Trends and Tools in Corporate Energy Management: An Overview

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ABSTRACT

Nationally, improvement in energy intensity of industry stagnated until the later half of the 1990s. Even so some companies continued to improve their energy efficiency and set challenging energy reduction targets. These companies exhibit the best in energy management practices. However, it is believed many, or most, companies do not utilize best energy management techniques. Examination of the chemical industry shows that best energy management was being driven by environmental concerns. Now, of course, rising energy costs, especially natural gas and petroleum, are reawakening interest in energy management performance and practices in industry.

This paper will examine and report on the trends in industrial energy intensity (energy use per unit of production), the energy reduction goals and targets of chemical companies—as an industry example—engaged in best energy management practices, the activities of individuals and groups interested in better (or best) energy management, and the tools available (or being developed) for managing or benchmarking energy management. The paper concludes that an interest exists in developing an industry-led, voluntary program to promote best energy management practice.

Introduction

Corporate energy management is the set of company-wide management objectives and procedures by which a company manages all aspects of its energy acquisition and use. Corporate energy management practices wary widely from company to company. Some companies engage in what the Alliance calls "best energy management practices" while others pay scant attention to energy.

Certainly the substantial increase in natural gas and petroleum prices during 2000 has re-awakened industrial companies' interest in managing their energy use wisely. Prior to 2000, the evidence shows that virtually no improvement in manufacturing energy intensity had taken place between the mid-1980s and the mid-1990s. In fact, it worsened by four percent. Only during the last few years—actually just prior to the rise in fuel prices—did noticeable improvement in industrial energy intensity show up in the data (as shown below in Figure 1). Whether this improvement was due to increased efforts in energy efficiency or to changes in the mix of energy-intensive versus non-energy-intensive production activities is not clear at this time.

While most companies let concern for energy efficiency languish, a few continued to emphasize managing energy as a vital part of their corporate values. This was especially true of companies that adopted strong environmental goals. Alliance research has identified the common practices of the very best of these companies. Recent research by the Alliance on the chemicals industry—the industry with the largest energy use—provides some evidence as to the trends and strength of improvement in energy efficiency.

Alliance interaction with industry suggests that there exists a need for and an interest in the use (and development) of tools that would aid in the implementation of best energy management practices. Two types of tools are valuable (1) tools that can be used to benchmark performance, and (2) tools that can be used for specific energy systems, e.g., steam system performance optimization. Few tools currently exist that meet the first need; many tools exist to meet the second need, though many of these tools are ones available only from equipment vendors.

Trends in Manufacturing Energy Intensity[1]

Data on manufacturing intensity and energy efficiency are available from the Bureau of Labor Statistics (BLS) under its multifactor productivity data and the Energy Information Administration. The trend in energy intensity for all of manufacturing (SICs 20-39) is first examined in Figure 1. Shown is the 3-year moving average[2] of the ratio of the energy and output indexes; in other words, an energy intensity index.

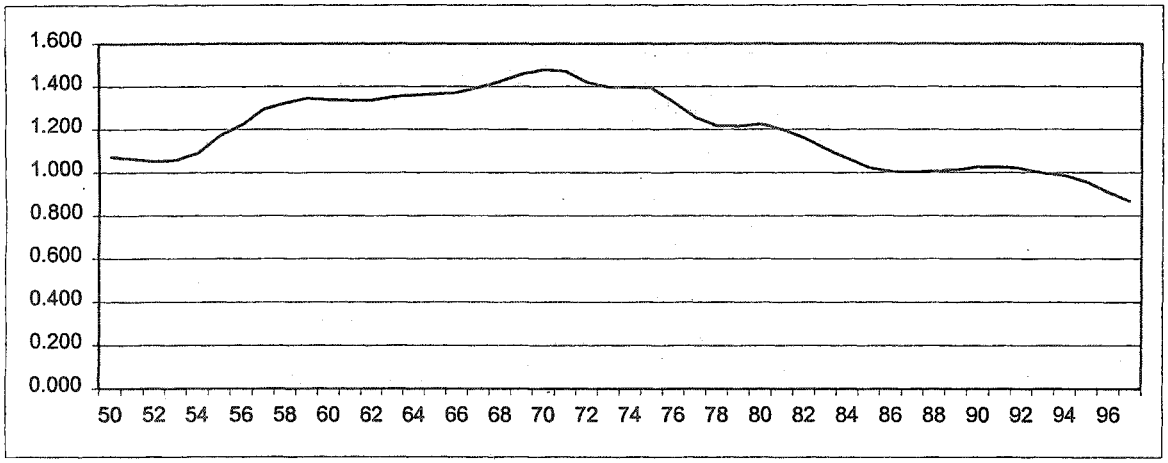

Figure 1. Index of U.S. Manufacturing Energy Intensity, 1949-1997: Bureau of Labor Statistics (3-Year Moving Average) (1992=1.000)

