Chapter 8

Issues and Options

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INTRODUCTION AND SUMMARY

Developing countries need energy services to raise productivity and improve their standard of living. But the traditional way of meeting these energy needs, through increasing energy supplies with little attention to the efficiency of energy use, raises serious financial, institutional, and environmental problems. The magnitude of these problems underlines the need for improving the efficiency with which energy is currently used and produced in developing countries.

This report has shown the potential for improving energy efficiency through the adoption of proven cost-effective technologies. For a wide range of electricity using services, energy savings of nearly 50 percent and life cycle cost savings to consumers of nearly 30 percent are possible with current or near-commercial energy technologies. Energy efficiencies could be further improved by technologies expected to be commercial in the near to midterm.

While the energy saving advantages of these technologies are usually recognized, the common perception is that their widespread adoption will not occur because of their high initial cost, an important consideration for poor, heavily indebted countries. This study shows, however, that when the capital requirements of both supply and end use technologies are combined-on a systemwide basis—higher efficiency technologies reduce overall capital costs. The higher capital costs of the energy efficient end use equipment are more than offset by the lower investment required for electricity generation.

Even with major end use efficiency gains, the rising demand for energy services means that increases in supply will also be required. Improved supply technologies offer opportunities to augment the efficiency of energy production and distribution, while moderating environmental impacts. Recent cost reductions in renewable technologies (e.g., wind turbines, photovoltaics, and biomass conversion) will encourage their increased use, and also help improve rural energy supplies.

The rapid adoption of these technologies is, however, being held back by a variety of technical, institutional, and economic and financial barriers that occur throughout the entire technology transfer and diffusion process.

- Technical. Many improved technologies, though well established in industrial countries, may not be well adapted to conditions in developing countries. People in developing countries may not be aware of new technologies or have access to the training necessary to make effective use of new technologies
- Institutional. Both public and private developers are organized to fund large scale conventional energy supply expansion rather than demand side energy efficiency projects. Rules and practices in the critically important electric power sector often do not give efficiency and renewable energy equal weight with conventional large scale supply options in providing energy services.
- Economic and Financial. Energy prices are frequently subsidized in developing countries and therefore provide neither the economic incentives for energy efficient equipment, nor adequate revenues for system expansion. Particularly in poor countries, consumers may not have access to the capital needed for the higher initial costs of energy efficient equipment (even though these technologies reduce costs to the user over the product's lifetime, and lower overall capital costs for the nation).

The United States has strong reasons for taking a leadership role in policy changes to overcome these barriers to rapid diffusion of improved energy technologies.

International political stability depends on steady broad-based economic growth in the developing countries, which in turn requires economic and reliable energy services. The developing countries are of growing importance in global energy markets and global environmental issues. Because of their rapid population increase, the developing countries are projected to account for over one half of the increase in both global energy consumption and associated CO_2 emissions over the coming decades, despite their low levels of per capita consumption. Sharply rising demand for oil from the developing countries contributes to upward pressure on interna-

tional oil prices. Developing-country debt, often energy related, affects the stability of U.S. and international banking systems. At the same time, developing countries offer the United States major trade opportunities in their large and expanding market for energy technologies.

This chapter explores ways in which the United States could contribute to more rapid technology diffusion in developing countries, the policy mechanisms that could be used, and their relative costs and benefits. A large number of U.S. programs already influence or have the potential to influence technology adoption in developing countries, and many are undergoing change--often at the instigation of Congress. This chapter describes those programs that appear, on the basis of our analysis of developing-country needs and U.S. policy interests, to provide the greatest opportunities for effective action. These areas establish a framework for more detailed program planning and analysis.

This is a timely moment for reviewing U.S. policies towards the adoption of improved energy technology in the developing countries. These countries are themselves demonstrating interest in seeking alternative ways of meeting the demand for energy services, despite the difficulties inherent in changing entrenched systems. Increased attention is being given to politically sensitive questions of energy price reform, improved management, and operations efficiency in State-owned energy supply industries. Several developing countries are taking steps to encourage private investment in electricity, and in oil and gas exploration and development. Many developing countries now have capable energy research and policy institutions. Progress is also being made on the environmental front. At present, efforts are largely directed at local rather than global conditions, though developing countries have also participated in international environmental protection treaties. There is also evidence of change in donor institutions. The bilateral donor agencies and the multilateral development banks (MDBs) (of which the most influential is the World Bank) are beginning, often under pressure from Congress and nongovernmental organizations (NGO), to incorporate environmental planning into their projects, develop energy conservation projects, and encourage a larger role for the private sector. While many problems remain, this momentum for change offers a good opportunity for U.S. initiatives.

