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ENERGY AND DEVELOPMENT

Energy Use in the Modern Sector: Industry. Working Paper

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INTRODUCTION

As a consequence of the more than tenfold increase in petroleum prices in the 1970s, most countries, including developing countries, have initiated policies and programs aimed at increasing domestic production of petroleum and alternative sources of energy. In most developing countries, initial efforts to reduce the cost of imported energy have focused principally on the energy supply side, and except for attempts to increase energy prices and the temporary rationing of energy supplies, relatively little has been done on the energy demand management side. However, many industrial countries have accomplished significant savings through energy demand management. In most developing countries, the opportunities to improve the energy situation by more efficient utilization of energy are substantial and are normally more economically attractive than increasing supplies. More efficient energy consumption is often also the fastest way to achieve improvements in the energy balance of a country. Policies aimed at increasing domestic energy supply normally take several years to yield significant results, whereas energy conservation/demand measures, particularly in industry, which is the single largest consumer of commercial energy in most developing countries, can produce immediate results. Therefore, appropriate management of energy consumption in industry should be a critical element of an overall national energy program.

CONCEPTS

Energy conservation is defined as energy demand management activities that aim at increasing the efficiency of use.* The efficiency of use has two different, although not separate, components: technical efficiency and economic energy efficiency.

The first component, technical efficiency, is often measured by the first law of thermodynamics, which provides a quantitative estimate of the ratio of useful energy output (of a given process or piece of equipment) to energy input (see Session 2). For example, the first law of thermodynamics indicates that the technical energy efficiency of most boilers ranges between 70 and 85 percent. However, the first law is of limited interest,

*This concept is not related to the concept used in physics of "conservation of energy," which states that energy cannot be created or destroyed, although it can be changed from one form to another.

as it generally provides high technical efficiencies that do not indicate the real potential for improvement. The second law of thermodynamics, which considers the quality of energy, is often preferred when value judgments in energy efficiency must be made. Efficiency under the second law is defined as the ratio of the least amount of energy necessary to achieve a particular objective to the amount of energy actually used to attain this objective. Using this law, energy efficiencies of most industrial processes range between a few percent (e.g., grinding) to 45 percent (co-generation of heat and electricity), as opposed to 40-90 percent using the definition of efficiency under the first law.

Because second-law efficiency computation is a rather complex exercise that is seldom required for the typical industrial energy user,* energy efficiency will be considered as technical efficiency according to the first law (see Appendix A).

The second component, economic energy efficiency, is not a well-defined concept in absolute terms. Rather, one often refers to relative economic energy efficiency when an energy-related decision such as switching fuel in a sector results in providing the same energy service (e.g., producing steam at given temperature and pressure conditions) at a lower cost. The practical implications of this definition are not simple, as most energy-related decisions involve other production factors such as labor, raw materials, or capital. Rather, economic efficiency must be viewed in the global context of investment efficiency and optimal resource allocation. Consequently, economic energy efficiency is better measured using conventional investment theory under adequate pricing assumptions. Similarly, the macro measurement of a nation or a sector's energy efficiency, often measured as the ratio of total or commercial energy used to GDP, is of limited value in international comparisons because it fails to point out the specificities of the nations or the sectors.

Energy savings are the measure of increased energy efficiency, either in technical terms (e.g., toe saved annually in a given industry or operation) or economic terms (cost savings at the enterprise level or the national level). In this session, energy savings will be measured in technical terms, or physical quantities.

The energy conservation potential for a given activity (industry, process, or plant) over a given period can be defined as the maximum amount of energy — computed either at the primary energy or end-use level — that could be saved using specific technologies under specific economic conditions. In the case of LDCs, these technologies are generally well known, and have been extensively demonstrated and used in industrialized countries. In most cases, the economic conditions require short paybacks (i.e., less

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*Second-law computations are routine in engineering firms that design new processes and equipment.

than 5 years). Therefore, in estimating the potential, it is necessary to identify all options that meet the selected technology and economic criteria.

For example, cement manufacturing requires between 0.1 and 0.2 toe/ton in LDCs; in Sri Lanka, for example, specific energy consumption is about 0.17 toe/ton, compared with the best world performance of 1.00 toe/ton. Sri Lanka would set itself an ambitious goal if it were to strive for an energy consumption level of 0.12 toe/ton over the next 5 to 10 years.

APPROACHES

There are two approaches to estimating energy conservation potential. The micro approach (which can also be called the "bottom-up" approach) consists of estimating at the plant level cumulative energy savings resulting from the implementation of all possible conservation measures corresponding to the selected technological and economic conditions mentioned above. The other approach, or macro approach, uses a baseline ratio of energy to economy indicator (e.g., toe/thousand dollars of GDP) and projects it into the future according to recent past trends. By comparing this trend (for example, an energy/GDP elasticity of 1.1) to other countries or any other reference, it is possible to set a goal ex ante (e.g., to reach an energy/GDP elasticity of 0.8 in 10 years).

While the macro approach has the advantage of being easy to implement, its value is highly questionable for reasons mentioned above, as it is difficult to take into account the country- or the sector-specific characteristics (e.g., industry mix, equipment age). The micro approach provides more useful results but requires a large amount of resources in time and manpower to implement. For example, a representative number of plant audits must be conducted to provide basic data. Because of these constraints, a rough macro approach may be preferred to launch a program, and the potential estimate may be refined later by using the micro approach. Once the approach has been selected and the conservation potential estimated, one can attempt to project how much can be saved under specific conditions.

Projected savings are that part of the potential that can be reasonably achieved. The full realization of the energy conservation potential is prevented by social, institutional, and financial factors. In many industries in LDCs, the energy conservation potential exceeds 50 percent of the current energy consumption (e.g., textile finishing, bricks), while the projected savings range between 10 and 15 percent over a 5-year period and a conservative 25-30 percent, at best, over a 10-year period.

CONSERVATION AND DIVERSIFICATION

LDCs can reduce energy costs in industry in two generic ways:

- Through conservation. Energy conservation is an energy demand management function that aims at reducing the quantity of energy currently used. Such reduction can be achieved at low cost by modifying operating practices or at higher cost by modifying the equipment and the process. All actions belonging to this group result in an actual reduction of energy consumption at the national level.

- Through fuel diversification, also called fuel switching, which entails the conversion of energy-using equipment from one fuel to another form of energy (e.g., coal, electricity). Switching to a cheaper fuel, such as coal or noncommercial fuel (e.g., bagasse, wood residues), does not generally reduce the quantity of energy used.* It does, however, improve the national energy situation by displacing higher value fuels (oil or gas).

