Sustainable energy perspective for Asia

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About TERI

A dynamic and flexible organisation with a global vision and a local focus, TERI was established in 1974. While in the initial period the focus was mainly on documentation and information dissemination activities, research activities in the fields of energy, environment, and sustainable development were initiated towards the end of 1982. The genesis of these activities lay in TERI's firm belief that efficient utilisation of energy, sustainable use of natural resources, large-scale adoption of renewable energy technologies, and reduction of all forms of waste would move the process of development toward the goal of sustainability.

A unique developing-country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. It is with this purpose that TERI has established regional centres in Bangalore, Goa, and Guwahati, and a presence in Japan, Malaysia, Russia, and the United Arab Emirates. It has set up affiliate institutes: TERI–NA (Tata Energy and Resources Institute-North America) Washington, D.C., U.S.A., and TERI Europe, London, U.K.

TERI hosts the annual Delhi Sustainable Development Summit, which is swiftly gathering momentum as a major forum for the convergence of globally renowned leaders and thinkers dealing with the issue of sustainability.

With a staff strength of over 500, drawn from multidisciplinary and highly specialised fields, offices and regional centers equipped with state-of-the-art facilities, and a diverse range of activities, TERI is the largest developing-country institution working to move human society towards a sustainable future. Well on its way to becoming a cybercorp, TERI makes effective use of the latest developments in modern information technology in both its in-house and outreach activities. TERI lays great emphasis on training, capacity building, and education. In 1999, it set up the TERI School of Advanced Studies, recognised as a deemed university by the University Grants Commission, India. The School is evolving as a research university, offering doctoral programs in bioresources, biotechnology, energy, environment, and regulatory and policy studies.

Having celebrated its silver jubilee in February 2000, TERI is now poised for future growth, driven by a global vision and outreach, with a philosophy that emphasises and assigns primacy to enterprise in government, industry, and individual actions.

Sustainable energy

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Preface

The last quarter of a century has witnessed accelerated economic development in the world as a whole, but we still remain responsible as a global community for mindless over-exploitation of natural resources and environmental degradation. We continue to live with a pattern of growth which is unsustainable. The concept of sustainable development has been refined since it first surfaced in the 1970s and it today takes cognizance of economic, environmental, and social dimensions. We also understand far better the need for ensuring equitable development and time has only proven what the condition of 'have-nots' in this age of increasing globalization can result in. There has been increased action at the international level to define the responsibility of the global community in moving towards a cleaner and greener development path. We have seen a spurt of international conferences, especially in the 1990s to define our commitment, and Asia, the fastest developing region in the world, has been active in the entire process of initiating and informing debate in this field.

Of specific importance in this arena has been the energy sector. Better understanding of linkages between energy and development has resulted in it becoming intrinsic to the sustainable development debate. This sector has been dynamic and, in some parts of the world, has been responding to the challenges of sustainable development. Overall, we are moving towards cleaner fuels, but not rapidly enough. We are diversifying our fuel-mix and our sources of fuel supply to address security issues—a lesson that the price shocks of the 1970s taught us. We are increasingly trying to find ways to tap indigenous resources, especially renewables to tackle the concern of equitable access to basic energy services, particularly in developing economies. We are recognizing the significance of regional cooperation in tapping reserves, and this perhaps will become a binding force for overall development across societies. But so much still remains to be done to provide the world with sustainable energy solutions.

While building the bridges for regional cooperation, we are also moving in a direction of correcting inefficiencies in our respective energy sectors. Distortions induced by subsidies have brought forth that in the absence of adequate targeting mechanisms, subsidies, instead of facilitating equitable access, can further distort market structures and encourage inefficient energy use. The importance of unbundling of energy supply organizations with an independent regulatory framework has been a common lesson from experience across the world.

With some positive developments worldwide and in Asia, have we reached where we had aimed to at the Rio Summit in 1992? The WSSD (World Summit on Sustainable Development) is a time for collective introspection. Have we been able to provide universal access to basic minimum energy services? How far have we reached in addressing environmental concerns? Have we been able to tap indigenous sources more efficiently? How far have our research and development efforts led us in harnessing new and promising energy sources? Have we been able to correct distortions in our market structures?

This publication addresses some of these questions for Asia and in this process has led us to directions for the road ahead. It is a long and difficult path, but one that we together can tread. This publication is an attempt at informing the debate at the WSSD.

R K Pachauri
Director-General, TERI

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Chapter

1 Intent and content

Ten years after the Earth Summit in Rio de Janeiro, leaders of governments, international organizations, and civil society come together once again to retrospect and plan for the future: have we delivered on our promises at Rio? Are we on a sustainable path of development? Where do we go from here?

The 1990s have been a tumultuous decade for the Asian continent, marked by wars and political upheavals, and by economic crises and financial volatility experienced by select countries. At the same time, the decade has witnessed structural reforms allowing a greater role to the market forces in many sectors. The energy sector has come into sharp focus in the 1990s, given its important role in the socioeconomic development process and its impact on the local and global environment. The Ninth Session of the United Nations Commission on Sustainable Development had sustainable energy development as its theme. The energy sector also figures prominently in the Draft Plan of Implementation, now under discussion for finalization at the World Summit on Sustainable Development, Johannesburg.

Given this backdrop, TERI undertook an exercise under the auspices of the AEI (Asian Energy Institute) to review developments in the energy sector in Asia. With sustainable energy development as the underlying theme, the document draws upon the existing literature as well as the views and perceptions of eminent personalities and experts on the impact of changes in the energy sector on the economy, society, and environment in Asia. The views of stakeholders (comprising political leaders, government representatives, non-governmental organizations, multilateral organizations, academia, and energy experts) were elicited through personal interviews and questionnaire responses (refer Annexure 1 for the list of interviewees).

The document spans the evolution of the concept of sustainable energy development and how it has unfolded in the countries of the Asian region. Specifically, it focuses on the developments in the energy sector in Asia in the past 25 years and on their relationship with and impact on economic growth, societal well-being, and the environment. This document also examines the likely trends in energy use, intensities, fuel mix, and impacts on the environment. This analysis is placed in context through a synthesis of stakeholder perceptions. Drawing on these facts and insights, the publication seeks to generate a more balanced understanding and debate on the progress towards sustainable energy in Asia.

This study defines Asia in its wide geographical spread – Central, West (Middle East), South, South-East, and East – while bringing out the regional differences in terms of energy endowments, levels of development, and consumption patterns (refer Annexure 2 for the regional classification of Asia). Regional peculiarities are brought out through select country examples.

To be disseminated at Johannesburg, this publication aims to inform and influence the larger sustainable development debate.

Chapter

2 Sustainable energy: the concept through time

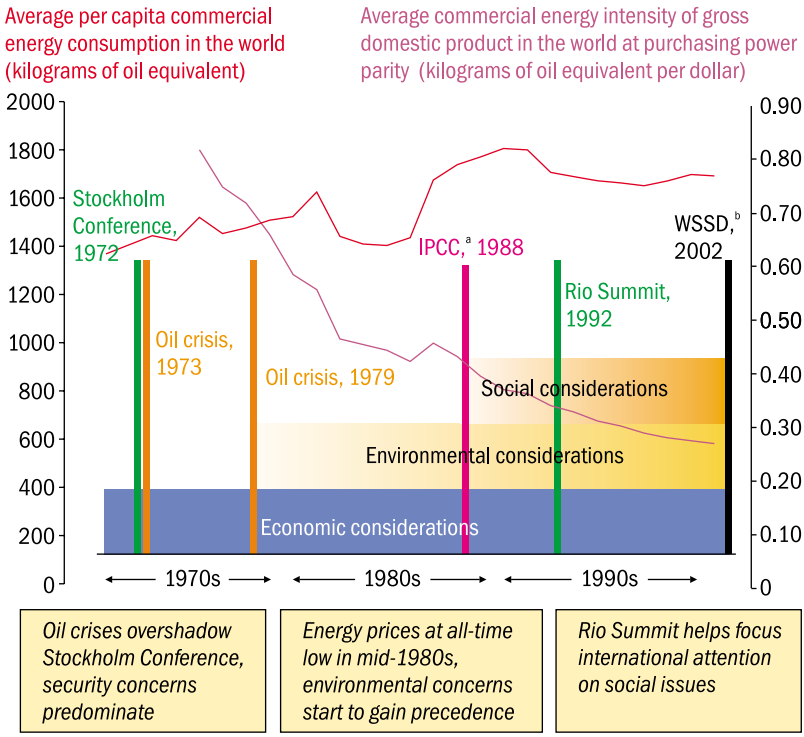
The concept of sustainable energy development has widened over a period of time to include economic, environmental, and social aspects, based on realities and constraints perceived by society. While the 1970s were dominated by economic concerns in the wake of the oil price shocks, environmental considerations began to gain prominence in the 1980s, as the threats posed by the oil crises diminished and as environmental concerns became better understood. The 1990s saw the social dimension of sustainability being recognized by the international community at large.

Sustainable development needs to be understood in its many dimensions. There is the temporal aspect—development today cannot be at the expense of development tomorrow. Sustainability also needs to be envisaged in its composite whole, as a dynamic system of interdependent forces—economic, social, and environmental.

As the fundamental fuel of development, energy is basic to sustainability. The *World Energy Assessment* succinctly defines sustainable energy development as 'energy produced and used in ways that support human development over the long term, in all its social, economic, and environmental dimensions...' (UNDP 2000). This chapter attempts to unearth the evolution of this concept and the underlying imperatives.

The period of oil price shocks: security concerns dominate energy policy

The 1970s and the early 1980s were dominated by the oil price shocks of 1973 and 1979 (Figure 1). This led to core economic



[a] Intergovernmental Panel on Climate Change; [b] World Summit on Sustainable Development

Figure 1 Evolution of sustainable energy development: integration of economic, environmental, and social dimensions

Source Data from World Bank (2000)

concerns being the guiding principles for fundamental changes in the policies of national governments and international bodies. The urgent need for oil security management and energy policy cooperation led to the creation of the International Energy Agency in 1974. The first Energy Policy Paper of the ADB (Asian Development Bank), issued in March 1981, '…focused on overcoming the crisis caused by the oil price shocks and laid considerable emphasis on supply augmentation in the DMCs (developing member countries) of Asia, based on developing indigenous energy resources.' It also identified the need for large investments to meet the energy requirements of rapidly growing economies in the DMCs (ADB 2000).

The price shocks had cast a shadow on the entire strategy and the process of growth being pursued by different Asian economies. Many developing countries had scarce foreign exchange reserves

and were also dependent on the import of capital. High oil prices implied high energy import bills, leading to energy and capital imports competing for scarce foreign exchange reserves (Siddayao 1990). Failure to solve the energy sector's problems could thus derail the entire strategy of development.

The 1980s: environmental considerations become important

The threats posed by the oil prices gradually receded during the 1980s, with the oil prices falling to an all-time low in the mid-1980s. This allowed the impact of the Stockholm Conference of 1972 and the steadily increasing awareness of environmental issues to gradually gain momentum particularly within national governments. In India, for instance, it was only after 1985 that a separate Department of Environment was created and environmental clearance became a prerequisite for investments in the energy sector.

A landmark feature of the 1980s was the report of the Brundtland Commission in 1987, intended as a stock-taking of achievements since the Stockholm Conference. The report highlighted that the continued flagrant use of natural resources, worsening level of pollution and waste, and unabated poverty would lead to a noticeable decline in the quality of life. It prescribed the adoption of a development path that would enable us to meet our needs without compromising the ability of the future generations to meet theirs. The report struck a chord and by 1988, momentum had built up for a major event to discuss and act upon the Brundtland Commission report—the Rio Summit in 1992 (TERI 1998).

While local concerns received the first priority, by the late 1980s global environment concerns had become important. The Intergovernmental Panel on Climate Change was set up in 1988 by the World Meteorological Organization and the United Nations Environment Programme. This was followed by the Framework Convention on Climate Change being opened for signature at the Rio Summit. For the first time, the global environmental fallout of the energy sector was recognized and institutions established to deal with the problem. These concerns peaked in the 1990s when other stakeholders – industry and civil society – also became increasingly conscious of the impending environmental issues.

The 1990s: social agenda integrated within sustainability concerns

While energy access had been high on government priorities, it was not until the Rio Summit that the international community accepted the importance of the social side of the energy problem. The Summit provided an all-encompassing view of the nexus between development and the environment, and brought into focus issues related to poverty and equitable consumption in the pursuit of sustainable development. The World Bank Group '...strengthened its focus on poverty reduction and sustainable development in the late 1990s, it updated its programmes for using its comparative advantage to help developing and transition countries exploit energy's many links with poverty reduction and sustainable development' (World Bank 2001). There was growing recognition that energy strategies are inextricably linked to social development. '...Energy services are a crucial input to primary development challenges of providing adequate food, shelter, clothing, water, sanitation, medical care, schooling, and access to information...' (UNDP 2000). The other related issues that received emphasis were those that linked energy to women's issues, demographic transitions (population trends and urbanization), and lifestyles.

Sustainable energy development as understood today

The various dimensions of sustainable energy development are well understood today as elaborated by the Ninth Session of the Commission on Sustainable Development.

> *Energy for sustainable development can be achieved by providing universal access to a cost-effective mix of energy resources compatible with different needs and requirements of various countries and regions. This should include giving a greater share of the energy mix to renewable energies, improving energy efficiency and greater reliance on advanced energy technologies, including fossil fuel technologies. Policies relating to energy for sustainable development intended to promote these objectives will address many of the issues of economic and social development as well as facilitate the responsible management of environmental resources* (CSD 2001).

