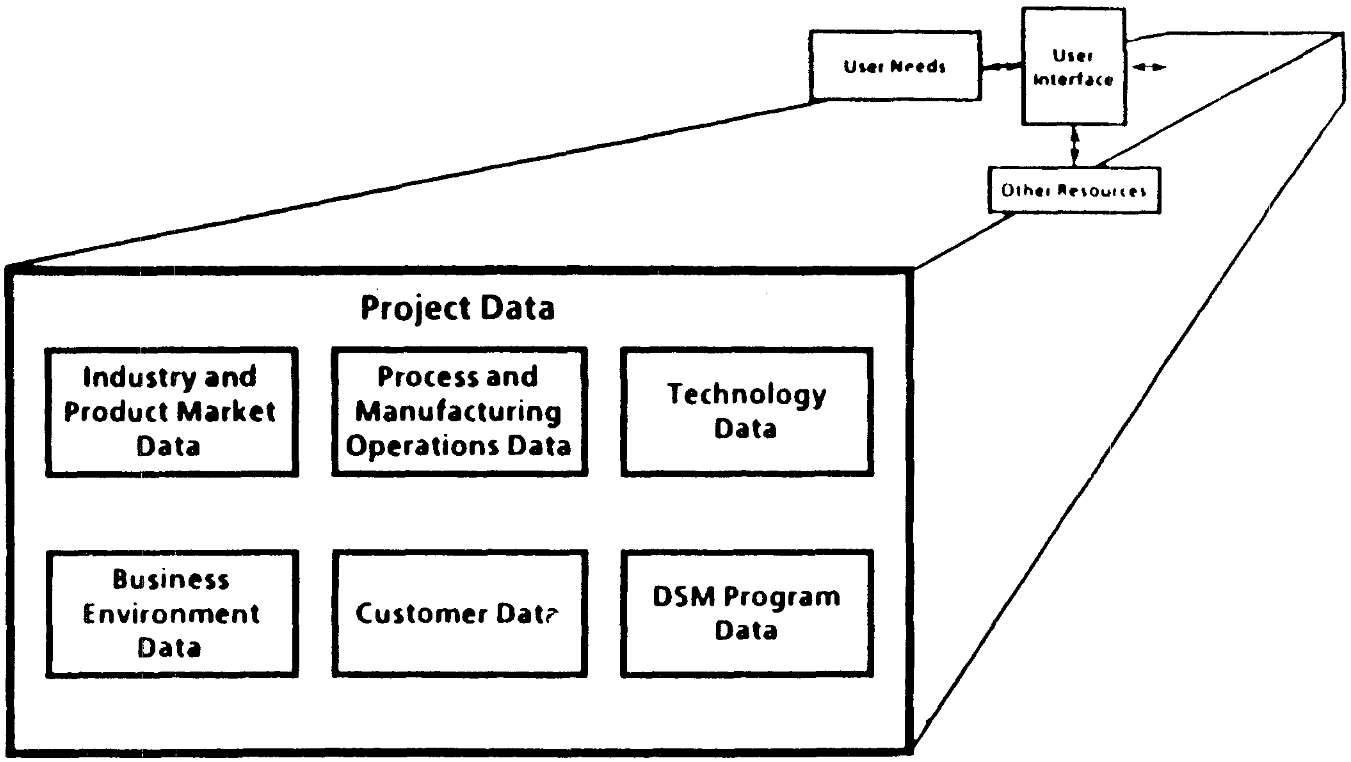
Industrial Data Project Overview



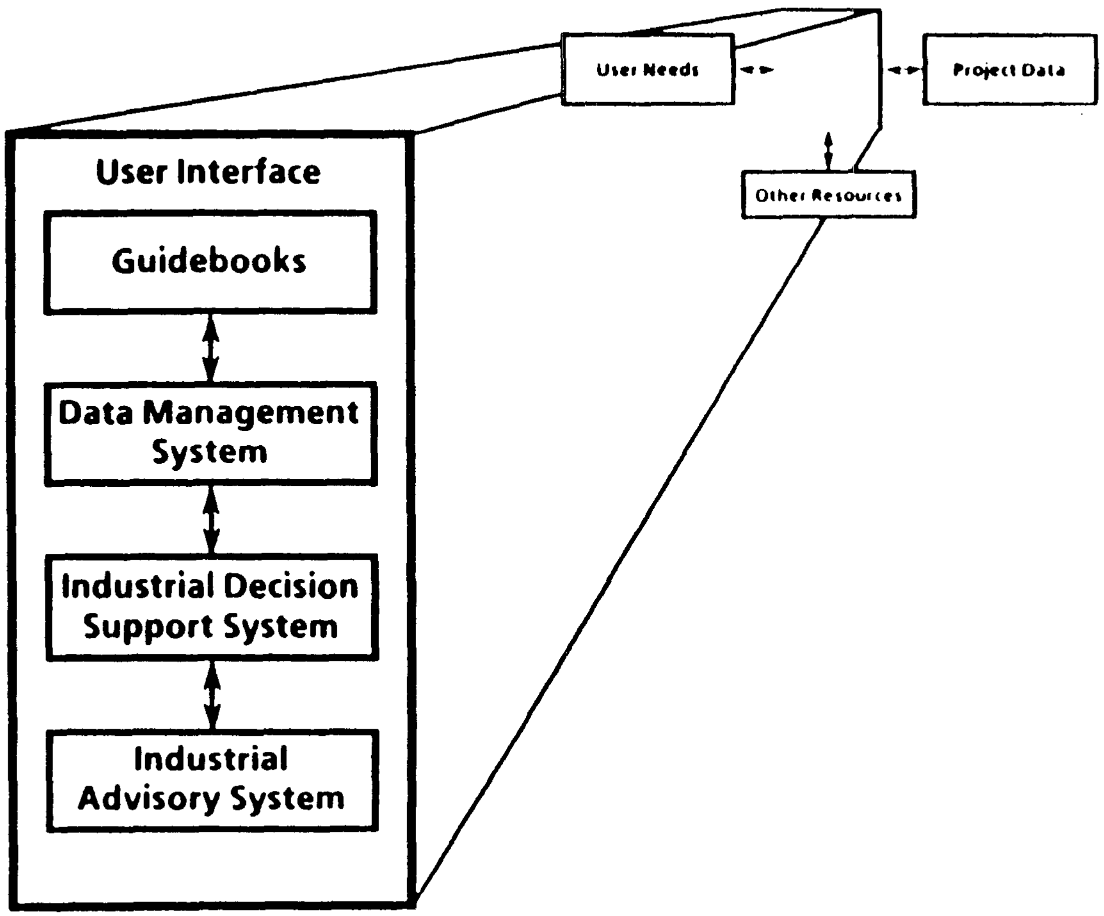
User Needs


User Interface
Project Data
Other Resources
User Needs
Market Planners/ DSM Program Managers
Forecasters
Economic Developers
Customer Service Managers/ Representatives
Rates Staff
Corporate Planners

Project Developed Data Resources



User Interface



Hierarchy of Capabilities

Product	Look-Up Data	Search and Retrieve	External Access to Data/Models	Assess	Customize	Tutor
Guidebooks	●					
Data Management Systems	●	●				
Industrial Decision Support System	●	●	●	●		
Industrial Advisory System	●	●	●	●	●	●

Software Products by Utility Audience

	Guidebooks	Database Management System	Decision Support System/ Expert System
Market Planners	●	●	●
Forecasters	●	●	●
Corporate Planners	●	◔	○
Rate Analysts	●	◒	○
Economic Developers	●	◒	◔
Customer Representatives	●	○	○

DATA NEEDS FOR MODELING AND FORECASTING

Larry Butler (SCE)

I am going to speak primarily as somebody who has done a lot of industrial forecasting and comes from a planning environment, not a market research environment. I shall close off with some comments on the nature of utility market research as it stands today, but I shall not say much on that because it has already been covered here by PG&E. I will instead focus primarily on planning and forecasting aspects of industrial demand.

