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The International Energy Agency (IEA) was formed by the United States and other industrial nations in response to uncertainties over availability of oil and oil prices. The President's energy program emphasizes the reduction of demand through conservation, but the United States has lagged behind other members of IEA in adopting conservation measures. The conservation policies and practices of four European countries--United Kingdom, West Germany, Sweden, and Denmark--were examined to develop information on effective measures applicable to U.S. efforts. Findings/Conclusions: Although quantitative information on energy conservation activities of the countries studied was not available because some measures were not instituted primarily for conservation and some were not in effect long enough, some successful measures were identified. In the United Kingdom, increased insulation standards for new housing units are expected to save 15% more energy than former standards, and savings in industry are expected through consulting and advisory programs and better housekeeping practices. In West Germany, savings of 8 to 12 million tons of coal equivalent per year are anticipated by 1985 from tax credits to industry for district heating or use of garbage for powerplants. In Sweden, new building standards are expected to increase energy savings by 40% annually, and expansion of a refuse incineration plant is expected to result in annual savings of about 160,000 barrels of oil. In Denmark, increased standards for new buildings are expected to achieve savings of 39% to 55%, and savings are expected to result from a retrofit program for government buildings, from insulation and boiler projects, and from district heating. Levies of progressive taxes in three of the countries on engine size or vehicle weight result in purchases of more efficient automobiles. Recommendations: The Secretary of Energy, in consultation with the Secretary of State, should evaluate the applicability of foreign conservation measures to U.S. energy

conservation efforts and consider how best to: develop a foreign conservation data base, assess potential for U.S. use, identify U.S. users of such information, and distribute the information as quickly as possible to those concerned. (Author/HTW)



04555

UNITED STATES GENERAL ACCOUNTING OFFICE

U.S. Energy Conservation Could Benefit From Experiences Of Other Countries

The President's energy program emphasizes that demand should be reduced through conservation. Because the United States has lagged behind other members of the International Energy Agency in reducing energy consumption, GAO sought to identify successful energy conservation measures of other countries which might be used in U.S. conservation efforts.

U.S. officials agreed that other countries have more energy-efficient concepts, products, systems, and operations than does the United States. GAO suggests that a coordinated effort be made to identify, assess, and distribute such information to U.S. users.



UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

ENERGY AND MINERALS
DIVISION

3-178205

The Honorable
The Secretary of Energy

Dear Mr. Secretary:

The President has emphasized reducing energy consumption through conservation, and the International Energy Agency has reported that the United States lags behind other members in energy conservation. In view of these facts, we examined energy conservation policies and practices of four European countries and developed information on those effective measures which seemed to be applicable to U.S. efforts.

The measures were discussed with cognizant U.S. officials, who generally agreed that foreign countries have concepts, products, systems, and operations that are more energy efficient than those of the United States. Some U.S. agencies, before becoming part of your Department, began to evaluate foreign technologies, but there is no systematic Government program for identifying and assessing the benefits to be derived from the foreign conservation experience. Therefore, we are recommending that the applicability of foreign experiences to U.S. efforts be more fully evaluated. Such an evaluation should consider how best to

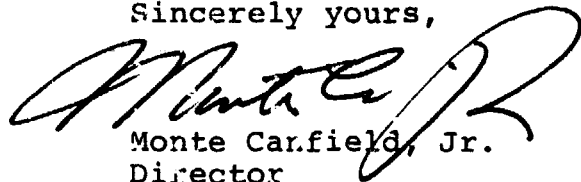
- develop a foreign conservation data base,
- assess the potential for U.S. use,
- identify U.S. users of such information, and
- distribute the information as quickly as possible to those concerned.

As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to

submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the four committees mentioned above and to the Chairmen of energy-related Congressional committees. We are also sending copies to the Acting Director, Office of Management and Budget; and to the Department of State.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "Monte Carfield, Jr.", written in dark ink.

Monte Carfield, Jr.
Director

GENERAL ACCOUNTING OFFICE
REPORT TO THE SECRETARY OF ENERGY

U.S. ENERGY CONSERVATION
COULD BENEFIT FROM
EXPERIENCES OF OTHER
COUNTRIES

D I G E S T

A cornerstone of the President's energy program is to reduce demand through conservation. The International Energy Agency's 1976 conservation review reported that the U.S. conservation programs lagged behind those of other nations. Cognizant U.S. officials generally agree that other countries have more energy-efficient concepts, products, systems, and operations than does the United States.

Some U.S. agencies have begun to devise programs to evaluate foreign energy conservation technologies. These programs are extremely modest in terms of the range of energy conservation policies and practices of foreign countries.

NEED FOR COORDINATED APPROACH

There is no systematic U.S. Government program to identify, assess, and distribute information about conservation experiences of other countries that could be used in U.S. conservation efforts.

The President's emphasis on conservation and creation of a new Department of Energy to centralize energy activities provides the impetus and organization for a coordinated, systematic evaluation of conservation measures by other countries to determine which concepts, products, systems, and operations could make U.S. energy conservation efforts more effective.

EUROPEAN EXPERIENCE

GAO identified successful energy conservation measures in Europe which seemed applicable to U.S. conservation efforts.

Energy savings achieved by the United Kingdom, West Germany, Sweden, and Denmark could not be measured for the most part because

- data was not collected by the countries for measures which were instituted primarily for purposes other than conservation,
- sufficient time has not elapsed to measure results, and
- energy reductions may have resulted from other than conservation factors, i.e., weather conditions or recession.

Below are examples of these countries' energy conservation measures. (See ch. 2 and app. I.)

The United Kingdom

Increased insulation standards for new housing units, effective in 1975, are expected to save 15 percent more energy than standards implemented in 1973. Insulation of existing public housing has created jobs and is expected to achieve average energy savings of about 25 percent. Industry consulting and advisory programs are expected to achieve energy savings estimated as high as 25 percent in some industries. As much as 10 percent in savings through better housekeeping practices promoted by energy managers is anticipated for industrial plants.

West Germany

Energy savings of 8 to 12 million tons of coal equivalent per year are anticipated by 1985 from tax credits to industry for district heating or use of garbage for powerplants.

Sweden

Building standards applicable after July 1, 1977, are expected to increase energy savings by 40 percent annually. Expansion of

a refuse incineration plant is expected to result in annual savings of about 160,000 barrels of oil at a current value of about \$2.2 million.

Denmark

Increased standards for all new buildings effective in February 1979 are expected to achieve savings of 39 to 55 percent. A retrofit program for government buildings has a two-fold objective of providing jobs and reducing energy consumption. Anticipated savings from insulation and boiler projects are 12 to 15 percent and 25 to 30 percent, respectively. Energy savings estimates for district heating range from 15 to 60 percent, and the heat/powerplants burn coal, which reduces dependency on imported oil.

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Three of the four countries levy progressive taxes on either engine size or vehicle weight, with the result that buyers opted for more efficient automobiles.

RECOMMENDATIONS

In view of the general agreement among U.S. officials that energy practices and products of other countries are more energy efficient than those of the United States, the Secretary of Energy, in consultation with the Secretary of State, should evaluate the applicability of proven foreign conservation measures to U.S. energy conservation efforts and consider how best to

- develop a foreign conservation data base,
- assess potential for U.S. use,
- identify U.S. users of such information, and
- distribute the information as quickly as possible to those concerned. (See p. 21.)

