Energy & Environmental Sustainability in East and Southeast Asia

Development for most countries has been guided by a growth orientation typical of development in Europe, North America, and recently, Japan. This orientation focuses on wealth-creating material development and requires intensive use of energy and environmental resources by large-scale technical systems operating within an urban-industrial centered institutional framework.

Exploiting the benefits of energy efficiency and environmental protection requires an institutional transition guided by a different orientation to development that focuses on sustainability. The achievement of energy efficiency in industrializing countries depends on the adoption of effective institutional systems to direct capital, technology, and research toward the development of least-energy-cost services.

To provide a framework for strengthening energy efficiency and environmental protection institutions in industrializing countries as the foundation for their pursuit of sustainable development, a study was conducted by the World Bank during 1990 and 1991. With a study team composed of researchers from the Center for Energy and Urban Policy Research (CEUPR) of the University of Delaware; the Korea Energy Economics Institute (KEEI); and the Environmental Planning Institute (EPI) of Seoul National University, the research focused on the energy, environment and development situations of four Asian countries — Indonesia, South Korea, Malaysia and Thailand. Interviews with energy and environment ministry officials, nongovernmental organization representatives, and university researchers in each country were used in conjunction with national data, research reports, and World Bank analyses to examine the feasibility of and obstacles to sustainable development strategies in the four study countries.

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Energy, Economy, and Environment

Since the early 1970s, Asian economic growth has outpaced that of any other region in the world [1]. While inflation-adjusted economic growth in the world economy averaged 2.1% per year during 1977-1987 (Table I), the 37 countries of Asia grew at an average annual rate of 4.8%. The pace of economic change was even more rapid in East and Southeast Asia, earning the subregion a reputation for dramatic economic growth virtually unparalleled in the twentieth century. The four study countries typify the recent Asian economic experience. During 1977-1987, each country registered an average annual real growth rate in GNP of at least 5.0%, and their combined growth rate for the ten-year period was 5.5%. Compared with the world economy, these countries grew an impressive 2.6 times faster; and outpaced other developing countries by a factor of 2.9.

Exceptional economic growth was accompanied by even more rapid growth in commercial

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Table I
Selected World Energy and Economic Trends [a]
1977 - 1987

Region	Population 1989 (millions)	GNP Per Capita 1987 ($US)	Energy Consumption Per Capita 1987 (gigajoules)	Energy Consumption Per 1980 $US of GNP [b] 1987 (kilojoules)	Average Annual Growth Rates For the Period 1977 - 87: Real GNP [b] (percent)	Primary Energy Consumption (percent)	Energy Consumption Per Capita (percent)	Energy Consumption Per 1980 $US of GNP [b] (percent)
[redacted]								
Rest of the World	**1,976.0**	**6,907**	**90.8**	**14,170.7**	**2.1**	**3.1**	**0.9**	**0.3**
Rest of the Developing World	**1,058.7**	**1,053**	**19.9**	**13,310.2**	**1.9**	**5.2**	**1.8**	**2.1**
Africa	622.9	661	13.9	12,771.9	1.9	6.4	2.5	3.3
Latin America [c]	435.8	1,613	28.4	14,078.4	2.0	3.6	0.7	0.4
Industrialized Countries [d]	893.2	13,803	173.3	15,124.1	2.3	0.5	- 0.1	- 1.8
Oceania	24.1	8,616	151.0	16,680.2	2.3	3.2	1.3	0.3

Sources: World Resources Institute. 1988, 1989 and 1990. *World Resources.* New York: Basic Books.

Notes: [a] Data not available for the USSR and Eastern Europe (except Hungary and Yugoslavia). Middle Eastern oil exporting countries -- Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates -- are not included because of exceptional economic circumstances experienced by these countries during the 1977 - 87 period.

[b] China is not included in these calculations because of the difficulty in establishing a reliable exchange rate between U.S. and Chinese currency. Percent for the four study countries is based on 1986 - 1987 only.

[c] Latin America includes the countries of South and Central America.