Let's start just by noting a few of the characteristics of industrial demand that differ from those of residential and commercial demand. Industrial demand is first of all cyclical. That is to say, it is dominated by the characteristics of the U.S. economy as a whole rather than being dominated in the first place by considerations that are particular to a region. So, unless something occurs like a plant going out of business, it tends to follow the national business cycle tightly, and the primary deviations from the cycle tend to be related to how industrial utility rates compare with costs of other energy sources.

Second, in the Edison service territory, and in other west coast regions as well, there is essentially no weather-related component in industrial sales. A primary implication of this is that we need not worry, as far as demand forecasting is concerned, about building shell characteristics.

Third, industrial demand varies enormously from firm to firm, whether measured in absolute terms or as scaled by, say, sales per square foot. That is true both between industries and within industries. Even industries that you think should run to a pattern do not. As a simple example, our oil refineries within the Edison service territory whether scaled by oil input or the amount of refined-product output vary in energy intensity by approximately a factor of three, even though the apparent output mix does not vary much. The reason is that, for any industry, a variety of processes can be used to get much the same output mix. The problem is not that the variety of processes is not known. If you hire Chem Systems, to name a good engineering firm with experience in refining, they can look at energy/output ratio and tell you what is going on at that plant. The problem instead is that the variety of processes is too great for the simplification in end-use models to have much explanatory value. The example I picked is a "clean" one because there are only so many things that go on at a refinery. There is an equally important problem at the output end. There is a great deal of difference between producing Stealth bombers and producing Piper Cubs, but they are both airplanes and they fall in the same SIC code.

Member of audience from a utility company: We do not have many refineries with common ownership. You have two refineries with the same company. Is that why they are different?

LB: Yes, because normally if you find them close together, they will be specialized in some fashion. There are industries in which that is not true. It is more or less true, for instance, in another major area, chemicals. You can establish a rough relationship between the air products firms that operate in your service territory and ones that operate in ours. Even there, there will be a huge difference, and again Chem Systems could tell you exactly, from knowing the input amount, what the outputs are going to be, the nature of the products they produce. But they will vary enormously. We do have an example of that incident within your service territory and ours put together. A single large industrial firm has an air products plant located in our service territory, and they have one located in your service territory. The purpose of that, at least partly, is to take advantage of whoever's rates are lower at the moment. But only one of those has a liquifier, ours. So ours never stops running completely, even when your rates are better. What does happen with a simultaneous occurrence of lower rates in your service territory and higher for ours is that we get a perverse demand schedule, demand-per-unit output skyrockets, in our service territory at least, on the visible outputs. It is totally countereconomic. They switch to a situation where the energy-intensive product is being produced in our service territory because of the high rates. Leave it to the firms to figure out how to do these things economically, but that is the way it works sometimes.

Let's now take these industry characteristics and define them a little bit further in terms of industry types. I shall just talk about process industries for a couple of minutes, though they are not really the core of this conference since the buildings in most process industries are peripheral. What is really interesting, of course, are the processes themselves. We talked about the forest products industry in the Northwest this morning. I wonder how BPA characterizes it, but from those load shapes given to us by BPA, I would characterize it as a process industry, even though they actually shut down for ten minutes a shift.

PG&E has a forest products industry as well, but the process industries that dominate demand in California are oil refineries, chemical plants, oil (mostly air reduction) field operations, and the only seasonal example, food-processing operations.

This list would be pretty much the same if we added the Pacific Northwest and also added aluminum. Now, the characteristics of these firms make them strange kinds of candidates for trying to do aggregate end-use modeling. The only advantage is there are not very many of these firms. So, it would be possible to model each firm individually. That more or less has been Bonneville's solution to process modeling. They have developed successful individual-firm models for both the aluminum and the forest products, covering a huge chuck of their industrial demand. This was based on previous EPRI work. These models have mattered. The aluminum model, for instance, played a significant role in the development of their radical new aluminum rate structure, a major success. They proved that the costs of those firms was such that they would be able to respond economically to a rate structure designed to respond to demand and prices for aluminum, and the models provided the kind of evidence required to convince rate regulation agencies.