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ABBREVIATIONS

EPA Environmental Protection Agency

CHAPTER 1

INTRODUCTION

Since the energy crisis in late 1973, increasing demand and diminishing domestic oil and gas reserves have magnified the growing U.S. dependence on imported oil and gas. Because of the uncertainty over availability of oil and over future price increases, the United States and other industrial nations 1/ in 1974 formed the International Energy Agency (IEA) as an independent body under the Organization for Economic Cooperation and Development (OECD), in part to find ways to lessen their dependence on imported oil. IEA's long-term cooperation on energy focuses on (1) energy conservation, (2) development of alternative sources of energy, (3) energy research and development, and (4) uranium enrichment.

IEA 1976 conservation review reported that the U.S. conservation program includes one of the most comprehensive education efforts in IEA but is severely hampered by low retail prices of all fuels, especially oil and gas. It noted that American's extensive use of these fuels makes it clear that U.S. retail prices must rise if U.S. industry and consumers are to take long-term conservation seriously.

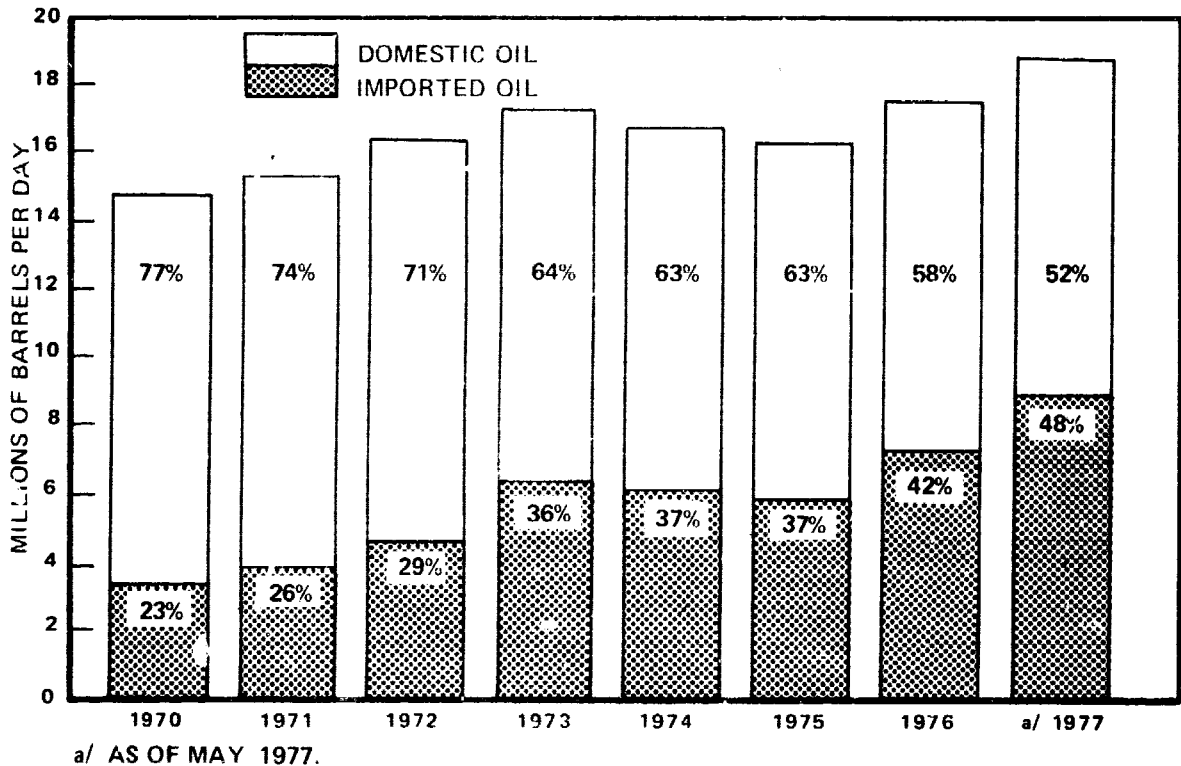
Because of this IEA report, we examined conservation practices which were being used effectively in the United Kingdom, Federal Republic of Germany, Sweden, and Denmark and which might benefit U.S. conservation efforts.

In October 1977 all IEA members agreed to limit oil imports from the Organization of Petroleum Exporting Countries to 26 million barrels a day by 1985--about 20 percent less than currently projected. This extremely ambitious goal underscores the importance that IEA members place on reducing consumption. To meet the 1985 import reduction goal, the members also agreed to certain guidelines, including commitments to energy conservation measures, pricing policies, increased use of coal, and an effort to bridge competing energy and environmental demands.

1/Currently includes Austria, Belgium, Canada, Denmark, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, Turkey, and United Kingdom.

ENERGY CONSUMPTION

The United States consumed an estimated 12.14 billion barrels of oil equivalent in 1975, about 54 percent of the total consumed by IEA countries. U.S. oil imports have increased greatly since the energy crisis, representing about 48 percent of oil consumption in the first half of 1977, compared with only 23 percent in 1970. Domestic and imported oil consumption is shown on the following chart.



Direct and totally reliable comparisons of energy efficiency between countries cannot be made, since energy consumption is affected by price, standards of home comfort (heating and cooling levels), weather, recession, freighting costs, and levels of industrialization. Nevertheless, certain conservation measures would result in more efficient use of energy in all countries.

Numerous studies have identified a wide range of estimates on potential energy savings in the United States. Former Secretary of State, Henry Kissinger, in addressing the energy crisis and world order on August 3, 1977, said that

"The United States is theoretically capable of reducing its energy consumption by as much as 30 percent without affecting the rate of growth of our GNP [gross national product] or our standard of living. In 1975, Americans wasted more fossil fuel than was used by two-thirds of the world's population. Energy is wasted whenever energy expenditure can be reduced without higher economic or social costs."

CONSERVATION TECHNIQUES

OECD's World Energy Outlook-1977 stated that a number of conservation measures can be implemented now, such as increasing retail prices for energy. It noted that firm and outspoken political commitments to the need for energy conservation by national leaders together with selected mandatory measures can heighten public awareness and create the psychological climate necessary to reinforce the need for conservation efforts.

The report also stated that automobile and transportation efficiency standards, industry conservation monitoring and insulation standards, and building codes could be implemented now to realize energy savings in future years. To realize the potential benefits, however, programs must be balanced with their economic costs to individuals, the economy in general, and their overall effect on the lifestyle of the people.

These concerns are addressed in President Carter's April 1977 National Energy Plan, ^{1/} which identified conservation as a cornerstone. The Plan states that, by reducing the need for additional oil imports, conservation and improved efficiency in the use of energy can contribute to national security and international stability. The President acknowledges that the American people will have to make some sacrifices but, if properly implemented, the proposed Plan would not cause major changes in the American way of life and would be fully compatible with economic growth.

CONSERVATION EFFECTS

IEA stated that future energy policies should retain a balance between expanding energy supplies and restraining energy demand through conservation--that a barrel of oil saved is as useful as one produced. Many contend that conservation is better in many respects because it:

- Reduces dependence on oil imports.
- Buys time to develop and implement more long-term energy solutions.
- Can result in more efficient application of finite resources, thereby reducing waste.
- Reduces environmental damage and pollution.
- Can improve balance of trade for importers.
- Can create new job opportunities through such activities as retrofitting older buildings.