Category of Energy Management Measures

Depending on the level of effort required, energy conservation measures are often grouped into three categories:

1. **No-cost/low-cost measures,** often called "housekeeping" measures, which can be implemented very quickly and easily and at very small expense (e.g., shutting down equipment when not required, reducing excess air in boilers).

2. **Minor capital investments,** which require only limited expenditures, have paybacks of less than 2 years, and can be implemented within a few months (e.g., installing simple heat exchangers, replacing burners).

3. **Major modifications,** which require relatively larger capital expenditures, have longer paybacks, and require detailed feasibility studies prior to implementation (e.g., boiler replacement, steam system rehabilitation).

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*Coal and waste fuel combustion is less efficient than oil or gas. Consequently, more input energy is required for a given end use.

ENERGY SAVINGS POTENTIAL IN INDUSTRY

This session attempts to provide quantitative estimates of current industrial energy consumption patterns and savings potential in LDCs. The savings potential (or energy conservation potential) is defined here as the maximum practical amount of primary energy that could be saved using well-known technologies and practices and under specific economic conditions (see above). Technologies and practices considered here are those that are applicable to LDCs.* Economic conditions have been arbitrarily limited to a maximum simple payback -- that is, the number of years of energy savings that equal total modification cost -- of less than 5 years.

Under these conditions, the key factors that influence the magnitude of the savings potential are: (1) the amount of energy used in the sector; (2) the industry mix; (3) the processes used in each industry; (4) the level of energy use efficiency in each process; and (5) the type of fuel used. Precise estimation of the potential is not possible, owing to severe data limitations in most LDCs.

AMOUNT OF ENERGY USED IN INDUSTRY

Total 1980 commercial primary energy consumption in LDCs is estimated at approximately 1,350 million toe (mtoe).** The industrial sector of all LDCs combined used an estimated 600 mtoe, or approximately 45 percent of the world total, and represents the major energy-consuming sector. The share of industry in total commercial energy consumption varies from country to country, owing to a number of factors, including the relative size of the industrial sector compared with the other sectors of the economy (transportation, residential, agriculture, services) and the energy intensity of each sector of the country in question. In most industrialized countries the share of industry in energy consumption is generally in line with its share of GDP, whereas the pattern is significantly more varied in LDCs. In a number of low-income LDCs, industry's share of energy consumption far exceeds its share of GDP, reflecting not only the high energy intensity of these countries' industries, but also the lower income levels and milder climates (which reduce the use of commercial energy in households), and the proportionately low energy intensity of the agricultural or transportation sectors (e.g., China, India). In energy-rich countries, however, the opposite is true, as the share of total industry in national GDP exceeds its share of energy consumption (e.g., Indonesia, Mexico,

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*Advanced, not yet proven technologies, such as dry forming process in the pulp and paper industry or direct reduction using coal as a fuel in the steel industry, are not included.

**World Bank, The Energy Transition in Developing Countries, August 1983, page 5.

Nigeria). If manufacturing only is considered, the relative patterns are more in line with each other (see Exhibit 1.1).

INDUSTRY MIX, PROCESS, AND ENERGY EFFICIENCY

The type of industries predominating in a country has an important impact on the overall energy intensity of the industrial sector of that country. Some industries consume large amounts of energy per ton of product, therefore increasing the energy intensity of the sector. For example, the production of one ton of ammonia from natural gas or naphtha requires about 1 ton of oil equivalent (toe) as feedstock and fuel; aluminum can require up to 5.4 toe per ton. In contrast, construction materials generally consume less than 0.2 toe per ton of product, and electrical and mechanical equipment manufacturing requires less than 0.1 toe per ton. In some industries (such as cement), however, although energy consumption per ton of product is low, the total amount of energy consumed by the industry is large, and energy represents a substantial portion of the total cost of production. Petroleum refineries also consume significant amounts of energy, because the refineries themselves consume as fuel about 5 to 9 percent of the total crude processed by them. These industries provide significant opportunities for energy savings.

Energy consumption per unit of output (specific energy consumption) varies widely not only with the type of industry, but also with the process used. For example, modern and efficient steam reforming of natural gas for the production of one ton of ammonia requires 0.7 toe, whereas the older steam reforming processes require approximately 1.2 toe. Similarly, efficient new dry processes for cement manufacture require less than 0.08 toe per ton of cement, while most older wet processes require approximately 0.20 toe per ton. Other factors affecting the energy intensity of industry in a country include the age of the plants (owing to wear and tear, plant efficiency declines with age), the climatic conditions (manufacturing food in Korea during the winter months consumes significantly more energy than in tropical countries, owing to space heating requirements), and the general operating practices and skills of the plant operators (maintenance and down-time losses). Ranges of typical specific energy consumption in LDCs are provided in Exhibit 1.2.

FUEL USED

The type of fuel used in industry affects the savings potential for two reasons. First, the efficiency of utilization varies with the type of energy used. Coal is generally less efficient to burn than oil and gas,* and electricity accounted in primary energy is less efficient than direct fuel use

*Except in large high-pressure boilers.

Exhibit 1.1

Comparative Share of Industry in Total Energy Used and GDP in Selected LDCs (1981)

Country	Percent of primary energy used in industry		Percent of GDP[1] generated by industry	
	Commercial only	Total, including noncommercial	Manufacturing only	Total industry
Bangladesh	42.5	N/A	8	14
Bolivia	18.0	16.9	14	27
Brazil	51.6	40.7	22	37
China	69.2	50.9	N/A	46
Dominican Republic	28.2	29.1	15	27
India	53.8	N/A	18	26
Indonesia	15.6	N/A	12	42
Korea, Republic of	50.3	47.6	28	39
Mexico	21.8	19.4	22	37
Morocco	36.3	24.6	18	34
Nicaragua	25.6	16.4	26	33
Nigeria	24.6	N/A	6	37
Peru	22.5	19.1	25	41
Senegal	12.5	13.1	25	37
Sri Lanka	19.9	22.4	16	28
Sudan	16.1	4.1	6	14
Turkey	45.9	36.0	23	32
Uganda	11.4	4.4	4	4
Uruguay	34.8	31.5	26	33
Zimbabwe	41.4	30.0	27	37

[1]From World Bank Development Report, 1983, p. 153.

