CHAPTER 4
INDUSTRIAL SECTOR

4.1 INTRODUCTION

The opportunities for GHG mitigation in industry are somewhat different from those in other sectors because the greatest increases in the efficiency of energy and materials use often come not from direct efforts to reduce consumption, but rather from pursuing other goals such as improved product quality and lower production costs. Many investments undertaken for non-energy reasons yield energy-efficiency gains as a secondary consequence.

Industry is also different in that firms usually have an incentive to improve efficiency in order to reduce costs and maintain their profitability. The degree to which this incentive applies varies among countries depending on the nature of the economy. In the type of market economy toward which many developing and transition countries appear to be evolving, one can expect that industry will pursue a number of the available opportunities for improving the efficiency of resource use. Shortage of capital is a problem in many cases, but gradual improvement in efficiency is likely as investment takes place and new plants are built. Thus, mitigation strategies in industry can build upon and enhance efforts that may already be underway. Well-designed policies can have an important impact, but the overall economic and financial context is likely to be more significant in encouraging investment in energy efficiency than particular policies explicitly designed to have that effect.

4.2 MITIGATION TECHNOLOGY OPTIONS

Actions by industry that can reduce emissions from energy use include more efficient use of energy, fuel switching, and improved use of materials that reduce energy requirements. In addition, policies that lessen the demand for energy-intensive commodities can reduce industrial energy consumption.

Energy efficiency is the most important category for mitigation analysis. There are many technologies and practices that could enhance industrial energy efficiency. Minor operational changes, such as housekeeping and maintenance, are typically the cheapest, easiest to implement, and least risky, but usually yield the smallest energy and cost savings. Production equipment changes and energy conservation add-on technologies involve larger investments, typically thousands to millions of dollars, and may or may not be justified by reduced energy costs alone. Major process changes often require building a new facility and are usually justified only by strategic market development concerns.

Industry consists of a vast array of activities involving thousands of different processes that are often site-specific in design. Whereas the buildings and transportation sectors can utilize a limited number of energy conservation measures that may be widely applied, the industrial sector requires more of a focus on options in specific industries. Generic technologies that cut across industries represent only part of the full range of opportunities, and even these generic technologies are typically customized for particular applications.

Because of the nature of decision-making in the industrial sector, it is useful to consider two basic classes of technical options: (1) actions for which energy-cost savings are the dominant criteria, and (2) actions for which broader criteria such as overall production cost and product quality are the dominant criteria. One could call the former "energy-cost-sensitive options," and the latter "non-energy-cost-sensitive options."

4.2.1 Energy-Cost-Sensitive Options

Energy-cost-sensitive options include low- to medium-cost improvements to the energy efficiency of existing capital stock, production and use of more energy-efficient equipment, and fuel switching. Many energy-efficiency options are applicable across industries. These generic options often have benefits in addition to energy-cost savings that may be significant to their adoption.

4.2.1.1 Measures for existing processes

Some examples of energy-cost-sensitive measures that can enhance energy efficiency in existing plants are described below.[1]

- **Housekeeping, equipment maintenance, and energy accounting.** Good housekeeping includes activities such as carrying out inspections to encourage conservation; scheduling energy-intensive activities; turning off equipment when not in use; installing and using energy-monitoring equipment; wrapping tanks and pipes with insulation; and repairing leaks. Regular equipment maintenance can prevent the loss of efficiency that can occur over time. Energy accounting systems can be used to help motivate energy-conservation activities.

- **Energy management systems** can be used to systematically turn off or turn down process equipment, lights, and fans.

- **Motor drive system improvements** include use of high-efficiency motors, improved motor rewinding, power conditioning, drive control (especially with adjustable-speed drives), and use of more efficient associated equipment (pumps, fans, compressors).

- **Improved steam production and management** includes use of economizers and other heat recovery systems, attention to steam distribution systems, and use of more efficient boilers.