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Chapter

3 Energy for growth

The Asian economies have shown a rise in energy consumption over the last 25 years though the multiplicity of economic structures, demographic patterns, technological base, and social backgrounds, as much as differences in resource endowments, have resulted in a high degree of diversity in the pattern of energy consumption. There has also been a general decrease in energy intensity of the GDP (gross domestic product) except in some West Asian economies. There has been a conscious effort towards fuel and source diversification partly through trade and limited regional cooperation as also through greater utilization of indigenous resources. This process has been facilitated by the liberalizing policy framework that has been witnessed in Asia over the last decade and which can, in general be expected to enhance the efficiency of energy systems in the region. The experiences with sector liberalization in the region have useful lessons for countries embarking in this process.

Energy resource endowments

Energy resource endowments have significant implications for sustainability in all its dimensions—determining the fuel mix, energy security, environmental acceptability, and potential for regional cooperation.

The Asian continent is among the most richly endowed regions with hydrocarbon resources (Figure 1), although there are marked

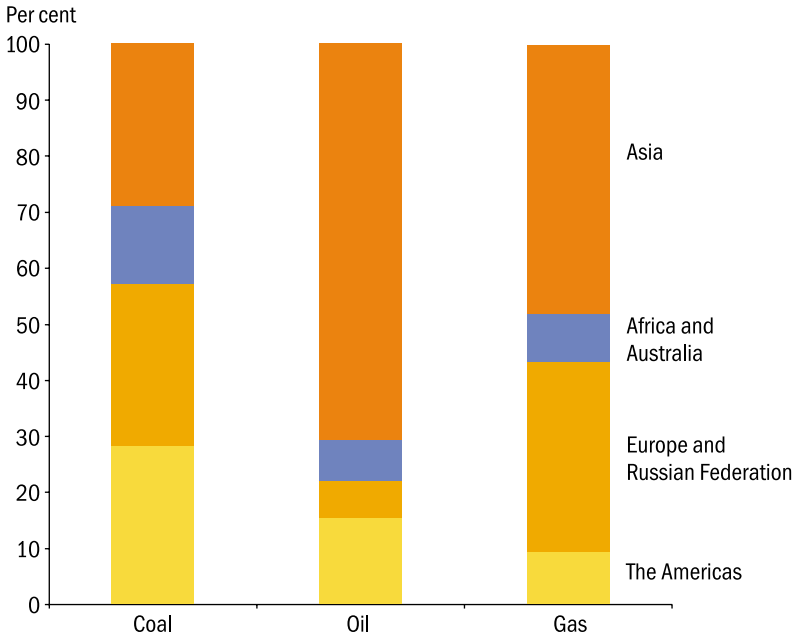


Figure 1 Hydrocarbon resources by region (2000)

Sources BP (2002)

geographical variations within the continent. It is a dominant player in the world's oil markets, accounting for 70% of the world's oil reserves, with West Asia (the Middle East) accounting for 65% of the world's reserves. Indonesia and Malaysia are, in fact, the only other countries with a history of significant crude production and exports though they are expected to become less important in the years to come. In the case of natural gas, Asia has almost 50% of the world's reserves, with West Asia accounting for 36% of the world's share. Of the East, South-East, and South Asian economies, only Bangladesh, China, Indonesia, and Malaysia have significant gas reserves.

Predictably, therefore, the dependence on West Asia will continue to rise in the rest of Asia, as also in the other parts of the world. This will enhance mutual economic interdependence through greater volume of international trade as much as intensify the concerns of the vulnerability to oil market shocks and the availability and security of international sea-lanes of communication.

The world's coal reserves are more evenly spread out with Asia's share being a little less than 30%. Within Asia, these reserves

are largely concentrated in China and India, which account for around 20% of the world stock. Given the volume and distribution of coal reserves in the continent, and the development of global coal markets, there are virtually no supply-related security concerns. However, in a large measure, any future growth in the dependence on coal would be shaped by the impact of environmental policy and regulation, especially in power generation.

The Asian region is also richly endowed with hydropower—around 35% of the world's technically exploitable hydropower capability exists in Asia. Almost 45% and 15% of this potential lies in China and India, respectively. Much of this hydropower potential remains unexploited (Figure 2). The high upfront costs of supply, controversial environmental issues, and planning and management of competing uses (power generation, water supply, irrigation, and flood control) are important determinants of the development of hydropower potential.

Given the need to move towards cleaner and more efficient sources of energy for reasons of sustainability, natural gas and

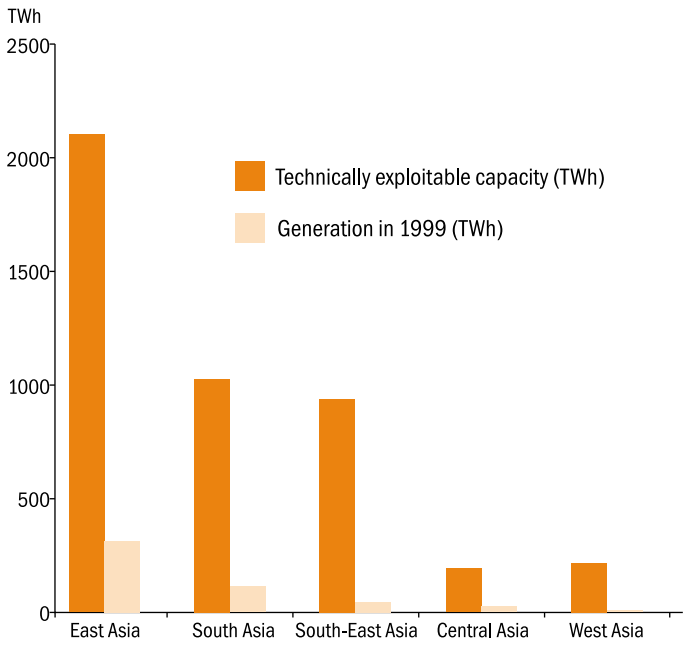


Figure 2 Hydropower in Asia: technically exploitable capability and production in 1999 (TWh)

Source WEC (2000)

hydropower offer significant potential for regional cooperation and trade within the Asian continent.

Energy consumption

Growth in aggregate energy consumption

Over the period 1975–97, rapid economic growth and increase in population, urbanization, and income levels, along with programmes for industrialization and poverty reduction have generated a strong demand for commercial energy in the countries of the Asian continent. The total commercial energy consumption in Asia as a share of the world rose from around 23% in 1975 to 26% in 1985 and further to 34% in 1997, with East Asia recording the highest share within Asia (Figure 3). Also, China, Japan, India, and the Republic of Korea dominated commercial energy consumption in the region with a combined share of over 70% in 1997.

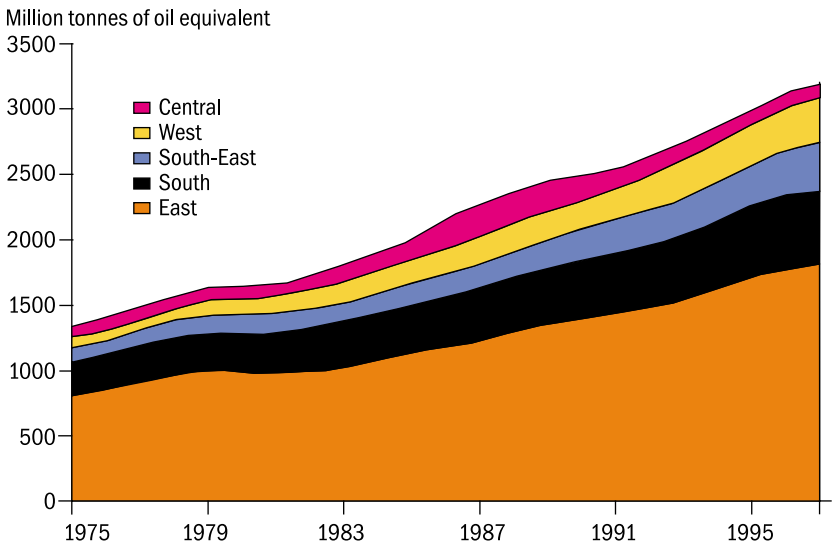
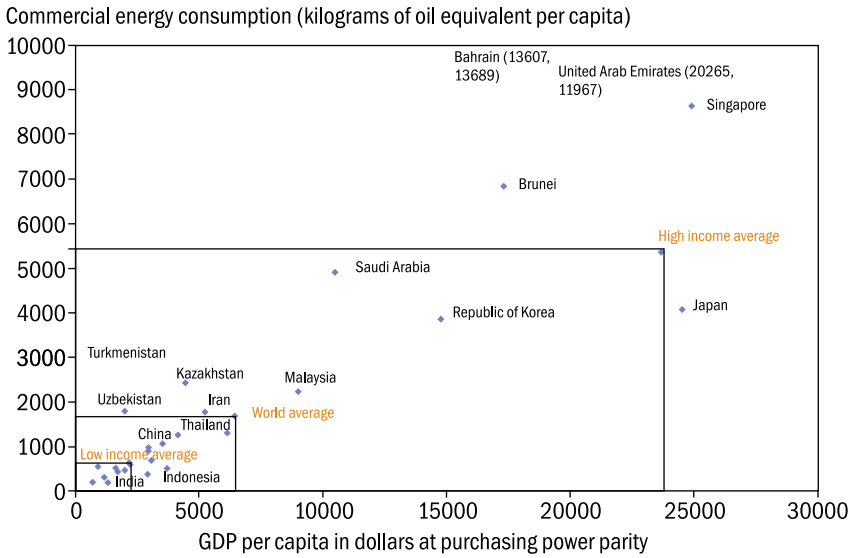


Figure 3 Regional shares in total commercial energy consumption – Asia

Sources Data from World Bank (2000)

A high share of energy needs continue to be serviced by traditional fuels in most South and South-East Asian economies (refer Chapter 4).

In per capita terms, most Asian economies exhibit a correspondence between the level of commercial energy use per capita and the GDP per capita (Figure 4). Economies that stand out in this trend include Japan – a high per capita income country with less energy consumption per capita than the average for high-income economies – and some West Asian countries with incomes per capita lower and energy consumption per capita greater than the respective averages for high-income countries. Perhaps, this can find explanation in the high level of energy self-reliance in the West Asian economies.



Note Commercial energy consumption per capita in Bahrain and United Arab Emirates fall outside the range of the figure and hence are indicated in parantheses

Figure 4 Correspondence between commercial energy use per capita and the GDP (gross domestic product) per capita – select Asian countries (1997)

Source Data from World Bank (2000)

The low levels of energy consumption in the developing regions of Asia suggest that these economies are likely to be among the fastest growing energy consumers in the world, particularly as they experience growing industrialization and urbanization, changing lifestyles, and a movement away from traditional fuels to commercial energy. As is true for the last two decades, the growth rate in primary energy supply in Asia, excluding Japan and West Asia,

though declining over time, would be higher (at 3.9% over 1997–2010 and 3.4% over 2010–20) than the world average (at 3% and 2.8%, respectively, for the two time periods) (IEA 2000).

What does experience suggest in terms of the sustainability of this growth? An attempt is made to address this question in the ensuing paragraphs.

Energy intensities of the GDP

The energy–growth linkage covering the scale and composition of output and the efficiency of energy use is well understood. In general, the energy intensity of economies rises with economic growth and increases in energy consumption (often related to a shift from non-commercial to commercial forms of energy, industrialization, and motorization), while the efficiency of energy use may be low. Beyond a certain level of per capita income, it begins to decline, indicative of the overall increase in the efficiency of energy use, the switch to more efficient fuels, and the structural changes towards less energy-intensive production (Figure 5).

Notwithstanding marked disparities within Asia, most economies have shown a downward trend in commercial energy intensities in the last 25 years (Figure 6). Notably, having

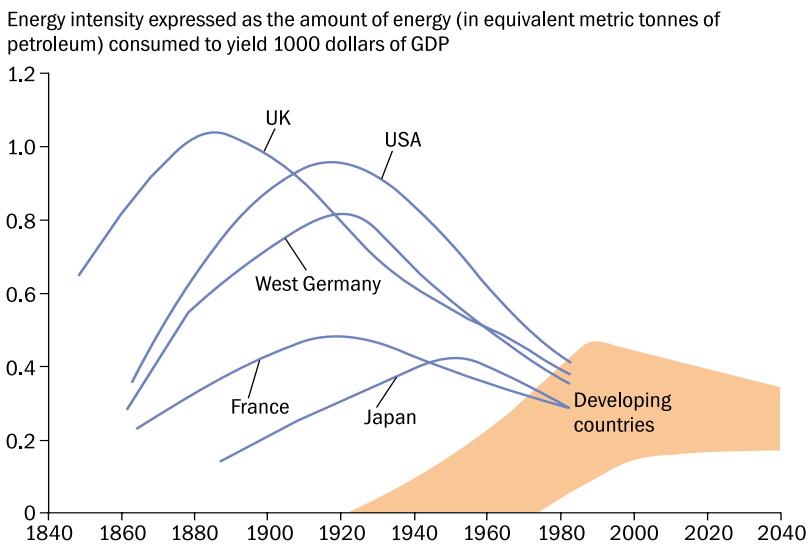


Figure 5 Energy intensity of GDP (gross domestic product) over the decades

Sources Holdren and Pachauri (1992)

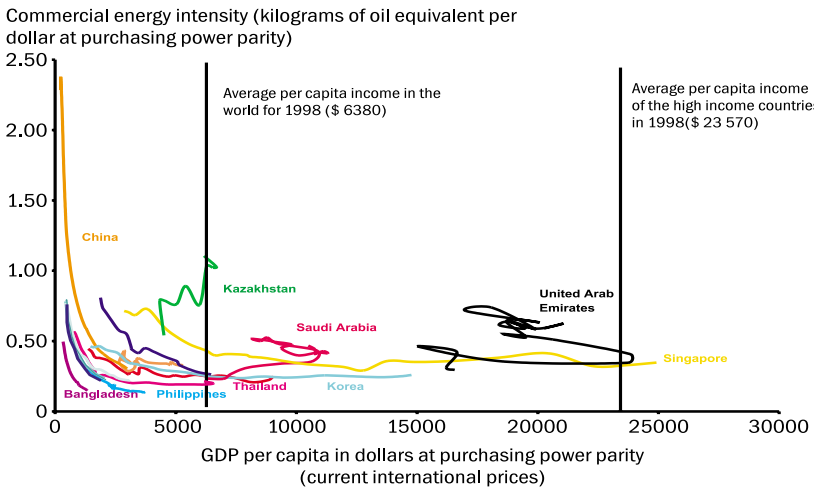


Figure 6 Commercial energy intensity and GDP (gross domestic product) per capita (1975–97)

Sources Data from World Bank (2000)

benefited from the experience of the 'early' developers, energy intensity peaks in the 'later' developing countries at levels lower than those of the former.