An analysis of possible U.S. actions to augment the process of improved technology adoption and diffusion provides a long list of policy options. The following merit priority consideration:

- Additional attention to energy efficiency, and the environmental impacts of energy developments in current bilateral and multilateral programs.
- Encouragement of energy price reform in developing countries, including assistance in adjusting to the impacts of higher prices. Rational energy pricing both encourages the adoption of energy efficient equipment and helps finance needed supply expansion. The United States has a number of policy levers (through bilateral and multilateral aid agencies, and in debt negotiations) to achieve this objective.
- Promotion of Integrated Resource Planning (IRP) and associated regulatory reform to provide incentives for investments in energy efficiency as part of electricity projects. The United States has experience with this approach in the electricity sector on which to base technical assistance to developing countries.
- Provision of technical assistance in a variety of other areas of potential large impact. Examples include environmental protection (an area of growing concern in developing countries), appliance efficiency, utility management, and transportation planning.
- Encouragement of private sector participation (including the private sector of both the United States and the developing countries) in energy development. The United States has policy levers through membership in MDBs and programs for export and investment support. The developing countries are indicating interest in further private sector development.
- Help in building institutions in developing countries, especially for technology development, adaptation, and testing.
- Expansion of U.S. trade and investment programs, recognizing that U.S. energy related exports and investment are an important channel for energy technology transfer to developing countries.
- Setting a good example to the rest of the world in energy efficiency and environmental protection. This provides credibility to U.S. policy advice to others.

Congress has already taken action in *several* of these areas by promoting IRP, efficient energy pricing, and consideration of environmental impacts of projects. The implementation of these Congressional directives may need to be monitored.

Since efficient energy technologies often reduce systemwide capital investment, redirecting capital funds from supply expansion to energy efficiency projects could free resources for additional investment in energy services. Even so, the rapid rise in demand for energy services may require more investment than that projected to be available. High levels of support will continue to be needed from the MDBs and other bilateral and multilateral financial institutions. At the same time supporting actions (e.g., debt negotiations, macroeconomic reform, and privatization) will be required to encourage increased private sector participation.

Several of the options for accelerating the adoption of energy efficient technology imply an increase in U.S. bilateral assistance. While increases in bilateral aid run counter to efforts to control budget expenditures, the share of bilateral aid (particularly in the U.S. Agency for International Development (AID)) directed to energy is at present low in relation to: 1) total bilateral assistance; 2) the share of energy in the aid efforts of other donors; 3) the potential importance of developing countries as markets for U.S. exports of improved energy technologies; and 4) the contribution of developing country energy use to global Warming. The current geographical distribution of AID energy expenditures is concentrated in the Near East. This distribution may not adequately reflect the totality of U.S. policy interests.

EXISTING U.S. PROGRAMS AND POLICIES FOR ENERGY TECHNOLOGY TRANSFER AND DIFFUSION

Technology transfer can be influenced through a variety of channels, both public and private. (See table 8-1.) These channels are:

. capital projects financed by development agencies,
. intergovernmental agreements on research and development,
. foreign investment and direct export sales, and
. training and technical assistance carried out by both the private sector and the government.

The U.S. Policy Framework

A substantial number of U.S. agencies already have programs and activities for energy technology transfer. These include: AID; the Trade and Development Program (TDP); the Departments of Energy, Commerce, and the Treasury; the Overseas Private Investment Corporation (OPIC); the Export-Import Bank (Eximbank); the Small Business Administration; and the U.S. Trade Representative (USTR). Through membership in international organizations, notably the multilateral development banks (MDBs) and United Nations (UN) programs, the United States exercises additional influence. Further, a number of industry groups and NGOs are also active in this field.

These agencies and organizations cover a wide range of technology transfer and diffusion activities: research, development, and demonstration; project loans and grants; education, training, technical assistance; information services; policy advice; and support to exports and private investment. Although the U.S. policy infrastructure for promoting energy technologies is largely in place, it has not in the past focused on efficiency and is only now beginning to accept efficiency as an important theme. In general, the U.S. energy technology transfer "program" lacks a consistent mandate. Efforts in energy are normally a small, low priority component of agency budgets.

