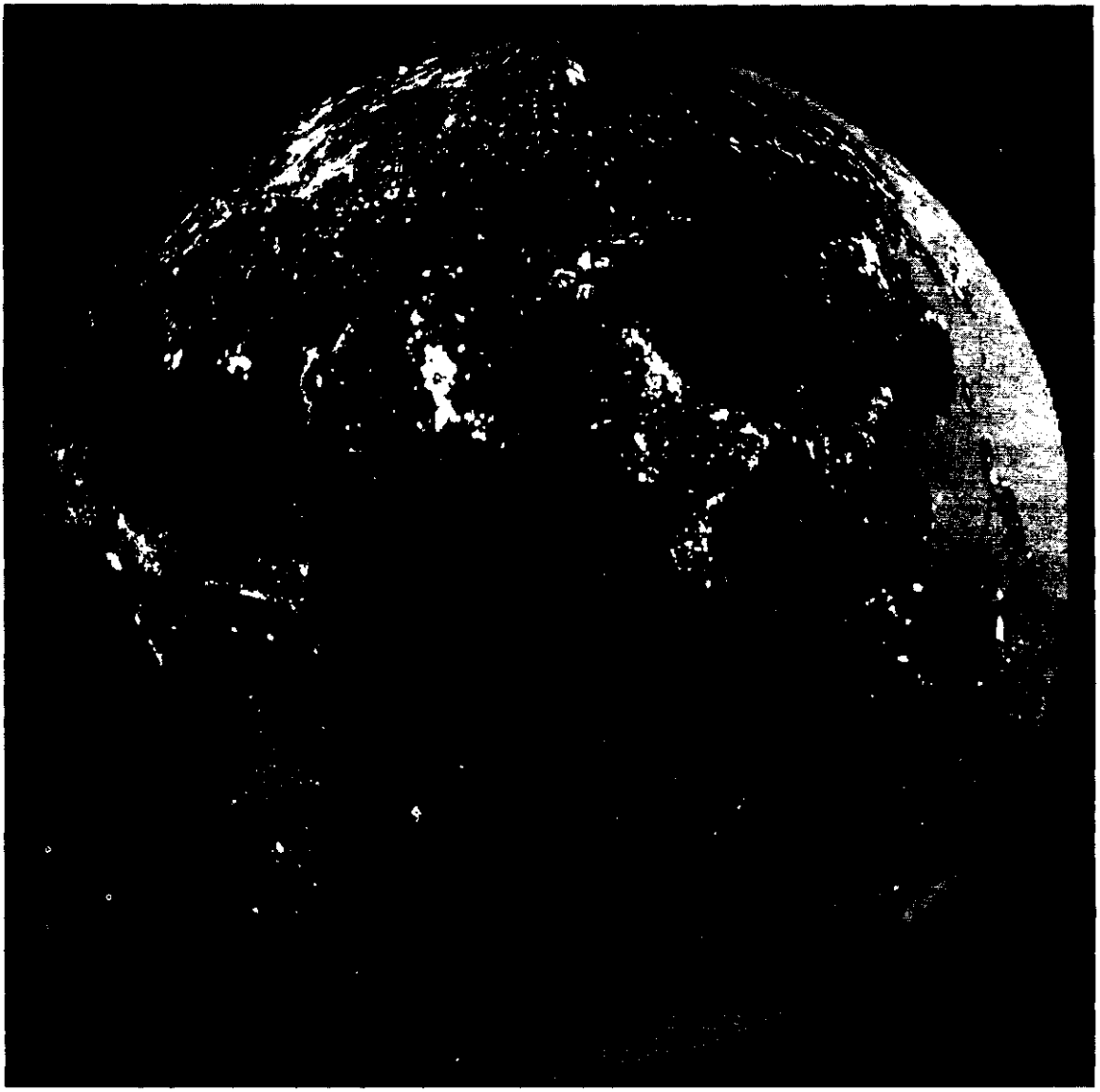
Chapter 9

International Dimensions: U.S. Influence and Regional Trends



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Chapter 9

International Dimensions: U.S. Influence and Regional Trends

INTRODUCTION

Greenhouse gas emissions are a function of many factors, including level and rate of technological development, rate of energy use (and types of fuels used), rates of land conversion and resource depletion (e.g., deforestation), agricultural practices (e.g., wet v. dry rice farming), and population growth and urbanization. These factors, their cumulative impact on emissions, and the problems faced in attempting to slow the growth rate in emissions vary greatly from one region or nation to another. These variations will be of paramount importance in any international negotiations regarding climate change and reductions in greenhouse gas emissions.

This chapter discusses three groups of countries:

- developing countries, most with market economies, some with centrally planned economies; [1]
- Eastern Europe and the U. S. S. R.--countries with centrally planned economies, many of which are changing to market economies; and
- the Organization for Economic Cooperation and Development (OECD)---developed countries with market economies (18 countries in Western Europe plus Australia, Canada, Japan, New Zealand, Turkey, and the United States).

Since energy use is likely to increase as material living standards rise in developing countries, an appropriate goal for the United States and other OECD countries is to help developing countries adopt technologies and practices that minimize emissions yet still enhance economic growth. This can be done by promoting efficient energy and materials use; renewable, nonfossil fuels (e.g., solar, nuclear, geothermal, biomass); and more sustainable use of forestry and agricultural resources. The same goal also is appropriate for U.S. and OECD policies regarding Eastern Europe and the U.S.S.R. In these countries, though, systemic obstacles to more efficient energy use (particularly rigid, centralized economic planning and highly subsidized energy resources) must be overcome.

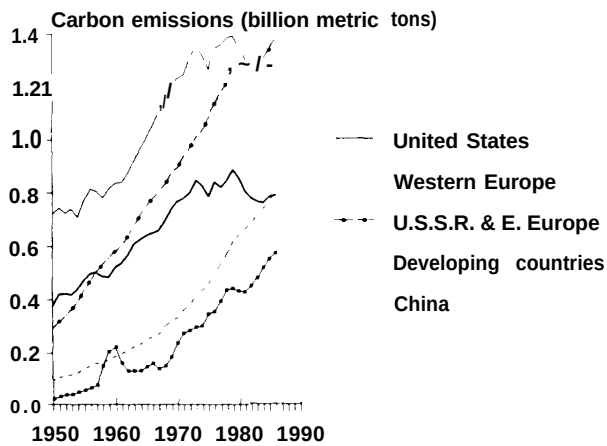
Clearly our impact in these spheres will depend on our own domestic policies. The United States and other OECD countries face the daunting task of implementing technologies and practices to reduce their own energy use without major economic disruptions.

Relative Greenhouse Gas Emissions

Worldwide carbon emissions from primary energy use account for an estimated 55 percent of the current 'radiative forcing effect' (see ch. 2) associated with all greenhouse gas emissions from anthropogenic sources (32). Overall estimated carbon emissions have risen in all regions since 1950 and have been highest in OECD countries, the U. S. S. R., and Eastern Europe (see figure 9-l). Since the early 1970s, however, carbon emissions have been relatively stable in OECD countries while continuing to rise elsewhere.

The OECD countries, U. S. S. R., and Eastern Europe currently contribute one-half to two-thirds of

Figure 9-l—Regional Trends in CO_2 Emissions From Fossil Fuels, 1950-86



SOURCE: G. Marland et al., *Estimates of CO_2 Emissions From Fossil Fuel Burning and Cement Manufacturing Using the United Nations Energy Statistics and* the U.S. *Bureau of Mines Cement Manufacturing Data*, ORNL/CDIAC-25, NDP-030 (Oak Ridge, TN: Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center, October 1988).

[1] The World Bank defines ''developing countries'' as low-income (e.g., China, India, Pakistan, Kenya) and middle-income (e.g., Indonesia, Philippines, Mexico, Brazil) (132). Also see ref. 104 for additional details.

Table 9-l—Fossil Fuel Use, by Region

	Average annual growth in fossil fuel use, 1950-95		Energy use by sector, late 1980s		
	Total	Per capita	Industry	Buildings	Transportation
Developed market economies	4.0%	1 .1%	35%	32%	33%
Eastern Europe and U.S.S.R.	5.2%	3.4%	60%	27%	13%
Centrally planned Asia.	9.5%	7.8%	45%	50%	5%
Developing market economies	6.4%	3.7%	49%	24%	27%

SOURCE: Intergovernmental Panel on Climate Change, *Energy and Industry Sub Group* Report (Geneva: May 31, 1990).

all greenhouse gas emissions, mostly from combustion of fossil fuels to power their economies. In 1986, the United States and other OECD countries accounted for over 40 percent of estimated emissions (1 10), although they are home to only 16 percent of the world's population (66). The U.S.S.R. and Eastern Europe, with 8 percent of the world's population, accounted for over 20 percent of estimated emissions.

The rest of the world—in essence the developing countries--contributed at least one-third of global emissions. Among developing countries the most important emitters are China, Brazil, Indonesia, India, Mexico, Thailand, and Ivory Coast (56).[2] China and India had the highest emissions from fossil fuel use, while Brazil and Indonesia had the highest estimated emissions from deforestation. The developing world could be contributing as much as one-half of global CO_2 emissions if the highest estimates of emissions from tropical deforestation (see ch. 7) are accurate.

Most developing country emissions currently stem from deforestation and other land use practices (e.g., methane from cultivation of rice and raising of livestock). Population growth probably will lead to further increases of emissions from these activities. Fossil fuel emissions are expected to grow very rapidly, paralleling growth in population and in energy consumption in all sectors (18, 31,32,56,76, 110). Chlorofluorocarbon (CFC) emissions also are likely to increase, because not all developing countries are signatories to the Montreal Protocol; the Protocol, moreover, permits those that did sign to increase their use of CFCs for 10 years before cutbacks are required (see box 2-C in ch. 2).

Emissions from OECD countries are expected to remain relatively stable, while emissions in Eastern Europe and the U.S.S.R. are expected to rise moderately as more services become available and as per-capita incomes rise (33).[3] As a result, total emissions from developing countries may equal or exceed those from the developed world within a few decades.

Energy Use

Globally, fossil fuel use has nearly quadrupled since 1950, growing fastest in the developing countries (see table 9-l). The OECD countries, including the United States, still account for slightly over half of global primary energy consumption, while the U.S.S.R. and Eastern Europe account for 24 percent (see figure 9-2).[4] Developing countries account for about 25 percent of the total. When estimates of traditional fuel usage are included, the developing countries account for a greater share of energy use, but such usage is not well quantified.[5]

Greater use of fossil fuels in OECD countries and in Eastern Europe and the U.S.S.R. reflects much higher levels of per-capita energy consumption than in developing countries (see figure 9-3). Per-capita rates in OECD countries could drop if energy-efficient technologies are more widely implemented,

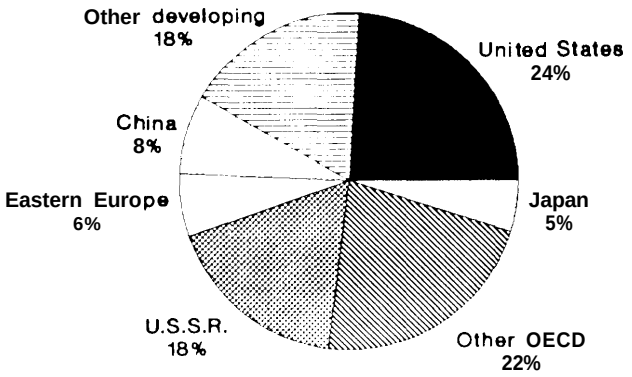
[2]This report is part of a U.S. Agency for International Development effort, mandated by the fiscal year 1990 Foreign Operations Appropriations Act (Public Law 101-167), to identify key developing countries contributing greenhouse gas emissions.

[3]Projections of future greenhouse gas emissions depend on assumptions about future energy supply and use, rates of economic and population growth, changes in land use practices, and emissions control policies.

[4]''Primary'' or ''primary commercial'' energy refers to energy commodities that are widely traded in organized markets (e.g., coal, oil, gas, and electricity; see ref. 104). "Traditional" or "biomass" fuels refers to firewood, charcoal, animal wastes, and crop residues. Some biomass fuels, particularly firewood and charcoal, are traded in organized markets.

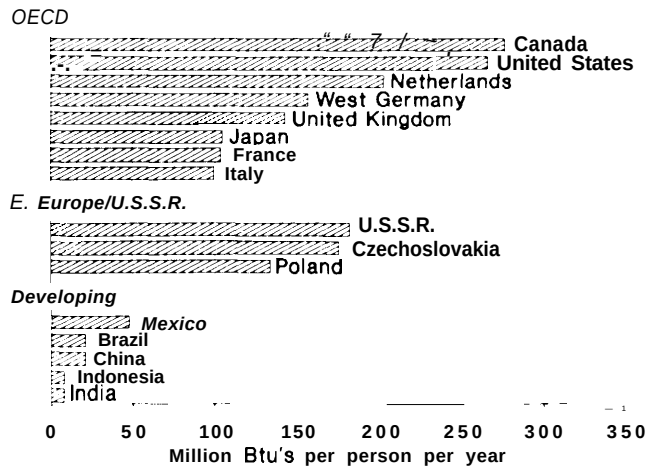
[5]Populations that live in rural areas in developing countries tend to have little access to commercial fuels and technologies. In these areas, traditional fuels satisfy most heating and cooking needs, and manual labor is used for most agricultural, transportation and industrial needs (104).

Figure 9-2—World Primary Energy Consumption, 1988



SOURCE: U.S. Department of Energy, *International Energy Annual,* DOE/EIA-0219(88) (Washington, DC: Energy Information Administration, November 1989).

Figure 9-3—Per-Capita Consumption of Primary Energy (excluding biomass)



SOURCE: U.S. Congress, Office of Technology Assessment, *Energy in Developing Countries, OTA-E-486* (Washington, DC: U.S. Government Printing Office, January 1991).

since population levels are relatively stable and economic growth is likely to be moderate. In contrast, per-capita rates in developing countries are likely to increase as development measures (especially for electricity generation, direct industrial use, and transportation) are implemented, even if energy efficiency measures are included.

Hence, the developing countries' primary energy consumption is expected to grow much more rapidly than that of the OECD countries, with Eastern Europe and the U.S.S.R. exhibiting intermediate growth (see figure 9-4). Various projections (31, 32, 34, 76, 110) indicate that the absolute portion of primary energy use in developing nations will overtake that of developed countries early in the next century, even though the per-capita difference between developed and developing countries is likely to persist well into the next century.

Deforestation

Tropical forests, located almost exclusively in developing countries, are rapidly being deforested and degraded (see ch. 7). Between 7 and 31 percent of worldwide CO_2 emissions may result from deforestation. Temperate-zone forests, located mostly in developed countries, currently contribute comparatively little to CO_2 emissions from deforestation, although they have undergone massive alterations, in some cases complete deforestation, in the past.