Historically, manufacturing energy intensity rose steadily from the early 1950s through the early 1970s after which it fell fairly steadily until the mid-1980s. In the mid-1980s, it stabilized until starting a further decline in 1994.

One thing to note, energy intensity in manufacturing worsened from the mid-1950s through 1970. This and subsequent behavior of manufacturing energy intensity exhibits a strong response to the real cost of energy. Figure 2 shows an index of real manufacturing energy cost constructed from BLS data.

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[1] The data in this section are from the Bureau of Labor's multifactor productivity data. The U.S. EIA's report, "Changes in Energy Intensity in the Manufacturing Sector 1985 - 1994," uses different data and methodology and reports different results. The author has made no attempt to report or reconcile the differences. Given the nature of the data (i.e., collected by surveys) from different sources makes it difficult and maybe not worthwhile to reconcile.

[2] A 3-year moving average was used simply to make it easier to see the long-term trend of the energy intensity index.

As the real cost of energy fell, manufacturing energy intensity rose. When the real cost of energy rose (1970 through 1984), manufacturing energy intensity fell (1970 through 1986). In general, the energy intensity in the manufacturing sector is driven by the real cost of energy, with an average two-year lag. This pattern is very likely to repeat itself in 2001 and 2002 with the recent rise in real energy costs.

But what is of particular interest is the behavior of manufacturing energy intensity in the mid 1990s. After a slow rise starting in 1987 through 1991, manufacturing energy intensity began a slow descent, which accelerated in 1995. This happened in the face of a stable and then falling real cost of energy.

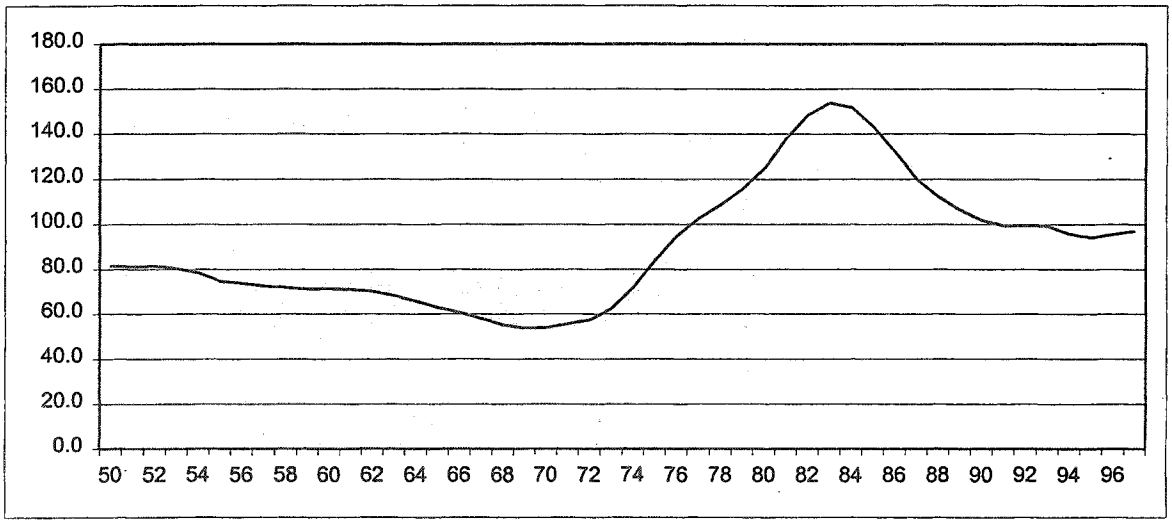

Figure 2. Index of the Real Cost of Energy in U.S. Manufacturing (1992=100)

Not all of manufacturing followed this pattern. There are some huge differences between industries. Table 1 shows for the 17 industries with BLS data through 1998, the patterns of change from 1990 to 1994 and 1994 to 1998. In addition, to provide a relative measure of importance, 1998 current dollar energy costs are shown for each industry.