The East, South, and South-East Asian countries have achieved declines in commercial energy intensities, mostly over 50% during 1975–97 [analysis based on data available in World Bank (2000)]. The case of China is exemplary, which, starting at more than twice the world energy intensity level [at 2.28 kgoe/$ PPP (kilograms of oil equivalent per dollar using purchasing power parity) against the world level of 0.81 kgoe/$ PPP in 1975] attained the fastest decline to reach 0.30 kgoe/$PPP, close to the world level of 0.26 kgoe/$ PPP level in 1997. Here again the West Asian region provides an exception; select countries, particularly Saudi Arabia and the United Arab Emirates depicted an overall increase in the energy intensity through 1975–97, with fluctuating trends over time. In keeping with the general trend, the US Department of Energy predicts a 1.38% per annum decline in energy intensity of the GDP for the developing countries of Asia during 1999–2020.

What factors have determined this decline in intensities? And what do these imply in terms of sustainability? Can answers be found in factors such as changing fuel-mix (and corresponding

linkages with technological development), import dependence, and energy prices? The following sections discuss some of these issues.

Fuel–mix

The most important determinant of fuel-mix remains domestic resource endowments, although, over the years there has been a change in the fuel-mix of the region with the general trend agreeing with that of the world—decrease in the shares of oil and coal with increase in those of relatively cleaner fuels (gas and hydro), and more recently of nuclear.

The overwhelming dependence on coal in India and China and on oil in the West Asian economies is illustrative of the bias towards domestic energy resources (Figure 7). Around 55% and 61% of the primary energy consumption in India and China, respectively, were derived from coal in 2000, although a shift in favour of oil and gas is already under way. Likewise, in the case of West Asia, which is primarily served by oil and gas, the share of gas has increased over the last 25 years. In 2000, oil accounted for 53% of the total primary energy consumption while the share of gas was 44%. The other major energy consumers, namely Japan and the Republic of Korea, being largely import-dependent, have diversified their fuel-mix towards a greater share of nuclear and natural gas. Some South-East Asian economies while increasing the share of gas have also increased the share of coal. The reasons for these shifts range from a conscious diversification of the fuel mix to technological breakthroughs that have allowed the tapping of resources such as gas.

Some forms of commercial renewable energy are well established and relatively mature, e.g., geothermal power is a major contributor to power generation in countries such as the Philippines—the country accounts for about 24% of the cumulative installed geothermal capacity in the world. Other fast growing renewables include solar and wind. The rapid growth of wind and solar is being driven by a combination of technology advances and supportive government policies, which create a virtuous circle of expanding markets and falling unit costs (BP 2002). China, India, and Japan together accounted for nine per cent of the world's cumulative installed wind turbine capacity in 2000. Japan, on the other hand, accounted for 45% of the solar installed capacity

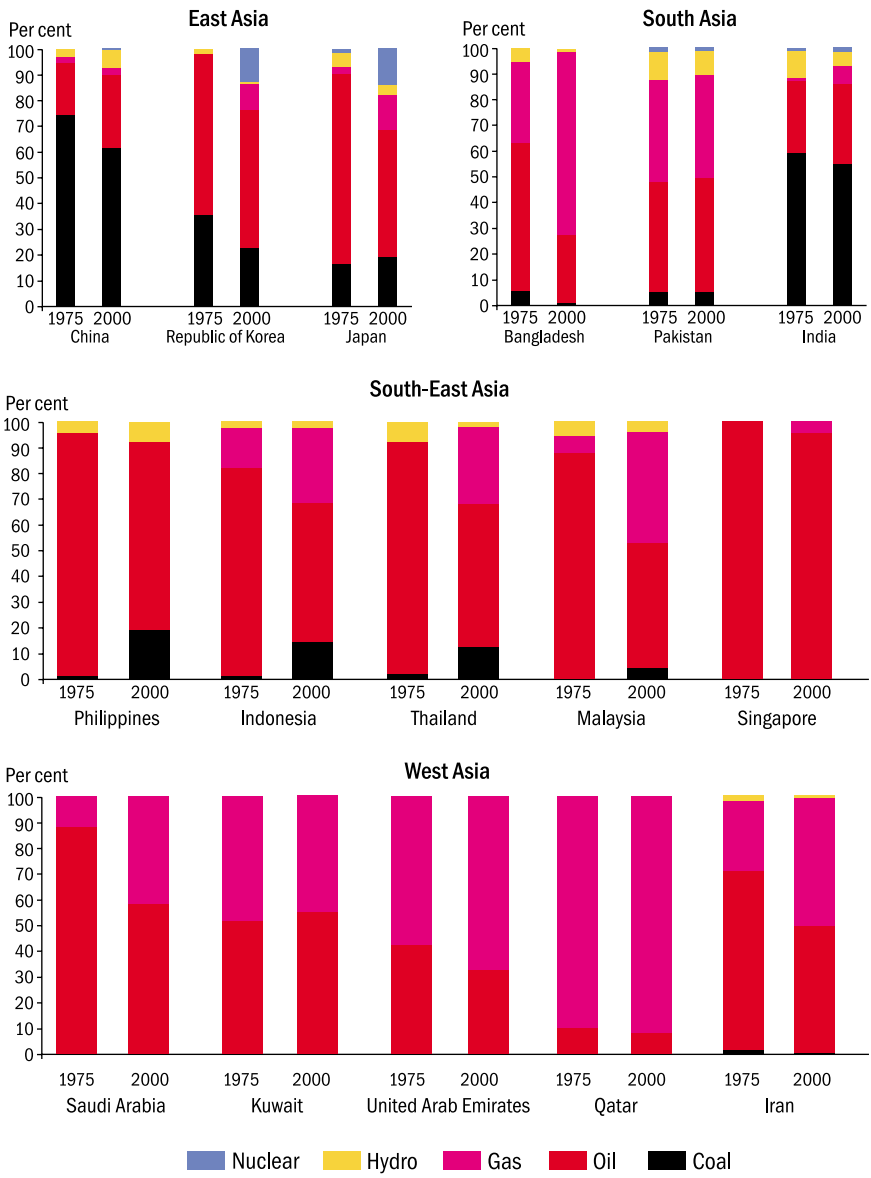


Figure 7 Fuel-mix for select Asian economies (1975 and 2000)

Sources BP (2002)

within the OECD (Organization for Economic Cooperation and Development) countries (BP 2002). The share of renewable energy sources in the total, however, remains insignificant due to (1) high capital and transactions costs of renewable energy, (2) market distortions in the energy sector on account of the copious subsi-

dies for the use of fossil fuels, and (3) unaccounted environmental externalities from the use of fossil fuels (Table 1). The share of renewable sources of energy in the global energy mix will probably remain small in the absence of determined market intervention measures.

Table 1 Net geothermal, solar, wind, wood, and waste electric power consumption (2000)

Country	*Billion kilowatt hours*	*Share in total electricity consumption*
China	1.55	0.13%
India	1.00	0.20%
Indonesia	4.58	5.31%
Japan	18.50	1.96%
Republic of Korea	0.07	0.03%
Philippines	9.18	24.28%
Thailand	1.33	1.47%

Source US DoE (undated)

The general trends witnessed in the fuel-mix are likely to continue. According to the International Energy Agency's *World Energy Outlook 2000*, the share of coal in the fuel-mix for South, South-East, and East Asia (excluding Japan) is expected to decline in the period 1997 to 2020 (53% to 43%); while that of oil, gas, nuclear, hydro, and renewables increase—with gas expected to report maximum increase (8% to 14%), and nuclear, hydro, and renewable energy, a marginal increase (collectively from 4% to 6%). Although the share of renewable energy is expected to double, their overall share in 2020 will be less than one per cent. For West Asia, the energy mix will be dominated by oil and gas, with the share of oil declining from 60% to 51% while that of gas increases from 37% to 46% over the time period.

Energy trade and the scope for regional cooperation

Trade has direct implications for sustainability as it allows countries to diversify the fuel-mix and move towards cleaner fuels. In line with the general trend, barriers to trade have been coming down in the 1990s. Asia accounts for a significant part of the

world energy trade, consisting of both energy importers and exporters (Table 2 and Figure 8). In general, importers also report lower energy intensities of the GDP as compared to exporters, thereby suggesting that high dependence on imports provides an impetus for lower intensities. Japan is a typical case in point.

Japan and the Republic of Korea are the two largest importers of hydrocarbons in the region, accounting for 55% of the crude imports, 79% of the gas imports, and 64% of the coal imports in Asia. The exporters are more diverse with 87% of the crude oil exports coming from West Asia, 51% of the gas exports being sourced from Indonesia and Malaysia (the share of West Asia being

Table 2 Asia's share of the world's exports and imports (1999)

Sector	*Share of exports (percentage)*	*Share of imports (percentage)*
Crude oil	49	32
Coal	20	47
Gas	21	19

Source US DoE (undated)

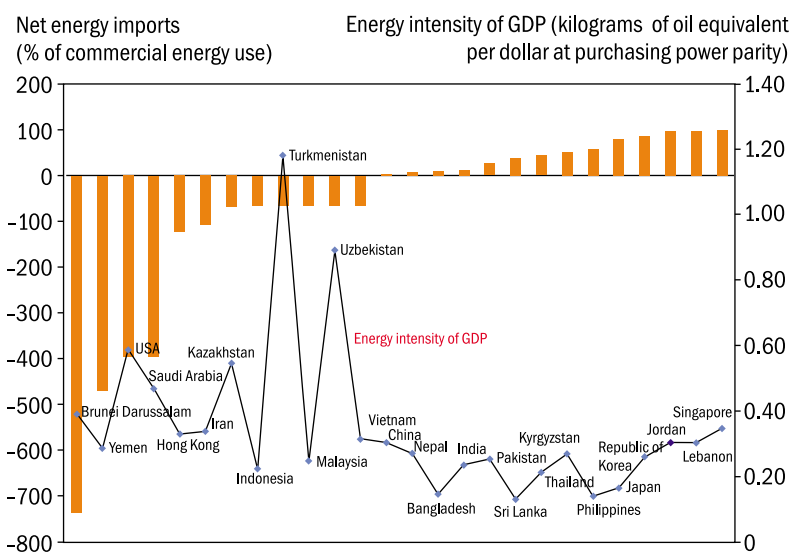


Figure 8 Net energy imports in select Asian countries vis-á-vis the commercial energy intensity of the GDP (gross domestic product) (1997)

Source Data from World Bank (2000)

13%), and 84% of the coal exports being accounted for by China and Indonesia (US DoE undated).

A sharp increase is expected to occur in international trade in energy, especially oil and gas, with the import dependency of current importers in Asia increasing (IEA 2001). China is likely to become a major importer in the region while West Asia is expected to remain the largest source of oil and increasingly of gas within Asia.

While trade throws open possibilities for the use of cleaner fuels, it also makes it increasingly more expensive to protect local economies from fluctuations in the world energy prices. For importers this has meant the need to increasingly pass on to the consumers the shocks of the system, while exporters have to ensure consistent financial flows. The members of OPEC (Organization of the Petroleum Exporting Countries) have been able to react quickly and prevent prices from remaining low after the crash in 1997. As countries move towards a more market-oriented system and lower tariff barriers there could also be greater volatility in prices; as much a security concern as access to energy sources.

There is large potential for regional cooperation in tapping the energy resources of Asia. Most of the energy resources yield optimal benefits when exploited by two or more nations rather than a national framework, especially when the countries are relatively small and the energy resource base is distributed across many countries. This is true for the planning and exploitation of the hydroelectric potential of a river valley system covering several countries, as well as, of gas grids connecting several markets, which would provide greater capacity utilization and lower costs. In the past, regional cooperation in terms of energy exchange amongst the Asian nations has been rather limited. A few examples can be cited from the Indian sub-continent. India has assisted Nepal in several hydroelectric schemes and the two countries are already exchanging power along several points of exchange along the Indo–Nepal border. India also provided technical and financial assistance for the 336 MW Chukha hydel project in Bhutan, in exchange for surplus power from the project, apart from providing assistance to several smaller projects in the country.

In terms of trans-national electricity exchanges in South-East Asia, two sectors of the ASEAN (Association of South-East Asian

Nations) power grid are already functional while the entire grid is expected to be operational by 2020.