Exhibit 1.2

Specific Consumption Levels in Selected Energy-Intensive Industries in LDCs

Industry	Process	Specific energy consumption[1] (10^{-3} toe/ton, 1982)
Steel	Raw steel	450-1,400
	Metal finishing	300-400
Aluminum	Hall-Heroult smelting	4,500-5,400
Petroleum	Refining	35-100
Fertilizers	Ammonia	800-1,100
Glass	Flat and containers	250-600
Construction materials	Bricks	90-200
Cement	Dry process	80-160
	Wet process	130-210
Pulp and paper	Integrated chemical	250-950
	Other	150-2,200
Food	Raw cane sugar	0[2]-850
	Cane sugar refining	0[2]-195
	Edible oil	80-335
Textile	Finishing	950-2,500
Other	Metal works, mining, chemical products, wood products, plastics	10-1,000

[1]Total commercial energy (fuel + electricity).
[2]In cases where only bagasse is used.

SOURCE: Hagler, Bailly & Company and World Bank estimates.

for thermal operations, especially when it is generated from fossil fuels. Second, countries using primarily oil and gas (e.g., Peru, Argentina) have a great potential for switching to cheaper and more reliable sources of energy, such as coal. However, with the exception of such countries as China and India, which consume primarily coal as industrial fuel (74 percent and 70 percent, respectively), most LDCs meet the energy requirements of their industries predominantly with petroleum products (fuel oil, naphtha, and gas oil).

The fuel mix used depends on economic and technical factors. Economic factors include the relative value of each form of energy and the capital cost of the required equipment, which is significantly cheaper for oil or gas than for coal or other fuels. Technical factors also influence the choice of fuel. For instance, oil or gas is required to manufacture petrochemicals, but coal can be used easily in cement production. Some industries, such as glassmaking, consume oil and gas almost exclusively because of the process requirements for clean burning and high temperatures (1500°C). Other industries, such as cement and steel, can use almost any fuel, depending on their costs and availability. Noncommercial fuels also play an important role in some industries in LDCs. Bagasse is a major fuel source for alcohol and cane sugar manufacturing, and wood residues and black liquor are extensively used in the pulp and paper industry.

ENERGY SAVING POTENTIAL BY INDUSTRY

While there are up to 250 major industrial products consuming significant amounts of energy, a few of them consume most of the total energy used by the sector. Major energy-intensive industrial products in LDCs are:

- Steel
- Cement
- Fertilizers
- Sugar
- Pulp and paper
- Glass
- Aluminum
- Bricks
- Finished textiles.

Petroleum refining, which generally is not considered part of manufacturing, also consumes an amount of primary energy comparable to these processes.

As shown in Exhibit 1.3, a substantial fraction of the world production of these products occurs in LDCs. For example, almost 90 percent of total world cane sugar production and 37 percent of cement production occurs in LDCs. Using the average energy efficiency ratios of Exhibit 1.1, total commercial energy consumption has been estimated. The results indicate that steel is by far the major energy-using product in LDCs, with a total of 89-95 mtoe. Next is cement, with 42-57 mtoe, and petroleum refining

Exhibit 1.3

Primary Energy Potential Cumulative Energy Savings in Selected Energy-Intensive Industries in LDCs

Industry	Product/process	Estimated commercial energy consumption (million toe)		Potential energy savings (million toe/year)		
				A	B	Total
Iron & steel	Raw & finished steel	109.0		3.3-7.6	16.3-21.8	19.6-29.4
Petroleum	Refining	54.0		3.8-6.5	8.1-13.5	11.9-20.0
Cement	All processes	52.0		5.7-7.0	9.1-14.3	14.8-21.3
Chemicals	Ammonia	19.0		0.4-0.9	3.8-4.1	4.2-5.0
Food	Cane sugar refining	17.5		2.8-3.2	2.6-5.2	5.4-8.4
Pulp & paper	All grades	15.0		1.6-2.2	1.8-2.3	3.4-4.5
Construction materials	Glass	14.5		1.5-1.7	2.2-2.9	3.7-4.6
Electrometallurgy	Aluminum (from alumina)	13.0		0.3-0.5	1.3-2.0	1.6-2.5
Construction materials	Bricks	8.5		0.9-1.3	1.3-1.8	2.2-3.1
Textiles	Finishing	3.8		0.5-0.6	0.6-0.7	1.1-1.3
Total 10 products		306.3	(47%)	20.8-31.5	47.1-68.6	67.9-100.1
Other products (estimated)		340.3	(53%)	17.0-34.0	34.0-51.0	51.0-85.0
TOTAL LDCs		646.6		37.8.-65.5	81.1-119.6	118.9-185.1

A = short-term measures; B = medium-term measures.
SO[redacted]E: Hagler, Bailly & Company.

(which does not belong to the traditional manufacturing sector, but is shown here because of the similarity of energy conservation with other industrial activities), with 40-45 mtoe. The pulp and paper industry consumed an estimated 21-31.6 mtoe, while all other energy-intensive products or processes used less than 25 mtoe in 1980. Other energy-intensive processes not shown on the exhibit include primarily chemical intermediary products (e.g., ethylene), metalworks (foundries, nonferrous metals other than aluminum), and some food processes.

An analysis of the candidate conservation measures for each of these industries shows that the savings potential is substantial in all industries, although conservation opportunities -- and thus the savings potential -- tend to be industry-specific. A summary of the findings is provided in Exhibit 1.4, where the conservation measures have been consolidated into two groups:

- Short-term measures requiring small investments and consisting mostly of combustion efficiency improvements, insulation, steam system efficiency improvements, and other housekeeping measures, including better energy management, measurement, and control (Group A)

- Medium-term measures requiring larger investments in retrofits of existing plants and additions to facilities, including waste heat recovery, combined heat and power generation, increased use of waste fuels, simple process controls, some process modifications, and replacement of inefficient equipment (Group B).

Based on detailed energy conservation reports prepared by the World Bank and surveys of LDCs' industrial energy conservation programs, it appears that the potential for savings varies greatly by industry. It is estimated that only 2 to 5 percent of the primary energy used in the primary metals industry (e.g., aluminum, steel) can be saved by low-cost measures (Group A), whereas up to 10-18 percent would be saved by the same type of measures in processes using essentially low-temperature heat (e.g., in the form of steam). Such processes include pulp and paper, food, and textile products (see Exhibit 1.4).

Similarly, the potential for energy savings by implementing more capital-intensive measures (Group B) is estimated to vary from 10-15 percent in metal-related industries to 15-25 percent in industries such as fertilizers, cement, and sugar, where waste heat recovery and use of waste fuels offer considerable savings potential in LDCs (see Exhibit 1.4).

