EAST-WEST CENTER

Energy Outlook to 2010: Asia-Pacific Demand, Supply, and Climate Change Implications

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The U.S. Congress established the East-West Center in 1960 to foster mutual understanding and cooperation among the governments and peoples of the Asia-Pacific region, including the United States. Principal funding for the Center comes from the U.S. government, with additional support provided by private agencies, individuals and corporations and more than 20 Asian and Pacific governments.

The Center promotes responsible development, long-term stability and human dignity for all people in the region and helps prepare the United States for constructive involvement in Asia and the Pacific.

SUMMARY The demand for energy is growing faster in the Asia-Pacific region than anywhere else in the world, driven by the region's rapid economic growth and increasing population. Faced with booming electricity needs but fearful of environmental pollution from coal and oil, countries are looking to other energy sources such as natural gas, nuclear power, and renewable energy such as hydropower and geothermal. Government and industry projections for some of these are ambitious and may not be met. Meanwhile, the region's dependence upon imported oil, primarily from the Middle East, will grow. Coal, already used more in the Asia-Pacific region than elsewhere, may increasingly be used to generate electricity. Plans for shifting to less polluting fuels may not materialize, with serious implications for the world's climate. Indeed, projections for fossil and nonfossil fuel use through 2010 indicate that without a dramatic increase in the use of clean technologies, promises to stabilize or reduce emissions of the greenhouse gas CO_2 will be almost impossible to keep.

Introduction

The region is the only part of the world that has seen major new demand for oil

In the year 2010, the Asia-Pacific region is expected to use 133 percent more commercial energy than it does today. (Commercial energy is oil, gas, and coal, and electricity supplied by power utilities. Here, the region is defined as all of Asia, except the former Soviet Union and the Middle East, plus all the Pacific Island nations.) This explosive consumption is the result of growing industrialization, expanding transportation systems, increasing population (currently about 60 percent of total world population), and the extension of electricity to rural areas. A particularly important need will be to meet the demand for electricity, which is expected to grow by 162 percent, more rapidly than total energy demand itself.

The growth of electricity generation in the region will be faster than world economic growth rates (6.5 percent during 1993–2000 and 5.3 percent during 2000–2010 for electricity compared with world economic growth rates of 2.4 percent and 3.1 percent during the respective periods). The high electricity growth rates will be in Southeast Asia, South Asia, and China, where electrification rates are still low but are expected to increase in the next 15 years. High economic growth rates in Southeast Asia during the outlook period will also accelerate growth in electricity demand. Relatively low growth rates are expected in the more mature economies such as Japan, Australia, and New Zealand, since most sectors of these nations already have access to electric power. Total electricity generation in the Asia-Pacific region is projected to grow from 2,668.6 terawatt hours (TWh) in 1993 to 4,135.6 TWh in 2000 and 6,958 TWh in 2010.

Table 1. Shares of Asia-Pacific electricity generation by energy source, 1980–93, with projections to 2010 (%)

Energy source	1980	1990	1993	2000	2010
Oil	35.1	17.4	15.4	8.3	4.8
Gas	7.8	11.2	11.7	12.6	13.8
Coal	28.3	41.5	45.0	51.6	49.9
Hydro	20.4	16.4	15.5	14.6	16.8
Nuclear	8.0	13.1	12.0	12.1	13.7
Geothermal	0.3	0.4	0.4	0.7	1.0
Others	<0.1	<0.1	<0.1	<0.1	0.1

Note: Rounding errors occur.

The mix of energy used to generate electricity is projected to shift by the end of the outlook period. Electricity generation sources, ranked by importance in 1993, were coal, hydro, oil, nuclear power, natural gas, geothermal, and other renewable sources. Coal's share in total generation is expected to increase from 45 percent in 1993 to 49.9 percent in the year 2010, while hydro's share will increase from 15.5 to 16.8 percent, nuclear power's share from 12.0 to 13.7 percent, and gas's share from 11.7 to 13.8 percent. Oil's share, however, is forecast to slip from 15.4 to 8.3 percent in 2000 and 4.8 percent in 2010. The new ranking will thus be: coal, hydro, natural gas, nuclear, oil, geothermal, and other renewables, with gas bumping oil out of its previous third place position and coal taking the largest share away from oil. (Table 1)

Energy Demand and Supply

The major energy sources used for the region's diverse needs are the fossil fuels oil, coal, and natural gas; nuclear power; and renewable resources such as hydro and geothermal.