The other instances of regional cooperation in the field of energy include the Malaysia–Thailand JDA (Joint Development Area) in which 10 gas fields have been discovered. This was the result of a partnership between Petronas of Malaysia and the Petroleum Authority of Thailand. Gas from the JDA would be evacuated through the 300-kilometres Trans-Thailand–Malaysia pipeline. Gas may also be exported from the Natuna gas field in Indonesia to Singapore, Thailand, and the Philippines. Unocal and Shell have been considering proposals for exports of natural gas from Bangladesh to India. Further development on this front has been stalled on account of political deadlocks as is the case of gas imports from Iran through Pakistan to India.

Given that about three-fourths of the natural gas transfer in the Asian region takes place through pipelines, there is economic merit in regional gas trade through pipelines such as the Trans–ASEAN gas pipeline system (about 8000 km long to link the East Asian markets). The transportation of LNG (liquefied natural gas) over long distances requires large dedicated reserves and infrastructure at very high investment costs, but the growth in energy demand and the rising concerns over the environment have made LNG the fuel of choice for power generation in the importing countries. Natural gas has the potential to provide security of supply for consumers and security of demand for producers.

Energy efficiency and conservation

Energy efficiency and conservation is one of the most important sources of enhancing energy availability in developing countries. Past trends do show a gradual improvement in the energy efficiency in the developing countries of Asia. However, the potential for energy efficiency enhancement and conservation remains in all the sectors of the economy. At an aggregate level, the OECD nations produce 5.5 times more GDP per unit of energy input compared to South Asia. These numbers reflect only commercial energy use—the efficiency of some developing countries would be lower if the use of poor-quality traditional fuels in inefficient devices were included (ADB 2001). Table 3 indicates the energy-saving potential for different sectors of the economy in India and China. At the supply end, transmission and distribution losses in

Table 3 Economic energy efficiency potentials (%) in India and China (2010)

Sector	*India*	*China*
Industry		
Iron and steel	15	15–25
Cement	17	10–20
Pulp and paper	20–25	20–40
Textile	23	15–28
Aluminium	15–20	20
Household		
Lighting	10–70	10–40
Refrigeration	25	10–15
Air-conditioning	10	15
Agriculture		
Pumpsets	25–55	20–50
Transportation		
Cars	7.5–10.0	10–15
Trains (diesel)	5–10	5–15
Trains (electric)	5–10	8–14

Source UNDP (2000)

the electricity sector range from 4% in Japan and Korea to 15%–25% in India, Bangladesh, Indonesia, and Pakistan (World Bank 2001).

Barriers to implementing energy efficiency policies include institutional, policy, and economic factors such as inefficient public sector monopolies and uneconomic pricing; attitudes and behaviour that cause excessive and inefficient energy use; non-compliance with environmental requirements; and indigenous fuel-supply limitations and technological gaps (ADB 2000; UNEP 2000). With the general liberalization of the policy environment and the move towards rational pricing, some of these factors are likely to get addressed. The potential for energy saving in the developing countries also illustrates the large gains in energy efficiency possible due to the transfer of technology from the developed countries.

Sustainable energy development in a changing policy context

The basic policy approach to energy challenges has been changing with time. This is reflective of the general change in the macroeconomic climate. There has been a shift in the 1990s from the public-sector and centralized-planning dominated policies to the greater acceptance of and reliance on markets. This has been true both of greater liberalization within the countries as well as a more open stance towards external trade and investment flows. Multilateral institutions have also laid greater stress on using their investments to promote sector reforms aimed at greater use of market-based instruments. The World Bank's lending for the energy sector fell from 25% of the total to less than 10% recently (World Bank 2001).

Financing sustainable energy development

With the change in the paradigm of growth, the energy sector has also witnessed a rapid increase in private investment. International investment flows rapidly increased in the early 1990s, peaking in 1997, and declined thereafter, following the financial crises. According to the World Bank, East and South Asia were the second and the third highest investment regions, respectively, accounting for about 45% of the total investment in the energy sector with private participation during 1990–99. The East Asian region recorded an investment portfolio of 60 billion dollars and the South Asia region a portfolio of about 20 billion dollars (Izaguirre 2000).

The bulk of this investment went into greenfield power projects which accounted for 80% of the investment in East Asia and for 93% of the investment in South Asia (Izaguirre 2000). Within the electricity sector, projects have been concentrated in generation while other aspects, principally distribution, have seen little investment. Natural gas was the other major sector to witness private investment mainly in the form of transmission assets.

Encouraging greater flows of private investment would require much deeper changes than the mere opening-up of the energy sector, still largely in the public domain. Reforms would imply basic changes in the functioning of the sector including a shift of power from the governments to credible independent regulators.

Such a process will take time. In this respect, the crisis of 1997/98 has helped to put things in perspective and encouraged the establishment of a more sustainable framework for the financing of the energy sector.

The experience of the electricity sector is a case in point. In the wake of the financial crisis, investments in the sector declined though those countries which had a smaller exposure to foreign capital suffered less. This was on account of the foreign exchange protection that was offered to these projects. A study of four Asian countries showed that Malaysia and Thailand, that had high levels of domestic funding – 90% and 75%, respectively– suffered less as compared to Indonesia and the Philippines that had only 14% and 3%, respectively, of domestic funding, (Gray and Schuster 1998). Thus the success of financing cannot end with financial closure, which can be induced by government guarantees. This process seemingly could overcome all the risks of these projects; experience showed otherwise.

This has led to greater emphasis on sector reform and on providing a framework for the markets and for competition. Presumably then such projects would take normal market risks and would thereby be less prone to 'guarantee induced' failures.

More fundamentally, the 1990s demonstrated that the ultimate source of financing is the consumers. This has necessitated sound policy and regulatory frameworks that could induce the right kind of investments and ensure correct pricing of energy.

Energy prices

The change in the policy regime has been accompanied with pricing reforms. However, the progress on this front has varied from one country to another. In Korea and Thailand, where petroleum plays a predominant role in the energy basket, petroleum prices have been almost fully deregulated. China initiated a policy of liberalization in mid-1980s that envisaged complete deregulation of consumer prices by the mid-1990s, when the domestic price of oil products generally equalled or exceeded the world market prices. Though the Chinese government has regulated electricity prices, in general the movement of electricity tariffs has been towards rationalisation, and they now compare quite well with the long-run marginal cost of supply.

The energy pricing regime in India was till recently, entirely regulated. It was based on a cost-plus principle and some social subsidies. Since 1996, the Indian government has introduced policy changes relating to the pricing of coal, oil, and to some extent, natural gas. The prices of coking coal and superior non-coking coal were deregulated in 1996, followed by those of other grades in 1997. This was followed by an order in 2000 which fully deregulated the prices of coal in the country. The administered pricing mechanism for the petroleum sectors was dismantled in 2002.

In Indonesia, the main fuels – oil, coal, and gas – are mostly produced under contractual arrangements with major international companies. Since Indonesia has been a large energy exporter, the export prices of oil, gas, and coal are set through international market operations and through contractual agreements between the buyer and seller.

In sum, a majority of the developing economies of Asia are moving towards market determined prices. More efficient pricing structures are expected to have favourable implications for energy conservation, for inter-fuel substitution, and for providing the right signals for greater private investments in the energy sector.

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Chapter

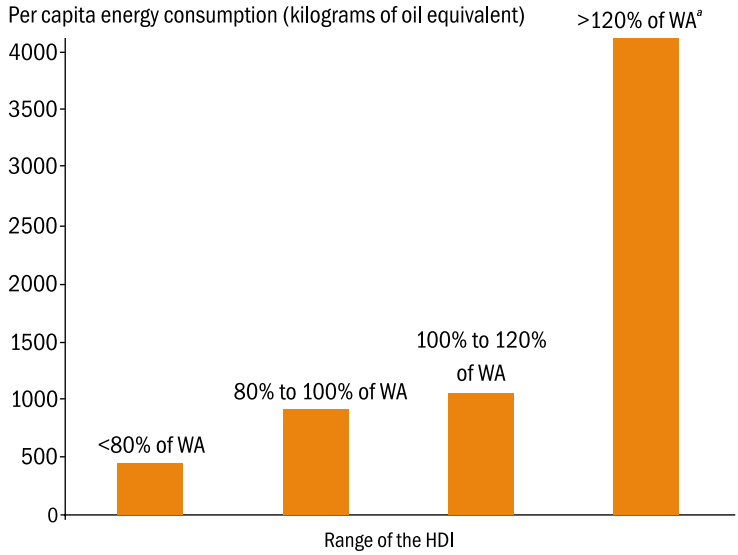
4 Energy for all

Energy services have intrinsic linkages with poverty eradication and the quality of life. While equitable access to energy sources has been an objective of government policy, efforts to ensure universal access to modern energy carriers through electrification or through the instrument of subsidies have been inadequate in most countries. The continuing reliance on traditional fuels has a visible impact on health with related gender issues. There is growing recognition of the importance of renewable sources of energy for rural energization, especially as decentralized sources in remote areas.

Energy–poverty linkages

The diversity in the quality of life in Asia can be gauged from the differences in the HDI (human development index) and the HPI (human poverty index). While the HDI for most East and West Asian economies stands greater than the world average, the value of the index for the South Asian economies is lower than the world figure. The South-East and Central Asian economies show a range of HDI levels. Moreover, of all the sub-regions within Asia much of the population in South Asia survives on less than a dollar a day. This gets reflected in the per capita energy consumption.

The level of the HDI seems to rise with energy consumption per capita (Figure 1). As a corollary, the skewed distribution of the HDI is also reflected in the energy consumption per capita. Only 5% of Asia's population records a value of the HDI greater than 120% of the world average. This section of the population also



[a] world average HDI level in 1999 (0.716)

Figure 1 Energy consumption per capita by the HDI (human development index) range

Note The ranges of the HDI are for the year 1999 and energy consumption per capita has been calculated based on data available for 1997.
<80% of the world average: Bangladesh, India, Myanmar, Nepal, Pakistan, and Yemen
80% to 100% of the world average: Hong Kong (Special Administrative Region of People's Republic of China), Indonesia, Iran, Jordan, Kyrgyzstan, Tajikistan, Uzbekistan, and Vietnam
100% to 120% of the world average: Bahrain, Brunei Darussalam, China, Kazakhstan, Kuwait, Lebanon, Malaysia, Maldives, Oman, Philippines, Saudi Arabia, Sri Lanka, Thailand, Turkmenistan, Qatar, and United Arab Emirates
>120% of the world average: Republic of Korea, Singapore, and Japan
Source Data from World Bank (2000)

consumes the highest levels of energy per capita, over 240% of the average for the world. Similarly, about 40% of the continent's population has an HDI value below 80% of the world average and per capita energy consumption less than 26% of the world average.

Clearly, the provision of energy services directly impacts human development and the quality of life through energy's role in services ranging from cooking, provision of clean drinking water, and water and space heating to basic health care, education, and economic opportunities—agriculture, transport, and small-scale industries (Figure 2).

This linkage is well demonstrated by the example of Tajikistan, where post-war disruption of the electricity supply, with availability

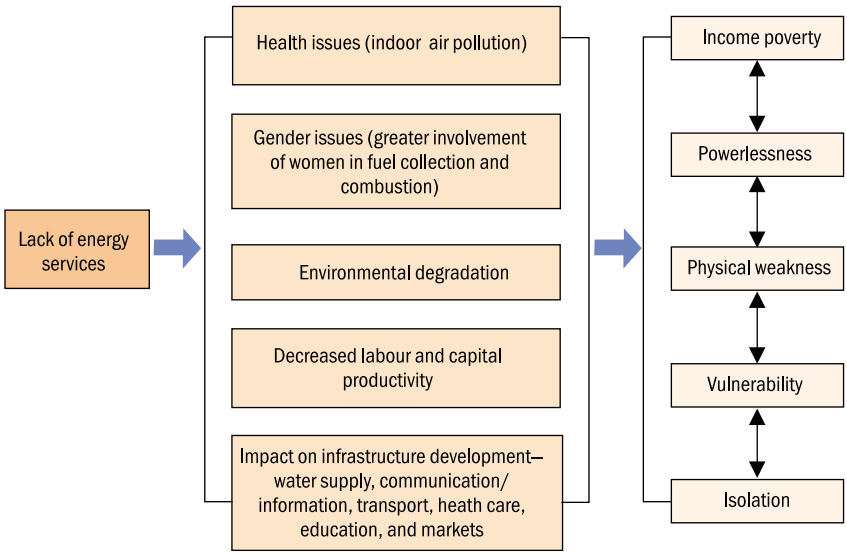


Figure 2 Exploring the linkages between energy and poverty

reduced to less than 2 hours a day, resulted in increased dependence on biofuels and diesel, with monetary and non-monetary implications. The time spent in gathering fuelwood and agricultural biomass was estimated at 15 days a year, with cooking taking 5 hours each day, and water collection requiring 3–25 km long trips each day. Agricultural productivity decreased by 20%–25%, the school enrolment decreased especially during the winter, and the delivery of health care services was affected.

The recognition of energy as a basic service for well-being has led to massive investments in infrastructure for electrification and large-scale subsidies for other modern energy carriers. How far has this effort towards ensuring equitable access been successful?

How equitable is access to energy services?