Efforts have been made to coordinate some aspects of these numerous programs through formal and informal charnels. For example, Congress in the Renewable Energy Industry Development Act of 1983 initiated a multiagency committee-the Committee on Renewable Energy Commerce and Trade (CORECT) to promote exports of U.S. renewable energy technologies (see box 8-D below). A U.S. General Accounting Office (GAO) evaluation of CORECT'S activities, currently underway, will provide guidance on whether CORECT can serve as a model for other areas such as energy efficiency and the environment.

Despite the large number of programs, the current level of U.S. bilateral aid for energy (see table 8-1) is modest. The main bilateral aid agency is the U.S. Agency for International Development (AID). Annual AID energy expenditures, largely grants, amount to $200 million, compared with MDBs' energy loans of $5 billion annually. The relatively small scale of

Table 8-l-Overview of Organizational Functions Relating to Energy Technology Transfer

Organization	Capital project support	Technology support and dissemination	Training and human resource development	Policy persuasion and advice	Private section support, export promotion	Level of resources (million $)[a]
U.S. agencies:						
Agency for International Development	√	√	√	√	√	$214 (1990 est.)
Department of Energy	—	√	√	—	√	$1-$10
Trade & Development Program	√	—	—	—	√	$8
Department of Commerce	√	—	—	—	√	NA
Environmental Protection Agency	—	√	√	√	—	NA
Treasury	√	—	—	√	√	NA
Export-Import Bank	√	—	—	√	√	NA
Overseas Private Investment Corporation	√	√	—	—	√	NA
Small Business Administration	—	—	—	—	√	NA
Multilaterals:						
World Bank	√	—	√	√	√	$3,704 (1987)
International Finance Corporation	√	—	√	√	√	NA
Multilateral Investment Guarantee Agency	√	—	—	—	√	NA
InterAmerican Development Bank	√	—	√	√	√	$405 (1988)
Asian Development Bank	√	—	√	√	√	$567 (1988)
African Development Bank	√	—	√	√	√	$185
UN Development Program	—	√	√	√	√	$25-30 (1988)
International Energy Agency	—	√	√	—	—	—
UN Industrial Development Organization	—	√	√	—	—	$5-10 (1988)

NA = Not available or not applicable.
[a]Lawrence Berkeley Laboratory, *Energy Technology for Developing Countries: Issues for the U.S. National Energy Strategy*, U.S. Department of Energy, December 19S9, p. 17.

U.S. bilateral assistance for energy suggests that the sums available will continue to be used to greatest effect by:

- using grant monies to promote technical assistance and institution building for technology transfer and diffusion;
- introducing energy efficiency and related environmental considerations into broader international policy discussions where the U.S. voice carries considerable weight;
- bringing influence to bear on the activities of the multilateral development banks, whose expenditures represent a major force in developing country energy decisionmaking; and
- developing cooperative approaches with other bilateral donors and lending agencies, and the private sectors in both the United States and developing countries.

AID Programs

AID is the major conduit for U.S. bilateral energy support. However, energy accounts for a relatively small share, about 3 percent, of AID's total annual economic assistance. Obligations have been declining in real terms in recent years-horn$214 million in fiscal year 1990 to $177 million in fiscal years 1991 and 1992.[1] Beginning in fiscal year 1991, assistance for East European countries is included in this total. Less than one-half of 1 percent of Agency staff are full-time, direct-hire energy experts.

AID assistance is concentrated in projects in Egypt and Pakistan,[2] which are the only two

[1]U.S. General Accounting Office, *Foreign Assistance: AID Energy Assistance and Global Warming, GAO/U. S. AID-91-22* 1 *(Washington,* DC: U.S. General Accounting Office, July 1991), p. 2.

[2]Funding to Pakistan has been suspended because of that country's nuclear weapons program.

countries to have major efficiency projects. In 1980, annual AID energy funding to Africa was just over $1 million. Latin America also receives little attention from AID for energy (under 6 percent of AID's total energy expenditures) despite strong U.S. interest in trade and investment markets in this area,

The remainder of AID energy expenditures is devoted to a centralized Office of Energy and Infrastructure that provides energy planning and policy advice on an agency-wide basis, supporting country missions with advice and training. In fiscal year 1990, the Office had a $15.4 million budget, which was increased to $20 million in fiscal year 1991 or about 8 percent of total AID energy assistance.