Oil. The Asia-Pacific region is the only part of the world that has seen major new demand in the world oil market in recent years. Between 1990 and 1993, the region's demand rose by three million barrels per day (mmb/d), which more than offset the declining demand in other regions. The consequent net increase was 0.5 mmb/d in global oil demand.

The region has relatively little oil resources. Proven reserves at the end of 1993 were about 4.5 percent of the world total. The region has a reserves-to-production ratio of approximately 18 years of production at current rates, which is far below the Middle East average of 104 years and well below the world average of 46 years. More than 80 percent of the region's proven reserves are in only three countries: China, India, and Indonesia. The major producers have been China, Indonesia, Malaysia, India, Australia, Brunei, and Vietnam.

Demand for oil products in the Asia-Pacific

region is expected to increase sharply over the next 15 years. Demand will grow by an average of 4.1 percent per year until the end of the century (from 14.9 mmb/d in 1993 to 19.8 mmb/d in 2000). In the first decade of the next century, demand will grow by 3 percent per year on average and reach 26.6 mmb/d. Demand for lighter oil products will grow more rapidly because of expansion of motor transportation in the region. At the same time, less fuel oil will be needed because of the increased importance of substitutes, especially coal and natural gas as fuels for generating electricity. Besides oil products, about 0.5 mmb/d of crude oil is burned directly in Japan and China, mostly for electricity, but this amount is not expected to increase.

The region's crude oil production, after reaching 6.9 mmb/d in the mid-1990s, will remain virtually unchanged for the rest of the decade but will decline slightly (to 6.7 mmb/d) by 2010. This reflects short-term increases, followed by gradual declines, in Indonesian and Malaysian production; increases in Burmese, Chinese, and Vietnamese production; and a much slower decline in Australian output than previously expected. Since the region's crude production is unable to satisfy regional demand, the gap between supply and demand will widen rapidly and the result will be a major increase in import dependence. Oil imports from outside the region, primarily from the Middle East, will account for two-thirds of the region's consumption by 2000 and three-fourths by 2010. (Figure 1)

Coal. Coal is the region's most abundant fossil fuel resource, and it will remain the primary fuel consumed during the 1993–2010 period. However, coal is a major contributor to air pollution and is being challenged by cleaner alternatives (natural gas, nuclear power, and hydropower). The size of the increase in coal consumption will depend on both economic growth rates and whether coal can meet tightening environmental regulations, particularly in electricity generation.

Coal will remain the primary fuel used

About 46 percent of the region's commercial energy needs are filled by coal, compared with 21 percent for the rest of the world—and China, the world's leading producer and consumer of coal, is the dominant factor in this use. Regional production is expected to grow from 1.67 billion metric tons in 1993 to 2.22 billion metric tons in 2000 and 3.07 billion metric tons in 2010, with Australia, China, and India accounting for 94 percent of the region's growth in coal production. Total consumption will rise from 1.69 billion metric tons in 1993 to 3.1 billion metric tons in 2010, with China and India accounting for more than 80 percent of the total. The region imports more coal than it exports, but four countries (Australia, China, Indonesia, and Vietnam) are net coal exporters, and their exports are projected to increase at an average rate of 3.4 percent per year. Australia's share of these exports will fluctuate around 76 percent through 2010. China will continue to be the region's second largest gross exporter, but since China also imports coal, Indonesia will be the second largest net exporter by the end of the century. The region will remain a net coal importer through the first decade of the next century, though its imports will remain small because of its large coal resources and active investment in the coal sector.

Coal's future may depend on the development of clean coal technologies. These improve the efficiency of coal use, reduce environmental damage,

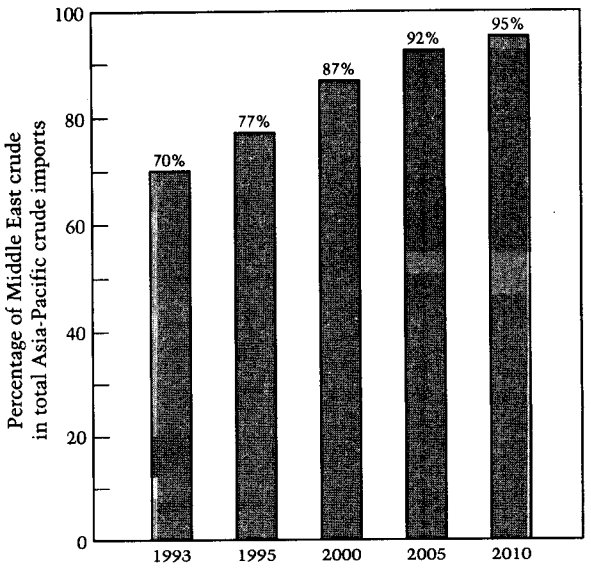

Figure 1. Asia-Pacific dependence on Middle East crude, 1993, with projections to 2010