The growth in per capita commercial energy consumption reflects a clear rich–poor divide, both across nations (refer Chapter 3) as well as within nations. On an average, less than 20% of the rural households had access to electricity in South Asia in 1970 (Figure 3). This implied large dependence on traditional fuels. A substantial proportion of the energy use in Asia is still serviced by traditional fuels (Figure 4), with most South and South-East Asian

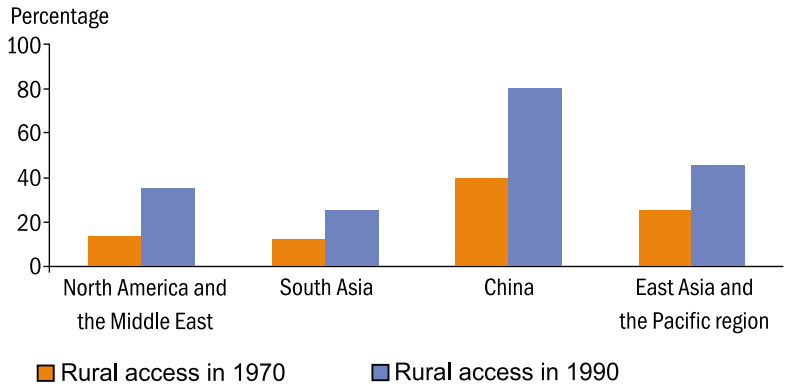


Figure 3 Rural access to electricity in 1970 and 1990 by region

Source WEC (2000)

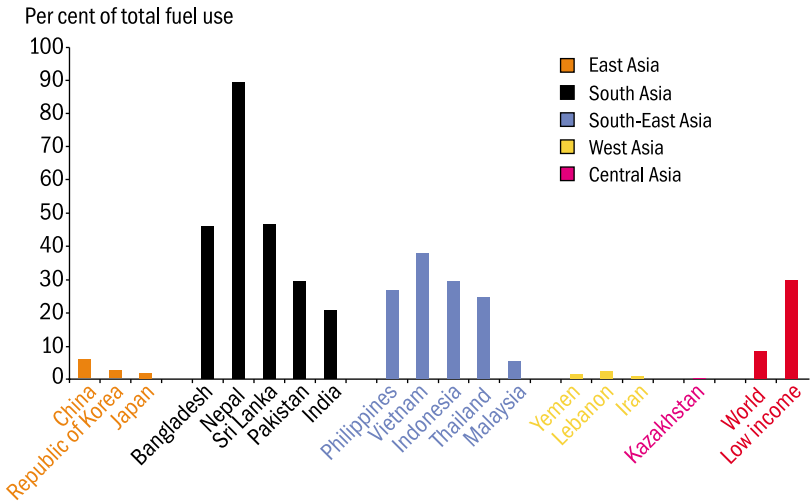


Figure 4 Traditional fuel consumption as percentage of total fuel use in 1997 for select Asian economies

Source UNDP (2002)

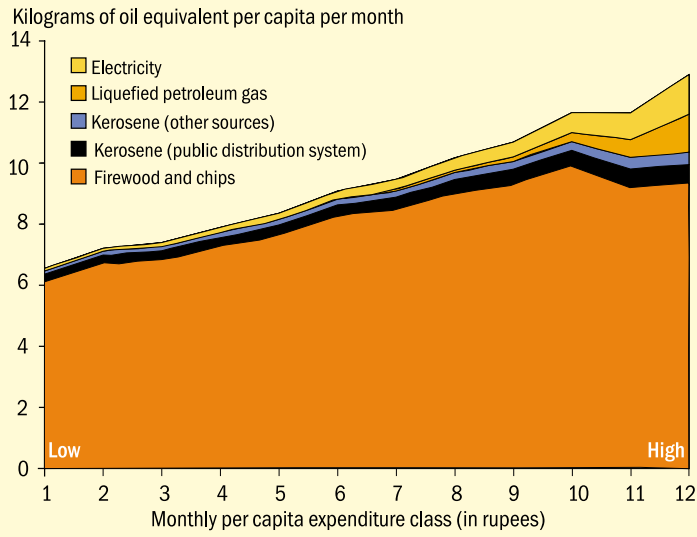
economies exhibiting more dependence than the average figure for the world.

This dependence is far more pronounced in rural areas (Box 1). According to the ADB (Asian Development Bank), rural energy systems in its developing member countries have the following common features (ADB undated).

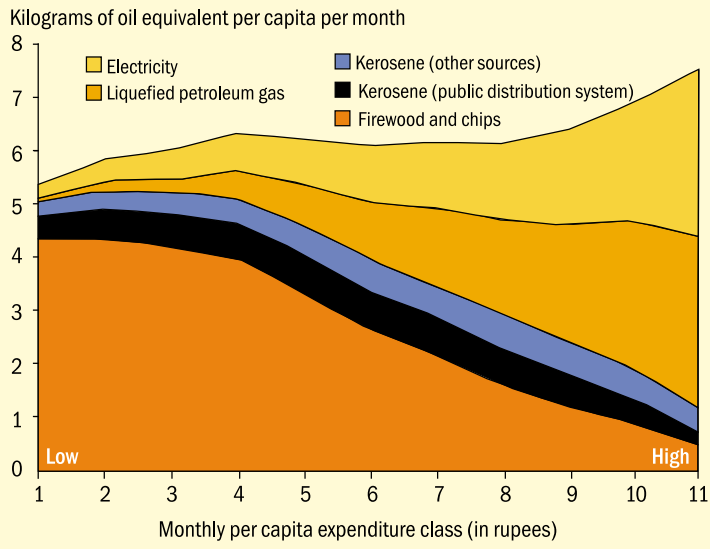
Box 1

Inequities in energy consumption in India: fuel use by expenditure class in the rural and urban sectors

Gross energy consumption by expenditure class (rural)



Gross energy consumption by expenditure class (urban)



Source NSSO (2001)

- Energy consumption is dominated by the domestic sector. In the rural economy in India, for instance, the domestic household sector is the most prominent energy consumer, followed by

the agricultural sector. It accounts for nearly 75% of the energy use in the rural areas with cooking being the largest end-use accounting for almost 90% of the total domestic energy use. Biomass fuels – fuelwood, crop residue, and animal dung – provide 85%–90% of the domestic energy and 75% of all rural energy (TERI 2002).

- Energy demand is determined by basic human needs rather than by factors such as choice, taste, or income.
- Traditional non-commercial energy sources are generally over-exploited but rural incomes are so low that alternative energy forms are not affordable unless offered at subsidized prices.
- Social and institutional policies (which often work to the disadvantage of the poor) determine the distribution of and access to energy resources.

The use of traditional fuels has visible implications for the health and social upliftment of women and children, who are responsible for fulfilling the energy needs of the households in the rural areas of developing countries. The collection and combustion of fuels at the lower end of the 'energy ladder' in traditional, often inefficient, devices subjects them to an unceasing cycle of work that often results in poor health, little or no education, and limited participation in local development programs and self-government bodies. In Nepal, for instance a woman spends 2.4 hours a day in firewood collection (UNDP 2000). Another study for Nepal revealed that women spent around 20% of their working hours in cooking and related household activities. Deforestation and a fast-reducing resource base along with inability of the poor to shift to commercial fuels has further implications for social and ecological sustainability.

Epidemiological research confirms the relationship between traditional fuel use and morbidity, mortality, and life expectancy among women and children (Bloom, Craig, and Malaney 2001). The burning of such fuels in limited space with no or inadequate ventilation usually produces large amounts of gases and aerosols, including carbon monoxide, hydrocarbons, and nitrogen oxides, which are common elements of outdoor air pollution. Aerosol components tend to contain organic compounds similar to those present in tobacco smoke and are therefore toxic.

Air pollution levels in rural microenvironments are often higher than in the most polluted urban environments. Studies point out that the concentration of particulate matter in homes in South Asia may even be 10 to 100 times more than those prescribed by the World Health Organization (WRI 1998). As a result of these practices, acute respiratory infection is prevalent in Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka, especially in the rural and hilly areas where indoor air pollution is high. Rural women in India are exposed to almost 5000 PPM (parts per million) of suspended particulate matter against the allowable maximum limit of 290 PPM for the occupational environment (Smith 1988). Bangladesh, India, Indonesia, and Nepal account for about 40% of the global child mortality caused by pneumonia; many of these mortal disease deaths are caused by pollutants from the burning of traditional fuels (ADB 2000).

Energy subsidies: failed targets?

The continued reliance on traditional fuels reflects the failure of energy subsidies to benefit the intended target population, while in the process introducing other distortions in the energy markets. As pointed out by the ADB, 'subsidies have been extensively used by the DMC (developing member country) governments in the energy sector to benefit particular classes of consumers (such as the poor, rural consumers, and residential consumers), or activities (such as irrigation, fertilizer production, and goods transportation). Such subsidies have often

1 failed to benefit the target population;
2 distorted the relative price of fuels, inhibiting fuel switching based on true economic costs or using renewable energy options;
3 sent price signals that promoted inefficient consumption;
4 imposed a heavy burden on the supply system and environment;
5 eroded the ability of the utility to undertake system expansion and connect new customers without additional budget support;
6 imposed a heavy and often unsustainable burden on the general tax revenues; and
7 impeded the efficient development of indigenous energy resources' (ADB 2000).

Box 2 discusses the findings of a study carried out by the International Energy Agency on the estimated magnitude of subsidies and the implied distortions in energy prices.

Box 2

Subsidies: magnitude and impacts

An analysis carried out by the International Energy Agency reveals distortions in energy prices of the order of 11% in China, 14% in India, 26% in Indonesia, and 80% in Iran (Table 1). Phasing out these subsidies would lead to significant energy savings, as high as 48% in Iran, and a corresponding reduction of carbon dioxide emissions.

Table 1 Energy subsidies in select Asian countries

	Estimated subsidy rate (% of reference price)[a]				*Energy-saving potential of subsidy removal* (%)[b]			
Fuel	*China*	*India*	*Indonesia*	*Iran*	*China*	*India*	*Indonesia*	*Iran*
Gasoline	0	0	0	59.4	0	0	0	20.2
Auto diesel	0	0	40.2	93.9	0	0	12.1	50.4
Liquefied petroleum gas	0	31.6	0	89.7	0	17.3	0	67.9
Kerosene	0	52.6	55.2	89.5	0	32.9	31.3	66.0
Light fuel oil	0	0	45.5	82.3	0	0	23.4	57.7
Heavy fuel oil	0	0	7.8	88.1	0	0	3.6	63.4
Electricity	38.2	24.2	0	48.1	21.4	0	0	28.0
Natural gas	18.7	22.5	28.4	77.8	12.8	16.6	16.9	55.1
Steam coal	8.3	13.1	0	0	14.8	16.5	0	0
Coking coal	73.1	42.3	0.35	0	40.1	24.1	0	0
Total[c]	10.9	14.2	27.5	80.4	14.4 (9.4)	14.0 (7.2)	13.9 (7.1)	53.5 (47.5)

[a] weighted average; [b] TPES (total primary energy supply) saved per TPES for the sectors covered in the study; [c] figures in parantheses are calculated using TPES for all sectors and fuels, including those not covered in the study.

Note Calculations are based on 1998 prices and quantities.

Source IEA (1999)

Decentralizing energy services: from electrification to energization

Over the years there has been acknowledgement of the fact that energy services may be best provided in a decentralized manner, by encouraging local institutions to manage their own energy

needs through indigenous resources. This has come with the recognition that since a large number of rural communities consume low quantities of electricity, extending electricity grids may be less economically viable than other decentralized forms of energy generation using local renewable resources. The attractiveness of renewable energy technologies such as wind, solar, and biomass lies primarily in their abundance. Biogas plants, applications of solar energy such as lanterns and home lighting systems, and water pumping and heating systems are some technological interventions that have become popular in the last few years (Box 3).

Box 3

Decentralized applications of renewable energy technologies: examples from select Asian countries

China: rural electrification with wind/photovoltaic hybrids

In the Inner Mongolia Autonomous Region, about 150 000 small wind systems have been disseminated, powering about one-third of the unelectrified population. In the low-wind summer months, however, the system output drops to a fraction of its rated capacity and the batteries cannot be fully charged.

This has led to the proliferation of micro-hybrids [addition of solar PV (photovoltaics) to wind systems]. In addition to lighting, radio, and television, the larger hybrid systems allow consumers to use refrigerators, washing machines, rice cookers, irons, and electric heaters.

Bangladesh: the success of Grameen Shakti

Grameen Shakti is a leading organization in the renewable energy sector affiliated to the Grameen Bank in Bangladesh. The organization aims not only at supplying renewable energy services, but also at creating employment and income-generating opportunities in rural Bangladesh. Its initiatives include supply, marketing, sales, testing, and development of renewable energy systems such as solar PV, biogas, and wind turbines. It has also installed more than 3185 solar PV systems, which have been used for a variety of applications in electronic repair shops, grocery stores, rice mills, telephone centres , and barbershops. The PV systems are also used for emergency lighting .

India: government initiatives

India ranks among the first worldwide in realizing the tremendous potential of renewable energy sources. The government has undertaken many programmes focusing on technology improvements for servicing the cooking and other requirements of the rural households. Notable among these is the biogas development programme. The biogas development programme was started in 1981/82. Of the total estimated potential of 12 million plants, 3.2 million family-type biogas plants have

Contd...

Box 3

Decentralized applications . . . *(contd...)*

been installed along with community, institutional, and nightsoil-based biogas plants as of March 2001. With the current level of achievement, the programme is estimated to have resulted in a saving of 3.9 million tonnes of firewood and 0.9 million tonnes of urea per year as well as provided 5 million person-days of employment.

The solar PV programme has found such decentralized applications as fixed and portable lighting units, water pumping, small power plants, power for telecommunication, railway signalling, offshore oil platforms, and television transmission. Solar PVs are being increasingly used for meeting the electrical energy needs in remote villages, hamlets, hospitals, and households in the hilly regions, forest areas, deserts, and islands of the country.