The Office of Energy and Infrastructure conducts a variety of policy, training, technical assistance, and institution building programs (see box 8-A). The Office of Energy and Infrastructure also coordinates a number of programs with other government agencies (e.g., the Department of Energy National Laboratories), multilateral aid donors, and private organizations (e.g., Bechtel and the American Wind Energy Association).

Congress has expressed a high level of interest in AID energy and environmental activities. For example, Congress has directed AID to encourage energy pricing reform, end use energy efficiency, Integrated Resource Planning (termed "least cost planning"), and renewable energy; and to increase the number and expertise of personnel devoted to these areas. AID has also been directed to include global warming considerations in its energy assistance activities. In particular, Congress requested AID to identify key developing countries in which changes in energy and forestry policies might significantly reduce greenhouse gas emissions.

Multilateral Bank Activities

The multilateral development banks (MDBs) operate major energy programs mainly devoted to large-scale conventional energy supply projects. Through their lending policies, the MDBs influence energy technology transfer to developing countries and in general play a major role in determining the types of energy projects that will be developed.

Among the multilateral donors (see box 8-B), the World Bank has the largest single energy program, providing three quarters of total multilateral energy lending, The World Bank exercises considerable influence in the energy sector of developing countries through its own loans and through the leveraging effect of its lending activities. For example, in 1989, World Bank energy sector loans of $3.8 billion together with Inter-American Development Bank (IDB) loans of $407 million formed part of the financing of 33 projects whose total cost was $25 billion. In addition, the World Bank has a large lending program in areas (e.g., transportation, industry, and urban development) that closely affect the way energy is used. Through these activities the World Bank has a good opportunity to act in an integrated fashion over many relevant sectors. It is also influential in setting policy guidelines.

The World Bank and other development banks have traditionally concentrated on large scale conventional energy supply projects. These include centralized electricity generation projects, and coal, oil, and gas production and processing. Few energy projects have been devoted to efficiency or the development of renewable energy resources, other than large scale hydroelectric. In their 1989 lending program, for example, MDB support for solar, geothermal, and wood-based energy projects accounted for less than 1 percent of total energy lending.[3]

Recently, often under pressure from Congress and NGOs, the World Bank has devoted more attention to energy efficiency considerations (mainly in the electricity sector) and has set up a special task force to examine efficiency efforts within the World Bank. The World Bank/UNDP Energy Sector Management Assistance Program (ESMAP) has been reorganized. As a program outside the main geographical departments that are largely responsible for project development, ESMAP could be well placed to develop innovative energy efficiency and renewable energy programs of broad application throughout the bank lending program. On the other hand, its isolation from the project development process could also diminish its effectiveness. By recently joining ESMAP, the United States has increased its voice in this potentially innovative program and could bring its influence to bear on improving the

[3]U.S. Export Come. for Renewable Energy, *Energy Lending at the World Bank and Inter-American Development Bank* (Arlington, VA: January 1990), p. 20.

Box 8-A—AID Office of Energy and Infrastructure

The Office of Energy and Infrastructure has five basic goals: increased consideration of environmental criteria; increased technical efficiency and financial performance of energy systems; greater private enterprise involvement in energy development and management; expanded use of suitable indigenous energy resources; and enhanced availability of energy for sustained rural development. To implement these goals, the Office currently supports the following projects.

Energy Policy Development and Conservation Project

This project includes the following elements: advancing the Multi-Agency Group on Power Sector Innovation (MAGPI); promoting least-cost investment planning; improving efficiency and performance of electric power systems in developing countries; encouraging price reform policies; developing institutions to promote technology innovation and commercialization programs such as Program for the Acceleration of Commercial Energy Research (PACER) in India; conducting technology assessment and prefeasibility studies, including options for rural power delivery; and developing a program in environmental management.

Energy Conservation Services Project

This project includes: promotional and planning activities related to energy efficiency as a response to global warming; energy efficiency in electric power systems; and efficiency in the industry, buildings and transportation sectors. Through this program, the Office of Energy is participating in the design and implementation of the Global Energy Efficiency Initiative and a PACER building energy efficiency project.