In previous reports and in congressional testimony, we discussed energy conservation's potential role in future energy policy and offered proposals for conservation programs. This report focuses on effective conservation measures used in several European countries and examines U.S. efforts to benefit from them.

^{1/}Our July 25, 1977, report, "An Evaluation of the National Energy Plan" (EMD-77-48), contains a detailed evaluation of the President's Plan.

SCOPE OF REVIEW

We met with American Embassy and government officials in Denmark, the Federal Republic of Germany, Sweden, and the United Kingdom and IEA and OECD representatives in Paris, France. We also contacted officials of Federal departments and agencies in the Washington, D.C., area responsible for energy conservation programs, including the Departments of Agriculture, Commerce, Housing and Urban Development (HUD), Transportation, and State; Energy Research and Development Administration (ERDA); 1/ Environmental Protection Agency (EPA); and Federal Energy Administration (FEA). 1/

We discussed the observations in this report informally with officials of these agencies and considered their comments.

1/The Department of Energy Organization Act, August 4, 1977, transferred the functions of these agencies and certain energy-related activities of other agencies to the Department of Energy.

CHAPTER 2

ENERGY CONSERVATION MEASURES IN EUROPE

The energy conservation measures of the United Kingdom, Federal Republic of Germany, Sweden, and Denmark did not all come about as a result of the 1973 oil crisis. Many of them, such as progressive vehicle taxes, district heating, and building insulation standards, were already in existence as part of the socioeconomic structure of each country. Some of the measures implemented as a result of the crisis included new building standards, retrofitting of existing buildings, and financial incentives for industry.

The governments of these countries do not have quantitative information on their energy conservation activities because some were not necessarily instituted for conservation reasons and data was not collected to measure energy savings while others have not been in use long enough to be measured and because of the overall difficulties attributing savings to a specific factor. Therefore, we could not quantify the energy savings resulting from most of the specific measures in these countries, but it is generally accepted that the ongoing measures, irrespective of their motivation, have limited or reduced energy consumption.

The measures we examined which appear to have potential for U.S. local, regional, or national application are discussed below and in appendix I.

PRICING POLICIES

The IEA 1976 conservation report stated that the most important elements of energy conservation are prices and taxes. We found that a relatively high rate has traditionally been applied to most forms of energy in the countries we visited. Since 1973, however, even higher taxes have been imposed as a means of reducing energy consumption, especially on retail gasoline. In the spring of 1977, taxes ranged from 49 to 61 percent of the retail price of gasoline in all four countries, compared with about 19 percent for premium grade gasoline in the United States.

	<u>Gasoline</u>	<u>Tax</u>	<u>Percent of tax</u>
Denmark	\$1.79	\$1.04	58
Germany	1.37	.84	61
United Kingdom	1.17	.57	49
Sweden	1.50	.77	51
Average	1.46	.805	55
United States	.67	.125	19

The U.S. tax represents total Federal and average State taxes. The President's National Energy Plan includes a request to authorize an additional tax on gasoline if specified annual gasoline consumption targets are not met. This tax would amount to 5 cents a gallon (up to a maximum total of 50 cents) if each year's consumption target was exceeded by at least 1 percent.

In Sweden gasoline taxes are used for rural electrification projects, investments for oil stockpiling facilities, and, more recently, to reduce energy consumption. In Germany most taxes are used for highway construction, with some earmarked for mass transit. The electricity tax in Germany is spent to subsidize coal use in powerplants. The United Kingdom and Denmark energy tax is imposed for general revenue purposes.

Pricing effects

Although none of the four countries could identify energy savings from higher energy prices, general agreement is that higher prices tend to reduce demand. OECD World Energy Outlook-1977 reported that:

"It has been difficult to identify separately the effect upon energy demand in the past two years produced alternatively by: recession, higher energy prices, milder weather and non-price conservation-- although all observers put the likely level of effect on these forces in that descending order."

Most of the officials contacted in the four countries agreed that pricing was crucial in determining whether citizens take conservation seriously. The officials believed that consumers will not independently try to conserve energy unless they perceive it to be to their advantage (i.e., financially foolish not to conserve).

THERMAL EFFICIENCY STANDARDS FOR NEW BUILDINGS

The United Kingdom, Federal Republic of Germany, Sweden, and Denmark had established national thermal efficiency standards for new buildings before the 1973 oil crisis; Danish buildings standards dated back to 1961. Since the oil crisis, these countries have placed increased emphasis on energy conservation and have passed new laws or amended existing laws to increase building efficiency standards to reduce heat loss. Some standards cover only new residences, others include all new buildings.

Although new laws are in various stages of implementation, the mechanisms for enforcing them are already in existence. Local housing authorities in all four countries are responsible for reviewing building plans, approving building permits, and making inspections during and after construction in accordance with national building standards.

Generally, the higher standards will increase building costs and decrease energy consumption, resulting in lower heating bills and eventual cost savings. Examples of energy savings estimated by the governments are as follows.

- The United Kingdom's increased insulation standards for new housing units, effective January 31, 1975, are expected to save 15 percent more energy than standards implemented in 1973.
- Sweden's building standards for all construction after July 1, 1977, are expected to increase energy savings by 40 percent over typical buildings constructed in the early 1970s.
- Germany's housing standards are expected to save 25 to 35 percent in home heating costs and to reduce energy consumption by 33 percent.
- Denmark's increased standards, which become mandatory in February 1979 for all new buildings, are expected to save 39 to 55 percent in energy use for a single family home.

Although we did not attempt to evaluate or verify the basis for these estimated savings, we believe that the measures will accrue substantial savings in energy.

RETROFITTING PROGRAMS

The law increasing thermal efficiency standards for new buildings has left a large area of potential energy conservation untapped--the existing stock of buildings whose construction has covered a wide span of styles, materials, years, and progressively increasing construction standards. To fill this gap, the governments of the four countries have enacted legislation providing financial assistance to encourage energy conservation in existing buildings by retrofitting--improvements to obtain energy efficiency.

The grant and loan programs of Sweden, Denmark, and Germany concentrate on the private sector, while the United Kingdom provides labor assistance for the public housing sector. Denmark also began a program for government buildings in 1975 to improve energy efficiency and to provide employment opportunities.

FINANCIAL INCENTIVES FOR INDUSTRY

The four countries all offer grants, loans, and/or tax allowances to reduce industrial oil use by

- adding insulation,
- improving heating systems,
- using waste or coal in lieu of imported oil for heating,
- improving industrial processes,
- investing in heat recovery techniques, and
- developing prototype and demonstration projects.

The actual energy savings or the success in shifting to readily available fuels could not be identified. However, experience in Denmark and the United Kingdom indicate that incentives must be large enough to be considered economically beneficial by industry.

CONSULTING OR ADVISORY PROGRAMS FOR INDUSTRY

Sweden and the United Kingdom have government sponsored industrial consulting or advisory programs on energy conservation. In the Federal Republic of Germany, nongovernment

agencies advise small- and medium-sized firms on energy savings techniques.