[d] Industrialized countries include the U.S., Canada, Europe and Japan.

energy use. While the rest of the world increased its annual energy consumption by 3.1%, Asia and the four study countries were expanding their energy use levels by more than 7% annually. On a per capita basis, the differences between Asia and all other regions were even more dramatic. Growth in this indicator for the rest of the world fell below 1% during 1977-1987, while Asia averaged 4.1%. The four study countries increased their per capita use by even more (4.5%). Already the most energy-intensive manufacturing region, Asia continued to utilize commercial fuel at an increasing rate (1.7%) per unit of output, while growth in the rest of the world was near zero. Although the four study countries used substantially less energy as a production input than other countries in the region, their combined growth rate in energy intensity of economic output (2.1%) was still increasing in 1987.

Rapid, energy-intensive economic growth has substantially raised the material capacities of Asia and the four study countries. But along with its visible benefits has also come escalating environmental problems. A basic measure of the problem is the quality of the air breathed by the people. Data from the Global Environment Monitoring System (GEMS) analyzed by the World Health Organization (WHO) indicate that SO_2 levels for 11 of the 24 Asian cities in the GEMS network exceed the WHO guideline of 40-60 $\mu g/m^3$ on high pollution days [2]. Five of the ten cities found by WHO to have average annual SO_2 levels above 100 $\mu g/m^3$ are located in Asia. In its monitoring of another common urban pollutant — suspended particulate matter (SPM), WHO found that 14 of the 30 cities with annual averages exceeding health standards (60-90 $\mu g/m^3$) were located in Asia (Fig. 1). All of the ten cities with the highest recorded SPM levels were in Asia.

The capital cities of the four study countries reflect the problems of air pollution accompanying energy-intensive growth. The air of Seoul has contained concentrations of SO_2 that for a decade have frequently been above WHO health guidelines. Jakarta, Bangkok, and Kuala Lumpur have registered SPM levels far in excess of WHO guidelines over the same period. These health-threatening pollutant concentrations are a direct outgrowth of the way in which energy is consumed for development. Resolving them requires different energy and development approaches.

Recent analysis of the greenhouse gas buildup [3] and the prospect of global climate change [4] have brought into even sharper focus the linked nature of energy, environment, and economic development. This work has underscored the central role of the energy sector, both as a source of the problem and as an agent for its solution. It is now known that energy production and use account for nearly 60% of worldwide greenhouse emissions. While the problem to date has largely been the responsibility of industrialized countries [5], a worldwide strategy is necessary if this global threat is to be averted.

Industrializing countries should participate in carbon reduction efforts to enhance their economic and environmental situations. In a wide variety of energy applications, *avoiding* or *reducing* carbon emissions is often the most economical choice. Analyses by industry and independent researchers have shown that a wide array of efficiency alternatives yield energy savings at or below the cost of supplying electricity [6]. These strategies in many instances avoid carbon and related emissions altogether or curtail them significantly. In virtually every energy application, traditional supply approaches are more economically and environmentally costly than energy efficiency options.

Yet, industrializing countries will need to increase energy consumption in order to sustain growth. At present, the industrialization process remains energy intensive, including in the four study countries, where per capita carbon emissions between 1980 and 1988 increased an estimated 29-42%. In this respect, the key question facing the study countries is not whether increased energy consumption is necessary. Rather, it is whether this increase will occur within an energy efficient environmentally sensitive development system, or whether it will reproduce the past of the already industrialized countries. There is increasing evidence that economic competitiveness *and* the recovery of a healthy environment hinge upon this choice. With high- and upper middle-income countries delinking economic growth and energy consumption through the introduction of higher efficiency technologies and integrated planning approaches, it is a critical time for energy and environmental policy makers and planners in the industrializing world.

An Institutional Framework

For most countries, change and development have been guided by a growth orientation that focuses on wealth creation as its primary objective. The development that has been typical in Europe, North America, and most recently in Asia and the Pacific Rim, reflects the goals of material accumulation and profit maximization; the institutional structures of these regions likewise reflect a distinctive growth orientation.

This growth orientation can be characterized in terms of its manifestations in prevailing ideology, energy and technological systems, and environmental views and subsequent impacts. It embraces profit maximization, cost reduction, and increasing consumption as driving forces of the economic and production systems. Development has depended upon continual increases in supplies of resources to produce goods and services to meet escalating growth in consumer demand. The industrial priorities of this institutional framework are not only seen to require the intensive use of energy and environmental resources, but have redefined these resources as commodities of exchange. Resources have thus been regarded primarily as inputs of production, and valued almost exclusively in terms of their contribution to economic viability.