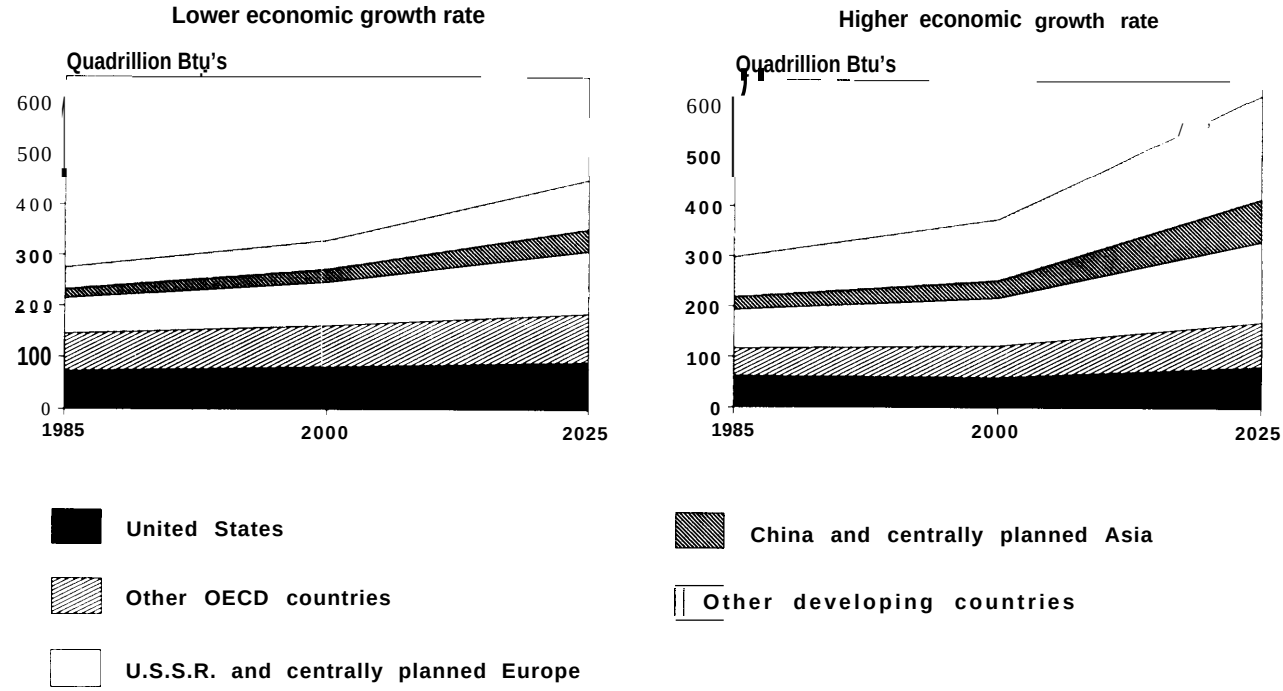
The major causes of tropical deforestation and degradation are the conversion of forests to temporary (e. g., ''shifting' cultivation) and permanent agriculture (including cattle ranching) and unsustainable timber harvesting practices. These practices are driven by rapid population growth, poverty and lack of land tenure for many people, national and international development policies that favor conversion of forests to agricultural and grazing land, massive foreign debts, and accounting systems that do not recognize many nontimber forest values.

Population Projections

Rapid population growth, in combination with economic growth, will fuel increased global demands for energy and land resources long beyond the time frame of this study, particularly in the developing countries. While decreases in current population growth rates would not greatly affect total emissions during the next two decades, they could have major implications for emissions levels during the remainder of the 21st century, depending partly on how rapidly renewable fuels and/or nuclear power replace fossil fuels.

For most of human history, the number of people was probably no more than 5 to 10 million, and even by 1750 it was still less than 1 billion. Since 1750, however, population growth has been extremely rapid (box 9-A). Now the world's population stands at 5.3 billion (figure 9-5), and it is growing at a rate of over 10,000 people per hour. The relationships among growth rates, birth and death rates, replace-

Figure 9-4-Projected Primary Energy Consumption by Region, for "High Emissions" (I.e., Base case) Scenario, 1985 to 2025



This figure shows projections of primary energy consumption under a "High Emissions" scenario--a base-case situation in which few or no steps are taken to reduce greenhouse gas emissions. Continued population and economic growth result in increased energy use and tropical deforestation; fossil fuels continue to dominate energy supply; and the share of coal increases. The figure on the left shows the projection for a low economic growth case; i.e., the average annual rate of global GNP growth decreases from 2.2 percent per year for 1985 through 2000, to 2.1 percent per year for 2000 to 2025, and to 1.3 percent per year for 2025 to 2100. The figure on the right shows the projection for a higher economic growth case; i.e., the average annual rate of global GNP growth decreases from 3.6 percent per year for 1985 through 2000, to 3.3 percent per year for 2000 to 2005, and to 2.6 percent per year for 2025to2100.

SOURCE: Intergovernmental Panel on Climate Change, *Emissions* Scenarios, *Report of the Expert Group on Emissions Scenarios (RSWG Steering Committee, Task A)* (Geneva: Response Strategies Working Group, April 1990).

ment fertility rates, and population age structure are examined in box 9-A.

World Bank and United Nations projections suggest that the world population will increase to over 8 billion by 2025 and over 11 billion by 2100 (the U.N. projection discussed here is its "medium" scenario, one of three scenarios modeled).[6] The Bank projects that population will stabilize at 11.5 billion some years later (2, 71). Projected growth rates also portend major rerankings of countries by population size (see table 9-2).

Over **90** percent of population growth is projected to occur in the developing countries of Africa, Asia, and Latin America (see figure 9-5). Unless current trends change dramatically, the proportion of the world's population living in Africa, the continent with the highest growth rate, would increase from 12 percent today to 26 percent in 2100. China's and India's growth rates (1.4 and 2.1 percent, respectively), while far from the highest in the world, are adding sizable numbers of people each year because of built-in population "momentum" (see box **9-A)** and large population bases (21 and 16 percent, respectively, of the global population) (66). The proportion of people living in the developed countries is projected to fall from 23 percent today to about 12 percent in 2100 (2). Growth rates in the U.S.S.R. and most European and North American countries are low, and three countries (Denmark,

[6]Population Projections are not Prediction, but rather are estimates of future population levels given assumptions (e.g., declining birth rates throughout the developing world), models, and collections of base data that vary in accuracy. Projections are increasingly subject to error the they reach into the future.

Box 9-A-Global Population Growth

About 10,000 years ago, humans began to shift from a hunting and gathering lifestyle to a more settled existence based on agriculture and domestication of animals. This shift permitted populations to increase, and by 1750 the world's population had grown slowly to probably around 750 million (50,67). Over the next two centuries, the world's population tripled to 2.5 billion (see figure **9-5). Between 1950 and 1987, it doubled again, to more than 5 billion.[1] At current rates, the world adds almost a billion people every decade (66).**

The first major increase, after 1750, occurred in the more developed countries as death rates began to decline slowly, probably due to improvements in nutrition and sanitation, and birth rates remained relatively high. The net increase was gradual (about 1.5 percent per year) (101). Eventually, though, birth rates also declined, and today the developed countries are growing by only 0.5 percent annually (71). The shift from high birth and death rates and low population growth to low birth and death rates with low or no **population growth is called the demographic transition.** This transition in the developed countries took place over a relatively long period.

The second major increase in world population began after World War II in the developing countries of Africa, Asia, and Latin America (101). It has been much more rapid than the first major increase for two reasons. First, death rates declined very rapidly, because of the transfer of medical and agricultural improvements from developed countries. Second, although lower birth rates followed rapidly in some countries (e.g., China, Mexico), in general they have not yet begun to parallel the decline in death rates. As a result, net growth rates have been high (2.5 to 3.5 percent and even higher per year) and remain explosive in many countries. The demographic transition in these countries is incomplete. Annual growth rates between 1990 and 1995, for example, are projected to be 6.7 percent in Afghanistan (which will double its population in about 10 years), 4.1 percent in Kenya, and between 3 and 4 percent in many African and Middle Eastern countries (71).

The **developing countries exhibit tremendous "population momentum" and will continue to grow for one or more generations even after the average fertility rate drops to replacement levels. The degree of** momentum depends on the population's age structure. When the majority of the population is still in or entering the reproductive years, even replacement rates (2.1 children per couple, which accounts for the death of some women during their child-bearing years) result in a net population increase. Many developing countries exhibit this age structure. In contrast, the age structure in developed countries is such that births roughly balance deaths.

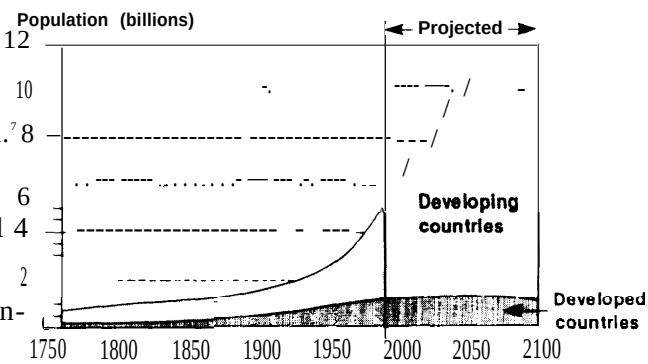
[1] A population's doubling time can be closely estimated by dividing 70 by the growth rate. For example, a population growing at 3 P@ per year will double in about 23 years (and increase by a factor of about 10 m a century).

Germany, and Hungary) exhibit zero or even negative growth.

Most developing countries support family planning, and over the past several decades many have reduced their birth rates, resulting in improvements in maternal health and per-capita economic growth.[7] However, while international support for family planning programs has remained relatively stable since 1972, it has declined as a percentage of official development assistance (92).

Urbanization—The world also is becoming increasingly urban. In 1950, 29 percent of the world's people lived in urban areas and today 48 percent do; by 2010, 56 percent of the world's population is projected to live in cities (89, 105). Great variations

Figure 9-S-World Population Growth, 1750 to 2100



SOURCE: Population Reference Bureau, 199(7 *World* Population *Data* Sheet (Washington, DC: 1990).

[7] In China, for example, since Chou En Lai's "Directive 51" in 1971 (101), fertility dropped from 5.8 births per woman in 1970 to the replacement level of 2.1 in 1984 (50). In Thailand, Colombia, and South Korea, it took 15 years or less to reduce average fertility from 6 to 3.5 births per woman (105). Mexico's fertility rate dropped from 6.8 births per woman in the early 1970s to 4.3 in 1982 and 3.8 in 1989, and it is projected to approach replacement level by 2010 (50, 65).

Table 9-2-Countries Ranked by Population Size for 1950,1989, and 2020
(population size In millions In parentheses)

Rank	1950	1989	2020 (projected)
1	China (563)	China (1113)	China (1523)
2	India (370)	India (833)	India (1308)
3	U.S.S.R. (180)	U.S.S.R. (289)	U.S.S.R. (355)
4	U.S. (152)	Us. (248)	Us. (294)
5	Japan (84)	Indonesia (188)	Indonesia (293)
6	Indonesia (83)	Brazil (151)	Nigeria (274)
7	Brazil (53)	Japan (123)	Pakistan (242)
8	United Kingdom (50)	Nigeria (115)	Brazil (242)
9	West Germany (50)	Bangladesh (115)	Bangladesh (230)
10	Italy (47)	Pakistan (1 10)	Mexico (152)
11	Bangladesh (46)	Mexico (86)	Philippines (131)
12	France (42)	Vietnam (67)	Japan (131)
13	Nigeria (41)	Philippines (65)	Iran (130)
14	Pakistan (39)	West Germany (61)	Ethiopia (128)
15	Mexico (28)	Italy (58)	Vietnam (121)
16	Spain (28)	United Kingdom (57)	Egypt (101)
17	Vietnam (25)	France (56)	Turkey (92)
18	Poland (25)	Turkey (55)	Zaire (85)
19	Egypt (21)	Thailand (54)	South Africa (83)
20	Philippines (21)	Irart (54)	Kenya (79)
21	Turkey (21)	Egypt (53)	Thailand (71)
22	South Korea (21)	Ethiopia (50)	Tanzania (69)
23	Ethiopia (21)	South Korea (43)	Myanmar (67)
24	Thailand (20)	Myanmar (41)	South Korea (58)
25	Myanmar (19)	Spain (39)	France (58)
26	East Germany (18)	Poland (38)	Sudan (57)
27	Argentina (17)	South Africa (39)	United Kingdom (57)
28	Iran (16)	Zaire (34)	Italy (57)
29	Yugoslavia (16)	Argentina (32)	West Germany[a] (56)
30	Romania (16)	Colombia (32)	Colombia (49)

[a]Excluding East Germany.

NOTE: This table shows that the relative population ranking of some countries will change through time. For example, the United Kingdom is projected to drop from 8th largest in 1950 to 27th largest in 2020, while Iran is projected to move from 27th to 13th position in the same period. The top four countries are expected to retain their current rankings, although Indonesia and Nigeria will approach the size of the United States.

SOURCE: Office of Technology Assessment, 1991, based on U.S. Department of Commerce, Bureau of the Census, *World Population Profile: 1989*, WP-89 (Washington, Dc: U.S. Government Printing Office, September 19S9).

Photo credit: Philip Teuscher, United Nations

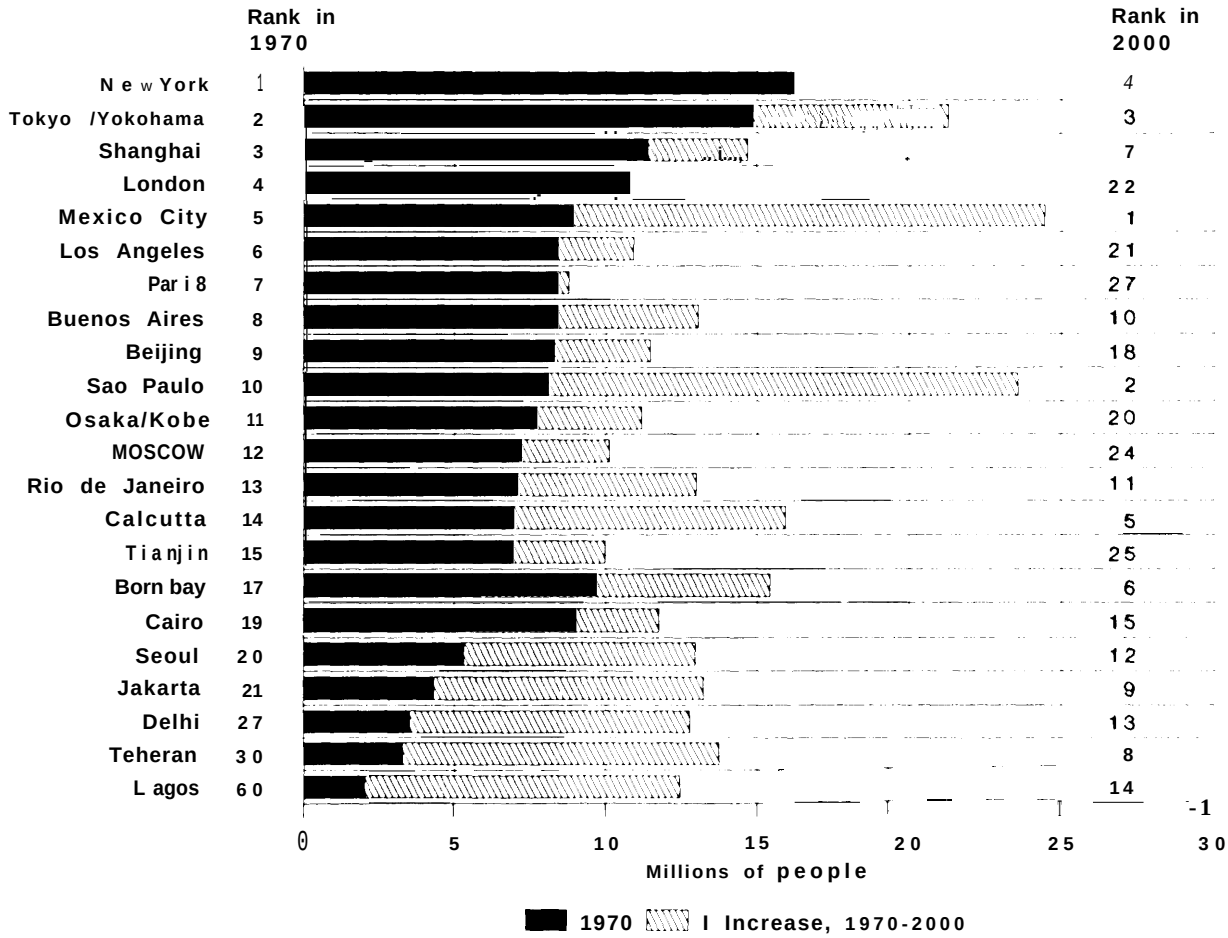
Urbanization is proceeding rapidly in most parts of the developing world, following past trends in the developed world; by 2010, 56 percent of the world's population is projected to live in cities.

exist among different countries and regions—for example, over 70 percent of today's population in the developed world and Latin America is urban, compared to 35 percent in Africa and 30 percent in Asia. Urbanization is proceeding rapidly in most parts of the developing world, though, following past trends in the developed world. Rapid urban growth in the developing world is reflected in the shift in location of the world's 10 largest cities away from the developed world (figure 9-6).