Overall, manufacturing energy intensity improved four percent from 1990 to 1994 and a further 15 percent from 1994 to 1998. This latter period was a real boom time for the U.S. economy. Examination of the trends in output versus the trends in energy use shows that in many of the industries experiencing substantial reductions in energy intensity (e.g., Electric Equipment) energy use and cost were rising, but output was rising far more dramatically. But even in major industries like chemicals and primary metals, substantial declines in energy intensity took place in the latter period.

Using energy intensity as a measure of energy efficiency improvement is less than desirable, however. Energy intensity is a function of two factors in any given industry: (1) actual improvements in energy efficiency, and (b) shifts in the shares of output accounted for by energy-intensive products/processes versus non-energy-intensive products/processes. In the chemical industry for example, steam use is a major energy cost. Steam cost is 19 percent of shipment value in the production of alkalis and chlorine, but only 2 percent in the production of plastics and resins. Shifts in production in favor of plastics and resins would lower energy intensity of the chemical industry without any change in the energy efficiency of producing either product.

So what can be said about energy efficiency and trends in corporate energy management? First, it is not likely that the recent changes in energy intensity is simply due to shifts in the composition of energy-intensive to non-energy-intensive products. There exists much anecdotal evidence that many companies, particularly very large companies, are devoting significant attention to energy management and energy efficiency.[3] Second, while the efficiency of use of energy by U.S. manufacturing is improving, there are many companies that are not emphasizing energy management. The experience of the chemical industry is illustrative.

Table 1. Percentage Changes in Energy Intensity, 1990 to 1994 and 1994 to 1998, and 1998 (Current Dollar) Energy Costs: 17 U.S. Manufacturing Industries

Industry (SIC)	Energy Intensity 1990-1994 (Percent Change)	Energy Intensity 1994-1998 (Percent Change)	1998 Energy Costs (Billions of $)
All Industry (20-39)	-3.9	-15.3	62.756
Chemicals (28)	-0.7	-11.0	11.710
Primary Metals (33)	-3.7	-20.5	7.325
Food (20)	+2.6	+3.6	6.861
Paper (26)	-4.3	-1.3	6.190
Stone, Clay, Glass (32)	-6.3	-2.2	4.576
Petroleum (29)	-9.4	-2.1	3.732
Rubber (30)	-7.5	-3.6	3.731
Fabricated Metals (34)	-7.1	-11.7	3.300
Machinery (35)	-21.5	-31.4	3.209
Electrical Equipment (36)	-25.7	-32.3	3.188
Transportation Equip. (37)	-5.4	-26.5	2.603
Textiles (22)	+0.3	+2.5	2.384
Lumber (24)	+8.3	-13.0	1.473
Printing (27)	+8.6	-25.2	1.344
Measuring Equip. (38)	-8.3	-39.7	0.912
Furniture (25)	-1.8	-1.6	0.615

The Case of the Chemical Industry

The chemical industry is the largest industrial purchaser of energy in the Untied States. Research was conducted to determine the emphasis companies in the industry place on energy efficiency. The Web site ChemIndustry.com was used to access chemical company home Web pages. The ChemIndusty.com site lists 110 companies as major chemical companies. These were the sites examined.

Out of the 110 companies, any reference to energy efficiency could only be found for 28 (25 percent) of the companies. One of the major elements of best practice corporate

[3] The EIA report on energy intensity verifies this by showing that after adjusting for estimated changes in the composition of production within industries, for most industries, the change in energy efficiency parallels the change in energy intensity; in other words, changes in energy efficiency explain the bulk of the change in energy intensity over time.

energy management is the establishment of top corporate commitment to energy efficiency. Companies committed to best energy management practice are highly likely to indicate such on their home pages because such commitment is part of their core missions and environmental goals. The lack of mention of energy efficiency on a company's home page, therefore, is an indication of lack of such commitment.

Even then, of the 28 companies mentioning energy efficiency as an important company concern, only 11 (10 percent overall) of the companies described their energy management commitment in terms that could be considered best energy management practice.