The characteristics of the conventional growth model embody the objective of wealth creation, as decisions are based upon the economic costs of production, and the definition of viable options is restricted to those that can be incorporated into the existing infrastructure. The tendency has been not only toward the development of large-scale technical systems, but also toward centralized control, which has expanded to an international scale. Within this framework, conventional growth has been typified by the development of urban/industrial-based centers of production.

The consequences of the conventional growth model include intensity in the use of energy and the environment. Driven by economic concerns, the prevailing objectives regarding energy production and use have been couched in terms of supply: not only to secure abundant, low-cost energy resources, but to ensure continuing energy supplies through diversifying the sources utilized. Efficiency has been defined in economic, rather than in energy terms, yielding improvements in technical efficiency and savings through economies of scale, while efficiency in the use of energy resources has largely been neglected in the economic calculation. Environmental concerns

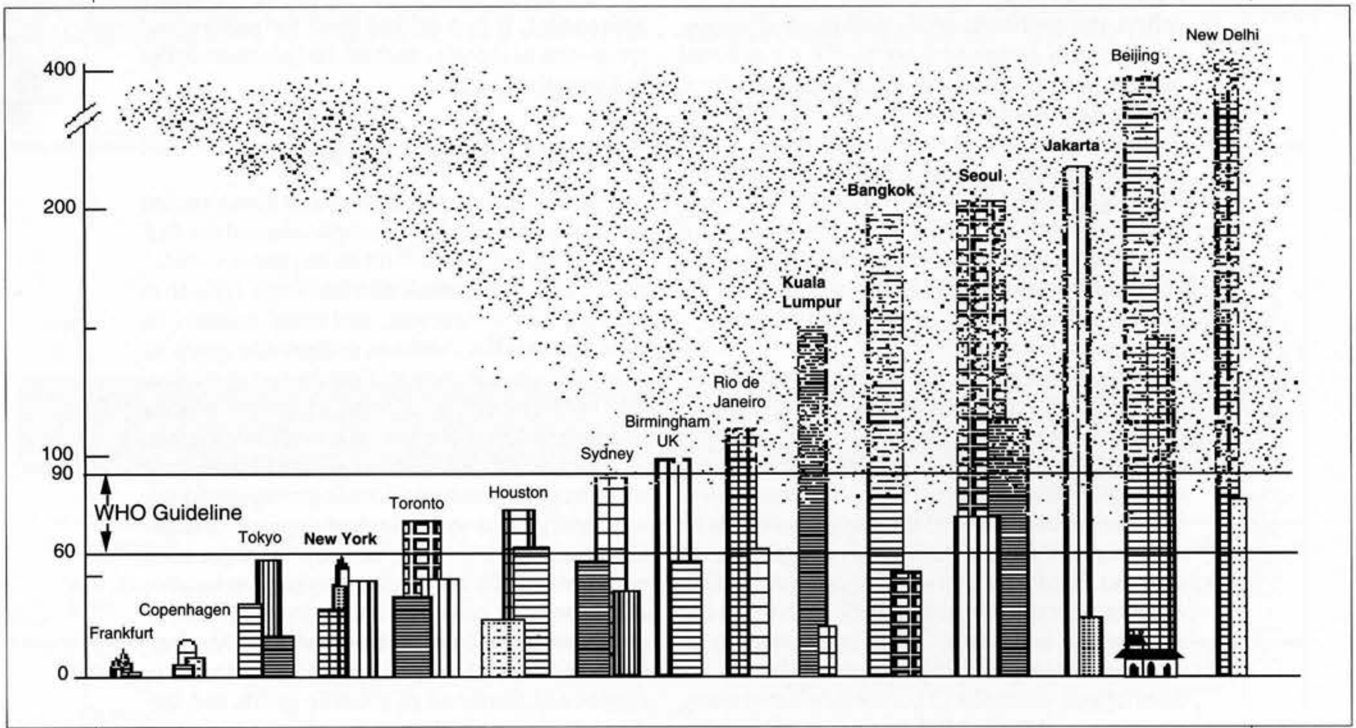

Fig. 1. Annual suspended particulate matter averages in selected cities: 1980-1984 [2].

and impacts have also been superseded by issues of profit and monetary cost. The environment has been viewed as a large pool of commodities available for unrestricted human use in the pursuit of economic advantage. Industrial systems organized in terms of the conventional growth model have relied heavily upon fossil fuels as the major sources of production and consumption, producing not only vulnerable energy systems, but creating environmental externalities that challenge the continuation of present institutional arrangements and threaten current patterns of societal existence.