For Edison, a feature that militates against trying to use that sort of approach is the mix in these industries between their percentage of value added in industry and their percentage of electricity demand. This kind of firm in Edison's service territory as in the rest of California accounts for about two-thirds of total industrial demand for electricity, but only for 10% of industrial employment. These industries are largely tied to the national economy, but with little sensitivity to other factors and slow growth. These plants, load factor tends to run at overall load factor of 90%. And I have already noted the advantage of the small number of these firms. There are only about five hundred process industry firms in the Edison service territory, many of these firms are like small paint manufacturers. So we have manageable numbers to do single-firm modeling but, with very complex process setups, little incentive to do that modeling.

The assembly industries, while having similar cyclical properties, have much higher labor intensity and much less energy intensity. These firms do have a small amount of weather sensitivity. By and large the firms are dominated by shift operations, the biggest ones in Southern California being the aircraft industry and two or three that are tightly tied to electronics, the electronics industry itself, plus computers and instrumentation. Since there is a fairly large number of plants, you might hope to conduct analyses of the sort we do for commercial firms. We say, okay, these things should run to a type in terms of output per square foot, or output per employee. Why not just model the extra end uses required by industry? The big reason we have trouble with this approach is that these firms do not vary just a little bit in energy per square foot or employee; or whatever. They are all over the map, within a SIC code, between SIC codes, no matter how you aggregate. The variation is big enough here to make end-use modeling a dubious process on anything except a firm-by-firm basis. Our conclusion has been similar to PG&E's and, increasingly, to the CEC's. We use an econometric modeling process, driven off of essentially national economic variables—total output or employment by industry—to forecast industrial demand, both assembly and process. We do not try to pretend that this kind of forecasting procedure is overwhelmingly deep as far as assumptions about technology are concerned.

Member of Audience: So you have one model for the assembly industries and one for the process industries?

LB: No, this is done at a two-digit SIC level. We have to watch ourselves on some of the scaling variables that we use because of the dominance of the aircraft industry, for instance. This means that you do well with a kind of funny scaling in that one. It helps to know a lot about what the government plans are for defense.

We supplement the econometrics with detailed industry-by-industry technology and market characterization studies, very similar to the ones PG&E described as its market research plan for the future. These are done by the market research group within our customer service department. We draw on those studies within planning to obtain market technology characterizations; to obtain market structure characterizations, and in particular to get at least a feeling for which firms are most likely to be active in energy-use changes.

Supplementary to these industry analyses is something that is now going on in considerable detail, and that is individual customer energy analysis: an attempt to essentially tailor the product that we offer to the energy service requirements, not just the electricity service requirements, of individual, large customers. Planners have an interest in this work because we have a requirement that we be able to tie what we think is going on back into some sort of larger view of what is going to happen to Edison's costs and sales. Planning, for instance, played a major role in the analysis of individual firm load data, which led to the development of Edison's strategy towards bypass.* Planning's responsibility is to keep an eye on what technology our customers are likely to see in the future to have a view of what kind of energy market place is likely to emerge in light of this technology to develop estimates at least of what kind of customer potential there is for particular technologies, and, finally to get a handle on what each technology' pattern of emergence is likely to be. A major feature of this, perhaps different from what has gone on in the past, is the degree to which the overall picture you get of what Edison is

* Editor's note: Bypass refers to the option that an industrial customer has of directly purchasing natural gas from an oil company, bypassing the utility. Customers then can produce both heat and electricity with this natural gas for their own use.

doing is very much micro-oriented, oriented toward the individual customer's behavior. In the past Edison might have said, "Well, those econometric extrapolations are good enough music, nobody needs to worry about going to the PUC except the planners." That is not true anymore. It is fundamentally a market research effort.