- **Industrial cogeneration** allows the substitution of waste heat from electricity generation for steam that would otherwise be raised in a boiler using fuel (this describes its most common application, the "topping cycle"). Cogeneration is an important option for industries with large process heat requirements such as pulp and paper, chemicals, and food processing. It is particularly attractive where there are on-site energy sources that are not being utilized.

- **Heat recovery** may involve transferring heat from high-temperature waste heat sources to more useful media such as steam or raising the temperature of low-temperature streams so they can be useful as heat sources.

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[1] Examples of successful implementation of energy-efficiency measures in a developing country are described in a recent report from India (NPC, 1993).

4.2.1.2 Measures for new equipment

Adoption of more energy-efficient new equipment is an option for devices widely used across industries, such as electric motors, pumps, fans, compressors, and boilers. It is an especially important option in countries where industry is growing rapidly and the manufactured equipment is outdated.

4.2.1.3 Fuel switching

Opportunities for switching to lower-carbon fuels vary among countries depending on the available resources. The most important options in a mitigation analysis are switching to natural gas or renewable energy sources (e.g., wood from managed plantations for boilers or solar thermal energy for low-temperature process heat demands).

4.2.2 Non-Energy-Cost-Sensitive Options

Non-energy-cost-sensitive options include major modifications to existing production capacity and addition of new production capacity that incorporates state-of-the-art technology. These options are usually specific to particular industries. Improved use of materials (through recycling and process yield improvements) can be considered in this category.

- **The nature of major modifications** to existing plants varies by industry. Some examples are improvements to electric arc furnaces and revamping open-hearth furnaces where they are still viable (steel), installing an improved aluminum smelter, improved ethylene cracking, and conversion from semi-dry to dry process or installation of pre-calcination (cement). Across industries, automated process controls based on new sensor technologies can improve product uniformity and quality and reduce waste from the product stream.

- **Installation of new production capacity.** New capacity is more productive and usually more energy-efficient than existing capacity. The degree of difference depends on the nature of the new technology which may be a slightly improved version of existing technology or an entirely new technique, the design of new systems, and the age and condition of existing plants. New capacity allows for application of improved technology, design, and process control. Major energy savings are often possible with process integration, which involves designing processes so that the number of heating and cooling steps are minimized. Proper sizing of equipment and matching of components can yield significant savings, as can use of controls and sensors.

  Promoting adoption of state-of-the-art technology is an important option over the 10-20 year time horizon during which capital stock is replaced and updated. Near-term adoption of advanced technology is probably not a realistic option for most developing and transition countries, but may be viable if one is considering long-term potential.[2]

- **More efficient use of materials.** Recycling scrap, whether from downstream fabricators or post-consumer wastes, bypasses the most energy-intensive steps of manufacturing the conversion of ores and feedstocks into basic materials. The largest energy savings are available in aluminum production. Smaller, yet significant, savings are possible for steel and glass. Process yield improvements and quality controls save energy by reducing the amount of material that must be processed to provide the desired output. Continuous casting in the steel industry is an example of a yield-improving technology that saves large amounts of energy. Automated process controls and sensors are an integral part of most yield-improving technologies.

4.2.3 Screening Options

Those industries having the largest emissions, or prospects for major growth, are most important to target in a mitigation assessment. Screening of technology options within a given industry can use the criteria listed in Table 2-2 in Chapter 2. Data availability and the resources available to collect data are important to consider.

4.3 INPUTS FOR INDUSTRIAL SECTOR ANALYSIS

4.3.1 Data on Production and Energy Consumption in the Base Year

A common approach is to separately consider each of the major energy-intensive industries and place all other industry in a single sub-sector. Along with the traditional energy-intensive industries (steel, cement, basic chemicals, etc.), one may also consider industries that are locally important (e.g., food processing or textiles). Units of physical production (such as tonnes) are preferable. For industries with a heterogenous product mix, economic measures such as value added can substitute for physical output.