Source Elsevier Advanced Technology (2001), MNES (undated), Urmee and Wimmer (1999)

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Chapter

5 Energy for / against the environment?

Air pollution remains an unabated environmental concern in Asia, with many cities recording pollution levels far above the WHO (World Health Organization) permissible limits. This degradation has been fuelled by the rapid growth of megacities, rising population and vehicular densities, and the concentration of industrial activities in urban areas. Transboundary environmental concerns have also assumed significance. While most countries have or are in the process of establishing a regulatory and institutional system to address environmental concerns, monitoring and enforcement remain inadequate. The merits of market-based instruments are being recognized gradually, especially due to the liberalizing policy environment in Asia.

Air pollution in Asia: a grim picture[1]

A survey, jointly conducted in 1992 by the WHO and the UNEP (United Nations Environment Programme) on urban air quality in 11 megacities of Asia, showed that 10 cities had dangerous emission levels of SPM (suspended particulate matter) while the Chinese cities also had significant levels of SO_2 emissions (Table 1). In the major cities and industrial areas of West Asia, the concentrations of the main air pollutants often exceed the WHO guidelines by a factor of two to five (UNEP 2002a).

Transport is a significant, often major, source of urban air pollution. Though the vehicular density in most Asian economies is

[1] Issues related to indoor air pollution have been covered in the previous chapter.

Table 1 Air quality in select megacities of Asia and the Pacific region

City	*Sulphur dioxide*	*Suspended particulate matter*	*Lead*	*Carbon monoxide*
Bangkok	Low	High	Moderate	Low
Beijing	High	High	Low	Low
Kolkata	Low	High	Low	Low
Delhi	Low	High	Low	Low
Jakarta	Low	High	Low	Low
Karachi	Low	High	Moderate	Moderate
Manila	Low	High	High	Low
Mumbai	Low	High	Moderate	Low
Seoul	High	High	Low	Low
Shanghai	Moderate	High	Low	Low
Tokyo	Low	Low	Low	Low

Low: WHO (World Health Organization) guideline normally met
Moderate (to heavy): WHO guideline exceeded up to a factor.
High: WHO guideline exceeded by more than a factor.
Sources UNEP (2000)

lower than the world average, these economies have been growing rapidly. The problems of a growing vehicular fleet are exacerbated by traffic congestion, low fuel quality, and poor automobile and road conditions (Figure 1). Much of this traffic is concentrated in a few urban centres; in Nepal, for instance, the city of Kathmandu alone accounts for nearly 50% of the total vehicles registered in Nepal (Ministry of Population and Environment 2000).

Energy processing and generation is the other major source of air pollution in the region. About two-thirds of the acid deposition in Asia and the Pacific region are caused by coal-fired power plants with outdated pollution control equipment (UNEP 2002a). In India, the management of fly ash is another concern as 60% of the power generated is coal-based and power grade coal contains on an average over 40% ash. In West Asia, oil refineries and power generation remain major sources of air pollution.

Urban air pollution exacts a heavy toll on health and the quality of life in Asia (Box 1). Estimates indicate that around 84 000 people die from outdoor air pollution each year in the cities of South Asia (UN ESCAP and ADB 2000). An estimate of the damages inflicted in terms of reduced economic life of capital

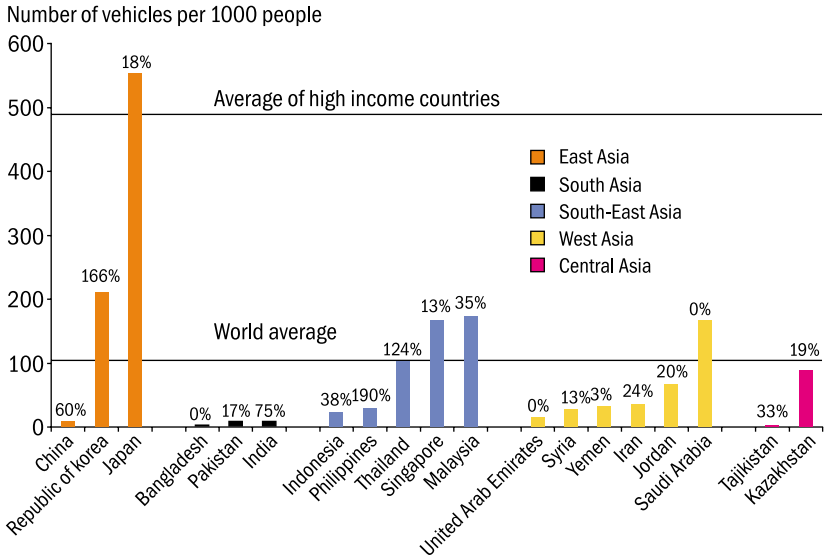

Figure 1 Vehicles per 1000 people in 1996 for select Asian countries

Note Percentage indicates growth over 1990–96.
Source Data from World Bank (2000)

Box 1

Health costs of air pollution in Asia: some evidence

Air pollution imposes heavy costs on human health and economic systems. In Mumbai (India), 60% of the urban population resides in slums and is exposed to rising levels of air pollution. Various studies and anecdotal evidence suggest that the health of a Greater Mumbai resident, especially in high-density traffic areas or near industries, is under serious threat. The health impact was estimated at 2800 cases of excess mortality, 60 million respiratory symptom days, and 19 million restricted activity days, with an estimated health damage cost of 400 million dollars a year (World Bank 1996a). Likewise, the losses from mortality and morbidity due to excess concentration of PM_{10} in Nepal were found to be of the order of 2.8 million dollars per annum (World Bank 1996b). Deterioration in air quality is costing Pakistan around 25 billion Pakistani rupees per year on account of adverse health and other effects (Government of Pakistan 1997). The economic loss due to the impact of poor air quality in Syria is estimated at about 188 dollars per year (UNEP 2002a).

A recent cross-sectional study conducted by the Department of Occupational and Environmental Health in Bangladesh provides evidence of high lead levels in the blood of rickshaw pullers, taxi drivers, traffic police, petrol pump operators, etc. Instances of lead poisoning have also been found in children causing developmental delay and neurological impairments at the Child Development Centre of the Dhaka Children Hospital in Bangladesh. The study also identified a significant rise in the mean lead levels in the blood of persons living in urban slums when compared to those living in urban middle-income areas and in rural areas.

goods, tourism, crop production, and other tangibles remains elusive due to the lack of reliable data.

Transboundary environmental issues

Over the last decade, regional issues related to haze (a brownish layer of pollutants and particles from biomass burning and industrial emissions) and acid rain have gained attention in Asia, because of the overwhelming reliance on fossil fuels – to the extent of 80% in the region[2] – with coal accounting for about 40% of the energy produced. The RAINS–Asia (Regional Air Pollution Information and Simulation Model for Asia) model, developed as an international cooperative venture involving scientists from Asia, Europe, and North America with support from multilateral organizations such as the World Bank and the Asian Development Bank, predicts that under the base scenario for 2020 (no major changes in economic and demographic trends or in energy and environment trends), sulphur emissions will increase from 33.6 million tonnes in 1990 to more than 110 million tonnes by 2020 – an increase of 230% – if no actions are taken to restrict emissions. The model predicts that large sections of southern and eastern China, northern and eastern India, the Korean peninsula, and northern and central Thailand will receive levels of acid deposition that will exceed the carrying capacity of the ecosystem. These could lead to irreversible ecosystem damage with far reaching implications for forestry, agriculture, fisheries, and tourism (Downing, Ramankutty, and Shah 1997).

The presence of a haze, which pervades many regions in Asia, was detected by an international study called INDOEX (the Indian Ocean Experiment). Based largely on INDOEX findings, a recent UNEP study called Asian Brown Cloud predicts that the haze is likely to have far-reaching implications through its impacts on the weather, water availability, agricultural productivity, and health (Box 2).

The other major issue is that of global warming, though the contribution of most Asian economies to carbon dioxide emissions, in per capita terms, especially those in South Asia is negligible as compared to the world average and the average of Organization for Economic Cooperation and Development countries (Figure 2). However, due to the expected growth in

[2] Excluding West Asia

Box 2

Asian Brown Cloud

In 1999, a team of scientists from Europe, India, and the US working on the INDOEX (Indian Ocean Experiment) project discovered a dense brownish pollution haze layer over an area of about 10 million square kilometres in the Asian continent. The study also revealed that this haze is transported far beyond the source region, particularly during the period from December to April. The United Nations Environment Programme subsequently initiated a comprehensive study, called Asian Brown Cloud, of the haze and its impact on climate study. The study suggests that biomass burning and fossil fuel burning are the major sources of air pollution. While it was infeasible to determine with confidence the relative contribution of biomass and fossil fuel burning to the observed haze due to lack of detailed emission data, the study surmises that biomass burning plays a major role in gaseous pollution (such as carbon monoxide), while fossil fuel combustion and biomass burning contribute to particulate (aerosol) pollution. The affected region (South Asia) is the most densely populated in the world characterized by a monsoon climate; high levels of pollution; and increasing problems of water stress, agricultural productivity, and health. The haze can potentially impact all of these aspects directly. It can also impact them indirectly through its effects on the atmospheric and surface temperatures and the hydrologic cycle.

Source UNEP (2002b)

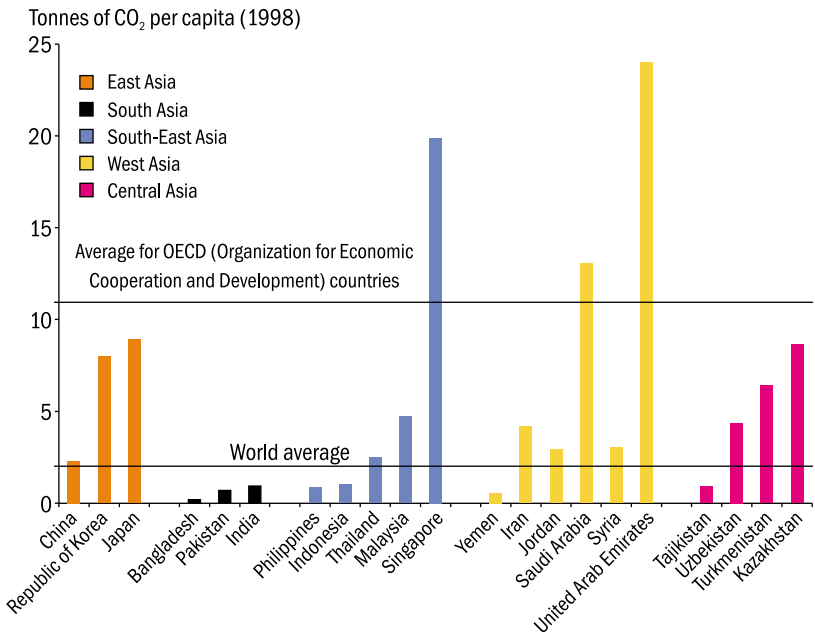

Figure 2 Per capita CO_2 (carbon dioxide) emissions in select Asian countries

Sources IEA (2000)

emissions in some large Asian economies, like India and China, there is pressure on these countries to mitigate emissions. The developing regions of Asia are also particularly vulnerable to the impacts of climate change due to the expectation of greater climatic variability in the regions especially in temperate and tropical Asia, a greater proportion of climate-sensitive sectors, and lower adaptive capacities in these countries given their limited resources (IPCC 2001).

The environmental policy framework in Asia: gradually moving towards complementary use of economic instruments

Following the 1972 Stockholm Conference on the human environment, many countries developed a substantial body of environmental law and regulations dealing with the protection of the environment and the management of natural resources, partially as a result of obligations under the multilateral environmental agreements (UNEP 2000). Over time, increasing concerns about environmental issues have led to the revision of laws and regulations and a broadening of their ambit. Increasing air pollution has prompted the definition of ambient and emission standards for principal pollutants, as well as emission standards for power plants, selected industries, and vehicles. The stringency of these measures varies across the regions. Japan, for instance, enforces the world's most stringent standards for automobile exhaust emissions, as well as strict standards to control smoke emissions from factories and other facilities. Singapore has been particularly strict in the enforcement of environmental regulations.

Other measures include the phasing out of leaded fuels, introduction of cleaner fuels like ultra low sulphur diesel and compressed natural gas, phasing out of old vehicles, mandatory use of catalytic converters, regular inspection and maintenance, etc. The national lead phase-out programmes in most of the countries have been quite successfully developed and implemented. The environmental impact assessments are now a common requirement in the region and most countries have come up with environmental action plans.

Many new public sector institutions have been established, including environmental ministries, while independent environment agencies and departments have been created to assist them.

Institutional frameworks for environmental protection vary and are at various stages of development. While in some countries such as Japan and India, institutional arrangements for environmental protection were initiated in the 1970s; in others (e.g. Cambodia and Myanmar), the institutional frameworks are in the initial stages of being strengthened. In many countries, the judiciary has become active in promoting environmental compliance and enforcement, thereby giving recognition to the emerging principles of environmental law. In several countries, though, effective enforcement of environmental legislation remains weak due primarily to a lack of political will; the relative weakness of environmental institutions; and inadequate manpower, funds, and technical expertise (UNEP 2000).

The use of economic instruments for pollution control has been modest, with an over reliance on command-and-control measures, though many countries have made a beginning with the use of market-based instruments. These include pollution charges (e.g. China, The Philippines, Korea, and Malaysia), favourable terms of investment for environmental technology (e.g. India, The Philippines, Korea, and Nepal), pricing policies (e.g. price differentiation between leaded and unleaded gasoline in Thailand and road pricing during peak hours in Singapore), etc. If properly designed, these instruments can ensure efficient, cost-effective, and flexible means to deal with air pollution arising from a large number of dispersed sources. These instruments are even more relevant in the liberalizing policy environment in Asia.