GENERAL AVENUES FOR U.S. INFLUENCE

Chapters 1 and 3 through 8 set out specific policy options in various sectors (i.e., energy, buildings, transportation, manufacturing, forestry, and food) which the United States could pursue in order to reduce or offset its own greenhouse gas emissions. There are many compelling reasons to do so (see ch.

Figure 9-6---The World's 15 Largest Cities, 1970 (actual) and 2000 {projected)



SOURCE: U.N. Department of International Economic and Social Affairs, *Prospects of World Urbanization, 1988,* Population Studies No. 112, ST/ESA/SER.A/112 (New York: 1989).

1), and by taking such actions to reduce its own emissions the United States could provide leadership through example.

The United States also could encourage other countries to follow suit.[8] This section summarizes how the United States can, in general, potentially influence other countries' policies and practices: through bilateral and multilateral assistance organizations, trade with other nations, and nongovernmental organizations (see table 9-3). The United States also could participate in negotiations on an international framework convention on greenhouse gas emissions. Such negotiations are expected to begin early this year.[9]

U.S. Bilateral Organizations and Involvement in Multilateral Organizations

The United States provides direct bilateral assistance to developing countries through the U.S. Agency for International Development (A. I.D.) and other government agencies, and it contributes to multilateral assistance through its participation in various international organizations (box 9-B).

[8]The section on the OECD (see "OECD Countries" below) describes actions that several industrialized Countries have taken without waiting 'o' the United States. As of December 1990, the United States was the only G-7 country without a CO_2 target goal. The G-7 (Group of 7) countries consist of Canada, France, Germany, Italy, Japan, United Kingdom, and the United States.

[9]In July 1989, the G-7 countries agreed at their Economic Summit that a U.N. framework convention on climate change setting out global principles was needed and that protocols containing concrete commitments could be fit into the framework as scientific evidence permitted. Several precedents exist for negotiating such agreements, most notably the Montreal Protocol on Substances that Deplete the Ozone Layer (see box 2-C).

Table 9-3—Examples of Avenues for U.S. Influence

Institutions[a]	Financing				Training, technical		Debt	Advice,
	Bilateral	Multilateral	Private	Exports	assistance	R&D		
me								
A.I.D.	x	—	—	—	x	x	—	x
DOE	x	—	—	x	x	x	—	x
EPA	—	—	—	—	x	x	—	x
Commerce	—	—	—	x	x	—	—	x
Treasury	—	x	—	—	—	—	x	x
International:								
World Bank	—	x	—	—	x	x	x	x
UNEP	—	—	—	—	x	x	—	x
IDB	—	x	—	—	x	—	—	x
Trade & industry:								
OPIC	—	—	x	x	—	—	—	x
US/ECRE	—	—	—	x	x	x	—	x
Eximbank	—	—	—	x	—	—	—	x
NGOs and foundations	—	—	x	—	x	x	—	x
Research organizations						x	—	x
B								

governmental organizations; OPIC=Overseas Private Investment Corp.; UNEP=U.N. Environment Program; US/ECRE=United States Export Council for Renewable Energy.

SOURCE: Office of Technology Assessment, 1991, based on OTA Workshop on "The United States, Developing Countries, and Global Warming," Sept. 9, 1989.

Total U.S. foreign aid assistance to developing countries is about $9 billion annually.[10] This represents about 20 percent of all such assistance globally and makes the United States the second largest donor in the world, after Japan. Compared to other countries, however, U.S. assistance is a small percentage of its Gross National Product (GNP) (83, 113). The U.S. portion was 0.19 percent in 1987 and 0.21 percent in 1988. In 1987, the larger Western European countries provided an average of 0.42 percent and Japan provided 0.31 percent; Norway topped the list at 1.10 percent.

Technology Transfer and Trade With Other Countries

More efficient energy production and use, renewable and/or nuclear energy sources, and CFC-free technologies could help reduce, or at least slow the rate of increase in, future greenhouse gas emissions in Eastern Europe, the U. S. S. R., and developing countries without necessarily impeding economic development. Improvements in energy efficiency are possible with available, commercialized technologies and services (see chs. 3 through 6).[11] Nonfossil fuel energy generation is possible with available technologies and services, including photovoltaic, wind turbine, geothermal, biomass, and nuclear systems.

The opportunity seems ripe for U.S. businesses to increase exports of energy-related technologies to developing countries, since much of the energy infrastructure needed to fulfill development aspirations is yet to be built, This is occurring to some extent—for example, U.S. electric power equipment manufacturers have entered into several energy-related agreements with China (55), and U.S. renewable energy companies have products installed in 150 countries (94). Exports of photovoltaics increased by 37 percent from 1987 to 1988, primarily in developing counties (82). The market in developing countries for electric power equipment over the next 20 years might be between $370 and $900 billion (93).

Even so, U.S. businesses often have difficulty competing in foreign markets (20, 37, 43). Several U.S. Government and private sector programs exist to facilitate U.S. trade in renewable and efficient energy technologies (box 9-C), although some analyses conclude they may not be as effective in helping the U.S. private sector as are programs of other OECD countries that provide similar assistance to their private sectors (94, 121).

Congress could facilitate U.S. trade in efficient energy and renewable energy technologies in several ways. First, it could expand the financial resources of independent agencies that finance technology exports, such as Eximbank and the Overseas Private Investment Corp. (OPIC), or those that fund project preparation work, such as A. I.D., as well as direct these agencies to focus resources on specific technology areas. For example, the FY 1990 Foreign Operations Appropriations Act (Public Law 101-167) directs Eximbank to set aside 5 percent of its energy industry export funds for renewable energy projects, and directs A.I.D. to focus on energy efficiency, renewable energy, and least-cost energy planning in the development of national energy plans.[12] Congress also could consider directing agencies such as A. I.D., Commerce, Environmental Protection Agency, and others to set up multi-agency committees to promote trade in given technology areas, perhaps using the Committee on Renewable Energy Commerce and Trade (CORECT) (see box 9-C) as a model for such efforts, and to facilitate better matches between U.S. goods and services and market conditions in host countries. EPA's National Advisory Council for Environmental Policy and Technology also might play a role, for example through its International Cooperation Committee.

Second, Congress could consider further use of ''tied-aid" financing (i.e., linking foreign aid to the financing of foreign purchases of U.S products)-a practice that runs counter to free market policies, but one that is used by other OECD countries. Congress appropriated some resources for tied-aid financing to Eximbank, which joined with A.I.D. in creating a $500 million tied-aid pool to leverage financing for exports of U.S. products in developing countries (21,

[10] Including bilateral and multilateral aid, food aid, and security-related economic support funds.

[11] Including reducing electricity transmission losses and methane leaks from natural gas production and distribution. The latter will be particularly important if national and international policies encourage fuel-switching from other fossil fuels to natural gas (122).

[12] The Act also appropriated $15 million for greater development and use of renewable energy and for initiatives to reverse tropical deforestation.

Box 9-B—Agencies and Organizations That Can Influence Greenhouse Gas Emissions

Many U.S. **and United Nations agencies, multilateral lending institutions, and international science and natural resource organizations have programs** that can potentially influence greenhouse gas missions in different parts of the world.

U.S. ***Government Agencies-The Agency for International Development (A.I.D.)*** is the lead government agency for administering foreign economic assistance, through training and institution building, education and research, policy advice, technical assistance, and technology transfer (115,1 16). In 1989, it spent $2.4 billion on bilateral development assistance, 18 percent of total **U.S.** foreign operations appropriations (including Economic Support Funds, military aid, and assistance channeled through multilateral organizations) **(97).[1] About $245 million was authorized for family planning programs, slightly over one-third of all such international efforts. The Foreign Operations Appropriations Act of Fiscal Year 1990 (Public Law 101-167) directed A.I.D. to concentrate more of its resources on helping to** reduce greenhouse gas emissions from deforestation and fossil fuel use in "key" developing countries. **A.I.D. administers numerous programs related to forestry and agricultural resources (see ch. 7), the sale and donation of agricultural commodities under Public Law 480, and the Foreign Disaster Assistance program. In the energy sector, A.I.D. has provided around $200 million annually over the last 5 years, about two-thirds for the power sector.[2] Current programs in this sector are emphasizing end-use energy efficiency and renewable energy resources and increased attention to natural gas and coalbed methane fuels.**

The Department of Agriculture (USDA) promotes and finances U.S. agricultural products, collects data on foreign production and consumption, and coordinates U.S. agricultural trade policy with other U.S. agencies (95). The agency's Foreign Agricultural Service works in over 40 countries. The U.S. Forest Service plays an increasing role in international forestry issues (see ch. 7).

The Department of Commerce helps U.S. manufacturers and businesses pursue overseas export opportunities, collects and disseminates commercial information, and supports other U.S. overseas programs, including the Eximbank and Overseas Private Investment Corp. (see box 9-C). For example, the department's International Trade Administration provides marketing assistance.

The Department of Energy (DOE) is examining how U.S. energy programs contribute to climate change problems, as a part of the forthcoming National Energy Strategy. It also runs several programs, such as the Committee on Renewable Energy Commerce and Trade (CORECT), to identify and promote energy technologies that can mitigate greenhouse gas emissions (see box 9-C). The department-run National Laboratories spend about **$10 million annually (mostly from** outside funding sources) to provide energy assistance to developing **countries** (43). The department also has over 30 bilateral R&D agreements with developing countries (primarily newly industrialized countries).

The Department of State is responsible for overall conduct of U.S. foreign policy, including U.S. representation in the Intergovernmental Panel on Climate Change (IPCC). U.S. Ambassadors are responsible for foreign aid and all other U.S. policy in their assigned countries. In a given country, the mission director for A.I.D. and any in-country representatives of other U.S. departments all report to the Ambassador (95).

The Department of Treasury is responsible for U.S. financial policies affecting other countries and for U.S. participation in international financial institutions such as the World Bank. The Office of Multilateral Development Banks directs the U.S. Executive Directors that sit on the boards of the MDBs; through the directors, the United States has been active in scrutinizing MDB environmental policies.

The Environmental Protection *Agency (EPA)* is examining global climate change issues-particularly energy use, deforestation, methane from agriculture, chlorofluorocarbons (CFCs), and sea-level rise--in the United States, Eastern Europe, U. S.S.R., and developing countries. It provides technical support for U.S. involvement in the lPCC.

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[1] About 80 percent of bilateral development assistance was allocated by Congress to functional sectors (e.g., health, population agriculture). About 20 percent ($5(N) million) was allocated to the Development Fund for Africa without reference to functional sectors.

[2] In fiscal years 1985 and 1986, over 80 percent of power sector assistance was for Egypt and Pakistan, with the remainder distributed among two dozen or so countries (93).

The U.S. Trade Representative is a cabinet-level agency charged with formulating overall trade policy and with conducting bilateral and multilateral trade negotiations.

Multilateral Development Banks (MDBs)-The MDBs--the World Bank and the three regional banks (Inter-American, Asian, and African Development Banks)-loaned developing countries over $25 billion in 1986 (69). Although this represents less than 20 percent of all development investments by developing countries themselves, it provides a more favorable atmosphere for other lenders (83,88,118). Many MDB projects have led to tropical deforestation or inefficient energy use, but recently the banks have begun to address these issues.[3]

The World Bank, the largest MDB, spent approximately $15 billion in 1989 (128).[4] Approximately $3.3 billion was in the energy sector; about two-thirds of this was for electric power generation. Bank funding for free-standing environmental projects during the period 1990 through 1992 is expected to be about $1.3 billion (13). The Bank recently issued an operational directive outlining procedures for assessing the environmental consequences of proposed Bank projects (see ch. 7). Environmental issues papers and action plans are being drawn up for borrowing countries, and the Bank expects these to have a growing influence on lending activities (128). These are important steps, but it is too early to ascertain their effect. In the energy sector, most projects now contain loan conditions, where necessary, to improve fuel pricing and the efficiency of energy consumption. The Energy Sector Management Assistance Program (ESMAP), established by the Bank and the UN Development Program in 1983 and funded at a level of $12.5 million in 1988, conducts assessments in the energy sector and facilitates energy policy recommendations and investments (43,131).

The three regional development banks have a larger role than does the World Bank in many countries, for example in Central America. The African Development Bank and Inter-American Development Bank (IDB) provided about $1 billion for energy sector projects in 1988 (43). The IDB has sponsored projects on watershed management, and meetings to coordinate activities with NGOs. With UNDP, it helped compile an agenda of environmental topics in Latin America and the Caribbean to serve as a vehicle for donor cooperation. In 1990, the IDB established an Environmental Protection Division to provide increased attention to environmental issues in project design, and it established procedures for evaluating environmental impacts (30). The division expands previous IDB efforts (including a 1979 policy statement and the establishment in 1983 of an Environmental Management Committee) to address environmental issues.

United Nations Agencies—The family of United Nations agencies provides assistance for a multitude of projects related in some way to climate change. Some of the better known agencies are briefly described here.

The U.N. Development Program (UNDP) allocated about **$0.5** billion of its $3.8 billion portfolio to environmental activities in 1989 (90). It provides funds and advisory services to developing countries for trade in development technology (43,108). It also helps finance over 50 of the national plans being developed under the Tropical Forestry Action Plan (ch. 7). UNDP also is developing Environmental Management Guidelines to identify environmental issues as early as possible in its project design activities.

The U.N. Environment Program (UNEP) reviews global environmental trends and coordinates environmental activities and provides policy guidance within the United Nations. It led the development of the Vienna Convention and Montreal Protocol to Protect the Ozone Layer and along with the World Meteorological Organization, jointly manages the World Climate Program and jointly coordinated the IPCC (see below).

The U.N. Food and Agriculture Organization (FAO) is active in energy assessments, planning for rural and agricultural development, fuelwood and charcoal projects, and tropical forestry issues (see ch. 7).

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[3] In contrast, the International Monetary Fund-which affects economic practices in developing countries through, fOr example, the conditions of its structural reform packages-has not taken steps to incorporate environmental concerns in ita decisions (45).

[4] The World Bank includes the International Bank for Reconstruction and Development the International Development Association and the International Finance Corp. 'l'he IBRD provides loans at interest rates related to the Bank's cost of borrowing the IDA provides interest-tie credits with long grace periods to poorer developing countries; and the IFC raises financing, generally in line with commercial lending rates, for private companies and joint ventures (43).