Reversing or halting the resource intensive and environmentally destructive modes of growth and development requires a reorientation of institutional values, goals, and interactions that encompasses the aims of sustainability. Energy efficiency and environmental protection become primary goals of this alternative view of development, refocusing societal emphasis away from short-term economic advantage and toward long-term viability; away from economic cost exclusively and toward social and environmental concerns. A sustainable development perspective recognizes the finite capacities of the current resource base, and embraces the goal of balance in production, consumption, and conservation activities (Characteristics of the conventional growth and sustainable growth models are contrasted in Table II).

The concept of sustainability is founded on the interaction and mutual dependence of society and the environment. Environmental impacts are to be treated as a central concern in economic decision making, stressing the preservation of resources and patterns of growth which enhance long-term economic viability and environmental integrity. Economic growth remains a dominant goal of development in the sustainable model; however, improved efficiency in the use of energy and environmental resources is viewed as essential to long-term productivity, and future, as well as present, needs are considered to be of fundamental significance. As stated by the World Commission on Environment and Development [7]:

> *Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technology development, and institutional change are made consistent with future as well as present needs.*

The development benefits of a sustainable model founded upon energy efficiency and environmental protection are substantial. Enhanced flexibility in responding to energy needs, the reduction of vulnerability to supply disruptions, and the conservation of indigenous resources are positive outcomes of a sustainable energy system. Environmental quality is improved, and the conflict between energy demands and environmental values is diminished. In addition to the direct benefits regarding the resource base, however, energy efficiency and environmental protection could yield positive societal impacts in the economic, social, technological, security, and planning arenas.

Conscious efforts to focus on end uses and to protect the resource base encourage least-cost, long-term planning. Productivity in both industry and agriculture is supported through reduced energy costs; and capital requirements to meet energy needs are minimized. Foreign exchange costs for energy imports can be decreased and the value of domestic resources enhanced as greater productivity characterizes energy use. Energy services can be provided at least cost, stimulating technological innovation and fostering future technical competitiveness. Finally, energy savings and environmental protection reduce the social costs engendered by development, as inequities of energy burdens are decreased between economic groups, and funds that would otherwise be dedicated to meet extensive energy demands can be redirected to address basic human needs. Self-reliance and a balanced approach to development can only empower industrializing countries in confronting internal needs and participating fully as members of the global community, both in the present and the future.

An Institutional Model for Energy Sustainability

Fundamental differences between the conventional growth and sustainable development models can be identified in energy decision making under these two orientations (see Table III). The character of energy decision making in each case is responsive to a set of general system goals that serve as standards for constructing particular institutional arrangements incorporating policy, markets and technology. In the conventional growth oriented energy system, energy decision makers act on the premise that increased energy consumption equals economic growth. Decision makers tend to emphasize the values of stability, reliability, and economic optimization; social and environmental impacts are treated as external to energy decisions. Energy choices are profit oriented and technology reliant on centralized, capital intensive systems of production and delivery capable of providing abundant fuel supplies to meet the requirements of industrial wealth creation.

These system goals guide and structure the characteristics of conventional growth oriented energy institutions. National energy policy institutions tend to focus on production incentives, reliability focused regulation, removal of some market imperfections, and standardization of technologies and delivery systems. Market institutions are characteristically supply oriented, capital intensive, and technology focused; prices reflect fuel competition among systems of production that tend toward monopoly or oligopoly. Technology institutions focus on the development of large-scale, centralized, and interconnected supply systems that are responsive to the demands of the prevailing system of energy production and delivery.