Note: Asia-Pacific intraregional crude trade is included in the total. Product trade is not included.

or both, and can be employed from the point of coal preparation through coal utilization. Clean coal technologies can add 15–30 percent to the capital cost of power plants in Asia. Low-cost technologies that recover 50 to 80 percent of the sulfur oxides, and more expensive technologies that recover about 95 percent of these emissions, are being developed and could have wide application in the region's low-income economies. Japan is currently the only Asian economy to universally adopt clean coal technologies. Hong Kong, South Korea, Taiwan, and Thailand are the most promising markets for their adoption by the end of the 1990s. Australia, China, India, Indonesia, and the Philippines are likely to depend primarily on low sulfur coal to diminish environmental problems for at least another decade. Though China is expected use clean coal technologies only selectively, it is still projected to become the first or second largest Asian user by 2010.

Natural gas is cleaner than oil or coal—but distribution is difficult

Natural Gas. Natural gas has become popular in the Asia-Pacific region—particularly among the power generating utilities, which prefer gas because of security of supply, minimal price volatility, and environment-friendly qualities. Gas use is expected to expand as new discoveries are made, as gas distribution systems develop, and as a popular preference for gas emerges in the region. Although natural gas burns more cleanly than oil or coal, distribution is difficult. Gas must be either liquefied by substantially lowering its temperature (–270°F) under high pressure for long-distance transport, or it must be kept under pressure for pipeline transport. Currently, its use is limited in the region by the lack of pipeline systems and the high costs of building them.

Gas reserves in the region are about 7.1 percent of proven world reserves. Asia-Pacific countries produced 17.3 billion cubic feet per day (cf/d) of natural gas in 1993. Nearly 5.2 billion cf/d came from Indonesia and another 2.3 billion cf/d from Australia. More countries have gas reserves than oil reserves, and the still relatively low degree of exploitation gives the region a reserves-to-production ratio of around 56 years of production at current usage rates. Japan will continue to be the most important liquefied natural gas (LNG) consumer in the world. Potential LNG consumers (China, India, and Thailand) could push the region's total LNG demand in 2010 above 100 million metric tons (mmt), which will be more than double the present level.

An average annual growth rate of about 6 percent is projected during 1994–2010, bringing natural gas demand (including LNG) in the region to 16.2 trillion cubic feet per year. The use of natural gas will grow much faster if oil prices remain relatively high. If the price of gas must remain excessively low to be competitive, many potential LNG projects may not materialize; however, domestic development of natural gas would still be encouraged, since most governments want to increase its use. A number of projects to expand gas pipeline networks domestically and internationally have been proposed. A gas network that would link members of the Association of Southeast Asian Nations—Thailand, Malaysia, Indonesia, Singapore, Brunei, and the Philippines—is a long way off, since many national pipeline systems have to be built first. Currently, there is only one international pipeline in the region, linking Malaysia and Singapore. Another project, to be completed this year, is a submarine trunk line linking a gas field in the South China Sea to a receiving station in Hong Kong.

Nuclear. Though steep investment costs and fears over safety have limited the use of nuclear power in many parts of the world, nuclear remains popular in the Asia-Pacific region. Faced with both booming economic growth and electricity needs, some countries have chosen nuclear power for its promise of relative self-sufficiency, albeit at a substantial cost. Japan, China, Taiwan, India, Pakistan, South Korea, and North Korea all have nuclear power programs, and Indonesia may join this group by 2010. In 1993 nuclear plants (not including North Korea's) had 9 percent (55.3 gigawatts [GW]) of the region's total capacity and actually generated 12 percent (321.2 TWh) of all the electricity supplied by utilities.

Ambitious official projections show nuclear power supplies growing at an average annual rate of 6.6 percent and reaching 952.6 TWh (13.7 percent

of total generation) in 2010. If all these plans materialize, about half of the generation would be in Japan (478 TWh), followed by South Korea (173.3 TWh), China (122.6 TWh), India (94.8 TWh), Taiwan (63.9 TWh), and Pakistan (20.0 TWh). These numbers, based on government estimates, may prove overly optimistic if the high operating and investment costs of nuclear energy are not reduced.