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Box 9-B—Agencies and Organizations That Can Influence Greenhouse Gas Emissions--Continued

The U,N. Population Fund (UNFPA) promotes strategies and provides assistance to developing countries to deal with national and international population problems. It provided about $169 million in 1988 for programs in 141 countries.

The UN. *Industrial Development Organization (UNIDO)* promotes industrialization in developing countries and provides assistance to improve industrial use of energy.

The *World Meteorological Organization (WMO)* monitors overall climate trends, provides a framework for cooperative research on models of global climate, facilitates the exchange of meteorological information between countries and, with UNEP, jointly sponsors the IPCC. It also jointly manages, with UNEP and the International Council of Scientific Unions (see below), the World Climate Research Program

Regional Organizations--The developed countries are served by many regional organizations, including the Organization for Economic Cooperation and Development (OECD), International Energy Agency (IEA), and European Economic Commission (EEC). The OECD's Environment Committee, for example, is assessing energy options related to climate change and socioeconomic implications of such change; its Development Assistance Committee provides a forum to coordinate donor efforts in addressing environmental problems in developing countries (109). The IEA provides a framework for promoting energy diversification, energy efficiency and conservation, and alternative energy sources; it also runs information and data exchange centers dealing with energy technologies.

Developing nations have some regional bodies that are beginning to provide similar services--for example, tie South Asian Association forRegional Cooperation (SAARC), Association of South East Asian States (ASEAN), Gulf Cooperation Council, Southern Africa Development Coordination Conference (SAD(X), and Organization of American States (OAS) (45).

Intergovernmental Panel on Climate Change (lPCC)--The IPCC was set up in 1988 under the auspices of UNEP and WMO to serve as the primary international forum for addressing climate change. It has three working groups charged with:

- assessing scientific evidence on climate change;
- . assessing likely impacts resulting from such change; and
- considering possible response strategies for limiting or adapting to climate change.

The groups are chaired by the United Kingdom, U.S.S.R., and United States, respectively. To encourage representation of developing country viewpoints, the IPCC established a trust fund to support the participation of developing countries; as a result, developing countries have comprised about one-third of the national delegations at recent IPCC meetings. On the other hand, no formal links have been established with the private sector or NGOs. The WCC'S final report was presented to the Second World Climate Conference and the U.N. General Assembly in late 1990. The findings from the scientific assessment working group are summarized in chapter 2.

International Science and Natural Resource Organizations-The International Council of Scientific Unions (ICSU) coordinates worldwide scientific projects and works with NGOs and intergovernmental agencies in project implementation. The ICSU runs the International Geosphere-Biosphere Programme, which conducts research on basic global processes, and is a joint manager of the World Climate Research Program

Numerous other research and management organizations and plans address natural resource issues, primarily in agriculture and forestry. For example, the International Fund for Agricultural Development (WAD), funded by OPEC and OECD members, makes financial resources available on concessional terms for agricultural development in developing countries (109). The Consultative Group on International Agricultural Research (CGIAR) is a network of regional and international organizations that conduct agricultural research in developing countries (CGIAR and Other agricultural institutions are described in ch. 8). The International Tropical Timber Organization provides a framework for coordination between tropical timber producing and consuming countries, and the Tropical Forestry Action Plan attempts to enhance donor cooperation and funding in sustainable forestry management. Both of these entities have come under severe criticism recently (see ch. 7).

Box 9-C—U.S. Trade in Renewable and Efficient Energy Technologies

Various programs to help U.S. businesses overcome obstacles in exporting efficient and renewable energy technologies to non-OECD countries have been established by the U.S. Government, independent government agencies, and the private sector.

Agency for International Development (A. I.D.) Programs—A.I.D. promotes energy-related technology development and transfer by supporting prefeasibility funding studies and by leveraging private, multilateral, and other bilateral resources for projects. Some of the leveraging is accomplished through the MDBs, using the Multi-Agency Group on Power Sector Innovation (MAGPI). The agency sponsors reverse trade missions and an energy and environmental training program for host country nationals. A.I.D. has established a Private Enterprise Fund for Eastern Europe to assist the export of U.S. technologies, including energy-related ones. It also is collaborating with India on a 6-year Program for the Acceleration of Commercial Energy Research (PACER) that promotes the commercialization of indigenous energy technologies and improvement of transmission and distribution planning and technologies; PACER has helped establish consortia that link the industrial, commercial, R&D, and government sectors.

Department of Energy and CORECT—The Committee on Renewable Energy Commerce and Trade (CORE(X) is a multiagency committee led by the Department of Energy and involving 12 other Federal agencies. Established in 1984, it promotes trade of U.S. renewable energy technologies (and is expanding its efforts to energy efficiency), brings government and business personnel from other countries to the United States for trade conferences and missions, provides technical assistance, and funds the Renewable Energy Design Assistance Center (REDAC) at Sandia National Laboratories to provide technical assessments, prefeasibility and feasibility studies, financing, and other forms of project support.

Export-Import Bank (Eximbank,)--Eximbank is an independent U.S. Government agency, chartered under the Export-Import Bank Act of 1945, that helps finance and facilitate the sale of U.S. goods and services to foreign buyers, particularly in developing countries (95,123). Its main programs are direct loans, guarantees, and insurance. The 1990 Foreign Operations Appropriations Act (Public Law 101-167) directed Eximbank to direct not less than 5 percent of its financial assistance in the energy sector to renewable energy projects. In FY 1990, Eximbank provided support for over $6 billion in exports. In the energy sector, it provided final commitments to support $2.1 million, and had pending final commitments for an additional $11.8 million, in renewable energy projects (i.e., hydroelectric, photovoltaics). Assuming pending commitments are fried, Eximbank's fiscal year 1990 support for renewable energy projects would represent 7.4 percent of its total energy sector support (21).

Overseas Private Investment Corp. (OPIC)-The Overseas Private Investment Corp. (OPIC) is an independent corporation created by Congress. It directly finances projects sponsored by U.S. private investors in over 100 developing countries and provides insurance against political risks for U.S. private investments in those countries. It can provide direct loans of up to $6 million to small- and medium-sized firms and investment guarantees for up to $50 million. In fiscal year 1989, OPIC provided project insurance totaling over $l.5 billion and direct loans and loan guarantees totaling $208 million (59). OPIC is developing a privately owned and managed Environmental Investment Fund for business enterprises in developing countries and Eastern Europe that involve renewable energy, ecotourism, sustainable agriculture, forest management, and pollution prevention (59,60,61). OPIC hopes to capitalize the fund with $60 million of equity raised from U.S. businesses and institutional investors and $40 million in OPIC-guaranteed long-term debt,

Private Export Funding Corporation—The Private Export Funding Corp. (PEFCO) is a government-sponsored commercial corporation that raises funds for export financing in the private market, using unconditional Eximbank guarantees.

U.S. ***Trade and Development Program—The*** U.S. Trade and Development Program (TDP), in **the** U.S. International Development Cooperation Agency. funds feasibility studies, consultancies, training programs, and other planning services for projects involving export markets for U.S. goods and services. Its focus is primarily on large public sector projects (43,93).

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Box 9-C—U..% Trade in Renewable and Efficient Energy Technologies-Continued

United States Export Council for Renewable Energy (US/ECRE)-US/ECRE is an umbrella organization **composed of eight national trade associations that represent manufacturers of renewable energy technologies. It promotes exports of these technologies, specifically for alcohol fuels, biomass, geothermal, hydropower, photovoltaics, solar thermal, wind and wood. It engages in country studies and market analyses; advises members on overseas projects, procurement opportunities, and trade shows; and serves as a clearinghouse for inquiries regarding renewable energy. It has collaborated with DOE and Volunteers in Technical Assistance on a low-orbit satellite system that will allow NGOs to communicate with each other and obtain technical information on renewable and other energy technologies.**

Other Industry-Sponsored Efforts--The **International Environmental Bureau (IEB) is a nonprofit educational division of the International Chamber of Commerce, funded independently by its member companies (19 from North America, 9 from Europe, and 1 from South America including such giants as ALCOA, Monsanto, and ARCO). Its principal purpose is to make available know-how and expertise on environmental problems to companies in developing countries and to medium- and small-sized companies everywhere, free of charge (36). It was established in 1984 and by July 1989 had received about 80 requests for assistance.**

The Foreign Credit Insurance Corp. (FCIC), an association of 50 or so private insurance companies, insures against commercial risk in short-term transactions with repayment terms of up to 100 days.

The Industry Cooperative for Ozone Layer Protection was set up by nine major companies (including AT&~ Northern Telecom, Boeing, Ford Motor Corp.) in October 1989 to promote cooperation in ending the use of chlorofluorocarbons (CFCs) as cleaning agents. CFC-113, for example, is widely used as a degreaser in the manufacture of computer and electronic parts. The cooperative intends to act as a clearinghouse for information on new, safe substitute solvents and to encourage their adoption. Its formation followed a 1989 announcement by Petrofirm that it had developed a citrus-based substitute for CFC-113.

22).[13] The extent to which this will be used for renewable and efficient energy technologies remains to be seen, but Eximbank also is working through CORECT to assist U.S. renewable energy businesses.

Third, Congress could continue to change restrictions on technology exports to Eastern Europe and the U.S.S.R. This could be done as part of the reauthorization of the Export Administration Act and/or by providing new directions on U.S. participation in the Coordinating Committee on Multilateral Export Controls (COCOM) (see section on "Eastern Europe and the U. S. S. R." for more discussion).

In addition, Congress could consider establishing, with the cooperation of host countries, technology research and/or assistance centers in Eastern Europe and developing countries, For example, EPA is coordinating the establishment of a center in Budapest that will function as an environmental information clearinghouse for Eastern Europe (111).[14] A.I.D. has proposed a Global Energy Efficiency Initiative, to be supported in part by developed countries and multilateral institutions, for promoting pricing reform, end-use energy efficiency, cogeneration, and private sector activities in other countries (99, 119). The National Laboratories could be directed to increase R&D on technologies for developing countries, as is being done for renewable energy at the CORECT-sponsored Sandia Renewable Energy Design Assistance Center.

Non-Governmental Organizations (NGOs)

Private agencies and organizations, or NGOs, have succeeded in mobilizing support from and participation by local communities in development and environmental projects around the world (129). More than 1,000 are represented at the UNDP's Nongovernmental Environmental Liaison Office, and over 240 were registered with A.I.D. as of 1989. Some are multinational (e.g., Greenpeace, Friends of the Earth). The U.S. funds foreign NGOs in developing countries through the Inter-American Founda-

[13] Projects would be in the telecommunications, electric power (including renewable energy), construction, and transportation sectors, with an initial focus on Indonesia, Pakistan, the Philippines, and Thailand (22).

[14] In 1990, the Senate Foreign Relations Committee approved the Support for East European Democracy Act (SEED II). The act would have included technical assistance for establishing business centers to provide information and logistical support for U.S. businesses operating in Eastern Europe and the U.S.S.R. (15).

tion and the African Development Foundation, through direct grants, and through hundreds of American NGOs that receive A.I.D. funding. Foreign and U.S. NGOs registered with A.I.D. received $456 million in development assistance funds in fiscal year 1989 (1 13) and an estimated $399 million in fiscal year 1990 (97).

Congress has attempted to expand and strengthen the role of U.S. and foreign NGOs in a number of ways.[15] Many NGOs, however, still lack the resources (financial, technical, managerial) and experience to implement plans and projects (45, 136). By building the capacities of NGOs, particularly in developing countries, it may be possible to foster more effective energy and natural resource policies and programs.

DEVELOPING COUNTRIES

Tropical deforestation is the major source of current carbon emissions in developing countries (ch. 7), while rice cultivation and livestock operations are the main sources of methane (ch. 8). Emissions from fossil fuel use are relatively low but are likely to increase as developing countries become more industrialized and their citizens use more modern methods for cooking, heating, and transportation. Indeed, total and per-capita energy consumption is rising more rapidly in developing countries than in developed countries.

The decisions that developing countries make in the next decade about how to pursue economic growth will affect emissions for decades to come. Economic growth could require dramatic expansions in energy services and infrastructure (e.g., industrial bases, electric generation). Opportunities exist today to implement efficient technologies and services to help meet these demands. Opportunities also exist to reverse or slow tropical deforestation. However, massive foreign debts make it difficult for developing countries to invest in energy-efficient infrastructures and also provide an incentive for rapid depletion of natural resources (in order to service the debts).[16] Some developing countries may not sign international agreements on climate change unless their concerns about debt and other development issues are addressed (63, 134).[17]

Contribution to Greenhouse Gas Emissions

CO_2 From Deforestation

Deforestation in developing countries accounts for between 7 and 31 percent of global CO_2 emissions, as well as unknown amounts of methane, N_2O, and other gases (ch. 7). While some deforestation occurs because of hydroelectric development and fuelwood consumption, the major direct causes are land use changes for agriculture (including cattle ranching) and timber harvesting. Perhaps 17 million hectares are deforested yearly.

CO_2 From Energy Use

The developing countries' share of world commercial energy use increased from 16 to about 25 percent between 1970 and 1988 (1, 31,43, 75, 76, 106, 127). China, India, and Brazil accounted for about 45 percent of developing countries' consumption of commercial and traditional fuels in 1988, with China alone accounting for 30 percent (104, 106; also see ch. 3).

Commercial energy use will increase as developing countries expand industrial and transportation infrastructures, continue to fully electrify cities, and begin or continue rural electrification programs(71, 104). New electrical power generation is likely to be based largely on domestic energy sources, primarily coal and hydroelectric facilities (93).[18] one-half of planned electricity generation in China and India, for example, is to be based on coal (56).

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[15]For example, Public Law 101.167 directed agencies such as A.I.D. to make increased use of U.S. and foreign NGOs and to provide technical assistance in increasing the institutional capacities of foreign NGOs. The 1989 International Development and Finance Act (Public Law 101-240) requires the U.S, Executive Directors to multilateral development banks to promote increased assistance and support for foreign NGOs. Congress also appropriated $1 million in fiscal year 1991 for a project to launch a low-orbit satellite linking NGOs in an information network (see US/ECRE in box 9-C) (82).

[16]Much of the hard currency generated b, developing countries flows back to lenders to service debts; annual interest payments on developing country foreign debt are over $60 billion (4 S). Debt service and austerity measures required under IMF structural adjustment agreements have led to government cutbacks in operating expenditures, often in natural resource management programs (56).

[17]The U.N. resolution to convene the U.N. Conference on Environment and Development (91), to be held in Brazil in 1992, includes the objectives of devising agreements regarding climate change and addressing the concerns of developing countries about debt and development issues.

[18]Power generation in developing countries rose by 8.6 percent annually between 1971 and 1987, compared with an average of 3.6 percent annually in developed countries (93). Most added capacity in developing countries has been fossil fuel plants, while much new capacity in OECD countries has been non-CO_2 emitting nuclear plants (34).

Photo credit: U.S. Agency for International Development

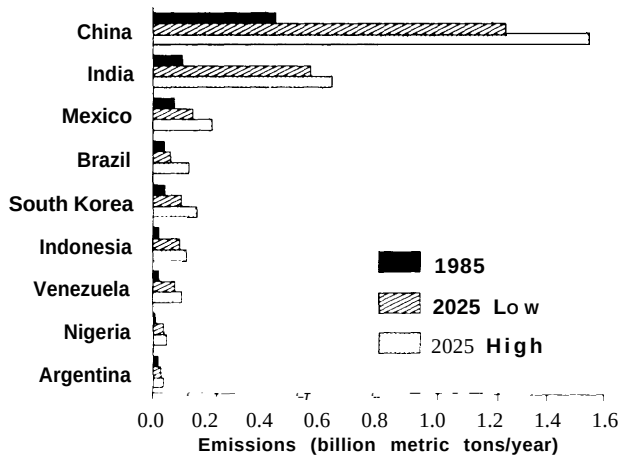
Animal wastes are a "traditional" energy source for cooking and heating in many countries.