Renewable Energy Applications and Training (REAT) and Biomass Energy Systems and Technology (BEST) Projects

These programs are both aimed at stimulating the use of renewable energy in development projects. REAT addresses the commercialization of renewable energy projects through the following elements; preinvestment studies; feasibility studies; training and informational activities in cooperation with the U.S. Export Council for Renewable Energy; participation in the FINESSE (Financing of Energy Services for Small-Scale Energy Users) program; and coordination with multilateral banks and bilateral donors through the MAGPI mechanism. BEST focuses on promoting biomass energy development, programs of applied biomass research; a Venture Investment Program; and information dissemination, including workshops.

Private Sector Energy Development (PSED) Project

The PSED Project is intended to catalyze policy changes that will enhance private sector involvement in the energy sector through the following means; conferences and workshops in assisted countries and in the United States; technical assistance; dissemination of Private Power Reporter, a publication based on an in-house database of project opportunities; financial support for feasibility studies; and coordination with other bilateral donors, multilateral development banks, and the private sector.

Conventional Energy Technical Assistance (CETA) Project

The CETA project is directed at transferring U.S. advances in energy technology to developing countries in the areas of resource assessment and development, and technology innovation. In the latter case, CETA has targeted coal combustion technologies, particularly atmospheric fluidized-bed combustion and integrated coal gasification combined cycle. CETA will be phased out in 1991, and the Energy Technology Innovation Project (ETIP) will take its place. ETIP will add a Clean Energy Technology Feasibility Study Fund; a focus on energy efficiency improvements in supply and distribution in the power sector (complementing the Energy Conservation Service Project); transfer of rehabilitation technologies; and workshops aimed at institutional reform in the power sector.

Energy Training Program

The Energy Training Program offers short-term (2 to 7 months) training to governmental, parastatal, and private employers in developing countries in the following categories: energy policy and analysis; indigenous fossil fuel development; power industry development; energy conservation and efficiency; alternative energy systems; environmental policy and regulation; pollution-control systems; and data collection and analysis. Through the Energy Training program, the Office of Energy also trains USAID personnel (in Washington and in overseas missions) in environmental topics, including the relevance of least-cost planning, efficiency, and renewable resources. In addition, the Office of Energy and Infrastructure works closely with AID missions to implement country specific programs and projects.

SOURCE: **U.S. Agency for International Development** Bureau for Science and Technology, **Office** of Energy, "Program **Plan,"** for **fiscal** years **1990-1992.**

Box 8-B—Multilateral Development Banks

Multilateral agencies are international organizations with a consortium of member nations or contributors. The United States participates in several multilateral organizations, principally as a member or majority contributor to four multilateral development banks (MDBs). Most of these agencies are associated with the United Nations. U.S. membership in each organization resulted from congressional legislation, and Congress annually passes new legislation to renew subscriptions of funds to the banks or to suggest policy direction to the U.S. representative. The Department of the Treasury has oversight of U.S. directors of the MDBs, and the Department of State has oversight of the U.S. participation in the UN, through the U.S. Ambassador to the United Nations.

The World Bank

The World Bank Group is an independent organization under the United Nations and is the largest multilateral development bank. It supports the majority of developing country loans, accounting for around 75 percent of all MDB loans made to developing countries. There are four interrelated organizations that are part of the World Bank Group: the International Bank for Reconstruction and Development, the International Development Association, the International Finance Corporation, and the Multilateral Investment Guarantee Agency.

The International Bank for Reconstruction and Development (IBRD) finances its loans through its own borrowings on the world capital markets, through retained earnings (approximately $1 billion in 1990) and through repayments on loans. IBRD loans carry near-commercial interest rates, repayable over a 15 to 20 year period. IBRD loan decisions are based on economic considerations and "prospects for repayment."[1] In **1990, IBRD** loans amounted to a total of about $15.2 billion, comprised of 121 projects.

The International Development Association (IDA) targets countries that cannot afford to pay the near-market interest rates of the IBRD loans. Currently, countries with $580 or less annual per capita GNP (1987 dollars) are eligible for IDA loans. Internationally, IDA is the largest source of multilateral development bank lending on ''confessional' terms. In 1990, IDA credits totaled over $5.5 billion, distributed through 101 projects. Credits were granted most heavily in Africa, with $2.7 billion distributed among 67 projects.