For certain industries, one may wish to disaggregate total production by product type. For example, one can disaggregate total steel production into carbon, stainless, and alloy steel. This kind of disaggregation may be difficult to estimate, but it allows for a more precise selection of technology options.

4.3.2 Forecast of Production in Each Sub-sector

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[2] State-of-the-art technology refers to the best available technology with demonstrated technical feasibility in actual production environments, such as in a commercial or large-scale plant. Advanced technology refers to technologies that are under development or have been seriously considered in concept and are expected to have an impact on the industry over the next 10 to 25 years. Companies will usually want to introduce advanced technologies in industrialized countries where the necessary engineering support is available.

Forecasts of production should draw on the assumed values for growth of GDP and industrial value added. For energy-intensive industries, projections of physical production can be based on historical relationships between production and GDP, with consideration of export/import possibilities. For basic materials such as steel, paper, and cement, one should also consider whether growth in per capita domestic consumption is on a rising or slowing path.[3] Materials substitution, such as use of plastics and aluminum instead of steel in automobiles, and use of a lower quantity of materials in products, such as in thinner, higher-quality steel, are important to long-run trends in demand for energy-intensive products (Williams *et al.* 1987), as are changes in export strategies. For other industries, the projection may be in terms of value added.

It is especially important to understand the future of the major energy-intensive industries in a country. This involves: a) understanding the current industry as to product quality, modernity of process technology, energy intensity, etc.; b) projecting domestic consumption using international comparisons, income levels, stage of technical sophistication of the general economy; and c) estimating unit costs for future production which could serve as a guide to estimating the role of imports or exports.

4.3.3 Technology Data

Analysis of the industrial sector often involves characterizing production technology options that can contribute to meeting each industry's future output. Such analysis works best for industries that produce a relatively homogenous mix of products (such as steel, cement, pulp and paper, oil refining). For industries that produce a more heterogenous mix of products, such as the chemical industry, one can focus on a few energy-intensive intermediate products (such as ammonia or ethylene). For light industries, which typically account for a large fraction of industrial value added but a small share of energy use, it is usually difficult to consider specific processes. Instead, one can analyze the application of generic measures in these industries.

The two general classes of technology options are (1) investments in existing plants, and (2) introduction of new plants. In each case, one can characterize several options that have different levels of investment and energy use, as well as different environmental implications. Several types of retrofits may be considered for improving efficiency in existing plants. New production capacity may employ various readily available technologies or state-of-the-art technology.

For each option, key criteria are:

- the overall production cost per unit of output (including operating as well as annualized investment cost);
- the capital requirement per unit output; and
- the energy intensity for different fuels and electricity.

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[3] In the U.S., per capita consumption of steel and cement ceased its historical increase in the 1970s and began a steady decline due to structural shifts in the economy and changes in manufacturing methods (Williams *et al.*, 1987). Nearly all developing countries are still on a rising path, but the rate of increase is likely to slow as an economy becomes more developed. The transition countries, on the other hand, have historically had relatively high levels of per capita consumption of many basic materials, and for these countries a decline in consumption is likely.

Other characteristics that are also important to consider include foreign exchange requirements, employment impacts, and environmental impacts (emissions of air pollutants such as SO_2, NO_x, and particulates; discharge of water pollutants).

An example of characterization of options from an analysis of the aluminum industry in India (Mongia *et al*., 1994) is shown in Table 4-1. The modernized Soderberg technology option has a lower unit production cost than the Soderberg retrofit, but the latter has much lower emissions and also a lower unit investment.[4] For existing plants using the "pre-baked" method, improved anode baking reduces both the production cost and emissions. Installation of improved smelters requires considerably more investment (all of it requiring foreign exchange), and increases the production cost. A new plant employing improved pre-baked technology, which is the main technology relevant to India, has somewhat lower emissions than the improved existing plant, but has a much higher production cost. Note that different technology options affect the intensities of fuel oil, coal, and electricity in dissimilar ways. Thus, the net impact on emissions depends on the fuel mix for electricity supply.