One analysis (76) developed two scenarios for CO_2 emissions related to energy use in nine developing countries (four Asian, four Latin American, and one African). One scenario assumed high emission rates (i.e., no constraints on economic and energy growth) and the other assumed lower rates (i.e., because of energy efficiency and fuel substitution measures). The projected CO_2 emissions rise significantly, even in the low emissions, energy-efficiency scenario (figure 9-7).

CFC Use

The main CFC producers among developing countries are China, Brazil, Indonesia, and Mexico. In 1985 their total production was 19 percent of U.S. production (1 10), but refrigeration, air-conditioning, and other CFC applications are expanding rapidly (26, 51, 76). For example, China has a goal of one refrigerator per household by the year 2000(71), and its population is growing by several million households per year. Its consumption of CFCs and halons is projected to increase 12 percent annually between 1990 and 1996 (38). Future CFC use in these countries thus will be significant if better technologies and substitutes are not widely and economically available (see discussion of refrigeration in ch. 8) or if limits on CFC use cannot be implemented (see box 2-C in ch. 2).

Figure 9-7-Projected CO_2 Emissions in Selected Developing Countries (including use of biomass)



CO_2 emissions in developing countries are projected to rise significantly by 2025, as shown here for four countries in Asia, four in Latin America, and one in Africa. The "High" scenario assumed no constraints on economic and energy growth. The "Low" scenario assumed that policies are enacted to improve energy efficiency and change the fuel mix.

SOURCE: J. Sathaye and A. Ketoff, *CO_2 Emissions from Major Developing Countries: Better Understanding the Role of Energy in the Long Term,* Interim Report, LBL-29507 (Berkeley, CA: Lawrence Livermore Laboratory, August 1990).

Methane

While there is great uncertainty regarding emissions levels, the main anthropogenic sources of methane are rice production under irrigated or flood conditions, livestock operations, fossil fuel production (including leaks from coal mines and natural gas pipelines and flaring), and landfills.[19] Rice cultivation and livestock operations account for an estimated 20 to 50 percent of global methane emissions. Developing countries are the major contributors of methane from rice production and, along with developed countries, major sources of methane from livestock (see ch. 8).

General Areas for Improvements

Important technical opportunities for stabilizing or reducing future emissions from developing countries include:

- increasing efficiency of energy use;
- moving toward natural gas and nonfossil fuels;
- developing and disseminating CFC substitutes; and
- slowing deforestation.

[19]Ch. 2 describes these sources in more detail; box 3-A in ch. 3 discusses landfills.

Increased Energy Efficiency

Developing countries tend to have inefficient energy production, transmission and distribution, and consumption systems (16, 43). For example, steam powerplants in many developing countries may use 20 to 45 percent more fuel per kWh of electricity than typical U.S. steam plants; many plants are operational only 50 to 60 percent of the time, compared with over 80 percent in developed countries, because of frequent power shortages and lack of proper maintenance (93). Electricity losses during transmission and distribution also are high (e.g., over 30 percent in the Dominican Republic and Bangladesh, and over 20 percent in Pakistan, India, and Egypt) (62, 93).

Many opportunities will exist over the next few decades to invest in improved, cost-effective technologies (93).[20] These technologies could include, for example, variable speed drives for industrial motors; electric arc furnaces for steel production; energy-efficient lighting, water pumping, heating, and refrigeration systems; and capacitors in electricity lines to reduce transmission and distribution losses (see chs. 3 to 6). Cogeneration might also increase effective electricity generation, primarily in the industrial sector (27). One study, for example, estimated that implementing energy-efficient technologies and practices in Brazil might reduce the total electricity demand projected for the year 2000 by almost 20 percent, at a cost far lower than the investments in new electrical generating capacity that would otherwise be needed (124),

However, technical and institutional obstacles to increased energy efficiency exist in developing countries. For example, many developing countries cannot use efficient motor-compressors in refrigerators because of problems with voltage fluctuations (104). Moreover, almost all developing countries grant monopolies to government-owned utilities for electricity generation and distribution, and many subsidize the price of energy supplied to consumers. As a result, utilities often operate inefficiently and end-users have little incentive to conserve.

Switching Fuels

Switching from coal to natural gas would reduce carbon emissions by 15 to 50 percent per unit of delivered energy, depending on the end product (steam or electricity) and the technology used (ch. 3). Switching to natural gas, however, might require retrofitting old facilities or building new ones (including the distribution infrastructure) and ensuring that methane leaks from production and distribution systems are minimized (96, 122). Natural gas also is not readily available everywhere; for example, China and India each contain less than 1 percent of total world natural gas reserves (1, 106).

Nuclear and renewable energy sources have fewer greenhouse gas emissions (and in some cases no emissions at all) per unit of delivered energy. Nuclear power currently plays a minimal role in most developing countries, however, and is unlikely to increase substantially in the near future (see ch. 3). Issues of concern include lead times to develop plants, safety and environmental risks, costs, and nuclear weapons proliferation. Some renewable energy supplies are modular, hence adaptable to local situations and to decentralized power systems, relatively easily maintained, and often cost-effective, particularly in remote areas (94, 1 12). Thousands of photovoltaic (PV) and wind systems exist in rural areas for water pumping, drip irrigation, electric power, and lighting. PV modules often are used to refrigerate vaccine supplies in rural areas. Small hydropower systems (e.g., less than 10 megawatts) have been used for milling grains, providing local electric power, and other applications. Biomass systems based on agricultural residues are used to produce electricity, process heat, and/or liquid fuels.

However, various factors still limit the role of renewable energy sources in developing countries. Of the many renewable energy projects funded over the past two decades by A.I.D. and other donors, few have resulted in subsequent commercialization. This is partly because donor agencies and host government institutions have rarely established appropriate mechanisms for financing (including provision of hard currency), business development, or consumer credit; in addition, the private sector in most developing countries plays a limited role in the

[20] A.I.D. (96) reviewed 1,500 energy projects in 11 developing countries (involving measures such as waste reduction, fuel switching, Process optimization, and cogeneration) and concluded that investments of $46 million were yielding actual annual savings of $26 million, with an average payback period of 1.8 years,

Photo credit: African Development Foundation

Thousands of photovoltaic and wind systems exist in rural areas for water pumping, drip irrigation, electric power, and lighting systems. Here, people in an Egyptian village are viewing a solar-powered television at their community center.

development and operation of electric power systems (93).[21]

CFC Reductions and Substitutes

Research into CFC substitutes is extremely active and some substitutes may be mass-produced within a few years. Proposed substitutes such as hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) have much lower ozone depletion potentials than do CFCs; some have 30 to 70 percent of the global warming potentials of the original CFCs (see ch. 2). However, new refrigeration systems with CFC-free (and more energy-efficient) insulation or with energy sources such as natural gas and solar energy show increasing promise (see ch. 8; also see "Switching Fuels' above on PV systems).

Slow or Decrease Deforestation

Slowing or reversing tropical deforestation will require much local, national, and international effort. Important steps include debt relief from creditor nations, enhancement of environmental ministries, promotion of sustainable commercial forestry practices and of reforestation, land reform within developing countries, and increased use of practices such as agroforestry, sustainable agriculture, and harvesting of nontimber forest products. These are discussed in detail in chapter 7.

Policy Directions for the United States

Since developing countries themselves finance 80 percent or more of their development activities (83), U.S. assistance to them might be best viewed as a catalyst for establishing cooperative programs to address development issues, including controlling greenhouse gas emissions (56, 83, 134). Congress can gear U.S. assistance and influence toward building local institutional capacities, and toward redirecting energy, natural resource, and population policies. Relevant sector-specific options (e.g., for transportation, forestry) are discussed in chs. 3 through 8.

Building Local Institutional Capacities

Building local institutional capacities can play a major role in redirecting natural resource, energy, and population policies in developing countries. Bilateral and multilateral lending and assistance

[21] A few countries, supported by A. I.D., have begun to open power production to the private sector, which should provide some incentive for more efficient production.

agencies (e.g., World Bank, UNDP and UNEP, and A. I.D.) already provide some assistance in this area. Most large A.I.D. projects, for example, contain some *training*, education, and institutional development component, and many of its agricultural projects have assisted in the development of national agricultural universities and research institutions (56). Congress could direct A.I.D. to increase its emphasis on such activities. This would likely require increased funding for education and training; environmental information gathering and analysis; conservation planning and policy analysis; and coordination of regional authorities and community-based organizations (56, 136).

Redirecting Natural Resources Policy

Most developing country economies are based on natural resources (45, 136), and many of these resources have been exploited rapidly during the past few decades. However, short-term revenue gains have come at the cost of reductions in the long-term and even immediate economic outlook for some countries. During the 1980s, for example, some countries that once were net exporters of tropical hardwood products found that their forests could no longer maintain a positive export flow (ch. 7). Resource depletion in one area also can have unintended consequences elsewhere—for example, upland deforestation has increased silting of reservoirs and flooding in many downstream areas (129).

Many national and multilateral development policies foster resource exploitation, including subsidies for cattle ranching and short-term, low-rent licenses for timber harvesting (ch. 7). The effectiveness of plans and programs such as the Tropical Forestry Action Plan can be evaluated in light of these considerations. Fortunately, direct bilateral and multilateral assistance is beginning to be restructured to promote more environmentally sensitive economic development. A. I.D., the World Bank, the Inter-American Development Bank, and UNDP, among others, are all developing or have recently adopted environmental assessment guidelines (ch. 7).

U. N.-endorsed procedures for estimating national economic performance (e.g., Gross Domestic Product, or GDP) do not account for values such as clean air and water, watershed protection, soil retention, and biodiversity (45, 70, 135).22 To address this, the U.S. Ambassador to the United Nations and the U.S. Executive Directors to the multilateral development banks (MDBs) could promote economic accounting procedures that include natural resource values and services. For example, this could be included as part of the World Bank's environmental assessment procedure. Congress also could encourage A.I.D. to expand its activities in promoting such accounting.[23]

Financing for resource conservation projects could also be increased. A new multilateral fund-a Global Environmental Facility or "Green Fund"--was established in November 1990 to provide funding for projects on greenhouse gases (e.g., non-CO_2 energy sources, energy efficiency, reforestation), biological diversity, marine pollution, and CFC substitutes (29a, 130, 133).[24] The World Bank will administer the facility, UNEP will ensure its policies are consistent with U.N. environmental goals, and UNDP will conduct prefeasibility studies. In addition to U.S. participation in the facility, Congress could direct U.S. organizations such as OPIC and A.I.D. to expand their activities in financing similar resource conservation projects.

Redirecting Energy Policies

A. I.D., various U.N. agencies, and the World Bank's Energy Sector Management Assistance Program (ESMAP) provided over $200 million in fiscal year 1988 for energy-related grants and assistance (table 9-4); in addition, over $6 billion was provided for energy-related loans. Including technical assistance from other countries and technical support derived from portions of the loans, total technical assistance for energy may be on the order of $500 million per year-less than 1 percent of total annual energy expenditures by developing countries (43).

Until recently, much of this assistance focused on conventional energy projects such as large hydro-

[22]These procedures measure the flow of economic activities rather than changes in resource stocks contributing to the activities; in essence, short-term economic gains represent interest being obtained from a shrinking capital/resource base, The U.N. Statistical Commission and Statistical Office currently is revising its guidelines on national accounting procedures, but provisions addressing the issue of natural resource depletion are not expected to be included (45),

[23]For example, A.I.D. is assisting Kenya and Niger in linking their current development assistance programs to such an accounting system (56).

[24]Similarly, the World Resources Institute suggested establishing a global International Environmental Facility, jointly financed by OECD bilateral development agencies and MDBs (136), Its purpose would be to promote coordination among UN agencies, developing country governments, and NGOS in identifying conservation needs and to help arrange financing from existing sources for projects.

Table 9-4-Funding for Major Energy Assistance to Developing Countries, 1988-89

Organization	Activity	$ Million	Year[a]
Loans:			
World Bank	Power sector loans	3,282	FY1989
	Oil and gas loans	581	FY1989
African Development Bank	Energy project loans	567	1988
Inter-American Development Bank	Energy sector loans	405	FY1988
Japan	Power and gas loans	1,100	FY1988
West Germany	Energy loans	410	1988
Grants and other assistance:			
U.S. Agency for International Development	Energy projects	130	FY1988
U.N. Department of Technical Cooperation for Development	Technical assistance	25-30	1988
U.N. Food and Agriculture Organization	Rural energy assistance	20-30	1988
UN. Industrial Development organization	Industrial energy assistance	5-1o	1988
World Bank Energy Sector Management Assistance Program	Preinvestment studies, training	14	1988

[a]FY = fiscal year.

SOURCE: Lawrence Berkeley Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, Sandia National Laboratory, Solar Energy Research Institute, Los Alamos National Laboratory, Pacific Northwest Laboratory, *Energy Technology for Developing Countries: Issues for the U.S. National Energy Strategy,* prepared for U.S. Department of Energy (Berkeley, CA: Lawrence Berkeley Laboratory, December 1989).

electric darns and coal plants; only a few World Bank and Inter-American Development Bank energy projects from 1980 through 1988 involved renewable energy other than large hydroelectric projects (126).[25] For fiscal year 1989, US/ECRE (1 12) estimated that World Bank lending for solar, geothermal, and wood-bassed energy projects amounted to less than 1 percent of its energy sector funding. Energy efficiency and renewable energy receive scant attention for many reasons, including:

- insufficient capital in developing countries to purchase technologies;
- lack of access in developing countries to relevant information on such systems;
- artificially low fossil fuel prices;
- reluctance by multilateral organizations to fund small projects, because of overhead and staffing demands; and
- lack of attention in assistance projects to disseminating commercial technologies and developing local infrastructures for their maintenance.

To address these problems, U.S. and multilateral policies could focus on several areas-improving energy institutions in developing countries; increasing energy efficiency; developing renewable energy sources (and facilitating their trade); and working with host governments to initiate reforms in pricing policies (e.g., subsidies for energy production) (24, 25, 43, 93, 96, 115, 116, 127, 128).[26]

Several U.S. agencies (e.g., EPA, A. I.D., CORECT, and DOE) already provide technical assistance and grants for energy efficiency and renewable energy technologies, often linked to financing from MDBs and private investments. Recent U.S. legislation (Public Law 101-167) directed A.I.D. to focus on least-cost energy planning, energy pricing policy reform, end-use energy efficiency, and renewable energy. Congress could direct A.I.D. to initiate activities in countries not currently served by the agency (e.g., China and Mexico) .27 The legislation also instructed the Executive Directors to the MDBs to promote end-use energy efficiency and renewable energy as criteria in decisions about new projects. Congress could ensure

[25]Of all multilateral and bilateral energy assistance from 1972 to 1980, an estimated 91 percent was for large, conventional electrical Power systems (including nuclear), 5 percent was for fossil-fuel exploration and recovery, 3 percent was for renewable energy sources, and 1 percent was for technical assistance (including energy planning) (25).

[26]Note, however, that many developed countries, including the United States, also subsidize various aspects of the production, distribution, and u* of fossil fuels.