The use of economic instruments requires a greater degree of flexibility in the regulatory structures while at the same time calling for an effective monitoring and enforcement regime. Differences in institutional competency amongst the developing countries in Asia necessitate that the transition towards economic instruments be gradual and the selection of instruments be on a case-to-case basis. Several countries in East and South-East Asia (China, Republic of Korea, and Malaysia and more recently Indonesia, The Philippines, and Thailand) have made considerable progress by introducing more flexibility in their regulatory structures and by experimenting with a variety of economic instruments (ADB 2001). By and large, however, at least in the foreseeable future, environmental management in the developing countries of Asia will be based on a mixture of regulation and economic instruments.

The countries have also taken some initiatives to collectively deal with the threats posed by transboundary pollution. The EANET (Acid Deposition Monitoring Network), with the participation of 10 East Asian economies, began a preparatory phase of monitoring acid deposition in 1998, which was to be regularized since January 2001. In South Asia, the Male Declaration on control and prevention of air pollution and its likely transboundary effects was adopted by eight countries in 1998. The declaration seeks to conduct baseline studies and implement an action plan for reducing air pollution (UNEP 2002a).

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Chapter

6 Sustainable energy: perspectives

This chapter presents the perspectives of various stakeholders representing research organizations, governments, industry, and NGOs (non-governmental organizations) on issues that have emerged in the debate on sustainable energy development throughout the last decade.

The 1990s witnessed a paradigm shift in the development philosophy that guides the economies in the Asian region. The most noticeable one being the role enhancement of non-government functionaries such as the private sector and the civil society due to disenchantment with the state and advances in information and communication technology. The decade also marked an unprecedented rise in the demand for 'sustainable development', based on a better understanding of the interdependent character of the social, economic, and environmental processes that define a system even as the physical boundaries of this 'indivisible system' have become indefinite. The energy sector has been an intrinsic part of this transformation owing to its role in meeting the basic needs of people as a fundamental infrastructural input and as one of the largest sources of environmental degradation.

The decade also began with what has been dubbed as the mother of all summits—the Rio Summit. To what extent have the developments in the 1990s been shaped by this landmark event? What have these developments meant for Asian economies in terms of sustainability? Is 'sustainable energy development' a mere slogan or has it guided policies at the national and international levels? Is technology diffusion and the flow of financial resources facilitating this process? What are the key elements that will constitute a sustainable energy future for the Asian region?

In seeking answers to these questions, views of experts were elicited through interviews and questionnaires. A focused analysis of stakeholder perceptions is presented below.

The Rio Summit: limited impact on the energy sector

It is generally accepted that the Rio Summit was a watershed in bringing together policy-makers and focusing their attention on the key issues surrounding sustainable development. While *Agenda 21* imperatives were a part of development planning in many countries like India, it was at the Rio Summit that the international community recognized the need for an integrated social, environmental, and economic approach to addressing sustainable development. The Summit and its offspring – the CSD (Commission on Sustainable Development) – provided every nation the opportunity to take stock and do the groundwork for policy change through a national Agenda 21 and an annual report card to be submitted to the CSD. The *Agenda 21* itself was weak in the context of the energy sector, addressing energy mainly in its relation to atmospheric pollution. It was only at the Ninth Session of the CSD in 2001 that sustainable energy development came to be recognized as an objective in itself.

At the same time, there was a general consensus that for all the awareness generated by the Rio Summit and the relatively low-profile CSD process, their role in creating a demand for change and in influencing policies has been limited. Though countries began to talk about integrating sustainability concerns in their energy planning, the overall trends in energy development and the opportunities for reform have been and are largely a function of overriding political, economic, and strategic considerations. Developments over the last decade were related more to the economic philosophy of giving more autonomy to the market, which guided economic policy formulation not only in the energy sector but also in almost every other sector of the economy where the government had control hitherto.

Though the experience across the region varies, the main trends over the last decade include

- deregulation, privatization, and restructuring of the industry;
- steps towards reform of market distortions;
- security imperatives for diversifying energy sources;

- search for more efficient energy generation technologies;
- increased focus on new and renewable sources of energy;
- recognition of the benefits of demand-side management; and
- efforts to institutionalize energy conservation practices.

Though these changes cannot be linked to the Rio Summit, these have strong linkages with the message of the Summit. All the above trends have the potential to help meet the needs of the underserved, reduce environmental impacts, and promote efficiencies that help foster stronger and more sustainable economic growth.

These developments are not without mistakes and inherent conflicts as illustrated by the hazards of opening the energy industry to the private sector without an appropriate legal framework and energy market as witnessed in India or the more generic issue of socio-political influence over pricing that has disrupted the smooth implementation of deregulation.

In terms of direct pursuit of the goals of *Agenda 21*, there was a general perception amongst the group that the decade of the 1990s has little to showcase—a larger number of people still have no access to energy or energy services even as the energy-consumption gap has widened internationally. Renewable sources of energy still account for a meagre share of the total. Large-scale inefficiencies continue to persist in energy generation, delivery, and consumption in the developing countries of the region. Governments have been responding to local environmental problems and the international community has done little to address impending global environmental issues. The developed countries have shown no signs of cutting back on profligate lifestyles that threaten the future of this planet.

Globalization: friend or foe?

Linked to this process of transformation is the phenomenon of globalization and its impact on sustainable development. Respondents felt that globalization presents both opportunities and risks for energy sustainability. Opening national markets to increased competition could in the long run favour or force economic efficiencies, which, in turn, promote more efficient and sustainable energy systems and increase investment flows and

technological transfers thereby enabling energy options that might otherwise appear uneconomic. Within the Asian region, the opportunities of energy cooperation are large, for instance, through an ASEAN (Association of South East Asian Nations) grid and through trade in gas and hydropower.

However, increased pressure from the global market could alternatively favour least-cost choices that are less sustainable in the long run. Stronger efforts at both the multilateral and national levels to promote investment in clean and efficient technologies can help ensure that globalization on the whole favours sustainable energy development. Governments would also need to ensure that the social objectives of affordable and equitable access do not take a back seat in the process of profit-making. With reference to the global environmental issues, globalization by itself can clearly have no impact. What is needed are environmental agreements backed by sincere commitments. These commitments have to be based on Rio's principle of common but differentiated responsibilities since developing countries need to give their populations a threshold level of economic prosperity before being burdened with environmental commitments, given that their share in global environmental damage is insignificant.

Energy in relation to the three pillars of sustainability

Economic growth: constrained by inadequate energy inputs?

Energy is generally believed to be a limiting factor for economic growth in the developing world while it remains a fundamental resource for continuing economic prosperity in the developed countries, as seen in the case of California, USA. While some Asian economies do not face a constraint with respect to energy availability, most are still grappling with energy shortages. Even in economies where access has been enhanced, low per capita energy consumption, particularly in rural areas, has constrained development. Given their low energy consumption levels and the structure of their economies, the linkage between energy consumption and economic growth is likely to remain strong in developing countries for some time.

Energy and social development: have subsidies worked?

Experts identified equitable and affordable access to clean energy as one of the major elements of energy policy in most developing countries. This has been sought to be achieved mainly through ambitious electrification programmes and through large subsidies on electricity and other fuels for some consumers (poor, rural, and residential) or uses (irrigation, goods transportation, fertilizer production, etc.). In the power sub-sector, governments have subsidized the sector through (1) the provision of grants and low-interest loans to utilities; (2) the provision of excessive equity without dividend expectations; (3) the exemption of the utilities from taxes and duties; and (4) the frequent rescheduling, and often cancellation, of debts owed to the governments by utilities. In addition, the governments have seldom allowed utilities to adopt tariffs that recover the full cost of supply and in most cases have required cross-subsidies from the industrial to the residential consumers, and from the urban to the rural and agricultural consumers. Instances of utilities being compelled to supply electricity free of charge to certain classes of consumers are also known.

Countries also have special programmes depending upon their local situations, such as the farm forestry programme in India in view of the dominance of biomass fuels and the promotion of localized renewable energy systems as in Bangladesh, China, and India.

While the rationale behind the government-subsidy programmes is justified, the majority of the respondents felt that the programmes themselves have typically been fiscally profligate with no hard targeting. This is evident in the perpetuation of energy shortages and consumption inequalities and in the growing number of people without access to energy. Despite subsidies, poor households in Asia pay a larger fraction of their incomes for energy than middle- and high-income households and continue to depend predominantly on traditional fuels. In the agriculture sector, it is the rich farmers who typically benefit disproportionately from subsidies. Not only have subsidies led to a decline in public investments, these have discouraged private investment in the sector and have hampered the development of local energy systems based on renewable sources of energy. While some energy

projects are built in consultation with local communities, in many cases, rural electrification has bypassed the needs of women, low-income households and even, high-priority social services such as schools and health clinics.

With the process of sector reforms under way, economies need to examine alternative approaches to meet their social obligations. This includes review of criteria and administering mechanisms for lifeline rates, income transfers, micro-finance, and promotion of indigenous community-managed decentralized energy systems.

Energy and environment

Energy policies: integration of environmental and efficiency concerns

There was a difference of opinion on whether environmental concerns had been integrated with energy policies. Some felt that this was the case, at least to some extent, though the experience varied by country. Another perspective was that heightened awareness about environmental concerns and about linkages between energy use and sustainable development had not translated into policy interventions, despite various conferences even after the Rio Summit.

Whether or not environmental concerns have integrated with energy policies, there is the issue of sub-optimal efficiency levels in energy supply and end-use due to energy policies. Price subsidization has supported inefficient energy uses in certain countries and sectors, often with negative economic and environmental consequences. Subsidized energy prices for farmers in India are an example. The recent market-oriented policies across the region can be expected to make a difference to the environmental performance of the energy sector.

Moreover, energy prices alone are not sufficient in internalizing environmental costs. There is a need to look at a broader regulatory framework. Enforcement of legislation is another important factor as seen in the case of China and India.

Renewables: their present and future role in the energy scenario of Asia

Stakeholders agreed that there was a need for a greater share of renewables given the problems of pollution associated with fossil fuels and the risks associated with nuclear energy. Moreover, a

stronger role for renewables can help meet critical energy needs, particularly in rural areas, and enhance energy independence. Significant opportunities exist to increase the use of renewable sources of energy in the Asia–Pacific region. Photovoltaic systems are, for instance, already established as economically and environmentally efficient ways of providing electric power to areas not connected to electricity grids, especially in rural areas.

Some respondents were of the opinion that the share of renewables will increase given the common thrust towards energy self-sufficiency and environment-friendly fuels. Another perspective was that despite their increased significance in the future, renewables will not fulfil the majority of the energy requirement.

All experts, however, agreed that strong policy commitments were necessary to encourage more investments in this sector. Moreover, renewable energy technologies will play an increasing role as costs fall due to economies of scale. Among the various energy sources, wind, small hydro, and solar were identified as the better options compared to biomass (not necessarily a pollution-free source). Hydrogen technology could also be a major energy option in the future.

New institutional models are required that will channel market forces and specific policy instruments to foster the development of an appropriate mix of existing and renewable energy technologies.

Technology transfer

Technology: the solution to sustainable energy development?

Technology was perceived as a significant component, but only a part of the solution to sustainable energy development. The use of technology, and not merely its presence, was identified as an important issue, which depends on a critical mix of the government and the market forces to create capacity, provide incentives, influence investment decisions, and ensure the integration of sustainable energy priorities into national planning. Institutional and financial considerations need to be addressed to make use of technologies that already exist. Apart from factors like economic and socio-cultural considerations, infrastructure development and pricing policies are also important. For large Asian economies

dependent on coal, there is a strong need to advance clean-coal technologies.

International technology transfer since the Rio Summit

Many experts were of the opinion that the international transfer of clean technologies to the Asian region had not increased since the Rio Summit. Innovation and indigenous processes were identified as being more important for reasons of socio-cultural compatibility and hence acceptability. There is, therefore, a need to shift focus from technology 'transfer' to technology 'diffusion'—to develop capacity and institutions, and to promote learning-by-doing.

Another perspective was that the concern about the environment, coupled with the development of more efficient technologies, had resulted in an increase in the international transfer of clean technologies to Asia, though this was not necessarily because of the Rio Summit. Market demand has led to cleaner technologies being made available.

Yet another perspective was that increase in technology transfer had not led to substantial improvements given that there were no marked differences between the energy consumption patterns and energy efficiencies before and after the Rio Summit. Though the Summit gave the development and market penetration of clean technologies in developing countries a boost, the private sector has not fully adopted clean technologies due to high risks and additional investment costs. Also, in some cases, clean technologies have raised the cost of power beyond the limits tolerated within the context of global competition.

Financing sustainable energy development since the Rio Summit

Some experts believed that with increasing globalization, foreign investment in energy technology had become greater since the Rio Summit, though not necessarily on its account. This increase, however, was felt to have contributed only modestly to the greening of the energy sector. Another perspective was that there was no direct link between foreign investment and greening, though the resulting efficiency enhancement would contribute to greening of the sector.

In terms of financial flows, it was noted that bilateral funding agencies and multilateral financing institutions, such as the Asian Development Bank, the European Bank for Reconstruction and Development, and the World Bank, had increased their energy investment portfolios after the Rio Summit for cleaner technology. However, the rise in the FDI (foreign direct investment) over the last decade was concentrated in a few countries, which provided a good market for the FDI, and excluded countries in sub-Saharan Africa, which required financial and technological assistance.

Private funds are not yet flowing into many developing countries particularly due to perceived risks by investors. Attracting private investment (both foreign and domestic) requires fiscal and pricing reforms in the energy sector. Though the private sector is bound to play a larger role world over, the public sector would continue its role of a long-term guarantor.