- Some of the ways in which industry is assisted include
- 1-day visits to identify good housekeeping techniques,
 - followup visits to check on implementation and savings achieved,
 - longer visits (up to 2 weeks) to identify possible technological changes and research and development projects,
 - an energy manager for each plant, and
 - courses in a school of fuel management.

PROGRESSIVE VEHICLE TAXES

Germany, Sweden, and Denmark levy progressive taxes on vehicles which make it more expensive to own large or high-powered vehicles. Although actual energy savings and effect of the taxes on the types of cars being purchased could not be clearly identified, the very nature of the taxes make it likely that many people will be motivated to purchase more fuel-efficient automobiles. The type of tax and applicable rate for the three countries are as follows:

- Germany has an annual tax of 99 cents per cubic inch of displacement on automobile engine.
- Sweden imposes an initial tax on cars of 25 cents a pound up to 3,520 pounds (\$880) plus \$69.88 for each additional 110 pounds. In addition, the car owner must pay a yearly progressive road tax of \$43.61 for gross weight up to 1,980 pounds plus \$10.12 for each additional 220 pounds.
- Denmark has a weight tax which is paid semiannually-- \$75.94 for up to 1,320 pounds; \$219.38 for 2,861 to 3,300 pounds; and \$303.75 for over 4,400 pounds plus \$16.88 for each additional 220 pounds.

Annual vehicle taxes imposed by these three governments based on selected weights and engine displacements are shown below.

	Vehicle taxes for			
	3,520-pound cars		1,900-pound cars	
	(engine size in cubic inches)			
	<u>140</u>	<u>300</u>	<u>140</u>	<u>300</u>
Denmark	\$607.50	\$607.50	\$253.12	\$153.12
Sweden	114.45	114.45	43.61	43.61
Germany	138.60	297.00	138.60	297.00

There is no U.S. Federal tax based on size of engine or weight of car. However, the President's National Energy Plan proposed an excise tax on less fuel-efficient automobiles and a rebate for new cars which are fuel efficient.

DISTRICT HEATING

Several European countries have found that significant amounts of heat can be supplied to buildings throughout a city by distributing low-grade heat (usually below 212°) from a central heat source via an extensive pipe network using hot water or steam. This process is called district heating.

This process requires a large, dense area of demand for heat, costly investment in pipe networks, and close proximity to a heat source. Therefore, district heating is normally associated with large, densely populated cities where capital investment costs per unit are minimized and can be offset against long-term savings in heat production. The concept and technology of district heating are well established and there is little technical risk in introducing it, but experience suggests it takes many years to develop or convert a major part of a city to the process.

District heating has fuel flexibility in that a central heating plant can use the fuel (oil, coal, refuse) which is the most economical for the customer. It can also use the otherwise waste heat from existing thermal power, industrial, refuse incineration, or nuclear powerplants.

Cheap waste heat from powerplants near high density areas has influenced the development of European district heating schemes. District heating has flourished in Denmark and Sweden, achieved moderate use in Germany, and is almost nonexistent in the United Kingdom.

REFUSE INCINERATION PLANTS

The original purpose of refuse incineration plants in Europe was to dispose of municipal waste where land was too costly or unavailable for use as dumping areas. Since the early 1970s, the heat output from trash incineration has been harnessed for heat or electrical production for residential and commercial sectors in Europe.

Refuse incinerators will be increasingly considered by European countries as demand grows on land and natural resources. Refuse incineration plants are costly investments and are usually owned by a municipality or a partnership of municipalities. The Federal Republic of Germany is the only one of the four countries which provides tax incentives to build these plants, but municipalities in Sweden and Denmark extensively use them as energy sources.

Sweden has 14 refuse incineration plants providing electricity, or heat and electricity. In Stockholm we visited a plant which started operation in 1970. It was built at a cost of \$16 million, operates 24 hours a day, and serves approximately 450,000 people. The 100,000 tons of refuse incineration each year produces the heat equivalent of about 200,000 barrels of oil. The entire operation, from refuse collection to deposit of waste ash, is done at a slight profit. This includes refuse collection fees and revenue from the sale of the electricity generated. The plant is to be enlarged at a cost of \$916 million so that by 1979 both heat and electricity can be produced. The steam generated will be sufficient to heat about 10,000 apartments. The incineration of waste will provide 80 percent of the fuel needed to run the plant. It is estimated that this expansion will result in annual savings of about 160,000 barrels of oil at a current value of about \$2.2 million.

In Denmark, waste heat from incineration plants has been used for district heating but not electricity production. The plants are owned and operated by the municipalities. Copenhagen built two large plants since conventional disposal of refuse in the vicinity of the city became no longer environmentally sound. We visited one of these plants, built in 1970 at a cost of \$20.4 million, which uses heat from refuse incineration for district heating. It draws on a population of 500,000 people and heats 20,000 homes.

CHAPTER 3

U.S. ENERGY CONSERVATION MEASURES AND GOVERNMENT'S

ROLE IN ASSESSING FOREIGN MEASURES

Governments must assume the lead in influencing, directing, and legislating the changes necessary for effective energy conservation. In the United States, the executive branch and the Congress have recognized the importance of energy conservation, as demonstrated by administration initiatives, legislation enacted, and the President's energy message of April 1977.

To ascertain whether U.S. energy conservation policies and practices might benefit from the European experience, we contacted executive branch agencies involved in energy conservation activities. We sought information on U.S. agencies' efforts to identify foreign conservation programs in general and, more specifically, the conservation practices identified in our review and the actions they had taken to benefit from the foreign experience. We also identified existing U.S. programs corresponding to the selected foreign energy conservation practices.

U.S. officials generally acknowledged that certain foreign products and practices, including all the measures identified in our review, can be used to consider ways to effect energy savings in the United States. We found, however, that there is little coordinated effort in Government to identify, assess, and distribute information about foreign conservation experiences.

Officials of several agencies agreed that European countries are well ahead of the United States in energy conservation because they have traditionally had high prices on energy whereas the United States has traditionally maintained low prices. Examples of European conservation measures which we compared to U.S. programs and agency comments on them are presented below.

THERMAL EFFICIENCY STANDARDS

No U.S. national standard has been developed applicable to thermal efficiency for new buildings. In an effort to develop such standards, the Energy Conservation and Production Act, amended August 14, 1976, required the Secretary

of Housing and Urban Development, 1/ after consultation with the Federal Energy Administration and the Department of Commerce, to develop performance standards to achieve the maximum practicable improvements in energy efficiency. The Administrator of General Services is to be consulted only for commercial buildings. These standards would have to be met in order to obtain financing from a federally insured lending institution. The act allows up to 3-1/2 years to develop the standards and 5 years to become effective. President Carter, in his National Energy Plan, directed that the effective date of the mandatory standards be advanced 1 year, from 1981 to 1980. Grants may be made to State and local governments to assist them in meeting the cost of adopting and implementing performance standards. The act authorized appropriations for the grants up to \$5 million for the fiscal year ended September 30, 1977, but we were told that these funds were never requested.

A HUD official responsible for developing the standards stated that HUD has not and is not planning to assess European thermal efficiency standards because the U.S. law requires performance standards for the overall use of energy for a building, whereas standards in the four countries visited are based on a maximum heat loss for specific building components (roof, outer walls, floor, windows, etc.).

