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10. ENERGY CONSERVATION Industry

FACTSHEET

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INTRODUCTION

The industrial sector is responsible for about 36 percent of our total energy consumption - 27.0 Q Btu* of the 1976 national total of 74.0 Q Btu. Since this is the largest share of the energy pie and particularly sensitive to the relation between Btu's and dollars, industry is undergoing thorough energy conservation analysis. Industrial energy consumption is also important because of the fuel mix; 41 percent of the natural gas, 18 percent of the oil, and 40 percent of the electricity (1976 figures).

While the industrial sector is a prime conservation target, it is so diverse that broad conservation strategies are difficult to find. It includes the steel industry with its coal-gulping blast furnaces and the less intensive garment industry. It has manufacturers of energy intensive plastics and makers of leather.

Although this Fact Sheet cannot cover all the industrial conservation options available, we can provide some perspective in the amounts and types of energy involved, give examples of conservation approaches in several of the energy intensive industries and summarize the possible savings throughout the sector.

RESOURCES

As in other conservation discussions (Fact Sheet #9 and #11), the resource considered here is not fuel reserves or fuel to be discovered, but commited resources to be saved. The targets are identified in the table below which shows industrial consumption by fuel.

The 1.35 billion barrels of oil in Table 1 represent 21 percent of the total U.S. consumption and more than half of the 2.58 Bbls of oil imported in 1976. The 8.21 trillion cubic feet of natural gas was more than the total used in the residential and commercial sectors. It must also be rememberd that additional gas and oil is consumed in the generation of electricity. The lower columns show the energy use per kilogram to produce specific materials. The high energy cost of aluminum, iron, copper, and the surprisingly high energy consumption in paper manufacture stand out and suggests recycling as an important strategy.

A recent projection of energy use (Bureau of Mines, 1975) anticipates an average annual energy consumption growth rate in the industrial sector of 2.3 percent. Thus, between 1975-1985, the industrial sector would be expected to use a total of 318 Q Btu. A 20 percent savings - a modest goal - would amount to 63 Q Btu, about the total energy consumed by the entire country in 1968. The "conservation resource" is one worth mining.

GENERAL CONSERVATION STRATEGIES

Generally, the conservation strategies in industry are of two types: reducing energy waste and improving efficiency. The first approach involves both leak plugging (better insulation, recovery of waste heat, adjusting equipment to high efficiency operation, etc.) and energy management (turning off lights, lowering thermostats, staggering work hours, etc.). Both

* See Glossary, Fact Sheet #18, for definition of energy units.

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TABLE 1
Energy Consumption
in the Industrial Sector:
by Fuel (1976)

Fuel	Amount*	Q Btu
Coal	144.4 M tons	3.79
Natural Gas	8.21 TCF	8.38
Oil	1.35 Bbls	7.40
Electricity	0.824 T kw-hrs	2.81**
		22.38

* Million (M) tons, TCF - trillion cubic feet, Bbls - billion barrels, Trillion (T) kw-hrs.

** Does not include the primary fuel used in the production of this electricity.

The industrial consumers of these fuels are identified below in Table 2. Consumption is broken down by industrial group and by specific industries.

TABLE 2
Major Energy Users in Industry

Industry Group	Total Energy (%)	Electricity (%)
Primary Metals	21	23
Chemical and Allied Products	20	29
Petroleum Refining and Related Industries	11	4
Paper and Allied Products	5	5
Food and Kindred Products	5	6
Stone, Clay, Glass and Concrete Products	5	5
Total	67	72

Energy Intensive Individual Industries

Industry	Specific Fuel Consumption (Million Btu/kg)	Percentage of Industrial Sector Fuel
Iron & Steel	29.1	15.2
Petroleum Refining	4.8	11.4
Paper & Paperboard*	27.0	5.4
Aluminum	170.5	2.8
Copper	28.4	0.4
Cement	8.7	2.5
Total		37.7

* Does not include heating value of waste products (bark and spent pulp liquor).

of these are relatively short-term responses. Being developed, however, are long-term and more expensive conservation technologies that can increase the savings in the future. Some specific examples are considered below.