It is estimated that as a group, the LDCs could save approximately 35 to 70 mtoe per year through short-term measures (Group A), and an additional 70 to 125 mtoe per year through medium-term measures (Group B). In percentage terms, these figures correspond to savings of 6 to 10 percent and 12 to 18 percent of total industrial energy consumption, respectively.

Exhibit 1.

Potential Cumulative Energy Savings and Investment Required in Selected Energy-Intensive Industries in LDCs

Industry	Product/process	Estimated commercial energy consumption (million toe)	Potential energy savings (million toe/year)			Investment cost (1982 dollars/ toe saved/year)		Total estimated investment required (1982 U.S. dollars, billion)		
			A	B	Total	A	B	A	B	Total
Iron & steel	Raw & finished steel	109.0	3.3-7.6	16.3-21.8	19.6-29.4	250-350	850-950	0.8-2.7	13.9-20.8	14.7-23.5
Petroleum	Refining	54.0	3.8-6.5	8.1-13.5	11.9-20.0	175-225	400-450	0.7-1.5	3.2-6.1	3.9-7.6
Cement	All processes	52.0	5.7-7.0	9.1-14.3	14.8-21.3	225-275	700-800	1.3-1.9	6.4-11.4	7.7-13.3
Chemicals	Ammonia	19.0	0.4-0.9	3.8-4.1	4.2-5.0	175-200	450-550	0.1-0.2	1.9-2.5	2.0-2.7
Food	Cane sugar refining	17.5	2.8-3.2	2.6-5.2	5.4-8.4	175-225	600-700	0.5-0.7	1.6-3.6	2.1-4.3
Pulp & paper	All grades	15.0	1.6-2.2	1.8-2.3	3.4-4.5	300-350	500-600	0.5-0.8	1.0-1.4	1.5-2.2
Construction materials	Glass	14.5	1.5-1.7	2.2-2.9	3.7-4.6	250-300	450-650	0.4-0.5	1.0-2.0	1.4-2.5
Electrometallurgy	Aluminum (from alumina)	13.0	0.3-0.5	1.3-2.0	1.6-2.5	200-300	450-550	0.1-0.2	0.6-1.1	0.7-1.3
Construction materials	Bricks	8.5	0.9-1.3	1.3-1.8	2.2-3.1	200-300	450-650	0.2-0.4	0.6-1.2	0.8-1.6
Textiles	Finishing	3.8	0.5-0.6	0.6-0.7	1.1-1.3	225-275	550-650	0.1-0.2	0.3-0.4	0.4-0.6
Total 10 products		306.3 (47%)	20.8-31.5	47.1-68.6	67.9-100.1	200-270	650-750	4.7-9.1	30.5-50.6	35.2-59.7
Other products (estimated)		340.3 (53%)	17.0-34.0	34.0-51.0	51.0-85.0	200-300	500-700	3.4-10.2	17.0-35.7	20.4-45.9
TOTAL LDCs		646.6	37.8-65.5	81.1-119.6	118.9-185.1	215-300	590-720	8.1-19.3	47.5-86.3	55.6-105.6

A = short-term measures; B = medium-term measures.

SOURCE: Hagler, Bailly & Company.

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The largest energy conservation potential lies in steel, petroleum refining, cement, and chemical industries (including fertilizers) (see Exhibit 1.5).

NATIONAL ENERGY EFFICIENCY IMPROVEMENT PROGRAMS

Despite the generally high economic attractiveness, at least from a national standpoint, of the energy conservation potential discussed earlier, actual energy savings may not materialize to the full extent desirable. This failure to achieve the full potential energy savings stems from a number of technical, financial, economic, and institutional barriers to energy conservation that are often encountered in LDCs. Major examples of such barriers are presented in Exhibit 1.6.

MAIN ELEMENTS OF INDUSTRIAL ENERGY SAVINGS PROGRAMS

To surmount these barriers and capture most of the potential for energy savings, an integrated energy savings program must be designed and implemented at the national level. Key elements of such programs include appropriate measures for (a) energy pricing, (b) technical assistance, (c) financial assistance, and (d) institutional and regulatory support.

ENERGY PRICING

To provide enterprises with adequate incentives for improving their energy efficiency through both conservation and fuel conversion measures, appropriate industrial energy pricing policies must address both the absolute and relative price levels of the various energy sources commonly used by industry (fuel oil, gas, coal, power) and, where relevant, a rate structure (electricity and natural gas rate schedules). Although the pricing strategy will depend on country-specific parameters, there is ample evidence to suggest that domestic prices for industrial energy need to be at least equal to international prices to provide adequate incentives for energy conservation at prevailing international prices for equipment. Rate structures for power or gas are also important in that respect. For example, declining block-rate structures may provide disincentives for energy conservation. Some countries, such as China and Romania, use quota systems for key energy products, with consumption above the quota carrying a substantially higher price. In any case, it is of the utmost importance that the government's energy pricing policy be announced in clear terms.

Experience from a number of countries suggests, however, that adequate energy pricing is a necessary -- but generally not sufficient -- condition for an efficient energy savings program. Energy pricing needs to be examined within the context of the overall pricing policy for industry. In countries with a cost plus price control system for manufactured products, there is often no real incentive to save energy. In addition, a policy of high or increasing energy prices will have its full effect only to the extent

Exhibit 1.5

Potential Cumulative Energy Savings and Investment Required in Selected Energy-Intensive Industries in LDCs

Industry	Product/process	Estimated commercial[1] energy consumption (million toe)	Potential energy savings (million toe/year, rounded)[2]			Typical payback[3] (years)	
			A	B	Total	A	B
Iron & steel	Raw & finished steel	89.0-95.0	3-7	13-19	16.0-26.0	1.0-1.5	4.0-5.0
Petroleum	Refining	40.0-45.0	3-5	6-11	3.0-16.0	1.0	2.0-2.5
Cement	All processes	42.0-57.0	4-7	6-14	10.0-21.0	1.0-1.5	3.5-4.0
Chemicals	Ammonia	15.5-18.5	.5-1	3-5	3.5-6.0	1.0	2.0-3.0
Food	Cane sugar	14.5-24.0	2-4	2-7	4.0-11.0	1.0	3.0-3.5
Pulp & paper	All grades	21.0-31.6	2-5	2-5	4.0-10.0	1.5-2.0	2.5-3.0
Construction materials	Glass	13.5-19.2	1-2	1-4	3.0-6.0	1.0-1.5	2.0-3.5
Electrometallurgy	Aluminum (from alumina)	11.0-12.0	0-1	1-2	1.5-3.0	1.0-1.5	2.0-3.0
Construction materials	Bricks	2.5-3.5	.5-1	.5-1	1.0-2.0	1.0-1.5	2.0-3.5
Textiles	Finishing	3.8-5.7	.5-1	.5-1	1.0-2.0	1.0-1.5	2.5-3.5
Total 10 products		252.3-311.5	17-34	36-69	53.0-103.0	1.0-1.5	3.0-4.0
Other products (estimated)		322.7-323.5[4]	16-32	32-48	48.0-80.0	1.0-1.5	2.5-3.5
TOTAL ALL PRODUCTS, ALL LDCs		575.0-635.0[5]	33-66	68-117	101.0-183.0	1.0-1.5	3.0-3.5

A = short-term, low-cost measures; B = medium-term, moderate-cost measures.