The characteristics of policy, market, and technology institutions are mirrored by energy-related aid institutions, financial institutions, and academic and research institutions. Energy-related aid institutions tend to concentrate on supply oriented programs centered around proven technologies of industrial nations; aid strategies seek to achieve export maximization, to stimulate new technology and energy markets in aid-receiving nations, and to cultivate investment opportunities for multinational corporations in aid-receiving countries. Financial institutions tend to give priority to the capital needs of large investors (producers) supporting large-scale projects to maintain technology expansion.

By contrast, in a sustainable development oriented energy system, energy decision makers act on the premise that energy efficiency equals sustainable development. Decision makers tend to emphasize the values of innovation, flexibility, equity, and social optimization; social and environmental impacts are treated as internal to energy decisions. Energy choices are equity oriented and community reliant, with a focus on decentralized delivery of efficient energy services to meet requirements for sustained development.

The energy and environmental systems appropriate to sustainable development are conservation oriented; institutions that comprise these systems are responsible for developing and implementing the most energy efficient and least environmentally disruptive means to achieve desired social outcomes. Development is seen to result from the achievement of energy efficient, environmentally sensitive service improvements that are broadly distributed among the population. Such improvements contribute to a pattern of stable long-term growth across sectors of the economy. Technologies are selected on the basis of assessment of their end-use efficiency and an assessment of their social and environmental costs. The orientation establishes a standard of achievement guided by the criterion of balanced, uninterrupted social and economic development of community rather than short-term material improvements subject to cycles of growth and decline. In this context, the community value of equity in the distribution of wealth counterbalances the value of sudden additions to wealth creation.

Under a sustainable development orientation, the energy system goals concentrate on achieving end-use efficiency in the delivery of energy services. The goal of energy efficiency tends to incorporate a concern for integrated resource

Table II
Development Models

Conventional Growth Model	Sustainable Development Model
General	
▼ Goal is profit maximization.	▼ Goal is long-term growth/viability.
▼ Commodity-oriented	▼ End-use oriented
▼ Consumption-driven	▼ Consumption/conservation in balance
▼ Resources are seen as "factors of production"	▼ Resources are see as limited, vulnerable, requiring stewardship
▼ Resources-intensive, governed by economic priorities	▼ Resource-conserving, governed by multiple priorities
▼ Urban/industrial-based centers of production	▼ Regionally dispersed centers of production
▼ Economic costs are primary	▼ Economic costs balanced by social and environmental considerations
Energy	
▼ Fossil fuel-based	▼ Greater use of alternative energy sources
▼ Goal: to secure abundant, low cost supply	▼ Goal: to secure end-use efficiency
▼ Reduce vulnerability by diversifying sources of supply	▼ Reduce vulnerability by reducing energy intensity
▼ Energy/technology-focused	▼ Energy/environmental conservation-focused
▼ Efficiency in economic production –scale economy –technical efficiency	▼ Efficiency in end-use/energy services –modularity –energy efficiency
Technology	
▼ Large-scale	▼ Small to moderate scale
▼ Central/international system	▼ Decentralization/locally responsive system
▼ Technology choice is driven by industrial infrastructure needs	▼ Technology choice is user-driven
▼ Technical decisions governed by production/economic costs	▼ Technical decisions governed by social/environmental costs
▼ Limited technical options –those that fit are favored	▼ Multiple technical options –those that create flexibility are preferred
Environment	
▼ Ecological assumption –humans dominate the environment	▼ Ecological assumption –humans/environment are mutually dependent
▼ Environment is seen as an abundant source of commodities	▼ Environment is seen as exhaustible, but sustainable resources
▼ Environmental impacts external to economic choice	▼ Environmental impacts central and internal to economic choice
▼ Use-strategy: intensive, governed by economic profitability	▼ Use-strategy: selective, governed by conservation principle to ensure –long-term economic viability –non-economic dimensions

planning that evaluates a wide array of supply and demand options for addressing energy needs. The energy system seeks to create conditions that support long-term sustainable development that is responsive to anticipated future energy needs as well as to current energy demand. In the context of this longer-term perspective, energy system goals include a concern for enhancing self-reliance and maintaining environmental quality.