[27]Public Law 101-167 directed A.I.D. to identify key middle- and low-income countries in which changes in energy and forestry policies @@ significantly reduce greenhouse gas emissions. In a report to A.I.D., ORNL (56) concluded that four developing countries stood out — China, Brazil, Indonesia, and India (China and India because of cord use and rice cultivation, Brazil and Indonesia because of deforestation and all four because of possible impacts from sea-level rise). Other candidates for attention were Poland, Egypt, Mexico, East Germany, Thailand, Colombia, the Philippine, Bangladesh, Nigeria, and Zaire.

that A.I.D. and the Department of Treasury have sufficient resources to comply with these provisions. A.I.D. also could review the effectiveness of the Multi-Agency Working Group for Power Sector Innovation (MAGPI), which was established in 1987 to coordinate activities among donors (including A.I.D. and the World Bank) in power sector lending, in achieving these objectives.

To overcome the reluctance of agencies and lending institutions to finance small projects, Congress could promote "bundling' '----combining several small projects (e.g., for renewable energy) into a large project that supplies a substantial amount of energy and involves financial scales more customarily handled by large development banks (e.g., $5 million or more). Indeed, Public Law 101-167 instructed the Treasury Department to work with borrowing countries to develop loans for bundled projects on end-use energy efficiency and renewable energy. The "Green Fund" (see above) might be used to finance bundled projects. Congress also could promote greater funding by smaller development organizations. For example, the Inter-American Foundation (IAF) and the African Development Foundation (ADF) work with the larger Inter-American and African Development Banks to fund (IAF) or implement (ADF) community-scale, grassroots development programs (102); to date, though, they have rarely been involved in energy projects.

population Policies

History of U.S. ***Population*** Policy—The United States has supported the right of couples worldwide to control the number and spacing of their children since the mid- 1960s. The Foreign Assistance Act, as amended in 1965, considered family planning an important contributor to economic development and improved health and nutrition (17, 44). The Act also established A. I.D., which has been the major source of U.S. population assistance funds.

In the 1970s, as developing countries became increasingly worried about their ability to accommodate rising numbers, support for family planning programs grew rapidly. A U. N.-sponsored conference in 1974, attended by 137 countries (including the United States), adopted a "World Population Plan of Action" that called for "socioeconomic development as well as health and family planning programs designed to reduce excess fertility" (63a). It asked that governments provide individuals and couples with the information and means to determine the number and spacing of their children. Today, about 84 percent of the people in developing countries live in countries with some type of governmental population policy (29).

Meanwhile, the United States grew increasingly conservative about family planning, primarily because of concern over abortion. At the 1984 world population conference in Mexico City, the United States reversed its earlier position by declaring that population growth was a ''neutral' factor and that economic development could compensate for any population level.

New restrictions on A.I.D. made organizations associated with abortion services in developing countries ineligible for funding. Thus, in the mid-1980s, two of the most important international population assistance programs lost U.S. funds: the International Planned Parenthood Federation (IPPF) and the United Nations Population Fund (UNFPA).

Current Issues for U.S. Population Policy— With respect to family planning assistance, Congress can now consider the appropriate level of funding, how funds should be distributed, and under what restrictions or sanctions. Arguments for and against attaching sanctions to funds, though, are beyond the scope of this report.

U.S. funding earmarked specifically for A. I.D. 's population account declined from $290 million in fiscal year 1985 to $218 million in fiscal year 1990 (97).[28] Total funding for population-related projects is slightly higher in each year, though, because of funds allocated under the Economic Support Fund and the Development Fund for Africa.[29] Among major donors, U.S. assistance is relatively high in terms of absolute amounts but relatively low in terms of its share of GDP (92).

[28] These are actual or estimated expenditures and vary slightly from official authorizations (e.g., $198 million authorized in fiscal year 1989, $202 million expended).

[29] For example, total funding in fiscal year 1989 was about $245 million, Congress authorized $198 million directly for A.I.D. 's population planning account, and population-related projects also received about $30 million from the Development Fund for Africa (3) and an estimated $18 million for projects in Pakistan and Egypt funded under the Economic Support Fund (97, 98).

There is disagreement as to whether these levels are adequate and appropriate. Some people argue that family planning assistance should be reduced or eliminated as a part of international aid (17). However, the UNFPA ('71) concluded that more assistance is needed if the world's population is to stabilize at or near the UN's ''medium' projection of 10 to 11 billion people.[30] In particular, more assistance is needed to meet the ''unmet need for contraception."[31] The UNFPA estimates that the cost for direct contraceptive services and a range of backup activities (e.g., education, women's programs, research, and evaluation) would be several billion dollars per year.

U.S. funding prior to 1986 was distributed primarily through bilateral aid, U.S.-based NGOs, IPPF, and UNFPA. These pathways include a complex network of donors and recipients, making it easier to tailor assistance to the needs and conditions of specific areas. A broad array of agencies and channels can also be helpful when political factors make some sources of aid more acceptable than others. Loss of UNFPA and IPPF as channels, however, has removed much of this flexibility and reduced overall U.S. influence in family planning assistance.

EASTERN EUROPE AND THE U.S.S.R.

The U.S.S.R. and the Eastern European countries account for about one-fifth of current global greenhouse gas emissions, mostly from combustion of fossil fuels to provide energy.[32] Their existing energy infrastructure is both massive and inefficient; thus, investments are needed both in new, more efficient facilities and in retrofitting existing facilities for better energy use.[33]

Efforts to promote energy conservation and efficiency and thereby reduce future growth in carbon emissions in these countries must overcome several systemic and institutional obstacles. Most resources, including energy, are priced at artificial values that do not reflect their true costs. Currencies convertible in Western markets, needed for purchasing modern, energy-efficient equipment, are lacking. Rigid quotas set by central economic planners for goods and services provide no incentives for efficient production. Finally, implementation of plans for alternative energy sources is hindered by a fragmentation of responsibilities among multiple government agencies. Thus, even when opportunities exist, there are strong disincentives to save energy and raw materials and to make efficient capital investments.

These obstacles have led to high industrial demand for energy, energy-inefficient production of goods and services, less electricity for nonindustrial consumers, and low standards of living. Energy-inefficient industrialization also has led to severe environmental problems in the region. Many rivers and groundwater aquifers in Eastern Europe and the Soviet Union are seriously polluted from industrial wastes and agricultural runoff (e.g., 9, 19, 77, 87). Forests in the Black Triangle region (an area shared by Poland, Czechoslovakia, and Germany) and other areas exhibit severe effects from anthropogenic air pollutants (e.g., 49).

The political revolutions sweeping through Eastern Europe and the U.S.S.R, augur many changes in economic systems, energy-use patterns, and environmental protection. Eastern Europe is returning to the economic traditions of Central and Western Europe that prevailed in the region before World War II. Hungary, for example, has been active in introducing market mechanisms and decentralizing its economy (39), and other countries are following suit. Some Eastern European countries may become observers to the European Community in a few years, and some may even become members. Even so, they are likely to remain tied to the U.S.S.R. for decades, through trade and political agreements.

The United States can help Eastern Europe and the U.S.S.R. cope with inefficient energy use and greenhouse gas emissions, and at the same time benefit from increased trade opportunities with these countries. Opportunities exist to remove export restrictions, facilitate joint ventures, and increase

[30] To achieve this goal, 56 percent of women in developing countries would have to use family planning by the end of the century, compared to 45 percent today,

[31] I.e., the percentage of fertile married and/or sexually active women who do not want more children or who wish to increase the interval between births and are neither pregnant nor protected from pregnancy.

[32] Eastern Europe includes Bulgaria, Czechoslovakia, East Germany (prior to unification with West Germany in October 1990), Hungary, Poland, and Romania.

[33] This differs from the situation in developing countries, which generally have less industrial infrastructure (see above).

technical assistance (e.g., see 20, 27a). U.S. influence may be greatest in Eastern European countries, where trade represents a greater proportion of GNP than it does in the U.S.S.R. (albeit most of their trade is with the U.S.S.R.). Trade and joint ventures with Eastern Europe (particularly Poland, Hungary, and Czechoslovakia at this time) might, however. be an effective avenue for influencing energy use in the U.S.S.R. The success of U.S. policies ultimately will depend on the degree to which the U.S.S.R. and Eastern European countries can reform their own economies.

Trends in Eastern Europe

Energy Use

Eastern European countries accounted for 6 percent of world energy consumption in 1988 (see figure 9-2). Coal was the predominant energy source, accounting for 69 percent of primary energy consumption in East Germany, 84 percent in Poland, and 58 percent in the region as a whole in 1988 (see table 3-1 inch. 3). Oil was somewhat more important than coal in Bulgaria, Hungary, and Romania, while natural gas was the most important energy source in Romania.

The industrial sector accounted for 60 percent of primary energy demand in the six Eastern European countries combined (32, 41). Residential and commercial buildings accounted for 27 percent, while transportation accounted for only 13 percent, These sectoral percentages differ sharply from those of the United States and other OECD countries.

Per-capita energy consumption in at least some parts of the region is roughly equivalent to that of some OECD countries (see figure 9-3), although per-capita income is much lower. For example, Hungary's per-capita energy use is about the same as Japan's, but its per-capita income is one-third to one-fifth that of Japan (39). Poland and Austria compare in a similar way (81).

According to one projection (41), without special incentives for energy efficiency but with structural changes (i. e., the composition of goods and services making up the economy) that are likely to occur anyway, primary energy demand in Eastern Europe will increase by about 40 percent between 1985 and 2025. Over one-half of the increase would occur in the buildings sector. In contrast, if incentives for energy efficiency are enacted (e.g., standards requiring greater automobile fuel efficiency; price reforms allowing energy prices to escalate to world market levels), energy demand could remain at about today's levels. Demand would decline in the industrial sector and increase in the buildings and transportation sectors.

Carbon Emissions

Projections of future carbon emissions have been made for Hungary (39) and Poland (8 1). For Hungary, without structural changes or energy efficiency measures (i.e., a ''Base' case scenario), projected emissions in 2030 are about 30 percent greater than current levels. A combination of structural changes and energy efficiency measures result in projected emissions in 2030 that are 20 percent lower than current levels. For Poland, a combination of structural changes and energy efficiency measures lead to a projected 20 percent reduction from current levels by the year 2030.

Trends in the U.S.S.R.

Energy Use

In 1988, the U.S.S.R. accounted for 18 percent of global primary energy consumption, second only to U.S. consumption (see figure 9-2 above). Per-capita energy consumption in the U.S.S.R. is comparable to that of some OECD countries (see figure 9-3), although per-capita income is much lower. In the 1960s and 1970s, the predominant fuel used in the U.S.S.R. shifted from coal to petroleum; since then natural gas has played an increasingly significant role. As of 1988, natural gas supplied the U.S.S.R. with 37 percent of its primary energy needs, petroleum 32 percent, coal 24 percent, and nuclear and hydroelectric power together 8 percent (see table 3-l). In the early 1980s, Soviet planners expected nuclear power to meet at least 30 percent of the U. S. S.R.'s electricity demand by the year 2000. However, public opposition to nuclear power-e. g., reactions to Chernobyl, massive demonstrations at the Ignalina facility in Lithuania, opposition to construction of the Crimean plant in the Ukraine---problems at the Soviet reactor construction facility, and lack of capital have stalled the program.

The industrial sector accounts for over 50 percent of total energy consumption (47). The most energy-consuming branches are ferrous metallurgy; fuels and power; machine building; and chemicals, petrochemicals, and petroleum refining (72). The build-

ings sector accounts for approximately 20 percent of energy use, transportation about 12 percent, and the energy sector about 16 percent (47, 73).

Between 1975 and 1988, Soviet investments in energy production increased almost fourfold, and in 1988 they represented 25 percent of all investments in the economy (42). Even greater investments in energy production may be needed if economic growth is to occur at a rate of 2 percent or more per year (47).

In light of such predications, Soviet authorities have directed all sectors to make more efficient use of energy. Goals for this were articulated in the 5-year plans for 1981-85 and for 1986-90. Soviet planners hoped to use conservation and efficiency measures to reduce projected energy demand by about one-half (47). This was to be achieved by restructuring the industrial sector (partly by reducing military expenditures) and adopting modern, more efficient technologies.

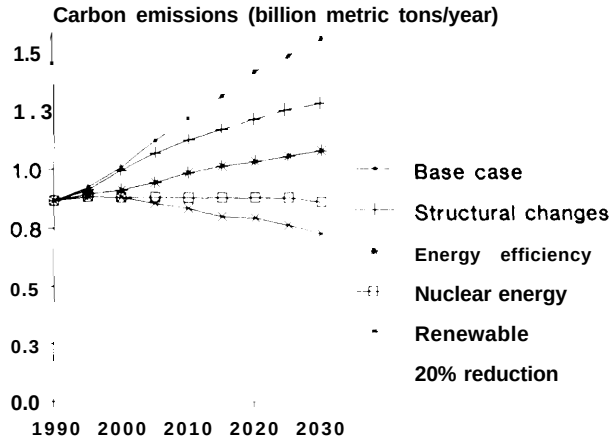
The extent to which these goals can be achieved is as yet unknown, particularly given the changes now taking place in the Soviet economic system. Energy savings are possible in the industrial, transportation, and buildings sectors (see chs. 4 to 6), but increased consumption of" products and services (e.g., automobiles, space heating, electric appliances, per-capita living space) and related energy use is likely. The net effect on total energy use thus is uncertain.

Carbon Emissions

The U.S.S.R. contributed an estimated 14 percent of global greenhouse gas emissions during the 1980s (1 10), primarily from fossil fuel combustion. If current trends in energy use continue (i.e., ‘‘Base’ case), one model (47) projects that emissions will increase 45 to 100 percent by 2020, depending on rates of economic growth (see figure 9-8; the Base case assumes economic growth at 3 to 3.5 percent yearly through 2005 and 2.5 to 3 percent thereafter).

In an “Energy-Efficiency” scenario, projected emissions would rise about “15 percent by 2020. This assumes that energy intensity declines by an annual rate of about 2 percent between 1990 and 2020, as a result of measures such as regulated electric drive motors, better lighting, gas turbines and combined-cycle plants, and multifuel boilers as efficient as those in advanced capitalist countries. Projected

Figure 9-8-Projected Carbon Emissions in the U.S.S.R.



Soviet researchers modeled future carbon emissions from the U.S.S.R. In a “Base” case scenario, for example, current trends in energy use continue and emissions increase by over 50 percent by 2020. In an “Energy Efficiency” scenario, projected emissions would rise about 15 percent by 2020. Projected emissions decline from estimated 1990 levels only if concerted efforts are also made to expand the role of nuclear power and renewable energy.

SOURCE: A.A. Makarov and I.A. Bashmakov, *The* **Soviet** *Union: A Strategy of Energy Development with Minimum Emission of Greenhouse Gases,* **prepared for U.S. Environmental Protection Agency (Richland, WA: Battelle Pacific Northwest Laboratories, April 1990).**

emissions actually decline from current (estimated) levels only if concerted efforts are also made to expand the role of nuclear power and renewable energy (47).

Options for Possible U.S. Influence

The United States might influence energy use and carbon emissions in Eastern Europe and the U.S.S.R. through technical assistance and expanded trade in energy-efficient technologies. Several U.S. Government and private sector groups already promote trade in energy-efficient and renewable energy technologies—including CORECT, OPIC, Eximbank, U.S. Trade and Development program (TDP), and the U.S. Export Council for Renewable Energy (US/ECRE) (see box 9-C above).