HA: Larry, you mentioned 65% of the energy flow goes to the major consumers ...

LB: That is the process industry.

HA: Yes, I was wondering how these things have changed over the last ten to fifteen years.

LB: Almost not at all, within our service territory, and nationally, too. I am sorry, that's a little bit of a misnomer. You have to get rid of the steel industry, within southern California service territory I usually throw it out from all our data. But with the one exclusion of the primary metals industry, the ratio of process to total has remained almost constant for a long time.

HA: And I also was wondering how often do you have to update your data using econometric models?

LB: What is the legal minimum? The legal minimum's every other year, geared to the Energy Commission's CFM forecasting cycle. We actually do it annually at the moment.

Member of Audience: Can you comment on the adequacy of individual customer analysis versus econometric analysis, for forecasting. Is there some feedback between the two?

LB: Let me explain it in terms of the way we handle the bypass analysis, because that is probably the cleanest example we have in hand of a direct, easy to understand feedback. Our first bypass estimate was made three years ago. What we started out with when we began was a wildly inaccurate Dunn & Bradstreet characterization of the amount of heat load we had in the service territory, which we tied to an amount of possible cogeneration that could be performed in the service territory, and then applied a standard market-research penetration analysis. We estimated one thousand megawatts bypassed by 1992. We still estimate roughly one thousand megawatts of bypass for 1992, but then our analysis is now based on individual customer analysis.

This second round characterization was done through our extensive individual customer-billing file, to which we applied, through a fairly sophisticated technology, a characterization of what bypass meant to customers. We ran this model for each of our 2,900 largest customers.

>From the point of view of actually providing much of a difference in forecast numbers, the new analysis did not do much. So, in a sense, we had performed with that first cut the critical planning function, which is to anticipate the problem far enough ahead to be able to do something about it. As far as being able to dictate a market plan, the first cut could not do that at all. The individual customer, second generation work led to a marketing response to the bypass. So the work is now a joint product of planning and our customer service department, and they are in the process of devising individual firm responses to bypass requirements.

Member of Audience: I want to ask if you have any comments about what I sense is an undercurrent in a lot of the conversation today, that when we move to the industrial sector, the unit of analysis that is fundamentally on our minds is not a physical unit but a business unit, it is a firm rather than a facility. And I wonder for much of the industry that we see in California, much of the growth industry, what the logical basis is for that being so different than it is in the residential and commercial sectors. The physical units seems the clear unit, since certain activities and certain energy use are associated with it. Do I hear that difference correctly?

LB: Yes, I think you have at least part of it, although in the case of residences the distinction between the economic unit and the physical unit is not all that different. The economic unit, the household, typically occupies a house and that is the only major piece of real estate.

Member of Audience: It is quite elastic, though, because kids move back into the house, or move out, people pair up, and so on.

LB: Yes, I think there tends to be some elasticity, but not nearly as much as there is in industry. The reason the economic unit is so critical to the whole problem on the industrial side is that the industrial facilities are so fungible. The way it was put to me by the guy at Hughes Aircraft when they were deciding on whether to do some expansion here or in, I think their alternative was Huntsville, Alabama, was that his decision was made on a strictly economic basis. And the problem he had was as follows: he was expanding by a million square feet a year and he was adding fifty thousand skilled aircraft workers. If he were to go to Huntsville, how many total aircraft plants will be in that area? The answer is one and that is the reason he did not go to Huntsville, Alabama. Now that was a very critical piece of corporate planning that I heard out of him.

Member of Audience: And quite an unusual one.

DATA NEEDS FOR THE ASSEMBLY INDUSTRY MODEL

Leigh Stamets (CEC)

I first want to note that Jim Lichter is our forecaster for the assembly industries but he could not make it today. I also want to note that the main focus of this talk is the assembly industry model that the Commission presently uses. We have a publication, CEC number P300-87-014, that describes not only that model but the other models that the Energy Commission staff use.