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[4] The calculation of production cost incorporates energy prices faced by Indian aluminum producers, which are subsidized. In an analysis from a societal perspective, one should use actual long-run marginal energy costs. The calculation of emissions reflects the Indian electricity supply mix, which is weighted toward coal. Thus, measures that reduce electricity use have a strong impact on emissions.

Table 4-1. Production Technology Options, Aluminum Industry, India

Criteria	**Technology Options**							
	Soderberg Existing	Soderberg Modernised	Soderberg Retrofit	Prebaked Existing	Prebaked Improved	Prebaked Smelter	Prebaked New	Import
Production Cost (Rs/tonne)	11.61	9.75	10.17	11.45	10.35	11.67	14.19	13.14
Investment (Rs/tonne)	0.00	6.95	1.25	0.00	2.41	16.92	34.40	0.0
Foreign Exchange (Rs/tonne)	0.00	3.37	0.00	0.00	0.00	16.92	34.40	0.0
Fuel Oil (TOE/tonne)	0.20	0.17	0.20	0.17	0.12	0.16	0.16	0.0
Coal TOE/tonne)	1.72	1.60	0.86	1.43	1.05	1.05	1.01	0.0
Electricity (Mwh/tonne)	16.90	15.80	16.20	17.00	16.60	14.50	13.70	0.0
CO_2 Emissions (tonne/tonne)	1.88	1.72	1.02	1.57	1.14	1.14	1.01	0.0

Note: Rs = rupees
Source: Mongia *et al.*, 1994.

For industries that use a variety of processes to produce a heterogenous mix of products, the method described above must be modified. In these cases, one can characterize generic measures such as motor system improvements or housekeeping. Options affecting electricity consumption are generally the most important for light industry.

In addition to the criteria discussed above, the product quality associated with technologies should be considered. A new plant will often have higher production cost per unit of output than an improved existing plant, but its products are usually of consistently higher quality, which means they can command a higher price in the domestic or export market.

Data on the characteristics of different technologies can often be obtained from in-country experts on the particular industry. One can use data from other countries if the technology is essentially the same as would be implemented in the study country, which is the case for certain types of products. For example, studies of a number of industries in the U.S. provide data on mid-1980s state-of-the-art technology and describe advanced technologies likely to be commercialized (Energetics, 1988). For options affecting existing plants, the simplest approach is to consider a typical plant for the industry. If there are only a few plants in the country, one could consider each separately.

4.4 DEVELOPING INDUSTRIAL-SECTOR SCENARIOS

This section describes two approaches that an analyst might use in developing industrial-sector scenarios. The exact method used to construct scenarios will depend on the energy sector model being used. The simple examples given below are more illustrative of the approach used with an accounting model, but they illustrate the basic steps and types of choices that must be made (either by the analyst or internally within the model) to develop scenarios.

4.4.1 Scenarios for Specific Industries: A Simple Accounting Framework

A study team may choose not to conduct a detailed analysis of specific production technology options. A relatively simple method for describing technology options in industries such as steel, aluminum, cement, chlorine, ammonia, and petroleum refining involves comparison with international energy intensities, including predicted state-of-the-art intensities. One needs to have a production forecast for the industry, and at least qualitative information on product mix (in industries like steel and petroleum refining where the issue is significant) and the type of production process used in existing facilities. For heterogenous industries, especially industrial chemicals, the fractional reductions in energy intensity can be based on those estimated for related homogeneous industries.

In the following, cement is used as an example. Table 4-2 shows current average fuel and electricity intensities for a hypothetical country and potential intensities that could be achieved in the future through either retrofit of existing plants or additions of new plants.