Officials of several agencies responsible for Federal standards for homes financed under certain Government loan programs and for developing energy-efficient building designs do not consider overall performance standards feasible, at least over the next few years. They noted that Sweden and HUD had tried unsuccessfully to develop and implement such standards. These officials believed it would be more realistic to adopt component standards similar to those used since 1974 to qualify for loans administered by HUD and the Farmers Home Administration. The Farmers Home Administration has recently developed and proposed more stringent standards to (1) reduce energy consumption for homeowners and (2) optimize the cost-effectiveness of additional energy-related improvements. Both the current and proposed standards, like the European standards, are based on allowable heat loss for specific building components.

The agency officials generally believe that the United States could benefit substantially from the experience of

1/The Department of Energy Organization Act, August 4, 1977, transferred this responsibility to the Secretary of Energy.

the foreign countries. Although they were generally aware that certain foreign countries have thermal efficiency standards for buildings, no objective assessment has been made to ascertain whether the European experience could benefit the United States. European experiences which could benefit the United States include identification of (1) overall application of thermal-efficient technologies, (2) how the various programs were implemented on the national level, (3) adverse effects brought about by such implementation, and (4) how the standards are enforced.

RETROFITTING PROGRAMS

Retrofitting of existing buildings in the United States is done in both private and Federal sectors. The United States has made some progress in promoting energy conservation for houses by providing financial assistance. The Congress has approved several programs in the past few years; however, some of them have been funded at levels substantially less than the Congress authorized. For example, the Energy Conservation and Production Act, authorized:

--FEA up to \$55 million in fiscal year 1977 to assist in achieving a prescribed level of insulation in dwellings owned or occupied by low-income persons, but only \$27.5 million was appropriated.

--HUD up to \$200 million to test the feasibility and effectiveness of various forms of financial assistance for encouraging the installation or implementation of approved energy conservation measures in existing dwellings, but no funds were appropriated. The Department of Energy Organization Act, August 4, 1977, transferred this program responsibility from HUD to the Department of Energy.

We could find no evidence that any Federal agency had assessed European retrofitting practices to learn from the experiences and reduce the time required to develop and implement similar programs. FEA officials stated that the European experience could be useful in promoting energy conservation in existing buildings.

CONSULTING AND ADVISORY PROGRAMS FOR INDUSTRY

In 1977 FEA initiated a series of half-day and full-day energy management conferences and workshops throughout the United States to help business and industrial decisionmakers

and managers identify the greatest opportunities for energy savings. The program will cost about \$3 million.

Although a 1976 review by the International Energy Agency identified consulting and advisory programs for industry in several foreign countries, FEA officials were not aware of them. They said that an assessment of other countries' programs would have been useful in developing the U.S. program and could have reduced the time required for planning and implementation.

DISTRICT HEATING

Several agencies are involved in identifying the use of district heating in foreign countries. Most of their studies, however, do little to assess how foreign technologies and experience can be used to improve U.S. implementation of district heating.

The Energy Research and Development Administration recently initiated a project to identify foreign district heating projects and particularly to assess potential for adopting Swedish standards and programs for the United States. A test project may be started in the Minneapolis-St. Paul area using the experience obtained in Sweden.

An ERDA official stated that using the experience of foreign countries and assessing their potential application for the United States is just being initiated. He added that this approach has been neglected in the past and even now the effort is relatively small in terms of potential benefits.

REFUSE INCINERATION PLANTS

Several agencies have been involved with the operation of refuse incineration plants. Both the Environmental Protection Agency and ERDA have contracted for studies of European waterwall incinerators, a specialized method of solid waste disposal. After potential overlap was recognized, the EPA study was redesigned to complement and expand upon the ERDA study.

The EPA contract, which was let in October 1976 at a cost of \$165,000, was justified on the basis that:

"Waterwall incinerator technology in this country is vested in only six facilities built between 1967 and 1976. In Europe, South America and Japan there

are several hundred units in operation or under construction. The sophistication with which these systems have been incorporated into the community is impressive. Many are located in the midst of dense residential neighborhoods. Heat recovered from the combustion of waste is used to generate electricity or is used in district heating systems. Some systems involve waste disposal, electricity generation and steam or hot water distribution in what is referred to as a 'total energy' system.

"Despite this widespread use and acceptance of this type of technology in other parts of the world, the concepts are receiving only mild acceptance here. One of the major problems is that substantive data of the type that an American decision maker or designer would require is just not available. Most information reaching this country amounts to brief plant descriptions presented by the operators of the facilities or the system designers. Problems, if mentioned at all, are not discussed in detail.

"A great deal of expertise in the design and operation of such plants which exists in Europe is not being utilized in this Country. Although several European equipment manufacturer's [sic] are marketing their components in this Country, effective utilization will not occur unless we can learn from the European experience."

The contract, which was to be completed in 1978, is to assess the technical, environmental, and economic effectiveness of European waterwall incinerators and to provide American decisionmakers and designers with the detailed information they need to incorporate the positive aspects of European incinerator design as it has emerged during the past 10 years.

EPA officials believe much more can be done in solid waste disposal. One official stated that an indepth, technical assessment, and dissemination of applicable foreign technology advancements would be more useful but that manpower and funding limits preclude such a program. Problems in constructing a municipal refuse incineration plant in Tennessee could have been substantially reduced had such knowledge been available. We were told that erosion and corrosion of boiler tubes will be a recurring problem and that future repairs can cost several hundred thousands of dollars over the life of the plant.

OTHER CONSERVATION MEASURES

U.S. officials agreed that the financial incentives to industry and progressive vehicle taxes used in Europe to conserve energy could be useful in efforts to develop U.S. energy conservation policies and practices. For example, the various financial incentives in the President's National Energy Plan could be evaluated against other countries' policies and practices. Financial incentives for industry could especially be useful to promote energy efficiencies in industry. An FEA official told us that the most frequent comment by about 2,100 chief executives of major companies was that tax incentives promote energy conservation. Also, an FEA-sponsored study in 1975 identified the value of foreign experience in developing programs to provide financial incentives to U.S. industry to invest in energy conservation technology. The publication of the information was delayed, but a report is now expected to be published toward the end of 1977.

ROLE OF FEDERAL GOVERNMENT

A more systematic assessment of foreign energy conservation practices would reduce the time required to develop and implement U.S. conservation programs. The passage of legislation creating a new Department of Energy provides a basis for a more coordinated approach to developing a method for tapping foreign conservation experience. The Department of Energy is to reorganize energy functions within the Federal Government and to develop effective management procedures for a coordinated national energy policy. The stated findings of the Congress in passing the legislation are as follows.

- Responsibility for energy policy, regulation, research, and development is fragmented in many departments and agencies, and thus does not allow for the comprehensive, centralized focus necessary to effectively coordinate energy supply and conservation programs.
- Formulation and implementation of a national energy program require the integration of major Federal energy functions into a single department in the executive branch.

Under legislation, an Assistant Secretary will be responsible for international programs and policy. It is too soon to tell what priority will be given to developing information on proven foreign energy-conserving products and

practices and disseminating it to Government, industry, and consumers.

We learned of several past proposals made by Federal agencies to use the foreign experience to assist U.S. conservation efforts. These proposals generally lacked high-level agency support, but there are indications that they are now receiving more favorable consideration. Two proposals to assess foreign products and practices for possible adoption by U.S. industry are described below.

