Overview

For many years to come, energy need not be a constraint to economic growth in the United States. OTA projects that in the next two decades investments in new processes, changes in product mix, and technological innovation can lead to improved industrial productivity and energy efficiency. As a result, the rate of industrial production can grow three times faster than the rate of energy use needed for that production.

Because the investments needed to improve energy efficiency are long term, a reduction in energy use growth rates resulting from investments begun now will continue through the 1980's and 1990's. Furthermore, this improvement will continue beyond 2000 as the proportion of new, energy-efficient capital stock increases. Improvements in energy efficiency for the next several years will be largely a result of housekeeping measures and investments that began during the 1970's.

In 1981, the industrial sector used 23 Quads* of direct fuel, electricity,** and fossil fuel feedstock, of which petroleum and natural gas constituted 73 percent. Four industries–paper, petroleum refining, chemicals, and steel–accounted for almost half of all industrial energy used. Over the past decade, soaring energy prices have led to significant changes in the absolute amount and mix of energy used in industry. Energy used per unit of product in the industrial sector decreased by almost 20 percent. This improvement was accomplished by housekeeping measures, equipment retrofits, and new process technologies that produce existing products and new product lines.

In addition to reducing the energy use growth rate, industry will continue its shift away from premium fuel use. For the next two decades, industrial coal use—particularly in boilers and in some large, direct heat units—will increase substantially because coal is cheaper than oil and natural gas. Moreover, the demand for purchased electricity will probably grow faster than the total industrial energy demand if the price difference between natural gas and electricity continues to decrease.

While industry has made significant strides in reducing energy use, **opportunities for further gains in energy efficiency from technical innovation are substantial.** Because capital stock has not turned over as quickly in recent years as it did in the 1960's, there is a large backlog of retrofit improvements to be made. Furthermore, high capital costs and the limited capital pool have kept many new process technologies from penetrating product markets. **OTA projects that new processes or process technologies would save more energy than would retrofits and housekeeping measures, and would reduce overall costs by improving productivity and product quality. However, such process shifts will entail large capital outlays, which in turn, will require general economic growth over many years.** Without economic growth, there will not be enough product demand or capital to support these productivity improvements.

A product mix shift away from energy-intensive products will also continue to contribute to the decline in energy use growth rates. Product mix shift will occur within specific industries (e.g., a shift from basic chemical production to agricultural/specialty chemical manufacture) as well as from one industry to another (e.g., a shift away from steel to aluminum and plastics in auto manufacture). These shifts are driven by

*A Quad equals 1 quadrillion (10^{15}) Btu.
* "This is final demand, so that electricity is accounted for at 3,412 Btu/kWh

changing demand patterns and international competition, as well as by increasing energy prices.

OTA found that corporations have a strategic planning process that evaluates and ranks investments according to a variety of factors: product demand, competition, cost of capital, cost of labor, energy and materials, and Government policy. In analyzing energy-related investment behavior, **OTA found no case in which a company accorded energy projects independent status.** Although energy costs are high in each of the four industries examined by OTA, costs of labor, materials, and capital financing are also high. **Thus, energy-related projects are only part of a general strategy to improve profitability and enhance a corporation's competitive position.**

Most firms regard energy efficiency as one more item in which to invest and not as a series of projects that are different from other potential investments. This view differs significantly from the view of firms that produce energy or energy-generating equipment where the **entire investment** is focused on increasing energy production. This difference has important policy implications because incentives aimed at reducing energy demand growth must compete with other strategic factors and are therefore diluted. Energy incentives directed at increasing energy supply suffer no such competition.

Of the four most energy-intensive industries, chemicals and paper will show the largest growth in production over the next two decades and will also show a substantial increase in energy efficiency. In the paper industry, energy use has risen slightly since 1972, but the industry is now more energy self-sufficient. In 1981 the paper industry generated half of all its energy needs through the use of wood residues as fuel. By 2000 self-generation of energy could result in the paper industry meeting over 60 percent of its needs internally. The limitation on the percentage of self-sufficiency is the value of the product foregone by using feedstock (wood) as fuel. Also, the paper industry's use of oil will decline as residual oil is displaced in boilers by coal and biomass fuels, OTA projects that over the next two decades, energy use per ton of paper will decline, owing to specific process changes in papermaking steps, such as oxygen-based bleaching, computerized process controls, and new methods of making paper.

The petroleum refining industry will show a decline in overall product output but will continue to improve its energy efficiency, although only slightly. Energy efficiency gains from retrofit and housekeeping measures will be merely offset by a shift to heavier, high-sulfur, crude oil feedstocks and by increased use of energy in refining because of market requirements for high-octane, unleaded motor fuels. Of the four industries, this is the only one in which product or process shifts are not projected to lead to less energy use. Nonetheless, overall efficiency can be expected to improve as a result of a number of anticipated technological changes in refinery operations, such as the extensive use of vapor recompression and waste heat boilers in the distillation and cracking processes and the use of computerized process controllers to optimize plant operations.