Best energy management practice is a set of energy management practices including the following elements:

1. Commitment by top-level management
2. Clearly-defined energy-reduction goals
3. Communication of the goals throughout all levels within the company
4. Assignment of responsibility and accountability at the proper level
5. Formulation of, and tracking, of energy use metrics
6. Identification of all potential projects on a continuous basis
7. Adoption of project investment criteria reflecting project risks and returns
8. Provision of recognition and reward for achieving the goals.

The 11 companies described specific numeric energy efficiency goals (Element 2: "Clearly-defined energy-reduction goals"). Several of these companies had continuously strived to reduce energy use since the first oil crisis. Seven of the 11 established specific goals during the years 1990-1995. Two of these companies that achieved their goals during the 1990-1995 period set new goals during 1996-2000. Four other companies established energy reduction goals during the latter period. A look at the targets and performance of these 11 companies provides insight on what energy reductions can be achieved.

3M. 3M has continuously maintained efforts to reduce energy use per pound of product produced since 1973. Since then it has reduced its energy use per pound produced by 59 percent. In 1995 it established its present energy reduction goal: to reduce energy use per pound of product by three percent per year.

Baxter. Baxter set a goal in 1996 to reduce its energy use per unit product by 10 percent by 2005. In 1998 it had surpassed that goal and set a new goal in 1999 to achieve a 30 percent reduction (using 1996 as the base year) by 2005.

BP. BP has for many years emphasized energy reduction. In 2000 it established a new goal of a 10 percent improvement in energy efficiency by 2010.

Chevron. Chevron began tracking energy use with an energy efficiency index in 1993 and has continuously set more aggressive energy reduction goals. From 1993 to 1997, Chevron achieved an 8.5 percent improvement in the index.

Dow. Dow recently set a new goal to improve its energy efficiency by 20 percent by 2005. In 1992, it consumed 3,276 MBtu per pound. By 1998, energy consumption per pound of

product had fallen to 2,799 MBtu (a 14.6 percent improvement). Dow's target for 2005 is approximately 2,250 MBtu per pound of product (if achieved, it will be an overall 31 percent reduction from 1992—over 13 years).

DuPont. DuPont hopes to hold energy use constant at its 1990 value through 2010. Between 1991 and 2000, DuPont increased output by 36 percent while using no more energy than in 1991 (a 26 percent reduction in its energy-to-output index). DuPont analysis shows that about one-half of this improvement was the result of improved energy efficiency and one-half from changes in the mix of products it produced. DuPont considers the 2010 goal to be a "stretch" goal. To achieve it, DuPont anticipates having to considerably alter its product offering from raw material and energy-intensive products to "knowledge-based" products.

Hitachi Chemical. Hitachi set a goal in 1990 of reducing its energy consumption per unit sales (1 million Yen) by 30 percent by 2010. Between 1990 and 1999, it had achieved a six percent reduction.

ICI Group. In 1995, the ICI Group set a goal of achieving a 10 percent improvement in energy efficiency by 1995. By 1991, it had already achieved a 12 percent reduction.

Johnson & Johnson. In 1991 Johnson & Johnson set a goal of reducing its worldwide energy use by 10 percent. By 1995, it had surpassed the goal, achieving a reduction of 14 percent. Given this success, it set a new goal in 1996 to achieve a reduction of 25 percent by 2000 (against the 1991 base year). By 1998, it had reached the 19 percent level.

Mitsubishi Materials. Mitsubishi set a goal in 1997 to achieve a continuous one percent annual improvement in its energy efficiency. This goal corresponds to national Japanese targets.

Solvay. Solvay has committed to achieving energy improvements equal to those established by the European chemical industry in its Voluntary Energy Efficiency Program (VEEP). From 1980 to 1990, the European chemical industry reduced its fuel and power consumption per unit of output by 30 percent. In 1990, VEEP set a new goal to achieve a further 20 percent reduction by 2005.

Overall, the goals and targets of these companies almost mirror the percentage change in energy intensity of the chemical industry as a whole. The approximate average reduction in energy intensity for the above (U.S.) companies is 12 percent for 1995-2000 compared to the 11 percent reduction industry wide for the years 1994-1998. Of course at least one-half of these companies were achieving savings of this magnitude during the early 1990s when the industry's energy intensity declined only 4 percent.