First, however, a few more general remarks are in order. In addition to looking at industrial energy consumption by fuel and industry, it is also helpful to consider the variety of end use. Most consumption is of thermal energy, 39 percent as process steam, and 26 percent as direct heat. Of the remainder, 26 percent is electricity and 9 percent is coal, oil, and natural gas products as raw materials. Of the 26 percent which is electricity: 20 percent goes into mechanical work of motors, 3 percent into refinery processes, 2 percent into heat, and the remaining 1 percent into lights and similar small uses. The most rapidly growing end uses are of electrical energy and raw materials. The fact that 65 percent of the energy is used in thermal form also strongly directs conservation efforts toward insulation, heat recovery, and more efficient heating apparatus.

With these general statements as background, we will consider some of the specific conservation techniques available to industry and estimate the achievable savings.

Energy Management: Several large commercial organizations (e.g., Dow Chemical, DuPont) now offer energy management advice to other companies. DuPont, for instance, decreased its Btu input per unit of product by 25 percent over the past decade and claims to have helped 91 other industries save $13 million in energy costs.

It is estimated that savings of 15 percent (without appreciable capital expenditures) are available immediately. With program redesign and some technological improvement, an additional 10 to 15 percent can be saved in the next 5 years and 10 to 20 percent more over the following 5 to 20 years.

Waste Heat Recovery: Heat is a necessary ingredient for many industrial processes, but much of it is wasted or used inefficiently. In the metals and glass industries, for example, significant amounts of energy are exhausted up the furnace stacks. The Energy Research and Development Administration's (ERDA) Conservation Office estimates that 7 Q Btu of high temperature heat energy is used for direct heating at an efficiency of only 20 percent. Much of the wasted energy could be used for preheating and reheating materials or used for the production of electricity.

"Co-generation," the simultaneous production of electric power and heat in industrial operations is a powerful energy conservation technique whose development has been slowed by economic and institutional barriers. It is estimated that the

energy savings potential of co-generation could reach 2.1 Q by the year 2000. Implementation of industrial co-generation will add more than 50,000 Mw of low cost generating capacity (more than the 1976 nuclear capacity) and reduce the need for utility expansion.

Recycling: Table 2 suggests the conservation potential of recycling. Recycling could save 200 M Btu's per ton of aluminum, 12 M Btu's per ton of steel, and 42 M Btu's per ton of copper. According to EPA, 60 to 75 percent of aluminum used in this country could be recycled (4 percent is presently), and 90 percent of the steel (1.4 percent is at present).

A large percentage of solid waste is paper; if recycled, it requires only about one quarter the energy of virgin wood pulp. Although the amount of recycled paper used in the paper industry has decreased from 35 percent of the 1944 total to only about 20 percent now, its use is showing signs of growth. There are now three mills producing paper from waste paper and its use - and energy savings - is increasing.

Other valuable materials are wasted. Much of the waste from plastic manufacture has fuel value. Carbon monoxide is discharged in large quantities by several basic industries (e.g., iron smelting, aluminum, and phosphorous production). The feasibility of using this as a raw material for plastics manufacture is under investigation.

A specific example of recycling which shows the savings that can be obtained is in the "coil coating industry," which produces painted steel coils for appliance manufacture. Past practice has been to spray paint the coils and dry them in a natural gas-fired oven. In one experiment, the paint solvents, which normally go up the stack (as pollutants) are recaptured and burned to provide heat for the drying ovens. The use of natural gas in this plant was reduced by two-thirds.

CONSERVATION TECHNOLOGY

Within various industries there is much energy to be saved by the introduction of new processes and technologies. In the iron and steel industries, replacement of the open hearth furnace with the "basic oxygen furnace" at some plants has saved up to two-thirds of the energy formerly consumed. Likewise, the newer "continuous casting" process eliminates much of the heating and cooling, primarily saving natural gas.

The aluminum industry is a large user of electrical energy. Modifications in the electrolytic cells used in refining could, it appears, produce savings as large as 25 percent. An even newer chemical (instead of electrical) process has been announced which promises even larger (up to 50 percent) reduction.

High temperature heat energy is used to produce portland cement. A steam process that operates at a lower temperature has been demonstrated and could save a significant amount of energy (as much as 0.1 Q Btu in 1985). Changing the cement itself from pure portland to a blended mixture using inert material such as fly ash (as is presently done in Europe) would produce similar savings and is being studied.