Renewable resources. The term "renewable resources" refers to those energy sources that tend to replace themselves naturally. These resources include hydropower, geothermal energy (if properly maintained), wind, solar energy, photovoltaic energy, and waste-fired or biomass energy (produced by burning urban, agricultural, and other wastes).

Hydro. Hydro facilities are the second largest energy source (after coal) for electricity generation in the Asia-Pacific region, but they are highly concentrated in just a few countries. They are the main source in New Zealand and in the Pacific Islands. South Asian countries depend heavily on hydropower. Nepal and Sri Lanka use hydro facilities for more than 90 percent of total electricity generation. China, India, and Japan together account for 76 percent of total hydro generation in the region, and their share is projected to increase to 80.4 percent by 2010. A large increase in hydro capacity is expected in Southeast Asia. Indonesia expects to more than triple capacity, and Malaysia, the Philippines, and Thailand plan to double their hydro capacities by 2010.

Only four countries pursue renewable energy sources other than hydro and geothermal on a large scale

The region's generation of electricity by hydro facilities, based on government and industry plans, is projected to increase from 413.5 TWh in 1993 to 605.6 TWh in 2000 and 1,166.0 TWh in 2010. The average annual growth rate of hydro generation is projected at 5.6 percent from 1993 to 2000 and at 6.8 percent from 2000 to 2010.

Geothermal. Only 0.5 percent of total power generation in the Asia-Pacific region is provided by geothermal power plants, which use subterranean heat from the steam of pressurized water to generate electricity. Most of the plants are in Southeast Asia. In 1993, the Philippines had 1.1 GW of geothermal capacity (about 56 percent of the region's total). New Zealand and Japan together have about 560 megawatts (MW) of geothermal capacity. Indonesia has the world's largest geothermal reserves—a potential of about 16 GW—of which only 273 MW has been developed so far. The Asia-Pacific region's total geothermal capacity is projected at 10.2 GW in 2010. Of its potential generation, 56 percent will be in the Philippines, 22 percent in Japan, 18 percent in Indonesia, and 4 percent in New Zealand.

Other renewables. Only four Asia-Pacific nations—India, Japan, China, and Australia—are actively pursuing development of other renewable resources for electricity generation on a large scale. In India, about 167 gigawatt hours (GWh) of electricity was generated in 1993 from power plants that use renewable energy. Financial incentives are provided to encourage private investors to develop renewable energy. Target generation from renewable resources in India is expected to increase to 566 GWh in 2000 and to 1,113 GWh in 2010. Japan promotes the development of renewable resources such as photovoltaic and wind power. The capacity of these renewable resources is targeted at 520 MW in 2000 and 1,800 MW in 2010. Of this, waste-fired plants are to provide about 500 MW in 2000 and 1,600 MW in 2010, and photovoltaic and wind-powered plants should account for 10 MW each in 2000 and 100 MW each in 2010. Total generation from these plants is expected to be 1,000 GWh in 2000 and 5,000 GWh in 2010. Australia is also experimenting with photovoltaic, wind-powered, and waste-fired electricity. China has long experimented with alternative energy sources.

The Energy Mix

There is significant room for change in the projected energy mix of the Asia-Pacific region. The availability of three key energy sources—hydropower, nuclear power, and natural gas—may prove to be other than the levels of supply currently projected by the governments of the region.

Expectations for the growth of hydropower are officially high. For example, China, which already

has the largest hydro capacity in the region, and Indonesia plan to more than triple their capacities, and several other countries are planning to double capacity. However, the development of hydro facilities, with their large scale dams and human resettlement problems, is often unpopular. Thus there is a serious question whether all of the projected capacity will materialize. In that case, where to look for energy: nuclear, oil, coal, or gas?