These system goals guide and structure the characteristics of energy institutions oriented toward sustainable development. National energy policy institutions concentrate on efficiency (rather than production) incentives, service focused regulation, and the creation of new, diversified institutions, technologies and delivery systems to promote a wide array of least-energy-cost services; technology choice is guided by the criteria of long-term efficiency improvement and resource conservation. Energy markets are innovation oriented and responsive to competition among a diversity of low capital projects for delivering least-cost energy services; prices reflect the social/environmental costs of service options and the competition among diverse service providers. Technology institutions focus on the development of numerous small-to-moderate scale, decentralized systems that are responsive to user needs rather than to prevailing systems of production and delivery.

Institutional Strategies for Energy Efficiency

In industrializing countries, the institutionalization of energy efficiency is more difficult, yet more urgent, than in developed countries [8]. Most industrializing countries have limited capital, underdeveloped markets, insufficient energy infrastructure, inefficient technologies, and inconsistent energy policies. They need an innovative institutional framework to mobilize their limited, existing efficiency mechanisms, and to create additional supports.

With the four study countries experiencing rapid, energy and environment intensive economic growth, it is a critical time for efforts to secure an effective institutional framework to promote sustainable development. Successful organization of an energy efficient, environmentally sensitive economy and society will enable the four countries to advance their social aims while avoiding many of the security, pollution, and inequity dilemmas that have accompanied industrial development in the past. Failure to institutionalize energy and environmental sustainability at this time will not only put the study countries at risk of these problems, but will also increase the difficulty and heighten the costs of future efforts to ameliorate the negative effects of rapid growth.

It is not easy to create new social institutions, nor to redirect them once they have been set in motion. For this reason, periods of institution building, such as the present one for the newly industrializing countries (NICs) of East and Southeast Asia, present special opportunities for national policy initiative and creativity. Similarly, there is an important opportunity for international development agencies such as the World Bank to cooperate with nations in establishing a supportive international context for sustainable development.

Presently, three of the study countries — Indonesia, South Korea and Thailand — have institutions specifically charged with national responsibility for promoting energy efficiency. The energy efficiency institutions (EEI) in these countries differ in their legal status, organizational characteristics, staffing, and program focus. Indonesia's Konservasi Energi Abadi (KONEBA), for example, is a private energy service company (ESCO) established in 1987 to work closely with government owned fertilizer companies in identifying efficiency options for this energy-intensive sector. It also offers audit, consultation, information, management, and analysis services to business clients (mainly) on a fee-for-service basis. The Korea Energy Management Corporation (KEMCO) is a public institution created by 1980 national legislation to carry out a full range of responsibilities. Reporting to the national Ministry of Energy and Resources, KEMCO receives about 40% of its funding from government sources, and the remainder from fees for service. The Energy Conservation Centre of Thailand (ECCT) is also a public institution with a mandate to improve national energy efficiency. Active since 1988, ECCT reports to the National Energy Administration and the Federation of Thai Industries, and is funded by government and international agency grants. Malaysia relies upon its Ministry of Energy, Telecommunications and Posts (METP) to address the country's energy needs and problems, including efficiency matters.

The existence of separate energy efficiency institutions appears to have helped Indonesia, South Korea and Thailand make greater headway in the scope and coverage of their energy efficiency policies and programs. Even so, progress has been moderate. Only KEMCO has the necessary policy and budget support of the national government to undertake large-scale, multidimensional programs (i.e., initiatives encompassing information gathering, technical assistance, technology development, and installation). It is the only EEI studied to have a significant variety of strategies underway (ranging from retrofit to redesign and the development of new materials) in more than one end-use sector, and only this institution has the experience (in excess of ten years) necessary to successfully pursue energy efficiency concepts from research to implementation and evaluation. In the judgment of the study team, KEMCO offers a valuable model to Asian NICs seeking to establish an EEI.

For all its achievements, KEMCO has had a modest influence on the Korean energy economy compared to the more traditional supply oriented institutions. Its budget is less than one-tenth that spent by the national government on supply policies. At least as serious, KEMCO has no sizable programs to address the fastest growing energy sectors in the society — transportation and electric utilities. The large SO_2, NO_x, O_3, and SPM emissions of these sectors, and their prominent role in related environmental problems such as urban smog, acid rain, and the potential greenhouse effect, underscore the need for programmatic action. In this regard, KEMCO's problems are not unique. The EEIs in the study countries have relatively small budgets and limited policy support; and no country currently has a major institutional initiative in either the transportation or utility sectors.