[1]From Exhibit 1.3.
[2]Using savings rate from Exhibit 1.4.
[3]Based on World Bank reports and review of industrial energy conservation programs and projects in various industries and LDCs. These paybacks are averages of the projects reviewed in the literature cited above.
[4]Estimated by differences from total.
[5]Range of estimates depends on assumptions made about total primary energy consumption and share of industry.

SOURCE: Hagler, Bailly & Company.

Exhibit 1.6

Common Barriers to Industrial Energy Conservation

Technical barriers

- Lack of suitable equipment

Economic barriers

- Domestic energy prices below international levels
- Cost plus price control system for manufactured products
- Energy costs only a small percentage of production costs in some industries

Financial barriers

- Limited capital availability
- High interest rates
- Lack of simple, accessible medium-term financing for energy-saving equipment changes

Institutional barriers

- Inadequate decision-making structure
- Unfavorable legislation and regulations
- Other national and industrial priorities
- Lack of information
- Lack of energy auditing capabilities
- Lack of energy management expertise in plants

SOURCE: Hagler, Bailly & Company.

that most enterprises are adequately aware of and informed about the various energy savings measures that are technically and economically feasible. Finally, energy costs account for varying shares of total production costs, depending on the industry concerned (see Exhibit 1.7).

In industries such as metal working, textiles, and food processing, where energy costs are proportionally modest, enterprises might give higher priority to investments designed to improve their productivity or competitiveness through other means. It is important to design an integrated energy conservation program that includes an array of nonpricing measures and programs. The primary nonpricing measures and programs are discussed below.

TECHNICAL ASSISTANCE

Technical assistance primarily involves promotion, training, and plant auditing.

Promotion and information campaigns help to create an awareness on the part of industrial managers, employees, and the public in general of the benefits of energy savings. The campaigns include brochures, pamphlets, general or industry-specific seminars, and energy savings contests. Training programs in energy conservation or auditing can be addressed to several different groups, such as energy auditors, energy managers of enterprises, boiler operators, and maintenance engineers, with good results. Technical assistance can be provided either in the form of free audits or audit assistance, technical advisory services, and referral services. All of the above services can be provided through appropriate institutions.

Energy audits of large and medium-sized energy-intensive facilities constitute the core of any industrial energy savings program. Energy audits are necessary to estimate the energy savings potential, identify the individual energy savings measures to be taken, and estimate their investment cost and impact on operating costs. Depending on the energy consumption level of each facility, the complexity of the in-plant energy distribution and utilization systems, and the objectives pursued, several types of audits can be designed.

Energy audits can be performed either on a voluntary or a mandatory basis. The latter case is generally used for establishments exceeding a certain energy consumption threshold (e.g., 1,000 tons per year of fuel oil equivalent). Some countries also provide subsidies for energy audits or provide free brief audits, often with the help of mobile energy diagnosis equipment. Crucial to the effective performance of an overall energy auditing program is the development, through training, of domestic energy auditing capabilities, particularly with respect to general and brief audits.

A useful complement to an energy auditing program is the training and appointment of energy coordinators or energy management teams in the

Exhibit 1.7

Typical Shares of Energy Costs Within Total Production Costs[1]

	%
Highly energy-intensive products	
Ammonia	40-50
Cement	40-55
Energy-intensive products	
Aluminum	25-30
Fertilizers	20-25
Steel	17-30
Glass	15-25
Paper	15-25
Other products	
Ceramics and construction materials	12-20
Metal works	3-15
Textile finishing	6-12
Food products	3-10

[1]Expressed as ratio of total energy cost (i.e., fuels and electricity) to total production costs, including depreciation.

SOURCE: World Bank.

major energy-consuming enterprises to ensure a follow-up of the energy audits and to help introduce better energy management practices throughout the facility. The role of the coordinators or teams can be either voluntary or mandatory.

A typical training program incorporates at least the following elements:

1. A 2-day seminar for senior officials of the ministries concerned, senior managers of public- sector corporations, and general managers of major energy-consuming industries and power plants, to create awareness of the importance of energy efficiency in industrial management.

2. A workshop (about 3-4 days) for energy coordinators and energy managers to develop awareness and provide understanding of energy conservation activities.

3. On-the-job training of government staff, energy coordinators, and energy auditors.

4. Seminars for representatives of private-sector industries and the Chamber of Commerce to make them aware of benefits from energy conservation activities.

FINANCIAL ASSISTANCE

Most industrial countries (ICs) -- and some LDCs -- that have formulated a national industrial energy savings program have provided, at least initially, some financial assistance and incentives. Despite the inherently attractive returns on energy savings investments, such assistance has proved necessary to overcome the disinclination to make energy conservation investments, even where energy prices constitute an adequate incentive. Owing to their relatively modest size and impact on total production costs, many energy conservation investments receive a low priority within the enterprises' investment budget. In general, grants for energy conservation -- to the extent that they have been used for energy savings projects in industrialized countries -- have been phased out and replaced over time by preferential interest rates, accelerated depreciation, and other tax-related incentives, including duty tax exemption for imported equipment. Subsidies for energy audits have been maintained in many countries. In many LDCs, the prices of the key energy products used by industry are substantially below international price levels, and therefore provide little incentive to firms to invest in energy-saving facilities. In these cases, some form of financial assistance for capital investments might be needed during the transition period, provided that its capital amount is reduced as energy prices are gradually increased. The desirability of such a subsidy should, however, be weighed against the merits and feasibility of a policy of faster energy price increases.