APPLIED THERMODYNAMICS

One can, using the knowledge of thermodynamics (the study of heat and work), compute the "ideal" or theoretical efficiency of a heat engine in terms of the difference between the input and output temperature of the working fluid.* By comparing actual efficiences with this upper limit, engineers can find out how much additional improvement is possible. The maximum theoretical efficiency of a coal-fired plant, for instance, is about 60 percent and modern plants operate at 40 percent.

It is also possible to compute the minimum energy cost of manufacturing operations. From the limited application of such theoretical studies to actual industrial processes, it is clear that there is much room for improvement. In the manufacture of iron and steel, for instance, application of 1973-level technology would allow production at 18.8 thousand Btu/kg. The theoretical minimun is 6.6 thousand Btu/kg. The opportunities for improvements are even better in petroleum refining (3.6×10^3 Btu/kg at 1973 levels vs. a theoretical 0.5×10^3 Btu/kg), aluminum manufacture (167.6×10^3 vs. 27.7) and cement making (5.2×10^3 vs. 0.4). Paper manufacture which requires (1973 levels) 26.1×10^3 Btu/kg should require almost no energy according to thermodynamics.**

It will not be possible, of course, to achieve these theoretical minima, but they should serve as a challenge to engineers to make improvements in existing processes.

CONSERVATION IN THE ELECTRIC UTILITY INDUSTRY

The electric utilities industry is the largest user of primary energy. In 1976 it consumed 2.4 Q Btu's, 20 percent of the year's total. While 45 percent of that energy came from coal, 15 percent was from scarce natural gas and another 16 percent from oil. With an average generation efficiency of a little less than 33 percent, it takes 3 units of primary energy to produce 1 unit of this intermediate energy. Since industrial electrical consumption is

* See, for instance, Energy-Environment Source Book, Chapter 3, Volume II, John M. Fowler, NSTA, Washington, D.C., 1975.

** For a fuller treatment of these estimates, see reference in the bibliography of this Fact Sheet.

growing rapidly, energy conservation in this sector is of great importance.

The energy used to generate electricity can be conserved by reducing electrical consumption or by increasing either/both the primary fuel conversion efficiency or the efficiency of end use. While some reduction in the end use did take place in 1974 and 1975, growth resumed in 1976 and most projections show increasing reliance on electricity. Thus, there seems to be no doubt that the fraction of our total primary energy going into electrical generation will increase.

There are several strategies, however, which can increase the efficiency of generation and utilization of electricity. The leveling out of the peaks and valleys of the demand discussed in Fact Sheet #16 would accomplish this, as would the new rate structures which are being proposed to dampen peak load usage. There are also technological improvements in electrical generation under development. Improvements in electrical transmission, which still accounts for 10 percent or more loss, are being sought.

SUMMARY

The Industrial sector uses 36 percent of our yearly energy total. Its energy mix includes much natural gas, which is in short supply, and electricity, whose generation wastes much primary energy. It is thus, on all counts a prime target for conservation measures. A large variety of strategies could both lower consumption and improve utilization efficiency in this sector. There are management techniques - careful energy audits and controls - which have reduced consumption by 20 to 30 percent in several industries already. Waste heat recovery, recycling, and the application of new technologies can all help significantly.

The ERDA target for the year 2000 for conservation in the industrial sector is 8 Q Btu, plus another 4 Q Btu improvement in electrical generation and transmission efficiency. These 12 Q Btu would be about 8 percent of the 160 Q Btu consumption projected for 2000 - a modest target given the potential we have described.

The financial support for conservation comes from several sources. The Federal Energy Administration has been primarily involved in the application of existing strategies, while ERDA funds support research and development. The 1977 budget authority for ERDA in the conservation area came to $160 million out of a total of $3.01 billion. ERDA expenditures on conservation in the industrial and electric utility sector in FY 1977 are expected to total about $15.4 million.

The potential "resource" of conservation is large and the time lag for change-over to these strategies is much shorter than for any other technological option. Energy conservation has finally achieved a prominent place in this Administration's energy policy. The pressure of economics may force it to become a part of our national ethic.

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