Table 4-2. Energy Intensity of Cement-Making Technology Options (Example)

	Current Average, Country X	Current Average, OECD	Retrofit	1990 State-of-the-Art	2010 State-of-the-Art
Fuel (GJ/tonne clinker)	5.0	4.2	3.8	3.15	3.0
Fuel (GJ/tonne cement)	4.5[a]	3.80[a]	3.42[a]	2.84[a]	2.40[b]
Electricity (kWh/ tonne cement)	120	155	150	145	130

Source: Holderbank, 1993.

[a]) clinker/cement = 0.90.
[b]) clinker/cement = 0.80. This requires additional grinding of the steel slag or power plant fly ash used as additive.

We assume that Country X produced 10 million tonnes of cement in the base year of 1990 and that 20 million tonnes is the forecast for 2010. Base case and mitigation scenarios can be created using the categories in Table 4-2. For each scenario, one projects the amount of future production coming from each type of technology. This would typically require some consultation with industry experts and an exercise of judgment.

In the example shown in Table 4-3, half of the production in 2010 continues to come from plants existing in 1990. In the Base Scenario, no production comes from retrofit plants, while in the Mitigation Scenario half of the plants are retrofit. As for new cement plants, in the Base Scenario half of the new production comes from plants using 1990 average technology in the OECD countries, while half comes from plants using 1990 state-of-the-art technology. In the Mitigation Scenario, an effort is made to utilize better technology in new plants. One might also include early retirement of older plants in a mitigation scenario, in which case more of the production in 2010 would come from new plants.

In using this method, it is important to qualitatively justify the more important assumptions and to discuss important technical issues, such as the fraction of additives in the cement, and any fuel switching or use of supplementary fuels (not considered in this example).

A baseline scenario should reflect the fact that many of the technical options that improve the efficiency of energy or materials use will be adopted by industry as it responds to market conditions. The extent of adoption will depend on the incentives, constraints, and regulations faced by industrial managers.

Table 4-3. Cement Industry Scenarios, 2010 (Example)
(Production in million tonnes, except as stated)

Technology Category	Base Scenario	Mitigation Scenario
Existing Plants:		
Current	10	5
Retrofit	0	5
New Plants:		
OECD Average	5	0
1990 State-of-the-Art	5	5
2010 State-of-the-Art	0	5
Total Production	20	20
Total Energy Consumption		
Fuel (million GJ)	78	66
Electricity (billion kWh)	2.7	2.7

4.4.2 Scenarios for Specific Types of Equipment

The method described in this section allows one to estimate the potential impact of policies designed to improve specific types of equipment widely used across industries. It is most easily applied for new equipment. The general approach given below can be incorporated in each of the bottom-up models described in Chapter 3, but the method of selecting technologies for baseline and mitigation scenarios varies among them.

The method accounts for retirement and introduction of existing and new equipment in a simple manner. It requires data on end-use equipment stocks, which are usually not readily available for most types of industrial equipment. If a study team wants to analyze a mitigation option associated with a particular type of equipment (e.g., motors), it may try to collect the necessary data to use this method. The simplest approach is to analyze equipment at the aggregate industry level since separately analyzing equipment within each industry is much more data-intensive.

The method requires projection of the number and characteristics of different types of equipment in the target year. The assumptions and parameters used should be consistent with the industry-wide scenarios. Depending on the data that are available, one may consider a few or many types/sizes of equipment. Considering several sizes is desirable, as the opportunities for efficiency improvement typically vary with size. The steps involved are described further below. The option considered in this simple example is the adoption of energy-efficient new motors instead of standard motors. A similar approach could be used for other types of new equipment.

A comparable approach may also be used to analyze options that would affect existing and new motor systems. In this case, two general options could be considered: (1) retrofit improvement to existing systems, and (2) improved design and use of high-efficiency components in new systems. This analysis can be difficult, however, as information on the characteristics of these systems in a country is hard to obtain, and drawing generalizations as to costs and energy savings impacts is problematic.[5]

Step 1. Characterize the base-year stock of motors. This requires data on the number of motors in each type/size class considered and the average utilization (hours/year) and efficiency (%) in each class. Using average size (kW or hp), utilization, and efficiency in each class, one can calculate average electricity intensity for each class of motor. Stock characterization generally requires survey data.