The top four lending sectors-agriculture, energy, structural adjustment, and transportation-account for over 50 percent of IBRD/IDA (referred to subsequently as "World Bank") loans. In fiscal year 1990, 16 percent of the World Bank's loans went to the energy sector, making energy second only to agriculture. Over two-thirds of World Bank energy sector loans are to the power sector (notably hydropower), and most of the rest to oil and gas exploration and development. Structural adjustment is the fastest growing sector, accounting for 15 percent of Bank lending in recent years. Typical conditions of structural adjustment loans relate to macroeconomic reforms, such as pricing policies, including energy prices.

The International Finance Corporation (IFC), an independent affiliate of the World Bank promotes private sector investment by providing long term loans and risk capital without government guarantees to private sector companies. Of the 125 IFC projects in fiscal year 1990, 6 were energy related, and amount to an IFC investment **totaling** $140 million in loans and $40.8 million in equity and syndications. Three projects were in oil exploration, two in electricity transmission and/or distribution, and one in hydro. The majority of IFC's investments are in local financial institutions, such as banks and credit unions.

The Multilateral Investment Guarantee Agency (MIGA) aims to stimulate foreign direct investment in developing countries by providing guarantees to foreign investors against losses from noncommercial risks. MIGA was initiated in 1988 and has guaranteed a total of $132.3 million for four projects, with the projects totaling $1.04 billion in direct foreign investment. One project is energy related, an investment by GE of the United States in a lighting product manufacturer in Hungary.

The Regional Development Banks

The regional development banks, the Inter-American Development Bank, the Asian Development Bank, and the African Development Bank, all conform to the World Bank model. Each makes loans to developing country members and each has a confessional arm that makes grants and loans to the poorest member countries.

(continued on next page)

Box 8-B—Multilateral Development Banks--Continued

The Inter-American Development Bank (IDB) annually makes loans amounting to about one-tenth of the World Bank's total, with lending in fiscal year 1989 around $2 billion. The United States has the single largest subscription. About 25 percent of the IDB's loans, about $407 million in fiscal year 1988, go to the energy sector. IDB's energy lending closely parallels that of the World Bank; large hydropower projects usually receive the most funding, followed by fossil fuel generation and exploration, electricity transmission and distribution, and oil and gas development.

Japan and the U.S. contribute equal amounts to the Asian Development Bank. In fiscal year 1988, ADB made $2.8 billion in loans, with $392.14 million going to energy projects. The projects included oil and gas exploration; transmission and distribution; and one hydropower project.

The African Development Bank with its confessional arm, the African Development Fund (AfDB/AfDF), dispensed about $2.2 billion in loans and grants in fiscal year 1989. AfDB/AfDF lends for energy projects as part of the public utilities sector. In fiscal year 1989, the public utilities sector comprised 18.2 percent of the Bank's loans and grants. The near-commercial loans for energy totaled $185.4 million in fiscal year 1989, with confessional loans totaling $69.7 million, and one grant of $900,000 for a joint water supply/power project in Sudan.

[1]World Bank, *Recent World Bank Activities in Energy* (Washington, DC: October 1992), p. 2.

SOURCE: Office of Technology Assessment, 1992.

interaction between ESMAP and the Bank operational department.

World Bank energy project lending usually contains requirements to increase energy prices to cover long term marginal costs, as well as other policy and institutional reform conditions. A more active role in energy efficiency, however, may be useful. Past experience in removing market distortions in power sector pricing and increasing competition and operating efficiency indicate that it may take many years to improve the functioning of the energy market.

The new Global Environmental Facility (see box 8-C) provides an opportunity for additional energy efficiency projects. The criteria governing lending under this fund, however, appear to exclude energy efficiency projects that would be cost effective if energy prices reflected long term production costs. Such an interpretation risks excluding many energy efficiency projects from consideration. It is as yet too early to assess the operational impacts of these rules.

Despite these initiatives, energy efficiency still receives minor attention. This appears to be the result of three factors: First, energy efficiency projects are more diverse and complex than conventional energy supply projects and harder to put into a project format for lending. Second, results of energy efficiency initiatives are hard to forecast and incorporate in supply plans. Third, past emphasis in favor of traditional supply-side projects is difficult to change. Given the importance of efficiency, it is of particular concern that there is no clear organizational center of expertise within the World Bank to support implementation of energy efficiency projects.