Estimates of growth of hydro, nuclear, and natural gas may be highly optimistic

Nuclear power's contribution to electricity generation at the end of the outlook period may be highly exaggerated in official projections. Japan's government, for example, is forecasting about 70 GW of nuclear capacity in 2010, but insiders believe that the capacity may not exceed 55–60 GW. Similarly, official projections of nuclear capacity for Taiwan and China are higher than the levels that might be realistic. It seems very likely that nuclear power generation will fall short—far short—of current projections. In that event, what is the alternative: oil, coal, or gas? (Figure 2)

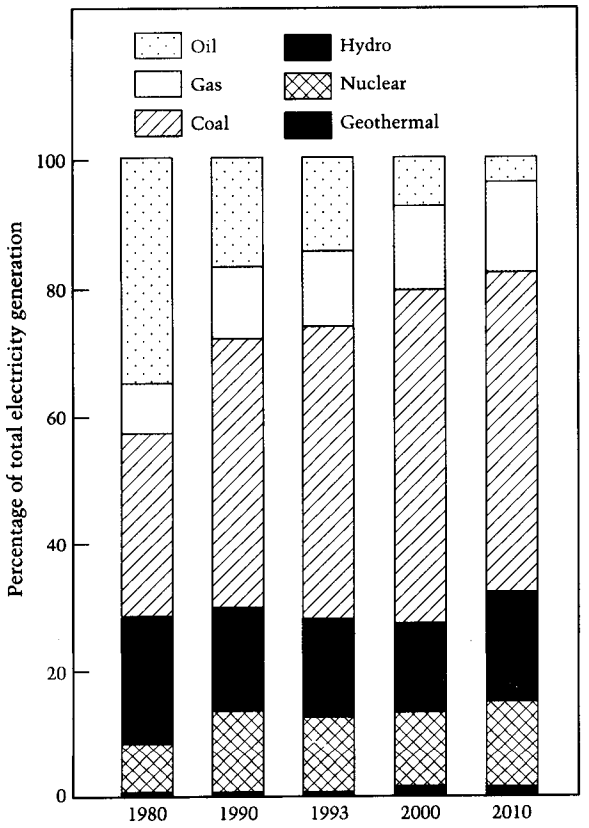

Figure 2. Asia-Pacific electricity generation from fossil fuels, 1980–93, with projections to 2010

The demand forecasts for natural gas may be either excessively optimistic or pessimistic. In the case of liquefied natural gas (LNG), forecasts represent a wish list of governments and industry, but demand will depend on both the actual emergence of buyers and the availability of supplies. Though gas pipelines are expensive, many may be built by 2010. On the other hand, lower-than-expected demand for LNG and a lack of standard pricing may result in a much lower level of LNG consumption than governments are forecasting. If that is the case, where will the energy demand turn: to oil or coal?

The use of both oil and coal will increase in response to lower-than-expected hydropower and nuclear power and potentially lower gas supplies in the region. Indeed, the demand for oil and coal could be substantially higher than current projections, if plans for hydro, nuclear, and LNG do not materialize. Many of the region's governments, including Japan's, will have no option but to add more coal and oil to their energy mix. One result will be an increase in carbon dioxide (CO_2) emissions—the gas most associated with the greenhouse effect.

Climate Change Implications

The governments of many developed countries have pledged to attempt to hold CO_2 emissions at their 1990 levels. The governments of the newly industrialized and developing countries have expressed concern for climate change, but feel that economic development—which is necessarily energy intensive—must be considered in the formulation of any climate change response strategy. Lowering CO_2 emissions will require either widespread use of clean technologies or a dramatic decrease in coal and oil use, with natural gas, nuclear energy, hydropower, or other energy sources filling the gap.

The use of clean technologies is not widespread in the region, because their costs are often viewed as prohibitive. Efforts continue to develop cleaner and more affordable technologies for energy exploitation. Some argue that developed countries must help solve the dilemma of development versus

environmental protection by developing affordable cleaner technologies and transferring them to the region's developing countries. Meanwhile, many hopes for lowering greenhouse gas emissions have been pinned on increasing the use of nonfossil fuels throughout the region. Projections for this new energy mix raise two questions: What will be the effect on CO_2 emissions if government and industry projections of increased nonfossil fuel use are met? And, given that these projections appear unrealistically high, what will be the effect on CO_2 emissions if fossil fuels fill the gap?