It is also necessary to provide adequate access to medium-term financing for energy savings investments, particularly in the case of small or medium-sized enterprises with only a few relatively small energy conservation projects. Normal banking channels might entail unduly cumbersome and time-consuming procedures and collateral for such simple investments. Simpler forms of medium-term financing that are worth studying in this respect include financial leasing or acceptances.

INSTITUTIONAL AND REGULATORY ASPECTS

Industrial energy pricing is an integral part of overall energy pricing and should normally be handled through the energy pricing framework existing in most countries. There are, however, a variety of specific institutional and regulatory mechanisms that can be envisaged for the remaining elements of the industrial energy conservation programs mentioned above.

Since 1973/1974, most LDCs have established energy conservation centers that deal mainly with industry. Such centers emphasize the technical assistance functions mentioned above, often in collaboration with other training or technical assistance entities, and sometimes with private-sector participation, as in Japan and France. Only a few LDCs to date have established such centers. However, several countries, including Portugal, Bangladesh, Pakistan, Thailand, Turkey, and China, are in the process of establishing energy conservation centers. To have maximum impact, the centers should be constituted and staffed on the basis of an in-depth review of the nature of the industrial sector in the country, the potential for energy savings, and the capabilities of the domestic technical specialists. These centers are only rarely involved directly in financial assistance (particularly because energy conservation grants have gradually yielded to loans with preferential interest rates and tax incentives, at least in most ICs). All of these centers render information and promotion services, and most sponsor training programs. Among the latter, the training of plant energy managers and local energy auditors is of special importance.

While the regulatory framework varies from country to country, many ICs and some LDCs have enacted a basic energy conservation law of a very technical nature. In most cases, energy consumption standards are foreseen for boilers, furnaces, and other combustion units, and sometimes for industrial lighting, space heating, and other items. Energy consumption standards by product are significantly more difficult to establish and administer. The record varies considerably from country to country as to the usefulness of and compliance with such standards. Other important aspects generally covered by regulations, and of particular interest to most LDCs, are the mandatory appointment of energy managers and the mandatory performance of energy audits in industrial establishments that exceed minimal energy consumption standards.

The experience of most ICs with energy conservation programs indicates that to be successful, energy conservation regulations should be

complemented by appropriate measures for promotion, incentives, and free technical assistance. The exact blend of "carrot and stick" needs to be considered in the light of individual country circumstances and likely industry response.

EXPERIENCES OF SELECTED COUNTRIES

A review of past and planned industrial energy conservation programs in several ICs and LDCs indicates that the reduction of industrial energy consumption is an objective common to most countries. While most industrialized countries initiated efforts to use less energy in 1974, only a handful of LDCs -- led by the Republic of Korea (ROK) -- reacted equally quickly to the first oil price shock. By the end of the 1970s, other LDCs -- mainly in Southeast Asia, North Africa, and South and Central America -- had begun to respond to the second large oil price increase. To date, LDCs in the Middle East and equatorial Africa (except Kenya) have placed little emphasis on cutting energy use.

The ICs generally initiated a conservation program that embraced all sectors, with emphasis on the transportation, residential, and commercial sectors, which offer significant short-term energy savings at low cost. LDCs, on the other hand, generally emphasized industrial energy conservation, in part because industry in LDCs accounts for a higher share of total energy consumption than it does in ICs.

In their initial phase, these programs (1974-1980) have varied widely with respect to key program elements such as institutional set-up, energy pricing, legislation and regulations, incentives, technical and financial assistance, and financing channels used to provide financial assistance. Both results and expected savings are highly country-specific; in addition to the conservation policy itself, they depend on such factors as industry structure, industry energy efficiency, and the level of existing legislation and regulations on energy conservation.

Some countries have apparently achieved impressive energy savings (expressed as a physical amount of energy per physical unit of output), while others -- in some cases, countries with very stringent programs -- have performed poorly. For example, energy-efficiency leaders like Sweden and France achieved only about 6 percent savings over the 1974-1980 period, whereas the United States achieved more than 10 percent. However, to accurately gauge program succcess, the initial energy efficiency level must be taken into account. In this case, Sweden and France started with a ratio of industrial GDP to industrial energy used of approximately U.S. $2,000/toe (1975 dollars); the United States, on the other hand, began with a ratio of less than U.S. $1,000/toe. Although all LDCs started from a low efficiency level, their results have been mixed.

In the following sections, we first summarize and attempt to analyze the various elements of the IC and LDC programs. Then, we summarize the key lessons that can be drawn from the countries' experience.

Program Initiation

Most ICs, but only a few LDCs, started industrial energy conservation efforts after the first big oil price increase in 1973. Attention in LDCs focused instead on obtaining external financing to cover the additional energy costs. By the end of the 1970s, however, almost 20 LDCs were designing industrial energy conservation programs to counteract the second oil price hike, out of domestic political necessity, and because of pressure from international financial organizations.

Institutional Set-Up

Both ICs and LDCs implemented energy information and awareness campaigns using their appropriate government agency (generally under the Department of Energy or the Department of Industry). In many cases, efforts to organize the program have faltered, usually because too many government bodies were involved in the decision and implementation process, and sufficient coordination and authority were lacking (e.g., Sweden, Korea). While most countries understood the need to create a new organization -- or expand an existing one -- to oversee industrial energy conservation, there have been many "trials and errors" with respect to (1) its proper location within the government organization, (2) the extent of its role (advice vs. implementation), (3) its staffing (5 or 500 people), (4) its responsibility with respect to regulation, legislation, and financial matters, and (5) its scope (selected sectors or all sectors).

On the basis of the experience of the various countries that have been reviewed, the best structure appears to be one consisting of three bodies:

1. A policy group, placed directly under the appropriate minister (energy, industry, planning), whose prime responsibilities are to design the energy conservation program, ensure coordination with other entities, and assume overall responsibility for energy conservation matters. This policy group may also be in charge of program evaluation.

2. An implementing agency (e.g., AFME in France, KEMCO in Korea), placed under the policy group and headed by a director, with or without direct industry participation, whose prime function is to implement the program adopted by the government. Its main activities are conducting information and awareness campaigns and audits, and promoting and monitoring overall energy conservation activities.

3. A research center, also placed under the policy group, staffed with 10-20 researchers responsible for carrying out all types of studies, data collection, and analysis required for policy planning and evaluation. The research center can also be in charge of conducting technical research and development on energy-saving technologies/equipment to help their penetration of the local market. In LDCs with low industrial energy use, the research center may not be necessary to get the program under way.