Before conducting this analysis, it was expected that these companies would exhibit performance much better than average. Either the size of these companies relative to the market is strongly affecting the industry average (which could be true) or many more companies, that don't make their energy savings efforts known, are engaged in the same level of effort.

Energy Prices Versus Environmental Goals as Drivers of Industry Energy Efficiency

Until the very end of the decade of the 1990s, real energy prices paid by industry remained relatively constant initially and then declined to their lowest levels of the decade by 1998. During these years, the behavior of real energy prices acted as a disincentive to care about energy efficiency. Why then did firms like those above set (and achieve) vigorous energy intensity or energy efficiency reduction goals? In virtually all cases, they did so as part of their setting strong environmental goals. These firms set major goals to reduce waste, air pollutants, and, in many cases, carbon emissions. In the U.S., about 80 percent of all air emissions are the results of burning fossil fuels and about 90 percent of all carbon emissions are the result of burning fossil fuels. Firms that set strong environmental goals included energy as an important part of their goals because of energy's dominate and direct relationship to air pollution and greenhouse gas emissions.

Since 1998, however, industry, like many of us, is experiencing major increases in fuel costs. Between October 1998 and October 2000, the price of residual fuel oil rose 139 percent, industrial electricity rates rose 7 percent, and natural gas rates 88 percent. Natural gas rates have continued spiraling upward. Now all of industry has the added incentive to save energy in the face of the rise in fuel costs. These price changes are as severe, or more severe, as any experienced during the first or second oil crises. Alliance to Save Energy research shows that during the period of the oil crises, the elasticity response of the manufacturing sectors energy intensity (ratio of energy to output) was -0.3 percent and the lag between increases in the real price of energy and declines in industry energy intensity was two years. If this response were to repeat itself and the 1999-2001 energy price rise were to maintain itself for several years, say an average of 100 percent over five or more years, the Alliance predicts energy intensity of the manufacturing sector will decline just to price alone by 30 percent over the same period (with a 2-year lag).

Interest In and Tools For Corporate Energy Management

Interest in Corporate Energy Management

The Alliance interacts with industry in a variety of ways. We have about 60 corporate associates who provide unrestricted support. Most of these associates are manufacturers of energy efficient devices and services. The Alliance co-manages the DOE Industries of the Future *BestPractices Steam* Program, which puts us into contact with providers of steam system equipment and services and industrial users of steam. The Alliance also interacts with industry through a variety of conference and other program involvement and through research of industrial energy use. Through these contacts and activities we have observed growing interest in corporate energy management in a number of ways.

First, and foremost, in January 2000, the Steering Committee of the *BestPractices Steam* Program formed a Task Force to promote the concept of marketing tools and services of the *BestPractices* Program to top corporate management by marketing best energy corporate management. The theory is that to increase the interest in, and demand for, the products and services of the *BestPractices Steam* Program requires first increasing the awareness and obtaining the commitment of top corporate energy management. But this could best be done by not trying to sell the *BestPractices Steam* Program alone, or even the

overall *BestPractices* Program, but to sell the CEO on the value of adopting and maintaining overall best energy management practices. If this could be done, then a "demand-pull" environment could be created in which DOE's OIT *BestPractices* Program could flourish.

The Steering Committee of OIT's *BestPractices* Program has established a marketing subcommittee to develop a marketing strategy for the program, a strategy that, hopefully, will include a plan for marketing energy management best practices to top corporate management of companies in the IOF industries (nine in all: agriculture, mining, aluminum, steel, metalcasting, glass, forest products, chemicals, and petroleum refining).

In early 2000, the Alliance conducted research on the energy management practices of the largest 400 manufacturing companies. Results of that research showed that half of the respondents had potential interest in a voluntary, industry-led program promoting corporate energy management. If such a program were established, actual participation will depend heavily on the perceived value of the program.

Our discussions with individuals in industrial companies and industry trade groups indicate a high degree of interest in an industry-led, voluntary, corporate energy management program. This interest runs the gamut from suppliers of energy efficiency equipment and services to trade groups representing industrial energy users to individual industrial company energy managers. Two particular interests stand out. First is benchmarking. Corporate energy managers want to know how they compare to companies in their industry overall and at the plant level. They are very interested in benchmarks for certain systems that could apply to their company as well as generically across companies. To help meet this need, the U.S. EPA is developing benchmarking data on industrial energy performance through its *Energy* Star Program. Second is that if a program existed it could serve as a potential point of leverage to use in selling top management on greater support for energy efficiency efforts. Information like case studies and innovative energy management practices could be used to bolster support requests.