▼ *Strengthening Existing National Institutions*

Enhancing existing institutional capacities requires an identification of barriers to institutional development in the four countries and of policy options for overcoming these barriers.

Table III
Energy Institution Models

Conventional Energy Institution	Sustainable Energy Institution
System Goals	
▼ Economic growth	▼ Sustainable development
▼ Abundant, low-cost energy supply	▼ End-use efficiency
▼ Mix of fuel sources	▼ Enhanced self-reliance
▼ Reduced vulnerability to world price change	▼ Environmental maintenance
Institutional Goals	
National Energy Policy	
▼ Production incentives	▼ Efficiency incentives
▼ Reliability-focused regulation	▼ End use-focused regulation
▼ Removal of market barriers (in some cases)	▼ Creation of efficiency-environmental institutions
▼ Expansion of demand	▼ Expansion of end-use efficiency
▼ Local adaptation to national choices	▼ Local choices and responsibility
▼ Standardization of delivery systems	▼ Diversification of delivery systems
Energy Market	
▼ Supply-oriented	▼ Efficiency-oriented
▼ Capital intensive and concentrated investment pattern	▼ Diversified capital investment pattern
▼ Fuel-based prices	▼ Social/environmental cost-based prices
▼ Emphasis on near-term rate of return	▼ Emphasis on life-cycle costing
▼ Balances supply and demand of fuel quantities	▼ Balances supply and demand of energy services
▼ Fuel competition	▼ End-use competition
Technology System	
▼ Large scale/technology-intensive	▼ Small-to-moderate scale
▼ Central/interconnected systems	▼ Decentralized/locally responsive
▼ Industrial infrastructure-driven technology choice Limited technology options	▼ User-driven technology choice
	▼ Diverse technology options
▼ Engineering decisions based on production/economic costs	▼ Engineering decisions based on social/environmental costs
Technology Transfer/ International Assistance	
▼ Emphasis on export maximization	▼ Emphasis on self-reliance
▼ Transfer of proven energy technologies of industrial countries	▼ Development of energy-efficient technology
▼ Reliance on creation of commercial energy markets	▼ Reliance on creation of end-use efficiency energy markets
▼ Priority given to energy supply/production by international agencies	▼ Priority given to end-use efficiency and service availability by international agencies
Finance (Public and Private)	
▼ Priority given to capital needs of small number of large investors (producers)	▼ Priority given to capital needs of large number of small investors (users)
▼ Large scale projects favored	▼ Modularity favored
▼ Short- to near-term perspective	▼ Long-term perspective
▼ Focus on economic risks	▼ Focus on social/environmental risks
Education, Research and Training	
▼ Power/production engineering	▼ Environment-sensitive engineering
▼ Market/engineering economics	▼ Social economics/least-cost analysis
▼ Production/capacity planning	▼ Integrated resource planning
▼ Economic/technology forecasting	▼ Policy studies/scenario analysis
▼ Supply-side/technology management	▼ Demand-side management
▼ Environmental impact analysis	▼ Environmental conservation analysis

The results of the interviews conducted with officials from the four countries indicate that there exists a set of common operational impediments to effective performance of existing energy efficiency and environmental protection institutions in the four study countries. These common impediments include: inadequate staffing levels, underfunding of energy efficiency and pollution abatement programs, and a lack of national emphasis on energy and environmental conservation goals. Each country's institutional system manifests the effects of limited national commitments to the goals of energy efficiency and environmental protection. In addition, several structural and behavioral barriers thwart institutional promotion of energy efficient, environmentally sensitive technologies and approaches. While the specific features of these structural and behavioral barriers differ from the four study countries, all of the barriers are identified as salient to each of the countries. Officials from the four study countries agree that these barriers inhibit the organizational, planning and policy performance of each country's institutional system.