Step 2. Estimate number of motors in each class in the target year. Estimated growth in the number of motors can be based on projected growth in industrial value added. One should also consider structural trends in the industrial sector that may affect the future distribution of motor types and sizes (refer to the industry-wide scenarios).

Step 3. Estimate the number of base-year (survivors) and new motors in target year. This requires a retirement rate for base-year motors, which should be made in consultation with industry experts. Motors in developing countries are often rewound rather than replaced with a new motor.[6] The number of new motors in the target year is simply the difference between the total number of motors and the number of survivors.

Step 4. Characterize the average energy consumption and cost of new standard and high-efficiency motors; estimate CCE. The best source of data on new motor efficiency is test data for motors available in the study country. Efficiencies reported by motor manufacturers may also be used. Costs can be based on actual motor prices, net of taxes. If high-efficiency motors are not produced locally for a particular type/size, they may be available as an import. The cost used in the analysis should be net of import duties. Estimation of the average energy consumption requires data on typical utilization (hours/year) for each type/size of motor. Estimation of motor lifetime should consider operating conditions in the country. Such data may come from a survey of expert judgement.

Steps 5 and 6. Construct baseline and mitigation scenarios. In the baseline scenario, a "frozen efficiency" case would use 100% standard new motors, while a "likely trends" case would use some mix of standard and high-efficiency new motors. A technical potential migitation scenario would incorporate high-efficiency motors in all situations where they are judged to be applicable.[7]

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[5] Nadel *et al.* (1991) provides a useful discussion of technical (and policy options) for energy-efficient motors and motor systems.

[6] One could also analyze the option of encouraging purchase of an energy-efficient new motor rather than rewinding a failed motor. Rewinding often results in a loss in efficiency.

[7] For some specialized applications, high-efficiency motors are not commonly made. For applications with limited operating hours, they may not be cost-effective. For some applications, multi-speed motors are more appropriate.

4.5 MITIGATION POLICIES

A range of barriers in developing and transitional countries causes the rate of adoption of efficient technologies and practices to be less than it could be. To encourage the adoption of efficiency improvement and other mitigation measures by industry, a variety of policy options are available.

4.5.1 Policy Strategies[8]

Crafting policies to enhance energy efficiency is more challenging for industry than for other sectors of the economy. The greater difficulty arises from the diversity of industrial energy use and from the interconnections between energy and production costs, product quality, environmental compliance, and other sensitive business factors. Several points are clear, however. First, energy efficiency is best promoted through policies that: (1) increase investment in industrial plants, and (2) focus that investment in a manner that encourages adoption of efficient technologies and production methods. Second, the energy conservation and efficiency activities and investments should be consistent with sound business strategy. Energy taxes or mandated investments that are too costly can put domestic companies at a competitive disadvantage.

Increasing investment in industrial plants depends on a healthy business and financial climate. A business environment that includes both economic growth and competition tends to promote investment. Without market growth, corporations may have neither the resources nor the incentive to invest. Without competition, companies are under little pressure to invest. Competition that is vigorous but fair signals to companies that being profitable depends on being efficient. Competition has been an important force behind technology innovation and cost reduction in industrial economies, but progress in industrial energy conservation has also been made in economies where the state plays a strong role, such as China (Levine and Liu, 1992). A financial environment that includes low capital costs and a long-term outlook will encourage industrial investment.

Efficient technologies that are both cost-effective and reliable must be available at the time of investment, and they must be given adequate consideration in investment decisions. Investments can be focused to promote adoption of efficient technologies and practices through information programs, financial incentives, regulations, and technology research, development, and demonstration (RD&D). Policy options in each of these categories are listed in Table 4-4 and described briefly below. They vary widely in their potential energy saving impacts and their costs to the government, businesses, and consumers. To illustrate the range of effects, the specific options are sorted into three distinct levels, in order of increasing government involvement and energy savings. The basic level includes relatively low-cost, simple policy options. The moderate level includes options that are more ambitious and in many cases would require legislation and increased government spending. The aggressive level includes options that are quite ambitious, would require legislation, or an increased government role in energy regulation.