Department of Commerce-ERDA international technology sharing program

A project to share technology internationally was conceived early in 1976 on the general consensus of various Federal agencies that there are indeed many concepts, products, systems, and equipment being used in foreign countries that are more energy efficient than their U.S. counterparts. It was noted at that time that no Government agency appeared to have responsibility for gathering information on foreign energy conservation and disseminating it to the proper parties.

In August 1977 the Department of Commerce, in cooperation with ERDA, formally launched a program to improve the energy efficiency of U.S. industry by informing American businessmen of energy efficient equipment and processes in use or available in foreign countries. The program's feasibility will be tested by a data survey conducted through selected Foreign Service posts. Two approaches are being considered. The first would center on identifying energy-efficient technologies for one or more energy-intensive industries (e.g., glass, aluminum). The second would focus on products and processes available for sale or license to U.S. industries in a specific geographic area and the information would be disseminated through a published periodical. Under either approach, American business will benefit from proven and available energy-efficient items and techniques.

A Commerce official advised us that requests for bids for the surveys will probably go out in December 1977. The contract would be funded by ERDA at a cost of about \$100,000.

International technology transfer

In 1975 FEA contracted for a study to review the international technology transfer, as applied to the industrial sector. This included channels of transfer, barriers to and

incentives for transfer, and the role the Government might have in promoting the transfer. The plastics, petroleum refining, steel, and cement industries were used as examples of how industrial energy could be conserved through the use of foreign technology and the extent to which energy use was reduced in specific cases.

The draft report with specific recommendations was completed by the contractor in December 1975. We were told that FEA did not support the recommendations and delayed publication of the report. The report noted that, with few exceptions, the United States could benefit by importing foreign energy conservation technology. It stressed the importance of U.S. Government support of foreign technology transfer to help U.S. technology development programs and recommended Government initiatives to identify and assess foreign technology with a view to improving U.S. industrial energy efficiency.

ERDA supported the report findings and recommendations and plans to publish it soon. ERDA officials advised us that they subsequently received FEA support for the report findings and for its publication.

Despite ERDA's extensive involvement with identifying foreign energy-efficient technologies, it was not authorized to develop regulatory or legislative initiatives to implement conservation practices in the United States. FEA has had such responsibilities, including the development and implementation of equitable voluntary and mandatory energy conservation programs, and the efficient use of energy resources. As noted earlier, the creation of the Department of Energy combined these functions as of October 1, 1977.

ROLE OF MUNICIPALITIES

The needs of U.S. cities were emphasized during an FEA-sponsored conference in 1977 of the National League of Cities and the U.S. Conference of Mayors aimed at developing energy conservation guidelines for the cities. In an August 26, 1977, news conference, the mayors of cities pointed out that, although 75 percent of the U.S. population lives in 266 metropolitan areas, the administration has failed to recognize that energy conservation will succeed or fail depending on what happens in the metropolitan areas. They suggested that, through local media and town meetings, the authorities within each metropolitan area could begin to make serious and realistic attempts at energy conservation.

A Swedish study identified systematic municipal energy planning as a way of attaining national energy objectives and proposed legislation imposing this responsibility on the municipalities. The Swedish Government has supported this concept with several energy-related development projects.

CONCLUSIONS

The International Energy Agency's 1976 review of member nations' conservation policies and practices reported that the United States lagged behind in conservation results. Our review identified substantial savings achieved or expected from European conservation measures. U.S. officials generally acknowledged that certain European energy practices and products are more energy effective than those of the United States. However, there is no systematic U.S. Government program to identify, analyze, and distribute foreign conservation experiences that could assist U.S. energy conservation efforts.

The recent initiatives by the Department of Commerce and ERDA in seeking to identify foreign energy-efficient technology and products indicate awareness of the potential in examining foreign conservation advances. However, a comprehensive and coordinated approach is needed to develop information pertinent to U.S. conservation efforts.

The integration of major Federal energy functions into the newly established Department of Energy will permit the comprehensive and central focus necessary to effectively coordinate energy supply and conservation programs.

Federal officials should be mindful of the needs of regional and local governments in developing U.S. conservation efforts.

RECOMMENDATIONS

We recommend that the Secretary of Energy, in consultation with the Secretary of State, evaluate the applicability of proven foreign conservation measures to U.S. energy conservation efforts and consider how best to

- develop a foreign conservation data base,
- assess the potential for U.S. use,
- identify U.S. users of such information, and
- distribute the information as quickly as possible to those concerned.

ADDITIONAL INFORMATION ON EUROPEAN ENERGYCONSERVATION MEASURESTHERMAL EFFICIENCY STANDARDS
FOR NEW BUILDINGSSweden

In June 1976 the Swedish Government amended its building ordinance to provide for greater energy conservation in all buildings constructed after July 1, 1977. Buildings constructed under the new standards are expected to use 40 percent less energy than buildings constructed in the early 1970s.

This will save 10,000 kilowatt hours a year in an average single-family home and 9,000 a year in an average apartment but the new standards will increase building costs about 5 percent--about \$1,800 for a single-family home and \$1,450 for an apartment. Energy savings for offices, schools, hospitals, and factories are estimated to be at least on the same scale, with proportionately less increase in cost. These savings are expected to be achieved by 25 percent better thermal insulation and improved airtightness.

The new standards were drafted in close cooperation with the other Nordic countries, Denmark, Finland, Norway, and Iceland and are reportedly based, to the extent possible, on performance requirements supplemented by layout and technical construction requirements of the building. Deviations from the regulations are permitted if it can be proved that they will not increase total energy consumption. This allows the designer some freedom to design the building within prescribed limits and does not impede technical development. The regulations were also based upon current techniques and products which are readily available or which could be developed soon.

An earlier criterion considered by Sweden was to restrict energy consumption of a building to a specified amount per square footage or cubic volume. This had to be abandoned, however, as the parameters are too numerous and their complexity and interaction were not known.

Denmark

Denmark has had building insulation requirements since 1961. The law allows the Ministry of Housing to establish

building standards without parliamentary approval. Traditionally, the regulations are updated every 5 years. The latest standards, established in February 1977, become effective in February 1979 and will double the insulation requirements in effect since 1972. Danish officials told us it was not politically feasible to require the new standards to take effect earlier. One reason noted was the substantial changes placed on the construction industry.

The new building code also restricts the use of glass in the outer wall to 15 percent of the gross floor area of the building unless it is proved that heat loss will not be increased. Danish authorities believe this will result in many small buildings having triple glazed windows.

The increased construction cost is estimated at 1.4 to 5.4 percent for a single-family home, with resultant savings of 39 to 55 percent in the homeowner's fuel bill. The additional investment is expected to be paid back in energy savings over a period of 4 to 10 years. Similar estimates also apply to larger buildings.

Danish officials told us that enforcement of the standards will be left up to local authorities who must approve the standards before construction begins and who will also have the right to inspect the buildings during construction and at completion. Construction plans must be approved before construction loans can be obtained. We were further advised that if a person does not build to meet required standards, he is held liable for upgrading to such standards. Thus, if a person sells the house, the new owner has the right to have the home inspected and, if it does not meet standards, the builder/old owner must upgrade.