To more finely specify policy options that address the identified barriers to energy efficiency, we utilized the analysis developed by the Energy Division of Oak Ridge National Laboratory [9]. The policy options identified by the Oak Ridge study are consistent with the general priorities specified by energy and environmental officials of the four study countries. These are by no means exhaustive of the options that may exist within the particular governmental and economic framework of a specific country. Some options listed may be deemed infeasible, given national resource limitations. It is important to note, however, that many of the options identified require no significant increase in governmental resource allocations. What is clear from the listing is that policy options do exist to address each of the structural and behavioral barriers identified by officials from the four study countries. Moreover, just as the barriers are commonly experienced by the four study countries, so too many of the possible policy options for addressing these barriers are common to the four countries.

Implementation of these policy options would reduce or remove barriers to the performance of existing energy efficiency and environmental protection institutions. They would also contribute to a policy environment supportive of further institutional development and to structural and behavioral conditions that systematically and actively encourage end-use decision making consistent with the goals of energy efficiency and environmental protection. In this sense, the identified policy options represent possible discrete actions that would express and reinforce a general development orientation grounded in the objective of sustainability.

▼ *New Institutional Initiatives*

In addition to strengthening existing energy institutions and enhancing contributions to environmentally sensitive energy efficiency in each of the major energy sectors, we recommend new initiatives in four areas. These recommendations are based on evaluation of the results of analysis of the four study countries as well as on a general review of available options for promoting energy efficiency and environmental protection. While these proposed initiatives do not exhaust the opportunities for innovative and effective approaches to enhance energy efficiency and environmental protection in the four countries, they do constitute potentially significant steps that may be taken in the short-term to strengthen continuing patterns of environmentally sensitive energy efficiency improvement.

The four areas of recommended action are:

- ▼ integrated energy-environment planning,
- ▼ integration of energy-efficiency analysis into environmental impact assessment,
- ▼ regional cooperation in energy and environmental planning, and
- ▼ training programs in energy-efficiency and environmental protection.

These four areas deserve the immediate attention of the four study countries. Moreover, the success of efforts in these four areas depends on regional as well as national commitments and on the concurrent support and encouragement of international institutions such as the World Bank.

References and Notes

[1] For this study, Japan is included in the Industrialized Countries category, rather than in the calculations of trends for the Asian region.

[2] World Health Organization/UNEP, *Global Pollution and Health: Results of Health-Related Environmental Monitoring*. London: Yale Press, 1987, p. 46.

[3] "Greenhouse gas" comprises principally four chemical compounds — CO_2, methane, nitrous oxide and CFC. Increased concentrations of these chemicals in the upper atmosphere may lead to the absorption of radiative heat in the same way that glass traps heat in a greenhouse, causing surface temperature to rise.

[4] See, e.g., U.S. Environmental Protection Agency, *Policy Options for Stabilizing Global Climate*. Washington, DC: EPA, 1989 draft; and James E. Hansen *et al*. "Global climate changes as forecast by the GISS 3-D Model," *J. Geophys. Res.* (Aug. 20, 1988) and James E. Hansen "The greenhouse effect: Impacts on current global temperature and regional heat waves," Testimony before the Committee on Energy and Natural Resources, U.S. Senate, June 23, 1988.

[5] Industrial market countries account for 46% of the greenhouse gas buildup, the U.S.S.R. and Eastern Europe for 19%, and developing countries for 35% (despite the fact that the latter have over 3/4 of the population). See Christopher Flavin, *Slowing Global Warming: A Worldwide Strategy*. Washington, DC: Worldwatch Institute, Oct. 1989.

[6] See, e.g., Christopher Flavin, *Slowing Global Warming: A Worldwide Strategy*. Washington, D.C.: Worldwatch Institute, Oct. 1989, p. 47; and Arnold P. Fickett *et al.*, "Efficient use of electicity," *Sci. Amer.*, vol. 263, no. 3, p. 72, Sept. 1990.

[7] World Commission on Environment and Development, *Our Common Future*. New York, NY: Oxford Univ. Press, 1987.

[8] The institutionalization of energy efficiency is conceived as a process of affecting decisions which have direct or indirect energy use and supply consequences. Institutionalization refers to a condition in which decision makers routinely examine energy efficiency alternatives.

[9] Eric Hirst and Marilyn Brown, "Closing efficiency gap: barriers to the efficient use of energy," *Resources, Conserv. & Recycl.*, vol. 3, 1990.

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