Information Programs. The general lack of concern afforded energy in many corporations is a major barrier to investment in energy-efficiency improvements. This problem can be addressed through policies that raise the profile of energy efficiency as a national and corporate goal. The government could assist by providing technical assistance (audits, training), supporting education and advertising programs, supporting independent equipment testing/rating centers, and establishing equipment-labeling requirements.

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[8] This section is adapted from OTA (1993).

Financial Incentives. Financial measures can be used to alter investment patterns in order to promote the various technical objectives. These policy instruments include loan assistance, tax credits and other revisions to the corporate income tax code, and taxation of energy products or emissions. Reducing import duties on energy-efficient equipment (or on components that would get used in manufacturing such equipment) is also an option.

Regulations. Regulations are the most direct method of changing industrial behavior. Among the most viable options for influencing industry's use of energy are equipment efficiency standards, reporting and targeting requirements, and regulation of utilities to encourage industrial demand-side management programs and purchase of cogenerated electricity. By excluding substandard equipment from the market, equipment efficiency standards can have a large impact in a short time. They can also help to lower the price of higher efficiency equipment by increasing the size of its markets. Voluntary agreements with equipment manufacturers are a possible alternative to mandatory regulations.

Research, Development, and Demonstration. Continuous improvement in energy efficiency requires a constant flow of advanced, commercially available technologies, which in turn requires a sustained RD&D effort. Such efforts in developing and transitional countries can reduce dependence on the industrial countries for efficient technologies and also adapt technologies to local conditions. RD&D should stress technologies and processes that combine energy efficiency with more prominent corporate goals such as product quality, labor productivity, and compliance with environmental regulations.

Some of the above policies are best applied in combination. For example, loan assistance or other financial incentives can be combined with an auditing program. Equipment testing is a necessary precursor to standards.

Implementing agents for industrial energy efficiency programs may be government agencies, electric utilities, or organizations that have a specific mandate to promote energy conservation. These actors may also work together to further policy goals.

4.5.2 Options for Procuring Best Technology for New Plants

Some of the policy options discussed above will encourage industrial managers to seek the best available technology when building a new plant, but government can help promote good practices that can result in lower costs and higher chances for trouble-free operation. (In some cases, the government may be directly involved in the planning for new plants.)

For many commodity-type products, new plants often use standard designs which have been built before, and it costs far more to engineer and procure equipment for a plant that differs very much in either scale or technology from the most recently built similar plants. Companies should get competitive bids from potential technology suppliers, which encourages them to quote lower profit margins and put their best people on the project. They should also give clear signals to the bidders on the criteria for selection (e.g., the degree of undemonstrated technology that will be accepted).

4.5.3 Estimating What Policies Can Achieve

Much of the long-run improvement in energy efficiency for a given product is driven by technological progress that tends to reduce all inputs. Such progress is autonomous of changes in energy price and relatively insensitive to policy, apart from general policies that promote investment and R&D (Ross and Steinmeyer, 1990). Support for public and joint public/private RD&D is also important for indigenous technology development or adaptation, especially in the long run. While such policies are quite important for industrial development, they are not likely to be considered as mitigation policies.

For options that are more sensitive to energy costs, the policies discussed above can accelerate adoption of measures that industry might do on its own eventually or induce actions that would be unlikely to occur within a given time frame. Of these, the impact of regulations, especially minimum efficiency standards for equipment, is the least difficult to characterize. For other types of policies, the potential impacts are difficult to assess with accuracy. In these cases, one should make conservative assumptions, specifying clearly what the assumptions are.

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