However, trade is likely to be limited until systemic changes occur in Eastern Europe and the U.S.S.R. (9, 41). Some financial constraints to trade result from the difficult economic transitions occurring in these countries. Eastern Europe faces additional trade constraints because of Soviet intentions to make its oil supplies available at prevailing world

prices (paid in convertible currencies) and because of losses of scheduled oil shipments from Iraq (23).[34]

If these obstacles can be overcome, it might be easier to use trade to influence policies in Eastern Europe than in the U.S.S.R. Trade is a greater percentage of GNP in Eastern Europe than in the U.S.S.R. (see table 9-5), although much Eastern European trade is with the U.S.S.R. Many of these countries also have some tradition of Western industrial practices. This and the current economic and political changes occurring in Eastern Europe could create a more positive climate for trade with Western businesses.

Facilitating the use of energy-efficient technology in Eastern Europe, through trade and joint ventures, might also benefit the U. S. S. R.; almost 60 percent of all Soviet imports comes from Eastern Europe and technology comprises the bulk of the imports .35 U.S. companies could also attempt to set up energy-related joint ventures in the U.S.S.R.

Table 9-5--Total Foreign Trade as a Percentage of GNP, 1988, for Selected Countries

Country	Percent of GNP[a]
Centrally planned countries:	
Bulgaria	61 %.
China	32%
Czechoslovakia	33%
East Germany	3 0 %
Hungary	41%
Poland	20%
U.S.S.R.	9%
OECD countries:	
Canada	45%
France	48%
Italy	35%
Japan	26%
United Kingdom	44%
United States	16%
West Germany	6 6 %

[a]For centrally planned countries, data converted at U.S. purchasing power equivalents.
[b]Based on 1987 trade data.

SOURCE: Based on GNP and trade data in Central Intelligence Agency, Directorate of Intelligence, *Handbook of Economic* Statistics, *1989*, CPAS 89-10002 (Washington, DC: September 1989).

Constraints in Centrally Planned Systems

As noted earlier, several systemic and institutional constraints pose barriers to increasing energy efficiency and reducing energy use in Eastern Europe and the U.S.S.R. Energy subsidies, for example, substantially lower the cost of power to consumers, particularly industries. In Poland, subsidies accounted for 49 and 83 percent of the delivered prices of coal and natural gas, respectively, in 1987 (81); in Hungary, average consumer prices for energy were only about 30 percent of those in Western Europe (74). Rigid quotas for production of goods and services and use of energy destroy any incentive to save raw materials or energy. Enterprises must consume virtually all of the supplies allocated to them by central planners, even when not all are needed, in order to receive the same or a larger amount the next year.[36] Funding for maintenance (e.g., of pipelines; ref. 62a) often is inadequate. The production quotas also lead to greater investments in heavy industries (e.g., steel, aluminum, chemicals) at the expense of services and consumer goods. Trade with Western nations also is constrained by lack of convertible currencies.

Fragmented institutional responsibilities also limit governmental abilities to develop and implement new energy and environmental policies (40). In the U. S. S. R., six major ministries share the task of supplying energy.[37] Different ministries also direct the development and the use of specific energy sources.[38] In 1988, the high-level State Committee for Environmental Protection, or Goskompriroda,

[34]Petroleum is the U.S.S.R.'s most important means of earning hard currency on western markets; in late 1987, Soviet oil and natural gas exports supplied approximately 15 percent of Western Europe's use of each fuel (57). The elimination of subsidized oil imports from the U.S.S.R. might result in Eastern European countries consuming even more "brown" coal, unless and until investments are made to develop alternative energy sources and promote energy efficiency.

[35]Trade accounts for only 9 percent of the U.S.S.R.'s GNP. Imports from OECD countries represent O@' one-tenth of this, and technology is only a small Portion of these imports (6, 114). Energy in all forms comprises over one-half of the value of all Soviet exports.

[36]Fuel deliveries, for example, are planned on a centralized basis in accordance with guidelines on enterprises' assigned priorities in the national economy and their technical specifications, but the potential for energy conservation generally is not considered by planners.

[37]The Ministries of Oil Industry, Gas Industry, Coal Industry, Electrification, Geology, and Atomic Energy. While the Council of Ministers coordinates their activities, its own membership is comprised of some 60 Soviet industrial ministries and committees. Research institutes, universities, and academies of sciences in each republic also conduct R&D.

38 For example, identification of "proven stocks" of geothermal waters falls under the Ministry of Geology, but their use for hinting falls under the Ministry of Gas Industry. Likewise, development of solar power is entrusted to the Ministry of the Electrical Equipment Industry, but its *use is* under the Ministry of Power and Electrification.

Photo credit: W. Westermeyer

Gum's department store in Moscow. All over the U.S.S.R. and Eastern Europe, overcoming the obstacles typical of centrally planned economies-and ensuing economic and environmental problems-will be a formidable challenge.

was created to clean up harmful pollutants. Its powers were formerly distributed over numerous bodies; however, legislation formally defining its wide-ranging jurisdiction has not yet been enacted, and opposition has emerged from many of the ministries impinged on by Goskompriroda (40, 117). Movements by various Soviet republics to gain more autonomy will make jurisdictional questions even more complex.

Added to these systemic and institutional constraints to increasing energy efficiency and reducing energy use is the absence of global warming as a topic in domestic policy discussions. Although the U.S.S.R. has been significantly involved in the International Panel on Climate Change (IPCC) and chaired IPCC Working Group II on impacts (see box 9-B above), global warmingis unlikely to receive high priority in the current domestic policy agenda unless it overlaps and buttresses major domestic economic and environmental issues such as improving energy efficiency and local pollution control.[39] This is partly because devastating air and water pollution problems are much more pressing in the U.S.S.R. and Eastern Europe (77), particularly in the context of severe economic problems and changing political atmospheres.

U.S. and OECD Policy Barriers

The United States has erected many restrictions on technology exports to the U.S.S.R. and Eastern Europe for national security and other foreign policy reasons. U.S. restrictions were first codified in the Export Control Act of 1949 and now are codified primarily in the Export Administration Act (EAA) of 1979, which authorizes the President to prohibit or curtail the export of goods and technologies.[40] The Byrd Amendment to the Trade Act of 1974 (Amendment 435) also limits credit to the U.S.S.R. to $300 million in the aggregate without prior congressional approval (100). Moreover, for much of the 1970s and 1980s, U.S. trade with the U.S.S.R. took place within the context of ''linkage' (i.e., using trade to moderate Soviet behavior). The Jackson-Vanik Amendments to the EAA linked the extension of most-favored-nation trade status and eligibility for official export credits to increased emigration of Soviet Jews; the export of computers to the U.S.S.R. was linked to the treatment of dissidents.

These restrictions are made partly within the context of U.S. participation in the Coordinating Committee on Multilateral Export Controls (COCOM), a nontreaty agreement established in 1949 to harmonize export control policies among 17 OECD nations (1 14). By the end of 1989, COCOM had assembled a list of over 100,000 restricted items in 120 categories and developed guidelines for export licensing, with restrictions generally more stringent for the U.S.S.R. than for Eastern Europe.

Some bilateral and multilateral export restrictions have been reduced as Cold War tensions have eased (84). In June 1990, the United States agreed to remove 30 proscribed categories from the COCOM list, including advanced machine tools and computers, which are needed for modern automobile plants and other facilities (1 14) and for some pollution control equipment. The Administration also eased other restrictions imposed on the U.S.S.R. in response to the 1980 occupation of Afghanistan. Another indicator of liberalization in U.S. policies is

[39] A few Soviet scientists argue that future climate changes may benefit the U.S.S.R. (53), although this view does not appear to be generally held by Soviet officials.

[40] Public Law 96.72, as amended by the 1988 Omnibus Trade and Competitiveness Act (Public Law 100418); the latter allowed unlicensed exports of nonstrategic technical data to the U.S.S.R. and Eastern Europe (1 14).

the Support for East European Democracy (SEED) Act of 1989 (Public Law 101-179). SEED authorized almost $1 billion for Hungary and Poland for fiscal years 1990 to 1992, made the two countries eligible for OPIC and Eximbank loans and for TDP assistance, and specified that environmental assistance be provided to them.[41]

Policy Options

Remove U.S. Barriers on Exports-Congress could continue to liberalize export controls. One possible venue is during reauthorization of the Export Administration Act (EAA), which expired in 1990.[42] In this context, Congress could: specify removal from the COCOM control list of all items for which no specific justification for restriction exists; allow technologies that can be exported to China to also be exported to Eastern Europe and the U. S. S. R.; allow -reexports among these countries; and direct U.S. agencies (e. g., Commerce, Defense, Energy, U.S. Trade Representative) to review their procedures and policies to ensure that no unnecessary barriers exist on exports of energy-efficient or renewable energy technologies (1 14).

To help foster trade, the United States can extend most-favored-nation (MFN) status to more Eastern European countries, making trade with those countries nondiscriminatory (primarily in the sense of tariff concessions) (68).[43] The United States currently has granted unconditional MFN status to Poland (and Yugoslavia) and conditional status to Hungary (68,114).[44] After the President issued a Jackson-Vanik waiver, Czechoslovakia and the United States signed a bilateral trade agreement in April 1990. The President also signed a trade agreement with the U.S.S.R. in June 1990 that, if approved by Congress, would confer unconditional MFN treatment to the U.S.S.R. and provide procedures for improving trade relations (14).[45]

Encourage Joint Ventures and Direct U.S. Agencies To Enhance Trade—U.S. companies could try to export more energy-related technologies directly to the U.S.S.R. and Eastern Europe and to establish more joint ventures with these countries. Joint ventures between U.S. companies and Eastern Europe and the U.S.S.R. increased in all fields in the late 1980s. While fewer than 10 were started in 1985, 60 started in 1989, and over 140 may start in 1990 (20).[46] However, known ventures in the energy sector declined from 14 in 1985, to between 5 and 9 per year from 1987 to 1989.[47] Potential U. S.-U.S.S.R. joint ventures for construction projects in developing countries are also being explored (5).

Lack of commercial financing by U.S. banks and inability to change profits into Western currencies still pose major obstacles to increasing trade in the U.S.S.R, and Eastern Europe for some companies (20).[48] The latter constraint apparently does not apply to joint ventures that produce goods for export from the U.S.S.R. These earn hard currency that, under current Soviet law, the enterprises can keep.

U.S. business could be encouraged in the U.S.S.R. and Eastern Europe by increasing OPIC, Eximbank, and TDP resources and extending their activities to more countries. OPIC currently is authorized to

41 SEED authorized EPA to spend $10 million on educational, research, and technical and financial assistance, for example in establishing an air quality monitoring network in Krakow and a regional environmental center (managed by an international board of trustees) in Budapest. It authorized the Department of Energy to spend $30 million for retrofitting a coal-fired commercial powerplant in Krakow with clean coal technology; assessing Poland's capability to manufacture equipment enabling industries to use fossil fuels cleanly; and improving end-use energy efficiency in Poland and Hungary.

42 The Export Facilitation Act of 1990, which would have reauthorized the EAA and liberalize some U.S. trade policies, was vetoed by the President in November 1990.

43 MFN status also means that parties t. bilateral trade agreements or to the General Agreement on Tariffs and Trade (GATT) have reciprocal obligations.

44 Hungary has conditional status because it is subject to an annual approval of a Jackson-Vanik waiver. Romania received conditional MFN status m 1975 but declined to have it renewed in 1988.

45 In December 1990, th, President waived the Jackson-Vanik provision and approved credit guarantees for Soviet purchases of up to $1 billion in American commodities, making the U.S.S.R, eligible for loans to buy U.S. grain and for some Eximbank credits and guarantees. However, the June trade agreement will not be submitted to Congress for approval until Soviet emigration laws are revised, so MFN status cannot yet be conferred on the U.S.S.R. In addition, the continuing upheaval in the U.S.S.R. may make it difficult for the Soviets to take full advantage of this for some time.

46 As of January 1989, 191 joint stock companies were registered in the U.S ,S .R., of which 164 were Soviet-Western or Soviet-Japanese companies. Of these, 10 were in the energy sector,

47 @ Dec. 26, 1990, the United States announced it will double the number of joint trade-promotion programs in 1991; top priority will be given to helping the Soviets increase their oil and gas exploration and production capabilities-a means of obtaining needed hard currency.

48 Estimated debts range as high as $50 billion for the U, S.S.R. and $40 billion for Poland; billions of dollars are spent in servicing loan obligations. Some European countries, such as Finland, have proposed forgiving portions of these debts in exchange for political and economic concessions.

provide risk coverage to transactions in Hungary and Poland.[49] Eximbank is authorized to provide insurance, loans, and guarantees to transactions in Hungary and Poland (and Yugoslavia) because these nations have MFN status, and in Czechoslovakia because that nation recently received a Jackson-Vanik waiver (46). As part of these efforts, the United States could target specific industries and sectors that exhibit Potential for energy savings (e.g., ferrous metallurgy, refining techniques, appliances, gas turbines, and building and automobile construction).

Congress could direct US. agencies and organizations such as CORECT to assess opportunities for enhancing trade with the U.S.S.R. and Eastern Europe in renewable and energy-efficient technologies, as discussed above in the context of developing nations (see ''Redirecting Energy Policies"). Some agencies might be able to negotiate trade agreements; precedent exists, for example, in the form of a bilateral maritime shipping agreement signed by the United States and the U.S.S.R. (4). Congress could also direct Eximbank to allocate more funds for insuring exports of renewable energy technologies, beyond what is mandated in Public Law 101-167 (see ''Technology Transfer and Trade With Other Countries" above).

The United States also could work through the IMF and World Bank to develop policy reforms and loans that promote energy-efficient or renewable energy technologies. Poland and Hungary already are eligible for IMF structural readjustment loans, and Czechoslovakia is being reviewed for such status. Congress could consider authorizing funds for the proposed new European Bank for Reconstruction and Development, which is scheduled to open in late 1990 (46, 52). It may also wish to consider a Czechoslovak proposal (known as the Dienstbier Plan, after the Czechoslovak Foreign Minister) that Western countries establish a special fund in the bank to finance exports from Czechoslovakia, Hungary, and Poland to the U.S.S.R, (85).

Support Institutes or Centers for Energy Efficiency—The United States could support, either unilaterally or with other OECD countries, the creation of institutes or academic and research centers in Eastern Europe or the U.S.S.R. that promote energy efficiency and conservation. Initiatives to this effect are discussed in ''Technology Transfer and Trade With Other Countries" (also see footnote 41).

OECD COUNTRIES

The Organization for Economic Cooperation and Development (OECD) consists of the most industrialized countries in the world—18 Western European nations, plus Australia, Canada, Japan, New Zealand, Turkey, and the United States.[50] These countries, though they are home to less than one-fourth of the world's population, account for one-half of all global primary energy consumption (see figure 9-2) and, by EPA (1 10) estimates, for over 40 percent of current greenhouse gas emissions. The vast majority of emissions is from energy use, specifically the combustion of fossil fuels such as coal and oil. The United States alone accounts for almost one-half of OECD emissions.

Trends and Projections in Energy Use and Carbon Emissions

Energy Use

Total fuel use by OECD countries between 1973 and 1987 grew relatively slowly, and even declined between 1980 and 1982; it increased between 1983 and 1987 by an average of 2.3 percent yearly (34). Growth in electricity use, particularly in the residential and commercial buildings sector (especially for appliances, also for space heating) has been strong, accounting for over three-fourths of the growth in energy consumption since 1973; nearly one-half of all primary energy consumption in OECD countries is for electricity generation. Energy consumption in the OECD industrial sector, which accounted for 37 percent of total OECD energy consumption in 1985, increased by 1.6 percent annually between 1983 and 1986.

Of total primary energy consumption in OECD nations, oil accounted for 44 percent; natural gas, 19 percent; coal, 21 percent; hydroelectric, 7 percent; and nuclear, 9 percent (see table 3-l). Over 60

[49] OPIC recently approved its first project in Eastern Europe (insurance for a General Electric investment in a Hungarian electric lighting products company) and is establishing an Environmental Investment Fund (see ch. 7) and a European Growth Fund applicable to these countries (60, 61).