Program Goals and Scope

In the early stage of the program, very few countries had set energy conservation goals just for industry. Moreover, industrial energy efforts focused on housekeeping measures and low-cost energy savings measures. France and Sweden had national goals for industry, while the United States had a set of voluntary goals in selected energy-intensive industries. Although none of the announced national goals for industry has been reached, voluntary energy conservation program goals have been exceeded in the three countries that had such programs (France,* the United States, Japan).

Incentives and Policies

There has been much talk of the benefit of "market" energy prices, especially since 1979, but energy markets are far from "free" even now. Most countries embarked on conservation programs at a time when price controls and regulations were particularly heavy. Domestic oil prices have generally increased to reflect higher acquisition costs,** and additional taxes or "surcharges" have been levied on residual oil (France until 1980, Sweden). In contrast, much less has been done in other areas such as coal and electricity, which remain highly subsidized in many countries (e.g., coal in France and Korea). The modification of electrical rates (tariffs) has been studied, but there is little agreement on how this is to be done.***

Nonetheless, it is the general belief in ICs and LDCs that energy prices should reflect medium- and long-term acquisition costs and that subsidies

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*France set both national goals and voluntary energy conservation program goals in selected industries.

**Except in oil-producing countries (e.g., Indonesia), where domestic prices are still much lower than international prices.

***The issue of revenue redistribution through utility rates is the focus of many debates both in ICs and LDCs.

act as barriers to energy conservation. Again, practical implementation of such concepts is difficult because of the social issues involved.

In addition to energy pricing, countries with a substantial industry sector have provided a broad array of energy conservation incentives. The incentives include direct financial assistance (grants) for research, development, and demonstration (20 to 70 percent of total project cost) and for audits (100 percent for small and medium enterprises, and 50 percent for larger plants); soft loans (0.5 points to several points below market or prime with or without a grace period) for installing energy-efficient devices or equipment; and free technical assistance and information. The experience of the countries reviewed for the purpose of this report provides two facts worth noting:

- Countries -- especially LDCs -- with no financial assistance mechanism for project implementation obtained poor conservation results (e.g., Korea until 1980).

- In most countries, but particularly in France and Sweden, grants established in 1974-1976 were eliminated in 1980 because such programs were expensive and inefficient; market prices alone generally made candidate projects financially attractive.

Most ICs offer additional financial incentives such as tax credits, accelerated depreciation, easier access to credit, and nonrefundable funds in case of project failure. LDCs also generally consider or provide duty tax exemptions for improved energy savings equipment. In most ICs, but in very few LDCs, energy conservation equipment manufacturers enjoy substantial public aid and preferential tax treatment. Exhibit 1.8 provides a summary of the financial incentives made available for industrial energy conservation in selected ICs and LDCs.

Technical Assistance Program

Developed countries required several years to recognize the need for, and subsequently organize, an auditing program in industrial facilities. A key reason for the delay was the lack of qualified auditors (prior to 1974, there was no such job). In addition, industry was sometimes reluctant to have outside people gathering detailed operating information on their processes (particularly in the case of chemicals). With the exception of the United States,* all countries reviewed had a national auditing program, often mandatory, especially for large oil users (generally above 500-1,000

*There is no federal audit scheme in the United States. In some cases, however, there are audit programs at the state level.

Exhibit 1.8 EXPERIENCE FROM DCs AND LDCs: FINANCIAL ASSISTANCE

	Grants		Loans		Other	
	Audits	Projects	Preferential Interest Rates	Extended Grace Period	Tax Credits & Duty Tax Exemp	Accelerated Depreciation
Developed Countries						
U.S.					X	
Japan	X		X		X	X
Germany	X		X	X	X	
France	X	(X)	X	X	X	X
United Kingdom	X	(X)				
Sweden	X	(X)	X	X		
Developing Countries						
Korea	X					
Brazil			X	X		
Thailand	(X)		X			
Philippines	X		X	X	X	X
India			(X)			

Note: ( )= in preparation or limited application

Source: Hagler, Bailly & Company.

toe/year). For small and medium users, audits are voluntary, and often provided free of charge.

With respect to industrial energy auditing, LDCs have made audits mandatory for so-called "designated facilities" (e.g., Korea, the Philippines). Less stringent approaches (e.g., Thailand) have not been successful.

All ICs and LDCs have strongly emphasized energy awareness and information, relying on conventional media (e.g., booklets, pamphlets, television spots, forums, conferences) and more innovative vehicles (e.g., the bus concept in Canada and Japan, energy efficiency contests in Korea).

Technical assistance has consisted mostly of training energy managers and auditors. In LDCs, foreign assistance is generally required in this area, except in those countries with a broad industrial base and energy experience (China, Brazil, India). Exhibit 1.9 provides a summary of the technical assistance available for industrial energy conservation in selected ICs and LDCs.

Legislation and Regulations

The legislative and regulatory framework can be kept to a minimum in ICs, where price signals and financial and technical assistance are powerful enough to ensure significant savings. However, LDCs' experience provides ample evidence that regulatory means are necessary to achieve program goals. Legislation (called energy utilization or rationalization law, energy conservation law, or "an act to further promote energy conservation," Philippines) is generally required. Its implementation may involve a large number of government bodies in several ministries, as well as the key components of the industrial energy conservation institutional set-up (see "Institutional Set-Up," above). Regulations resulting from the law cover a broad range of energy-related activities and equipment, including lighting and space heating in industrial buildings, combustion efficiency of large boilers and furnaces, electric power factor, replacement of old energy-using equipment, and fuel diversification (e.g., United States, United Kingdom, Sweden). Exhibit 1.10 presents a summary of regulations related to industrial energy conservation in selected ICs and LDCs.

Quotas on oil consumption and supply interruptions have also been used in some cases (France, United States, Thailand).

RECOMMENDATIONS FOR PROGRAM DEFINITION AND IMPLEMENTATION

The selection of the type of industrial energy conservation program that a country might wish to implement depends greatly on the program's ease

Exhibit 1.9 EXPERIENCE FROM DCs AND LDCs: TECHNICAL ASSISTANCE

	Audits					Training	Other
	Large Plants		Small & Med.				
	Mandatory	Voluntary	Mandatory	Voluntary	Auditors	Plant Energy Manager	Information Program
Developed Countries							
U.S.		X		X			X
Japan		X		X	X	X	X
Germany		X		X	X	X	X
France	X			X		X	X
United Kingdom	(X)			X		X	X
Sweden		X		X		X	X
Developing Countries							
Korea	X				X	X	X
Brazil		X		X		X	X
Thailand	(X)			X	X		X
Philippines	X				(X)	(X)	X
India		X		X			

Note: ( )= in preparation or limited application

Source: Hagler, Bailly & Company.