The model we use is based upon essentially the data that are available to us, and on an average basis it makes use of the data for various industries. In addition to the assembly industry model that I shall be talking about today, we have a model for the process industries that is related specifically to production in various industries. The process model gives no direct consideration to the building energy impact that we are discussing here today. Table 1 displays the industries that we consider in our assembly industry model.

Table 2 displays the end uses that we presently consider in the models. The relevant end uses for today's workshop are space heat, space cooling, and lighting. An important part of space cooling allows for ventilation in addition to air conditioning. These variables use floor space as a driving variable, and the other end uses employ value of shipments as a driving variable.

Based the present data, the model predicts that about 27% of the assembly industry's energy use relates to space cooling and 17% to lighting (Table 3).

The model uses the algorithm shown in Table 4 for forecasting these end uses, with floor space as the key driving variable. Other variables are electricity use per square foot, price, price elasticity and floor space decay. Floor space is a function of the number of employees, with historical employee data obtained from EDD.

The energy intensity, or the electricity demand per square foot, relates to what fraction of the total energy for that industry is tied to this particular end use (Table 5). The Energy Resources Consultant (ERC) report, mentioned this morning, is our data source for the fraction of electricity demand attributable to each particular end use. In future years we assume a constant intensity unless there is some specific reason to change it. For both lighting and space conditioning the intensity values change due to construction standards. Changes in the intensities also reflect technology changes.

The ERC analysis remains the present source of end-use data. It is somewhat dated today, because it starts with 1977 Census of Manufacture data. The analysis relies on national energy data rather than California data. A comparison of past projections of the model (backcasts as opposed to forecasts) with electricity consumption for various industries and utility-planning areas indicates that the model does a fairly good job of accounting for economic, employment, and price trends. There are a few industries, transportation is an example, where growth predictions seems to have some particular problems.

This model suggests certain needs in the future (Table 6). It would be interesting and desirable to have California-specific end-use data at the appropriate levels. Even though the standards have been around for a while, when their impact on the industrial sector is considered, I have some concerns about how accurately the model describes their effect. Also, technological changes that either have occurred or will occur should be considered, such as for office equipment or with respect to the whole range of computer impacts, where the trends are specifically different.

JH: Where does the information on square feet come from?

LS: Basically, we concentrate on the relative change of the end use per square foot, so it is not critical to us to identify exactly how many square feet are in use. We start with a base year (e.g., 1977), and assume that we can track a change in the efficiency of new stock versus the existing stock from that time.

Member of Audience: For all these regions there exists a file of inventory that is updated every so many years.

Member of Audience: Inventory by industry?

Member of Audience: Of square footage by site. Samples that the facilities provide and submit.

LS: But we do not use that for this model, I mean, we strictly speaking have a parameter of square footage per employee. Let me put on that slide again. So, in the base year, and let's presume it is 1977, and possibly adding in the cogeneration sales, cogen- or self-generation use, we would have from the utility the electricity by demand in that base year. And then I can basically determine what fraction of the electricity is associated, say, with lighting. Then, if I use a factor for S and a factor for here, well, I have an intensity that I calibrate my model to, and then if I want to assume, due to standards, that this intensity changes by 10% or 20%, it is a straightforward exercise.

JH: Let me tell you the thoughts at the back of my mind in raising the question. Maybe that will help.

LS: O.K.

JH: Hashem, you might check me on some of the numbers, but it seems to me that about six or seven years ago, when the first nonresidential building energy-consumption survey was done at a national level, we started out, I forget all the historical process, with an assumption that there was something like thirty billion square feet of floor area in the United States. And in what was defined for that purpose as the commercial sector, there was also a lot of effort made to define what were the total utility sales to the commercial sector, similarly defined, which as we all know creates problems due to rate classifications that are not SIC based. In 1982, I think, I remember a comment by Linda Carlson, who headed that program and still does, where she admitted somewhat sheepishly, this is at one of the Santa Cruz summer studies, that they guessed wrong on the stock and in fact now thought that the number was closer to fifty billion square feet, which is I think about basically where it stayed. Well, that difference, assuming that you think you know what the total commercial electricity and gas sales are, clearly makes a difference in the absolute intensity and starts to make a rather dramatic difference in what you think you can achieve by implementing what were once mandatory building standards, which then turned into the voluntary national standards and actually some mandatory state standards. Well, the issue of average EUI, not relative changes over the years, does make a difference when you come to issues such as whether it is good to crank down Title 24, how well Title 24 would work in the industrial building sector in California, and so forth. So that is the thought that is behind my question. Do we really have the right ratio, assuming we know how each electricity is sold, just as far as the industrial sector is concerned? Do we really have the right relationship between amount of space that is covered and the intensity per unit space?