In the chemicals industry, energy efficiency improvements will result from a combination of retrofits to existing processes and technical innovation in new processes and products. For example, vapor recompression, process controls, and heat recuperators and exchangers will be added to existing processes to improve thermal efficiencies. In addition, there is a trend toward increased use of electricity and coal and away from premium fossil fuels, especially natural gas. OTA projects that by 2000, coal use will account for almost one-third of the fuel used in the chemicals industry. An important source of energy efficiency improvement in the chemicals industry is a shift in product mix. Because of higher profit margins and less foreign competition, the in-

dustry will increase production of less energy-intensive, higher value chemicals, such as pharmaceuticals and pesticides, relative to more energy-intensive chemicals such as ethylene and ammonia.

As the steel industry retools to meet foreign competition, there will be a large reduction in energy intensity. The major source of this decline will be investments in new processes—i.e., 1) the replacement of ingot casting by continuous casting, and 2) the substitution of electric arc furnace or mini mills for the blast furnace/basic oxygen furnace combination. With continuous casting, significant energy will be saved by not having to reheat cooled metal ingots before shaping. Electric arc minimills will save energy by substituting scrap metal feedstocks for iron ore, thus reducing coke demand. This trend will also result in the substitution of steam coal for metallurgical coal since the former will most often be used to generate electricity,

Over the years, Congress has passed a number of measures that affect the industrial use of energy. in general, the goals of these measures have been to reduce oil imports, encourage domestic production of fossil fuels, and reduce energy demand through efficiency improvements. **OTA found that legislation directed specifically at improving energy efficiency in industry has little influence on investment decisions.** At the highest levels of corporate financial decision making, there is an awareness of Government tax and industrial policies. However, OTA found that technical decisions and energy project evaluation tend to be separate from and subservient to corporate financial decisions. Moreover, the decision to invest depends not only on an individual project's return on investment, but also on such corporatewide parameters as debt-equity ratio, debt service load and bond rating, and, most importantly, the aforementioned strategic considerations of corporate decision making. **Because energy must compete with other factors of production when investment choices are made, policy incentives directed at energy demand alone will be just one of a number of considerations in making these choices.** Unless such incentives are substantial, they are unlikely to alter a decision that would have been made in the absence of such incentives.

To assess the effects of a range of incentives on energy use in industry, OTA selected a set of policy initiatives directed at energy specifically or at corporate investment in general. The latter include the accelerated cost recovery **system (ACRS) provisions of** the Economic Recovery Tax Act of 1981 (ERTA) and increased capital availability for investment, while the former include broadened and expanded tax credits for energy investments and the imposition of energy taxes on premium fuels. These policies are compared to a reference case consisting of current economic conditions and the tax code as amended by ERTA.

The effect of the ACRS on increasing energy efficiency depends on the ability of the ACRS to increase investment. OTA **found that the ACRS is a positive stimulus to investment when the industry is profitable and growing.** Under these conditions, total investment and energy efficiency improvements would be accelerated by the ACRS. **As long as conditions of high interest rates, low-to-moderate demand growth, and the like exist, however, the ACRS will do little to increase energy efficiency.**

Energy investment tax credits at a lo-percent level have little direct influence on capital allocation decisions in large American firms, and thus have little or no influence on energy conservation. These tax credits appear to be too small to exert any change in the return on investment of a company when the only factor they affect is energy. **However, energy investment tax credits directed at energy production, such as cogeneration by third parties, would be effective.** In this case, the entire investment would be covered by the tax credit, and energy would be the principal product being produced by the investment. Regarding investments in technologies that improve

the energy efficiency of industrial process technologies, however, OTA could find no case where decisions to undertake a project depended on gaining a 10-percent energy investment tax credit.

Taxes at a rate of $1 per million Btu on premium fuels—natural gas and petroleum—would change the fuel mix and cause energy efficiency to improve, although not by more than a few percent. Because of the already large cost differential between premium fuels and coal, the increase in costs as a result of the tax would not significantly change the economic incentive to switch to coal. The effect of the tax would be more significant for electricity, but there the availability of industrial production technologies that use electricity instead of petroleum or natural gas would be the limiting factor. Consequently, imposition of the tax would cause only a slight increase in conversion to coal and electricity from natural gas and petroleum. Investments in energy efficiency through retrofits and new process technology would still primarily be limited by capital availability and growth in product demand.

The fuel tax would have different consequences for each of the energy-intensive industries investigated. OTA found that a premium fuels tax would accelerate energy self-sufficiency and decrease natural gas consumption in the paper industry. The petroleum refining industry might be affected by a premium fuels tax in two ways: 1) some energy-related projects would be given a higher priority, and 2) earnings would decline because of a general decrease in product demand. In the chemicals industry, the domestic impact of a premium fuels tax is potentially detrimental. The greatest impact would likely be on the ability of the industry to export products as well as to make the domestic market more vulnerable to imports. Finally, a premium fuels tax would be least detrimental to the steel industry because only a small percentage of the industry's energy is derived from petroleum sources.

The best way to improve energy efficiency is to promote general corporate investment by reducing the cost of capital. Corporations that believe energy prices will continue to rise have a strong impetus to use capital for more energy-efficient equipment. Low interest rates affect energy efficiency to the extent that lower rates may allow a company's cash flow to go further, its debt service to be less burdensome, or its ability to take on more debt to increase. Lowering interest rates would increase capital availability and therefore allow more projects to be undertaken. Improvement in capital availability would magnify the effect of the ACRS because the ability to make use of the latter depends on the investment climate. **At the same time, however, it should be recognized that growth in product demand is essential if investment is to take place, even with lower interest rates.**