Tools for Corporate Energy Management

At the top corporate level, there are few tools available in corporate energy management. One tool, endorsed by the U.S. EPA's *Energy Star* Program, is the software "One-to-Five," developed by Energetics. This software tool allows companies to rate themselves (on a five scale basis) overall and by specific area of good corporate energy management practice. Through the program, a company can spot its strengths and weaknesses and develop a program or strategy to improve its performance. The program is best used under the guidance of Energetics, where its cumulated experience in working with companies can be applied and the user's company practices put in perspective.

The Georgia Institute of Technology through its Energy and Environmental Management Center (EEMC) has developed what it considers the first step to setting a standard for the energy management systems. The American National Standards Institute has accredited the EEMC as a standards developer. The EEMC is currently working with Delta to demonstrate the program.

At this year's Energy Management Workshop (Houston, May 1, 2001), sessions will be devoted to benchmarking corporate energy management best practices both at the corporate and plant levels. The results of these benchmarking sessions will be combined to provide a set of benchmarks.

Finally, the Alliance to Save Energy is developing a simple spreadsheet "Corporate Energy Management Self-Evaluation and Rating Tool." The tool will concentrate strictly on company-wide and top-level corporate energy management practices. In using the tool, a corporate energy manager can self score his or her company overall and by the eight elements of best corporate energy management practice. The score is compared to the Alliance's view of what constitutes best practice and a rating is provided.

Conclusions

U.S. manufacturing energy intensity (energy consumption divided by output) began significantly declining starting in 1994 after a decade of stagnation. Since this occurred before the recent rise in energy prices—it actually occurred while real energy prices were falling—the decline is considered the result of increased emphasis on reducing industrial environmental impacts on waste disposal, air pollution, and climate change. Many large companies adopted programs to minimize environmental impacts. For about one-half of these companies, energy efficiency is treated with the same importance as reducing solid wastes and air emissions. Many of these companies engage in best corporate energy management practices. Many other companies do not, however, or do not emphasize it at the top corporate level.

Of course, now with oil and natural gas prices rising dramatically, as well as concerns about electricity supply availability and cost, all companies are becoming concerned about energy use and energy efficiency. Even the companies known for practicing best energy management could do better, and those who have not practiced best energy management techniques, could do far better.

Many organizations and individuals are interested in better defining best energy management practices and seeing such practices adopted on a wide basis by industry. Those with this interest include energy-efficiency equipment and service providers, energy-efficiency groups, industry trade organizations, and industrial companies. Interest extends from the plant floor to the corporate suite.

Given the need and the interest, how best can better and more widely practiced energy management be achieved? Many believe the best course of action is to establish a voluntary, industry-led program focused on best energy management practices. This program would start by establishing what practices constitute best energy management practice. Performance would be defined as following certain accepted practices, not mandating particular numeric minimum performance standards. The program would establish an identity (i.e., logo, etc.) and promote participation. The program could provide information, support benchmarking activities, and supply advice. The program would, finally, recognize best practice performance of the participating companies.

References

For information on the chemical industry, see Web site: www.ChemIndustry.com.

Georgia Technology Institute. Energy and Environmental Management Center. Web site: www.industry.gatech.edu/energy/energy_mse2000.html.

Norland, Douglas L. and Laura Lind. April 2000. "Corporate Energy Management: A Survey of Large Manufacturing Companies." *Proceedings: 22nd National Industrial Energy Technology Conference*. Houston, Texas: Energy Systems Laboratory, Texas A&M University. Also printed in *Energy Engineering*, Vol. 98, No. 6.

One-2-Five Corporation. "One-2-Five Energy" software. Marblehead, Mass.

U.S. Bureau of Labor Statistics. Multifactor Productivity. Web: www.bls.gov/mprhome.htm.

U.S. Energy Information Administration. March 2001. "Changes in Energy Intensity in the Manufacturing Sector 1985-1994." www.eia.doe.gov/emeu/mecs/mecs94/ei/ei_2html.