RETROFITTING PROGRAMS

United Kingdom

In August 1976 the United Kingdom expanded an existing job-creation program to include roof insulation of housing units and other buildings owned by local housing authorities (approximately 2.5 million buildings). The new program is to provide worthwhile employment on projects which seek to provide community benefit with one of the cost-effective methods of energy conservation.

The local housing authorities submit applications detailing the number of homes to be improved and the number of jobs to be created. Once the government approves

applications, the authorities purchase the materials at 40-percent discount through contracts negotiated nationally by the government. The laborers, who are hired by the government, install the insulation at no cost to the authorities. The material costs about \$41 per unit and may be passed on to the renter through increased rent payments.

During our review, about 100,000 housing units were expected to be insulated under the program. Government officials estimate that energy savings will average about 25 percent for houses covered by the program. They noted that the savings could be less, depending on the residents' reactions to lower fuel bills, which could cause the residents to increase temperatures in their dwellings over their current temperatures. Also, the potential savings vary by buildings, depending on the type of structures and current insulation.

Denmark

The Danish grant program, to promote energy conservation in the residential/commercial sector, was initiated in 1975. The program had a two-fold purpose of increasing employment and encouraging energy savings in buildings constructed before 1965. The program was most recently extended in March 1977. Local authorities are responsible for approving applications and disbursing funds under the grant.

The grants range from \$87 to \$347 and are authorized for 25 percent of the approved expenditures for insulation and other energy saving measures for buildings not used for business. As of early 1977, approximately \$69 million had been granted under the program and an additional \$26 million had been approved. The government had not measured the energy savings.

As a result of the energy crunch in 1973, the government enacted a program to insulate and improve thermal efficiency in government owned and subsidized buildings. This program was enacted in September 1975 and required government agencies to submit requests to implement these improvements. The requests were evaluated on the bases of (1) cost of the project, (2) estimated energy savings, and (3) opportunities for employment under the project.

Although no specific criteria for approving the projects had been established, the general guidelines were that the costs attributed to new employment opportunities be at

least 50 percent of the project costs, and the project must achieve at least 10 percent energy savings. The ministry of housing is anticipating 12- to 15-percent and 25- to 30-percent yearly energy savings for insulation and boiler efficiency projects, respectively.

During September 1975 to March 1977, the authorized \$26 million was spent on government buildings under this program; an additional \$7.7 million was approved in March 1977, which will provide employment for 350 people. The \$26 million represents about one-tenth of 1 percent of the government's budget for that period--this would be equal to more than \$300 million for a similar U.S. Government buildings program in terms of the U.S. yearly budget.

No official estimates have been made of the program's actual energy and related monetary savings, but a special group has been established to identify such savings. We were advised that the results of this study are expected by the summer of 1978. A ministry of housing representative told us that, prior to additional appropriations for this program, parliament will probably require detailed justification in terms of cost effectiveness.

FINANCIAL INCENTIVES FOR INDUSTRY

The industrial loan programs identified in the United Kingdom and Denmark have had only limited success in most cases. The United Kingdom made about \$5.3 million available 2 years ago, but to date only three loans totaling about \$170,000 have been completed. Loans are made at current interest rates and are repayable over a period of up to 5 years. There must be a 3-year payback of investment through energy savings or the loan will not be made. United Kingdom officials stated that the current interest rate was not attractive enough to stimulate industry to borrow the money.

Sweden began its grant program in 1974 to promote more efficient use of energy as well as the use of fuels other than oil for heating buildings. The government decided on a grant program as opposed to a loan program because grants were considered more appropriate to offset disadvantages caused by operational changes. The program offers industrial/commercial building grants, industrial process grants, and prototype and demonstration project grants. The first grant applies to firms with less than 200 employees, and the remaining grants are given to all companies regardless of size. As of November 1, 1976, about \$31.3 million had

been disbursed. The Swedish Government has proposed an additional \$40.2 million for fiscal year 1978.

The Danish grant program started slowly but has gained popularity. During fiscal year 1976, about \$17.4 million was made available for industrial grants and only \$7.5 million was disbursed. The grants were for only 25 percent of approved expenditures, and the businesses had to pay income taxes on the grants. In fiscal year 1977, the grants were increased to 40 percent of approved expenditures and the \$8.7 million available was disbursed in a short time. The business must still pay income tax on the grants. Danish officials concluded that the 25-percent grant did not offer enough incentive but that the 40-percent grant does. Another \$8.7 million for industrial grants was approved for fiscal year 1978 with the 40-percent grant provision.

Both the Federal Republic of Germany and the United Kingdom established tax incentives in 1975 to promote energy conservation, but neither country had any statistics on the number of industries taking advantage of these incentives nor the related energy savings actually effected.

Germany allows a 7.5-percent tax credit against the total cost for district heating or use of garbage for power-plants. It is estimated that energy savings effected by the tax credit will be between 4 to 6 million tons of coal equivalent per year as of 1980 and 8 to 12 million tons as of 1985.

The United Kingdom offers industry a 100-percent, first-year tax allowance on expenditures for adding insulation to existing industrial buildings. The tax allowance normally covers expenditures for roof lining, double glazing, cavity wall filling, and draft exclusion and may also include expenditures on such devices as flexidoors and air locks if they are fitted for the purpose of thermal insulation. Installation costs as well as the costs of materials are allowable.

CONSULTING OR ADVISORY PROGRAMS

The Governments of Sweden and the United Kingdom offer industrial consulting or advisory programs. The National Swedish Industrial Board is responsible for an education program for small- and medium-sized industries. Within this test program, 20 to 30 companies were offered the services of an energy consultant, free of charge, to visit their companies for 1 day to give advice on energy conservation

measures. Also, a small handbook on energy was published for small firms. For fiscal year 1977, the budget for these activities amounted to about \$723,000. The board also spent about \$386,000 offering different courses in heating, ventilating, and operating economies.

The United Kingdom offers three consulting services to industry, all completely voluntary.

- The department of industry, started sponsoring a service in November 1975 to provide medium to large firms with 1-day free visits by consultants to advise on straightforward energy saving measures; 4,000 visits are planned over a 3-year period at a cost of about \$2.2 million. Government officials estimate the potential energy savings to be 5 to 10 percent from this scheme. Only 20 percent of the firms contacted to date have accepted this assistance. The department of industry plans to follow up on 400 firms to learn whether they implement any of the consultants' recommendations and what energy savings were achieved.
- The department of energy offers a similar consultation service for smaller firms. The firm selects a consultant, from a list compiled by the department, to make a 1-day visit to the firm and identify energy saving measures. The department reimburses the firm one-half the consultants' fee and other costs up to a maximum of \$52.63. This service started in December 1976 and after 2 months, 15 to 20 firms had participated. Potential energy savings would be comparable to those under the department of industry's service; there are no plans to follow up on the visits to identify the degree of implementation or actual energy savings achieved.
- The third consulting service offers a more detailed analysis of about 12 processes and 12 products to obtain information on the use of fuel and materials in selected industrial areas. The consultants visit the firms for as long as 2 weeks and go beyond identifying good housekeeping techniques. They identify potential technological changes and possible areas for research and development. Both the departments of energy and industry are working on this service and have incurred costs of about \$921,000 for the visits and for compiling the data. Estimated potential energy savings from this service is 10 to 25 percent.