The region's CO_2 emissions could rise much higher than projected

Scenario I: dramatic increases in nonfossil fuels. Though the region's total energy consumption is expected to increase by 133 percent by 2010, emission levels of CO_2 are expected to increase by only 87 percent, from 1,953 million metric tons in 1993 to 3,659 million metric tons. The disproportionately small increase in CO_2 relative to total energy use is due to projected increases in the use of nonfossil fuels to generate electricity. (Figures 3 and 4) Though fossil fuel use is projected to increase by 90 percent (from 88 billion gigajoules [GJ] in 1993 to 167 billion GJ in 2010), its share of the total energy picture will shrink. The nonfossil share of Asia-Pacific energy consumption in 1993 was only 3 percent, but it is projected to be about 21 percent in 2010. The largest share of the nonfossil increase in the Asia-Pacific region will come from hydro generation, which is expected to increase by 182 percent (753 TWh), followed by nuclear generation, which is expected to increase by 197 percent (632 TWh). Globally, by the year 2010, CO_2 emissions are expected to increase only 28 percent (from 6,275 million metric tons in 1993 to 8,037 million metric tons), according to the U.S. Department of Energy. Thus, even with increasing use of nonfossil fuels, the Asia-Pacific region's contribution to total fossil-related emissions worldwide is expected to grow from 31 percent in 1993 to about 46 percent in 2010.

Scenario II: additional fossil fuels fill the gap. The region's share of fossil emissions could go even higher, however, if the expected increase in nonfossil fuels does not take place in the electricity generation sector. That sector is expected to grow by 162 percent by 2010. The current projection of associated CO_2 growth—factoring in the expected increase in nonfossil fuels—is only 118 percent. With no increase in nonfossil generation, CO_2 emissions could therefore increase by an additional 44 percent. What will fill the gap in energy supply if, as

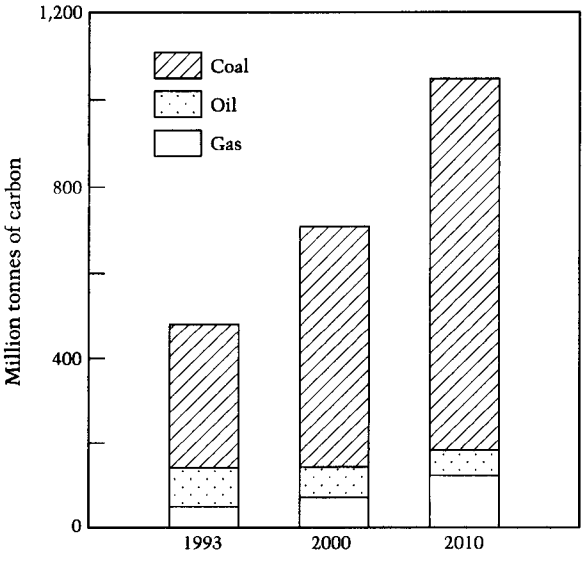

Figure 3. CO_2 emissions in the Asia-Pacific power sector, 1993, with projections to 2010

Note: Projections assume that all current plans for nonfossil fuel development materialize.

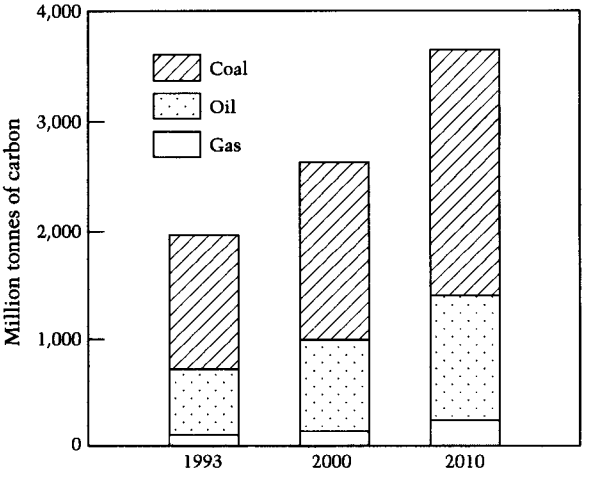

Figure 4. Total CO_2 emissions in the Asia-Pacific region, 1993, with projections to 2010

Note: Projections assume that all current plans for nonfossil fuel development materialize.

expected, some of the ambitious hydropower and nuclear generation projects do not materialize? Utilities would be forced to meet the energy shortfalls with increases in fossil fuels, and CO_2 emissions would rise above those implied by official plans.

Energy exploitation vs. the environment. Whether or not plans for nonfossil fuel development are realized, energy use in the Asia-Pacific region will have profound environmental effects. Fossil-based systems give rise to air emissions associated with issues such as climate change. Hydro facilities can have large land-use impacts and displace thousands of people. And nuclear facilities face public opposition associated with operational safety, waste disposal, high costs, and population displacement. Thus, in examining the environmental effects of energy development in the Asia-Pacific region, the issue is not whether there will be significant impacts on the environment but how, first, to minimize those impacts and then how to choose among them.

About this Publication

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