LS: Well, it is my impression that the specific amount of square footage that one should include in this type of model would be a very large uncertainty. Because you have to be very careful about what floor space you want to consider. Is this the warehouse floor space? Is this simply the administrative offices associated with the plant? I look at it from the simple standpoint of forecasting the demand, as being basically some type of coefficient that you derive essentially from ratios. Now, that allows you to make some adjustments for assuming efficiency changes and so forth. Now, if you want to say, "I know I have ten million square feet in a certain area and what is going to be the change on that ten million square feet," well then you are prepared to address that question.

Member of Audience: If we are looking twenty years ahead, though, we are going to have some significant impacts to things such as Title 24 if we want Title 24 to really apply to industrial buildings in California. It seems to me it is going to matter eventually, in something like a twenty-year forecast, whether Title 24 turns out to be, say, only 4% better than typical intensities in the pre-title 24 period. Or is it 25% better? That makes a big difference. And so I guess I am really puzzling over, getting back to the building services area, how long we can get along without having absolute square feet data.

LS: Yes, I see your point.

Table 1

CEC Assembly Model Industry Groups

Industry Group		SIC Code*
1.	Food Products	20 (203,206)
2.	Textiles	22
3.	Apparel	23
4.	Furniture and Fixtures	25
5.	Paper Products	26 (261,2,3,6)
6.	Printing and Publishing	27
7.	Chemicals	28
8.	Miscellaneous Plastics Products	307
9.	Rubber Products	30 (307)
10.	Glass and Cement Residual	32 (321,2,4)
11.	Primary Metals	33
12.	Fabricated Metals	34
13.	Office and Computing Machines	357
14.	Nonelectrical Machinery	35 (357)
15.	Communications Equipment	366
16.	Electronic Components	367
17.	Electrical and Electronics	36 (366,7)
18.	Transportation Equipment	37
19.	Instruments	38
20.	Miscellaneous	3

* Excluded industry subsectors in parentheses.

Table 2

Assembly Industry

End Use/Fuel Type Combinations

	Electricity	Natural Gas	Oil
Floor Space End Uses			
1. Space Heat	X	X	X
2. Space Cooling	X		
3. Lighting	X		
Production-Related End Uses			
4. Motors	X		
5. Process Heat	X	X	X
6. Refrigeration	X		
7. Process Electric	X		
8. Pollution Control	X	X	X
9. Miscellaneous	X	X	X

Table 3

California

Predicted Energy Use

	1985	
	GWH	% of Assembly Industry
Space cooling	7,100	27
Lighting	4,300	17

Table 4

Lighting and Space Cooling End Uses

For Each Industry For Each Utility

Annual Electricity Demand$_t$ = Function (Floor space square feet$_t$,*

electricity use per square feet$_t$,

electricity price

price elasticity,

floor space decay)

* Floor space is a function of number of employees.

Table 5

Calculation of base year intensity

$U_{ij} = E_{jb} F_{ij}/S_j$

where for end use i and industry j

U_{ij} = electricity demand of end use i per ft^2

E_{jb} = electricity demand by industry j in base year

F_{ij} = fraction of electricity demand for end use i

S_j = floor space for industry j

Table 6

Related Data Needs for Assembly Model

- Updated California Specific End-Use Data
  - Effect of standards
  - Technology Changes
  - Office Equipment Values