Exhibit 1.10

	Energy Conservation Law	Combustion Standards	Other Provisions
Developed Countries			
U.S.	X	(X)	X
Japan	X	(X)	X
Germany	X		X
France	X	X	X
United Kingdom	X	X	X
Sweden	X		
Developing Countries			
Korea	X	X	X
Brazil	X		X
Thailand	(X)		X
Philippines	X	(X)	(X)
India	X	X	

Note: ( )= in preparation or limited application

Source: Hagler, Bailly & Company

of implementation and administration.* In turn, the relative ease of implementing and administering a program depends on factors such as the need for new legislation and the strength of vested interests that would oppose any change in the status quo, as well as the number of people or organizations -- public and private -- that must be managed or coordinated to successfully carry out the objectives of the program. It is therefore essential that a country's institutional and regulatory resources available be systematically inventoried and evaluated before any decision is made on the management structure. Only when this assessment has been carried out and the institutional and regulatory deficiencies have been identified can recommendations for modification of the existing institutional and regulatory environment be made.

The institutional assessment should focus not only on government institutions, but on the institutional resources available in the private sector (e.g., trade associations, oil companies, architect/engineering firms) and quasi-public sector (e.g., nationalized companies, utilities, universities). The institutional problems most often encountered are:

- Lack of clearly articulated objectives
- Lack of coordination among government institutions
- Conflicting and sometimes contradictory responsibilities
- Lack of managerial and technical resources.

The successful implementation of any program, measure, or task requires that four fundamental management functions be carried out:

- Initiating, which sets the activity in motion

- Performing, which encompasses the day-to-day management or performance of the activity

- Funding, which ensures that the committed funds are delivered in time for proper performance

- Monitoring and enforcing, which involves overseeing other participants' performance, adjusting activities to accommodate changing circumstances, and enforcing applicable standards or regulations.

Each of these management functions can be carried out by a different institution. What is important is that each function be performed in an effective and timely manner.

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*Other criteria must also be considered -- e.g., potential energy savings, degree of private-sector involvement without government support, direct gross public costs, potential for adverse socioeconomic impacts.

Once the tasks or steps associated with the implementation of a program or a specific conservation measure have been identified, a simple matrix that arrays the four management functions with the specific tasks can be used to inventory and define the roles of the various public- and private-sector organizations that might be involved in the process. The same framework can be used to identify potential coordination problems that might exist across conservation measures.

Exhibit 1.11 presents an example of how the various management functions might be assigned in a hypothetical country where public- and private-sector institutions are already in place. For instance, several tasks (e.g., organization and conduct of survey, data base development) might be carried out by the National Institute of Statistics. A task force composed of representatives from the key ministries, national energy companies, universities, and industries could be created to participate in the design of the program. Once the energy conservation center has been created, it serves as the focal point for carrying out the mandate of the program, although it relies as much as possible on existing entities to perform some of the specific tasks. It can be seen from this example that the institutional arrangements are unlimited, and depend on whether program management is highly centralized or decentralized.

The existing institutional framework will often dictate the proper management structure. In the interests of objectivity and credibility, the experience of various countries has shown that the organization(s) pursuing policy development activities should be separate from the organizations responsible for policy implementation.

The degree of management centralization will also be dictated by the existing institutional and regulatory environment. In the past few years, many countries have taken steps --albeit limited ones -- toward improving the energy efficiency of their industrial sector; in many cases, existing ministries and government institutions have started to implement some conservation measures. A successful country-wide energy conservation program, however, usually requires one central body to oversee the day-to-day implementation of energy-related activities.

The focus should be on substance and not form. It is important to involve all key parties-at-interest -- both from the private and public sector -- in the planning and (if necessary) implementation process.

In evaluating institutional and regulatory options, consideration must be given to the speed at which changes can be made. Any program that requires new legislative authority will generally be more difficult to implement than one that does not. Programs requiring local action (e.g., building code amendments) will be even more difficult to adopt nationally because of the numerous jurisdictions involved. Other less serious obstacles to implementation are requirements for new administrative regulations or rules and requirements for agency reorganization. But perhaps the most important implementation criterion is the existence of public and political

Exhibit 1.11

Example of Institutional Arrangements

Phase/task	Management functions: Initiate	Perform	Fund	Monitor
I. Design				
Organize and conduct energy survey	NOI	NIS, AE, U	MOF	MOI
Identify barriers to conservation	MOI	TF, U	MOF	MOI
Analyze and recommend institutional modifications	MOI	TF, U	MOF	MOI
Review and propose modifications of existing laws and regulations and energy pricing policy	MOI	TF, U	MOF	MOI
Process energy survey	MOI	NIS, AE, U	MOF	MOI
Identify alternative programs	MOI	MOI	MOF	MOI
Estimate costs and benefits of alternative programs	MOI	MOI	MOF	MOI
Evaluate resources needed for each alternative	MOI	MOI, MOF	MOF	MOI
Review options for financing and incentives	MOI	MOI, TF	MOF	MOI
II. Start-Up				
Finalize national program	MOI	MOI	MOF	MOI
Set up organization	MOI	MOI	MOF	MOI
Launch awareness and information campaigns	ECC	TA, MOI	MOF	ECC
Develop auditing program	ECC	ECC, U, AE	MOF	ECC
Recruit and train auditors	ECC	ECC, U, AE	MOF	ECC
Conduct test audits	ECC	ECC	MOF	ECC
Organize financing channels	ECC	ECC, MOF	MOF	ECC
Adapt laws and regulations	ECC	MOJ	MOF	ECC
III. Implementation				
Define and publicize conservation goals and/or standards	ECC	ECC, MOI, TA	MOF	ECC
Conduct auditing program	ECC	ECC, U, AE	MOF	ECC
Implement training program for energy auditors	ECC	ECC, U, AE	MOF	ECC
Evaluate and implement projects	ECC	ECC	MOF	ECC
Monitor results	ECC	ECC, NIS	MOF	ECC
Develop data base	ECC	NIS	MOF	ECC

MOI = Ministry of Industry
ECC = Energy Conservation Center
U = Universities
AE = Engineering firms
TF = Task force
MOF = Ministry of Finance
NIS = National Institute of Statistics
MOJ = Ministry of Justice
TA = Trade associations

SOU[redacted]: Hagler, Bailly & Company.

support for a program, or at least the absence of opposition. Political acceptance is as critical to tactical planning as it is to strategic planning.