[50] The western European countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom, Established in 1%1, the OECD promotes increased economic growth and employment in its member countries and promotes the expansion of world trade in general.

percent of the electricity is generated from coal and nuclear power, at least in the 21 OECD countries belonging to the International Energy Agency (IEA) (34).[51]

Total OECD primary energy requirements are projected to grow by about 1,3 percent annually through 2005, because of continued growth in the industrial sector and expected increases in the use of oil for transportation (18, 34). Even so, the OECD's overall share of total world energy demand is expected to decrease from 50 to 40 percent because of greater growth in developing countries, Eastern Europe, and the U.S.S.R. How these projections are affected by the Persian Gulf situation is unknown; any lasting rise in oil prices might stimulate more efficient use of oil, but it also could make coal more attractive.

Many observers claim that the United States uses more energy per unit of GDP (i.e., has a higher ''energy intensity' than other industrialized countries. Indeed, while our technologies are comparable to those of other OECD countries, our energy usage patterns often differ (107).[52] For example, new car fuel economy in the United States is similar to that in Germany, Japan, and the United Kingdom (78, 107). However, the United States has more cars, higher vehicle miles traveled per capita, and an increasing penchant for less efficient light-duty trucks. Thus, transportation energy consumption per person is twice that of other G-7 countries (107).[53] U.S. residential heating efficiency, on a per square foot basis, is about the same as that of many other industrialized countries, but U.S. homes tend to be bigger so energy use per *house is* greater. Energy intensity in the U.S. industrial sector is relatively high, at least partly because the United States has large, energy-intensive industries (petrochemical, chemical, and primary metals) that were developed to use abundant energy supplies.

Carbon Emissions

EPA (1 10) estimates that OECD countries contributed slightly over 40 percent of all greenhouse gas emissions in 1985. Emissions between 1973 and 1987 (see figure 9-1; also see ref. 8) were relatively stable, even while economies and overall energy consumption generally grew, because of structural changes in economies and energy efficiency measures stimulated by the 1973 oil embargo (35). Major structural changes included a continuing shift from energy-intensive industries (e.g., steel and cement manufacturing) to service-oriented industries and continuing modernization of energy-intensive industries (35, 78). Energy efficiency measures have been particularly important in end-use applications such as passenger vehicles and electric appliances (35).

Between 1987 and 1989, however, carbon emissions increased from some OECD countries, including the United States, primarily because of falling energy prices, above-average growth in industrial production, and a weakening of energy efficiency programs (10, 18, 35, 103),

The European Community (12) modeled three scenarios for projected carbon emissions between 1987 and 2010 from its 12 member States (see figure 9-9).[54] The "Business As Usual' scenario (Scenario 1) projects emissions increasing 24 percent by 2010, with power generation and transportation accounting for about 60 percent of total emissions. The ''How Things Could Go Wrong' scenario (Scenario 2) projects emissions in 2010 about 40 percent above 1987 levels, In contrast, the ' 'High Economic Growth in Clean Environment" scenario (Scenario 3) projects emissions in 2010 about 17 percent below 1987 levels.

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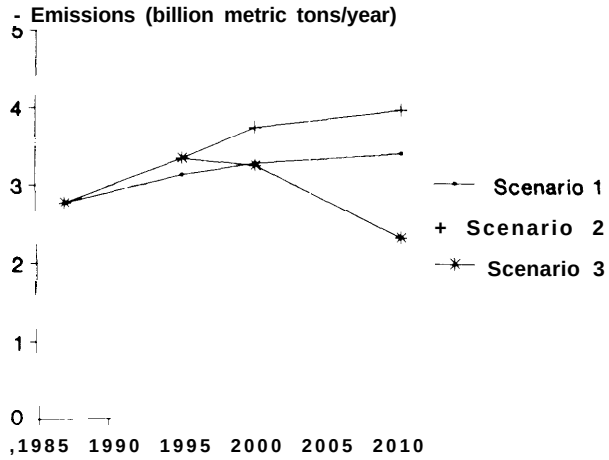
[51] The IEA is an autonomous body established in 1974 within the framework of the OECD with the purpose of implementing an international energy program. It includes all OECD countries except for Finland, France, and Iceland.

[52] Energy intensity (i.e., amount of energy consumed per unit of production) is a common measure of changes in energy efficiency. However, this ratio does not give a good picture of the relative efficiency of energy use in any one country or a correct comparative picture between countries (see 79, 80). Moreover, it can provide a false indicator of changes in relative energy efficiency in a country if the changes reflect the movement of energy-intensive industries overseas to developing countries, but the former host country still receives the benefits of the production (45, 104).

[53] I.e., Canada, France, Germany, Italy, Japan, and the United Kingdom.

[54] The ''Business as Usual'' scenario assumes economic growth of 2.7 percent per year and market-driven changes in energy use and conservation. The ' 'How Things Could Go Wrong' scenario assumes economic growth of 3.5 percent yearly until 2000 and 2.5 percent thereafter in addition, energy use in traditional heavy industries declines more slowly than expected, and transport congestion increases. The "High Economic Growth in Clean Environment scenario assumes economic growth of 3.5 percent yearly until 2000 and 3 percent thereafter however, strict government policies on energy conservation (e.g., changes in the fuel mix for power generation, including a doubling of nuclear power between 1987 and 2010) and environmental protection are rapidly implemented.

Figure 9-9-Projected Carbon Emissions in the European Community



The Commission of the European Communities modeled future carbon emissions from its member nations under three scenarios: "Business As Usual" (Scenario 1), "How Things Could Go Wrong" (Scenario 2), and "High Economic Growth in Clean Environment" (Scenario 3) (see text for assumptions). In Scenario 3, rapid implementation of strict policies on energy conservation and changes in the fuel mix (including a doubling of nuclear power between 1987 and 2010) result in projected emissions in 2010 that are about 17 percent below '1987 levels.

SOURCE: Commission of the Europea n Communities, "Energy in Europe, Major Themes in Energy, 'r Special Issue (Brussels: September 1969).

Policies Regarding Energy and Greenhouse Gases

Energy Use

OECD countries have enacted many policies over the last two decades regarding energy supply and efficiency (see table 9-6) (U.S. policies are discussed in chs. 1 and 3 through 6). On the supply side, many policies have been oriented towards the development of indigenous energy sources-particularly oil, natural gas, and coal, as well as hydroelectric power to a lesser extent—and nuclear power.

Demand-side policies have focused on end-use efficiency in the commercial and residential sectors (e.g., appliance efficiency standards, conservation programs developed by utilities for consumers, and energy labeling for homes). Most countries also have an active renewable energy development and demonstration program; several countries, including Denmark, West Germany, and the Netherlands, have had subsidy programs for wind energy systems, with subsidies tied directly to electricity production (54). Overall government funding for the development of wind turbine technology is estimated to be around $80 million annually in Europe.

However, the trend has been for less government involvement in energy policies (e.g., reduced subsidy programs, more deregulation, less emphasis on energy efficiency and renewable energy) (10, 35). Government energy research, development, and demonstration (RD&D) budgets have declined in the 21 IEA countries, from a total of $12.5 billion in 1980 to $6.9 billion in 1988 (35).[55] In 1988, only 7 percent of this was devoted to energy efficiency and only 8 percent was for renewable energy; 56 percent was for nuclear power.

How this picture might change when the European Community becomes a more integrated economic entity in 1992 is unclear. In 1986, though, the Community adopted policy objectives on which to base national energy policies (10, 11). Energy objectives for 1995 include reducing dependence on imports of oil by diversifying the fuel supply and improving the energy efficiency of end use by at least 20 percent. However, attaining the 20 percent goal is considered unlikely without stronger actions (10), and any increases in the use of coal relative to natural gas and oil would lead to greater greenhouse gas emissions.

Greenhouse Gas Policies

Some OECD countries have announced plans to unilaterally reduce their greenhouse gas emissions (see table 9-7), and in October 1990 the European Community pledged to stabilize CO_2 emissions from the community as a whole (although not necessarily from all member countries) in the year 2000 at 1990 levels (2a). It remains to be seen whether these countries can provide the regulatory and market incentives needed to achieve significant emission reductions. Nonetheless, their declarations indicate a willingness to accept responsibility to address global climate change.

[55] All figures in 1988 U.S. dollars. Energy RD&D expenditures in 1988 were less than 1 percent of each country's GDP, ranging from 0.14 to 0.98 percent; excluding nuclear power, the range was 0.08 to 0.58 percent. The United States and Japan accounted for 61 percent of total RD&D. See ch. 3 for information on U.S. RD&D budgets during this period.

Table 9-6—Policies Enacted for Energy Efficiency by OECD Countries, 1970s and 1980s

	IT	FR	UK	FRG	BEL	NE	GR	DEN	SP	POR	LUX	IRE
Information						x	x	—	x	x	II	x
Energy audits						x	x	x	x	x		x
Grants												x
Advice to local authorities											—	II
Educational material	—	x	x	—	—	—	x	—	x	—	—	x
Demonstration programs	x	x	x	x	x	x	x	—	x	x	x	x
Support for energy management	x	x	x			—	x	—	x	x	—	x
Ministerial actions	—	—	x	—	—	—	—	—	—	—	—	—
Energy labeling	x	—	—	x	x	—	x	x	—	—	—	—
Voluntary agreements	—	—	—	x	—	—	—	—	x	—	—	—
Fiscal measures								x	—	x	x	—
Building standards												

ABBREVIATIONS: IT=Italy, FR=France, UK=United Kingdom, FRG=West Germany, BEL=Belgium, NE=The Netherlands; GR=Greece, DEN=Denmark, SP=Spain, POR=Portugal, LUX=Luxembourg, IRE=Ireland.

SOURCE: Commission of the European Communities, "The Main Findings of the Commission's Review of Member States' Energy Policies," COM(88) 74 final vol. II (Brussels: May 3, 1988).

Table 9-7-Official Greenhouse Gas Emission Stabilization and Reduction Policies of OECD Countries

Jurisdiction	Base level year	Stabilization year	Percent reduction target	Target year
Australia	1988	2000	20% of all gases	2005
Austria	1987	Not declared	20% of CO*	2005
Canada[b]	1988	2005	Not declared	Not declared
Denmark	1988	2005	200/0 of $C0_2$	2000
France	1989/90	2000	Not declared	Not declared
Germany[a]	1987	—	25% of CO_2	2005
Italy	1990	2000	20% of $C0_2$	2005
Japan	1990	2000	Not declared	Not declared
Netherlands	1989/90	1995	5% of $C0_2$	2000
New Zealand	1990	Not declared	20% of $C0_2$	2005
Norway	1989	2000	Not declared	Not declared
Sweden[b]	1988	Not declared	Not declared	Not declared
United Kingdom	1990	2005	Not declared	Not declared

[a]Excluding eastern Germany. The German Bundestag's Enquete Commission (ref. 23a) has proposed a new target of 30 percent CO_2 reduction by 2005 for the entire country.
[b]Tentative.

SOURCE: OTA Survey of Embassies; Organization for Economic Cooperation and Development and International Energy Agency, "Summary of Actions in Member Countries To Deal With the Problem of Climate Change (Note by the Secretariat)," IEA/SLT(90)51(1 st Revision), draft (Paris: Standing Group on Long-Term Cooperation, Committee for Energy Research and Development, Oct. 24, 1990).

Several European nations, Australia, Japan, and New Zealand have taken the lead in declaring *official* greenhouse gas emission reduction schedules (see table 9-7). Australia has the most ambitious goal-a 20 percent reduction by 2005 in emissions of all greenhouse gases. Austria, Denmark, Germany, Italy, and New Zealand have CO_2 reduction goals ranging from 20 to 2.5 percent by 2005, while the Netherlands has a CO_2 reduction goal of 5 percent by 2000.[56] Japan, Norway, and the United Kingdom have thus far committed to a goal of stabilizing CO_2 emissions at 'current" (i.e., 1989 or 1990) levels within the next 10 to 15 years.[57] Canada and Sweden have declared *tentative* CO_2 emission goals to stabilize emissions at current levels by the year 2000. France has a goal of stabilizing CO_2 emissions at a level about 10 percent over current levels by 2000 (7). The United States has no official goal-for either stabilization or reduction. However, it is scheduled to host the first formal negotiating session on a framework convention early this year.

Table 9-8 presents a more detailed summary of OECD national policies and programs, both proposed and enacted, specifically designed to reduce greenhouse gas emissions. Among countries with official stabilization or reduction targets, the Netherlands has one of the most complete sets of proposals for increasing energy efficiency and reducing emissions from transportation, including a tax on CO_2 emissions.[58] The Swedish parliament also considered a tax on CO_2 emissions, initially in the energy production and transportation sectors (86), but it decided not to implement the tax until it coordinates its CO_2 emissions policies with other European countries (18a).

[56]For Germany, this schedule will apply to West German emissions only, since attaining large reductions in the currently inefficient East German energy sector would be a relatively easy task.

[57]The United Kingdom chose 2005. Japan also established a goal of stabilizing N_2O, CH_4, and other gases at today's levels.

[58]The CO_2 tax is an addition t. the existing fossil fuel tax, which consists of a general fuel excise tax and an environmental levy; the CO_2 tax adds an amount to the environmental levy.

Table 9-8—New Plans and Programs in OECD Countries, Specifically Designed To Reduce Greenhouse Gas Emissions, as of 1990a

Plan or program	AUS	CAN	DEN	GER[b]	JAP	NET	NEZ	NOR	SWE	UK	us
Carbon or CO_2 emissions tax	—	—	P	P	—	E	—	P	E	—	—
Modified utility planning/funding	P	—	P	—	—	P	—	P	P	P	P
Strengthened building or appliance standards	P	—	P	—	—	P	P	P	—	E	P
Support for renewable and/or alternative fuels[d]	P	—	P	P	P	P	P	P	P	P	P
TCMs or tightened fuel efficiency standards	P	P	—	—	P	P	—	P	P	—	P
Land use planning and/or reforestation	P	—	—	—	P	P	—	P	—	—	E
Energy audits and/or public information programs	P	—	—	—	P	P	E	—	—	—	—
CFC reductions faster than Montreal Protocol[f]	E	P	—	E	—	—	E	E	—	—	P

[a]Note that some countries may already be implementing these measures in programs previously established for other purposes (e.g., Canada has programs for utility planning and energy audits). This table refers only to new programs and plans that address greenhouse gas emissions as a top priority.
[b]West Germany only.
[c]Includes policies to encourage fuel switching and cogeneration.
[d]Alternative fuels include ethanol, methanol, and other biofuels.
[e]TCMs = transportation control measures (e.g., ride-sharing, public transit).
[f]See ch. 2 for more information about the Montreal Protocol on Substances that Deplete the Ozone Layer.

KEY: P. Proposed
E. Enacted

ABBREVIATIONS: AUS - Australia; CAN = Canada; DEN - Denmark; GER - Germany; JAP - Japan; NET. The Netherlands; NZ - New Zealand; NOR - Norway; SWE - Sweden; UK= United Kingdom; US = United States.

SOURCE: OTA Survey of Embassies; Organization for Economic Cooperation and Development and international Energy Agency,"Summary of Actions in Member Countries To Deal With the Problem of Climate Change (Note by the Secretariat)," IEA/SLT(90)51 (1 st Revision), draft (Pans: Standing Group on Long-Term Cooperation, Committee for Energy Research and Development, Oct. 24, 1990).

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