Official development assistance may need to play a greater role in sustainable energy development in the least developed countries, which would not be able to attract private sector investment. Credit arrangements, including micro-credit, will be needed to promote increased access to commercial energy in rural areas. There is a need to integrate the concept of sustainable development with the domestic agenda of economic and social development to attract financing. The mechanisms developed to implement the Kyoto Protocol could provide incentives to investors. The clean development mechanism could become the most important source of additional funding. A combination of the FDI as well as more resources and well thought-out micro projects could make an impact in hastening the move towards sustainable development.

To sum up

Expert perceptions reinforce the fact that while development in the energy sector may have been influenced and perhaps at times driven by international multilateral forces, the evolution of the sector and the integration of sustainability in various countries have been largely shaped by domestic imperatives.

The stakeholders identified a sustainable energy future as one defined by strategies that address the goals of efficiency and cost competitiveness, universal access, energy security, and

environmental accountability of energy systems. These strategies would include continued market reform, greater role for decentralized energy systems based on renewable energy sources, technological diffusion, and financial flows into developing countries, generally improving energy efficiency with a focus on demand-side management and the establishment of efficient structures.

Chapter

7 The road ahead

Preceding analysis reveals that much remains to be done in Asia by way of basic sector reforms. The developments of the 1990s have brought out the possibility of using markets to achieve sustainable growth. The success of the electricity reforms in the UK has created new visions of what competition can achieve. At the same time, the lack of discipline of markets has caused problems in other countries—in Asia these came into focus sharply after the financial crisis in 1997. Sector reforms are crucial to financial viability and efficiency, which becomes all the more essential in the context of an open economy. By decreasing costs, efficiency enhancement can facilitate access to basic energy services by the poorest. In addition, by enhancing efficiency and correcting the underpricing of the conventional sources of energy, reforms thus have the potential to strengthen the three pillars of sustainability.

The issue of access to energy is likely to occupy centre stage in Asia. Apart from the traditional concerns of food and employment, providing access to affordable and environmentally clean energy has become a major concern in the fight against poverty. This would require continuing the shift away from traditional fuels as well as making better use of subsidies. As has been seen earlier, in many countries in Asia, subsidies are not only poorly targeted but also have adverse consequences for efficiency and the environment.

Security will also be a concern although this may take new dimensions. Natural gas is amongst the fastest growing sources of energy worldwide, particularly in various parts of Asia. The exploitation of natural gas would require higher investment as the supply chain lengthens, with the depletion of the reserves located closest

to the market (IEA 2001). The potential risks of supplies being disrupted will also increase. On the other hand, this holds potential for regional cooperation. Similar is the case with Asia's hydropower resources and the increasing dependence on West Asia for oil.

The environmental implications of increasing fossil fuel dependence will continue to pose a challenge. That legislation alone will not have a major impact is apparent—the framework would need to be supplemented with economic instruments. Regional cooperation in arresting transboundary environmental concerns, as demonstrated in the RAINS–Asia (Regional Air Pollution Information and Simulation for Asia) and the Asian Brown Cloud studies, will increasingly become important. Regional concerns can assume a global dimension—the Asian Brown Cloud study, for instance, shows that the haze can move quickly over Europe. Given that the origins of this haze lie in the socioeconomic poverty of Asia, this must impart a greater urgency to the efforts of the international community in assisting the developing world in their fight against poverty.

The indivisibility of sustainability is seen also in the socioeconomic and environmental implications of traditional fuel use. Any strategy for sustainable energy use must focus on energy-efficient devices for those at the bottom of the energy ladder, while facilitating movement up the energy ladder. An important component of this strategy must be to increase the share of renewable energy sources. Given that the share of renewables in Asia is not likely to increase significantly in the business-as-usual scenario, this would require a more aggressive policy framework, which must include enabling measures like providing a level playing field between the conventional energy forms and renewables, as well as direct support to strengthen the research and development, marketing, and delivery systems for renewable energy technologies.

Thus what is required is a greater role for the markets on the one hand and a more sharply defined role for the government on the other. The latter needs to effectively intervene in areas like security and access where markets by themselves cannot perform. The essential components of sector reforms are listed below.

- Unbundling and smaller companies
- Allowing the private sector a greater role
- Credible regulatory framework

- Dismantling physical controls
- Cost-reflective energy pricing
- Increasing use of markets, both domestic and global.

Bringing about these changes will be difficult as the public sector has dominated the energy sector in Asia far too long. In many countries, these large structures need to be broken up, by function and in some cases also by geographical region. Given the dominance of the public sector, there would be limited private sector capacity to manage these entities. To ensure that the private investor is treated fairly, an independent regulatory framework is needed to provide efficiency signals that ensure the right kind of investments.

Subsidies in several countries of Asia have not always been properly targeted. Moving to a cost-reflective pricing regime would require patient education of those sections of the population that will be affected by an increase in the energy prices. While a greater reliance on market-based prices is essential, this needs to be done carefully as demonstrated by the experience of reforms in the California electricity sector (Besant-Jones and Tenenbaum 2001).

Reforms in the energy sector have been initiated in many countries in Asia, but, the progress has been slow. Given the complexity of the task, a gradual and phased approach is necessary. Commercialization and unbundling need to be taken up first. The induction of the private sector and of competition has to proceed in phases. In many countries, the capacity of the private sector has to be built up. In short, each country has to decide its own pace of change in each of the energy sub-sectors. A slow calibrated reform strategy will be the key in making the energy sector sustainable. While there are lessons from developed countries, there is much that can be learnt from experiences within the region. Besides information and capacity building, there are specific areas for energy cooperation and trade. It is this vision of cooperation that must inspire all the stakeholders in Asia in their efforts to improve the performance of their energy sectors.

The World Summit on Sustainable Development offers an opportunity for all countries to reflect, take stock, and determine the broad directions for action. The Summit is an important landmark in a process that has its origins well before Rio and has evolved considerably since, leading to greater understanding and

support for closer cooperation in the energy sector. It may resound the concerns that are well known and highlighted in this document. But would that alone suffice?

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Annexure

1 Interviewees

Mr Aminul-Huq
Principal Project Engineer
Asian Development Bank
The Philippines

Mr Amorn Phandu-Fung
Executive Director
Bureau of Energy Study Research and Development, Department of Energy Development and Promotion
Bangkok
Thailand

Mr Antonio De Castro
Executive Director
Centre for Renewable Resources and Energy Efficiency
Quezon City
The Philippines

Mr Antonio V del Rosario
President
Energy Development & Utilization Foundation, Inc.
The Philippines

Mr Ashok Khosla
President
Development Alternatives
New Delhi
India

Mr Bjorn Stigson
President
World Business Council for Sustainable Development
Switzerland

Mr Dick Jones
Senior Energy and ICT Advisor
Department for International Development
UK

Mr Dipal C Barua
Managing Director
Grameen Shakti
Dhaka
Bangladesh

Mr Elliot Diringer
Director
International Strategies
Pew Centre on Global Climate Change
USA

Dr Francisco L. Viray
Former Secretary
Department of Energy, The Philippines. And Vice-Chairman, World Energy Council

Mr Gilbert Parent
Ambassador for the Environment
Department of Foreign Affairs and International Trade
Canada

Dr Guenther Fischer
Project Leader
Land Cover Project
International Institute for Applied Systems Analysis
Austria

Prof. Gus Speth
Dean
School of Forestry & Environmental Studies, Yale University
USA

Dr Hoesung Lee
President
Council on Energy & Environment
Korea

Mr Ijaz Hossain
Professor & Head
Department of Chemical Engineering, Bangladesh University of Engineering and Technology
Dhaka
Bangladesh

Mr Jae-Joon Kim
Deputy Director
Energy and Resources Policy Division, Ministry of Commerce
Kwachon-city Kyonggi-Do
Republic of Korea

Mr Lester Brown
President
Earth Policy Institute
USA

Prof. M Nurul Islam
Professor
Institute of Appropriate Technology, Bangladesh University of Engineering & Technology
Dhaka
Bangladesh

Ms Ma Concepcion F de Claro
On behalf of Mr Motassim A. Al-Ma'ashouq President of Petron
Philippines

Sir Mark Moody-Stuart KCMG
Former Chairman & Member of the Board
Royal Dutch/ Shell Group of Companies
UK

Mr Meneleo J Carlos, Jr
President, Federation of Philippine Industries and former Chairman, Presidential Council of Adviser's on Energy Affairs, The Philippines

Mr Mizanur Rahman
Joint Secretary
Energy and Mineral Resources Division, Government of Bangladesh
Dhaka
Bangladesh

Prof. Mohan Munasinghe
Distinguished Visiting Professor of Environmental Management
University of Colombo
Colombo
Sri Lanka

Dr Nebojsa Nakicenovic
Project Leader, Transitions to New Technologies
International Institute for Applied Systems Analysis
Austria

Dr Norhayati Kamaruddin
Head
Energy Data Modelling & Consultancy Services, Pusat Tenaga Malaysia
Kuala Lumpur
Malaysia

Ms Noriyah Ahmad
Senior Principal Assistant Secretary
Ministry of Energy Communications and Multimedia
Kuala Lumpur
Malaysia

Prof. Ogunlade Davidson
Director
Energy & Development Research Centre, University of Cape Town
South Africa

Mr Peter D Garrucho, Jr
Chairman
Energy Council of the Philippines (World Energy Council Philippine Member Committee) and First Gas Holdings, Inc.

Mr Robert Lion
Member of the Board of Directors of the French High Council for International Cooperation & President – Energy 21
France

Mr Thierry Lefevre
Centre for Energy-Environment Research
Bangkok
Thailand

Prof. Wei Zhihong
Deputy Director
Global Climate Change Institute, Tsinghua University
Beijing
China

Prof. Y K Alagh
Former Union Minister & Member of Parliament
New Delhi
India

2 Regional classification – Asia

The classification followed in this study was adapted from that of the *Global Environment Outlook* published by the United Nations Environment Programme.

East Asia

China, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea

South Asia

Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka

South-East Asia

Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam

Western Asia

Bahrain, Iran, Iraq, Jordan, Kuwait, Lebanon, Occupied Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen

Central Asia

Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.

While the endeavour has been to include as many countries as possible for regional analyses, the choice of countries has been constrained by the availability of data. Wherever required, countries selected for the analysis have been mentioned.

About the AEI

While convening the Asian Relations Conference in 1947, Mahatma Gandhi appealed to Asians to seek an identity in the post-colonial age unique to the region. Four decades later, the Asian Relations Commemorative Conference, held in New Delhi, India, in 1987, emphasized the need for establishing an Asian collaborative research entity on energy. TERI, supported by the Government of India, responded by taking the initiative to launch the AEI (Asian Energy Institute) in New Delhi in August 1989.

The AEI aims to draw upon the expertise in the region to (1) promote greater information exchange; (2) facilitate the sharing and dissemination of knowledge; (3) undertake research and training activities of common interest to its members; and (4) analyse global energy developments and their implications.

A network of 15 energy institutes from Asia at its inception, the AEI has since grown to include representatives from 13 countries in Asia. Not limiting its reach within the boundaries of Asia, the Institute has expanded to include associate members from outside the region. At the Institute's launch, TERI was chosen to host the Secretariat of the AEI, a position it continues to hold. TERI also hosts the web site of the AEI (www.teriin.org/aei/).

Members

Bangladesh University of Engineering and Technology, Bangladesh
Global Climate Change Institute, Tsinghua University, People's Republic of China
Tata Energy Research Institute, India
Centre for Research on Energy and Material, Institut Teknologi Bandung, Indonesia
The Institute for Political and International Studies, Iran
Global Industrial and Social Progress Research Institute, Japan
The Institute of Energy Economics, Japan
Royal Scientific Society, Jordan
Council on Energy and Environment, Korea
Korea Energy Economics Institute, Korea
Kuwait Institute for Scientific Research, Kuwait
Pusat Tenaga Malaysia (Malaysia Energy Centre), Malaysia
Energy Development and Utilization Foundation Inc., The Philippines
Institute of Fundamental Studies, Sri Lanka
Energy Research Institute, Chulalongkorn University, Thailand

Associate members

International Institute for Applied Systems Analysis, Austria
Biomass Users Network, Brazil
International Institute for Sustainable Development, Canada
Fondazione Eni Enrico Mattei, Italy
Asia Pacific Energy Research Centre, The Institute of Energy Economics, Japan
Energy research Centre of the Netherlands, The Netherlands
Centre for International Climate and Environmental Research-Oslo, Norway
Energy Development and Research Centre, University of Cape Town, South Africa
Stockholm Environment Institute, Sweden
Centre for Energy, Environment, Science and Technology, Tanzania
Thailand Environment Institute, Thailand
Center for Environmental Initiatives, Massachusetts Institute of Technology, USA
World Resources Institute, USA

Sustainable energy: perspective for Asia examines the context within which the energy sector has evolved in the Asian region, especially in the last 25 years. The objective is to evaluate the sustainability of this evolution. This is accomplished through a brief analysis of energy endowments of the region, the trends in energy consumption, the fuel mix, and the role of energy trade in the region. The efforts for meeting the objective of providing energy to all have been analysed, along with the implications of growing environmental consciousness and scientific knowledge of the environmental impact of the energy sector. The document also looks at the problems with the past policies and the emerging trends.

Against this backdrop, this is an attempt to evaluate the perceptions and the priorities of development in the energy sector, especially the relevance of, and the impetus provided by, UNCED (the United Nations Conference on Environment and Development) in 1992. The views of eminent personalities, experts, and different stakeholders on the developments in the energy sector and their impacts on the economy, society, and the environment in the region are summarized in this document. These views are, not surprisingly, convergent and confirm that the wheels of change in the energy sector were set in motion prior to UNCED and that these changes were driven by political, economic, and strategic considerations. While there are encouraging signs, we are not yet firmly on the path to sustainable energy development.