For the first two consulting services, reports are issued to the firms visited identifying the findings and making recommendations for improvements. Under the third service, firms visited will receive recommendations for using improved available technologies in their particular processes or products. Information will be gathered on ways in which fuel and materials can continuously be used to benefit either a particular industrial sector or the manufacturing industry as a whole.

Lastly, the United Kingdom promotes the energy manager concept in industrial plants. An energy manager can be the chief engineer, production manager, etc., but the manager must be someone who is backed by the authority of the directors and has the confidence of the work force. According to the department of energy, the energy manager should be able to reduce, by as much as 10 percent, a firm's energy costs simply by better housekeeping, without any capital investment by the firm. United Kingdom officials have no estimate of the number of existing energy managers, but about 1,600 persons have attended seminars presented by the department of energy over the past year.

Closely related to this is the school of fuel management run by the government controlled British Gas Corporation to promote energy conservation through:

1. Demonstrating to management various methods for reducing gas consumption in its equipment (good housekeeping).
2. Showing management how to educate its own employees to use gas more efficiently with no redesign or capital outlay.
3. Advising management of the long-term savings in fuel costs which can be achieved through capital investment programs in new plants and equipment.

The school offers several courses, three of which are directly related to the energy manager. Two of the courses are short (1-2 days), and the third is a week-long program going into more detail. The courses cost from \$17.50 to \$26.25 for the short courses to \$131.25 for the week course. Attendance at the courses has varied; over 5,000 attended the fuel savings in practice seminars, over 500 attended the director and senior management course, and over 200 attended the 5-day fuel managers and energy conservation offices in industry and commerce course.

DISTRICT HEATINGDenmark

District heating originated before World War II, and was actually reinforced by the war since people on public district heating networks received more reliable heat than those relying on their own heating systems. Denmark imports 98 percent of its energy, and district heating was instituted to reduce dependence on any one energy source.

Currently, about 460 district heating schemes supply 30 percent of total domestic heat needs--20 percent from central heating plants and 10 percent from combined heat/powerplants. The remaining domestic heat requirements are met by (1) group heating schemes (multiple dwelling heating)--23 percent, (2) individual central heating--35 percent, and (3) traditional stoves--12 percent. Energy savings achieved through district heating range from 15 to 60 percent, but more important is the opportunity to reduce dependence on imported oil since the heat/powerplants burn coal.

District heating is voluntary where it is available. The homeowner has a choice of whether to receive district heating or not. Of course, the more houses connected, the lower the unit cost. Few government subsidies have been available. Many of the schemes were developed using capital borrowed at only 6 percent interest. Moreover, part of the capital charges were borne by the consumer, who was able to obtain income tax relief on his interest payments. The commercial success of the Danish schemes is explained in part by these favorable low interest rates.

In late 1976, the Danish Government promoted a number of short-term municipal projects to expand heat transmission lines from combined heat/powerplants to areas supplied with district heat from local heat stations. The government provides 25 percent through financial grants of the cost of expanding distribution lines and local authorities pay the remaining 75 percent. Only six municipalities received the grant money because only \$7.8 million was available. It is too early to estimate savings from this program.

Sweden

District heating started in Sweden on a large scale about 1953. The district heating companies often started their networks in new apartment blocks and later expanded them into existing building areas. Combined heat and power

schemes were started about 10 years ago to meet electricity requirements and at present continue to occupy an increasing proportion of the district heating market. Future growth depends on public acceptance of nuclear power stations, since Sweden has no natural gas and the use of oil-fueled central heating is discouraged on environmental grounds. For new developments, the real alternative to district heating is electric space heating.

District heating supplies about 14 percent of Sweden's space and water heating requirements and reaches 35 percent of the population. It exists to varying degrees in all big cities and is connected to 21 percent of the housing units. Most of the 50 district heating schemes run on oil, but some burn refuse, and one uses a nuclear power station.

In the 1950s and 1960s, district heating increased at a rate which doubled subscribers every fourth year. This rate of development was projected to last until the end of the 1970s. The reduced consumption of other forms of heating was expected to save \$120.5 million yearly by 1980. Its extension into the larger metropolitan areas would also reduce corrosion costs of individual heating boilers by up to \$120.5 million a year. Thus, the total potential calculable gain to society represented by district heating growth was estimated at \$241 million annually by the end of the 1970s.

District heating is voluntary and no government loans or grants are available to foster its growth. In fact, the goal set for 1975 in expansion of district heating has not been achieved due to the financial constraints of the municipalities that own and operate the schemes.

Germany

District heating existed in Berlin as early as the 1920s, but it was not used extensively in other large towns until after World War II. By 1960, it accounted for 1 percent of Germany's space and hot water heating requirements. Its early development was mainly connected to combined heat/powerplants. However, the cheap oil era from 1958 to 1973 and the need for markets for domestic coal caused considerable expansion of district central heating schemes. Currently, various heating schemes are being explored, including the use of nuclear power stations.

District heating currently provides an estimated 7 to 8 percent of Germany's space and hot water heating

requirements, and is expected to reach 12 percent by 1980. Sixty-eight percent of the heat supplied comes from combined heat/powerplants, most of which are owned and run by the local town utility companies.

District heating is voluntary and its planning is left to the town utility companies. The government does offer assistance for new combined heat/powerplants and district heating networks--a 7.5-percent tax credit to powerplants which provide district heating to conserve energy, and a 7.5-percent grant for expanding existing powerplants to provide district heating. In addition, the government subsidy for construction of coal-burning powerplants indirectly subsidizes new coal-burning combined heat/powerplants.

The ministry of economics has a plan for the power stations to invest \$840.3 million in district heating by 1980, for which the government will add another 33-1/3 percent grant to the 7.5 percent grant for a total of 40.8 percent, or \$342.9 million.

We were unable to obtain information on either the effect of district heating or its energy savings. We were told that the 7.5-percent tax credit, which applies to refuse burning and district heating to conserve energy, will result in energy savings of about 1.5 percent by 1980.

United Kingdom

In the United Kingdom, less than 1 percent of space heating is supplied through district heating, and very little of this is from combined heat/powerplants. Most of the schemes are group heating of typically 100 to 200 houses.

The United Kingdom has a relatively mild winter climate, and the majority of dwellings still do not have central heating systems. Energy supply is the responsibility of separate national bodies, not local authorities, and consumers have a choice of fuels, particularly for privately owned houses. In addition, the United Kingdom has been able to develop its indigenous resources of natural gas at an energy cost below that of imported oil.

A working party of the combined heat and power group was set up in 1975 to make a detailed assessment of the energy savings and economic benefit to be obtained through the widespread introduction of heat/power district heating schemes. It was found that there would be no economic

incentive to pursue such schemes because of present fuel prices, except in particular circumstances. Although combined heat/powerplants for district heating will save substantial quantities of energy compared with electrical heating, it is noted that gas and electric systems are already well established in high-density areas, with well-developed distribution infrastructures supplying large numbers of existing customers and backed by experienced organizations. Furthermore, although there is a definite case for district heating in large cities in the longer term, other possibilities, such as the use of heat pumps or high levels of insulation in dwellings, could be used in the short term.

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