Even with energy efficiency improvements, energy supplies in developing countries will need to increase, and MDBs will continue to be influential in the choice of technology. Increased utilization of natural gas offers both a cost effective and environmentally attractive opportunity for developing countries. However, a variety of economic and institutional factors (see ch. 7) have constrained its development. Oil exploration in many developing countries has also lagged. There is a role here for the MDBs to stimulate hydrocarbon development by helping provide information on geological prospects, insuring foreign investors, and providing assistance in developing satisfactory long term agreements between oil companies and developing countries.

In recognition of the MDBs role in energy lending, Congress has taken an active interest in their activities. Congress has instructed the U.S. Executive Directors to the MDBs to take into account end use energy efficiency and renewable energy in making decisions about new energy projects. Congress has also addressed the issue of bundling (or combining) small energy projects into large projects on the financial scale usually handled

Box 8-C—The Global Environmental Facility (GEF)

The GEF is a pilot program administered by the World Bank intended to provide grants or confessional loans to developing countries to help implement programs of global environmental protection. Four areas are included in the GEF:

1. Protection of the Ozone Layer,
2. Limiting Emissions of Greenhouse Gases,
3. Protection of Biodiversity, and
4. Protection of International Waters.

The second area, Limiting Emissions of Greenhouse Gases, is particularly related to energy supply and use. Energy efficiency and renewable energy are to be included under certain circumstances.

The World Bank, United Nations Environment Program, and United Nations Development Program jointly implement the GEF. The World Bank takes primary responsibility for project definition, evaluation, and lending. The initial 3 years of the GEF is considered a pilot program period, with an expected $1.5 billion budget. The United States has committed $150 million for GEF ''parallel" financing through AID for the initial 3-year period.

While the GEF is intended to address areas of global concern, substantial overlap with issues of substantial national environmental self-interest are also eligible. Eligibility criteria incorporate three types of projects: a) Projects economically viable on the basis of domestic benefits and costs to the country itself, but which would not proceed without GEF involvement; b) investment that is not justified in economic terms if full costs are borne by the country itself; and c) investment that is justified in the country context, but the country would have to incur additional costs to derive the full global benefits. It was intended that the GEF operations complement but not substitute for actions that could be supported under existing programs.

SOURCE: Office of Technology Assessment, 1992.

by the large development banks. It has done this by directing the Treasury Department to work with borrowing countries to develop loans for bundled projects on end use energy efficiency and renewable energy. In further action to facilitate development of small scale projects, the 1989 International Development and Finance Act (PL 101-240) requires the U.S. Executive Directors of MDBs to promote increased assistance and support for nongovernmental organizations.

This survey of current policies and programs with respect to the accelerated diffusion of improved energy technologies to developing countries suggests two broad types of policy options (options 1 to 3 of table 8-2). The first is to give the U.S. program greater cohesion by establishing and strengthening coordinating bodies in selected areas such as energy efficiency and environmental protection activities. The second is to monitor the implementation of existing congressional directives to AID and the executive directors of the MDBs with regard to energy efficiency, energy pricing, renewable, the bundling of small scale projects, and the role of NGOs in project lending. It maybe that there is less need for additional directives than effective implementation of existing ones,

IMPROVING TECHNOLOGY TRANSFER AND DIFFUSION

Three main categories of barriers to the accelerated adoption of improved energy technologies in the developing countries have been identified. These are technical barriers relating to the technologies themselves, institutional barriers, and economic and financial barriers. The following sections examine current U.S. activities and policies that help to remove these barriers and discuss options for improving their effectiveness.

Technology Transfer Support

Technology consists not just of the appropriate hardware, but also the knowledge and training necessary to use it effectively. In addition to technology research, development, and demonstration, the dissemination of information about technology and training in its use is also important to technology transfer.

Research, Development, and Demonstration

Since scale of production, skills, relative prices, and raw materials often differ among the developing countries, technology developed in the industrial

Table 8-2-Options

Structure of existing programs for energy technology transfer and diffusion

1. **To increase the cohesion and effectiveness of U.S. efforts, the Committee on Renewable Energy Commerce and Trade (CORECT) could be considered as a model for energy conservation and environmental programs.**
2. **The effects of previous congressional directives regarding energy efficiency, energy pricing, integrated resource planning, renewable, the bundling of small scale projects, and the role of non-governmental organizations in project lending could be monitored. It may be that there is less need for additional directives than effective implementation of existing ones.**
3. **Recognizing the need for continued conventional energy supply development, the MDBs could further encourage natural gas development in the developing countries.**

R&D and demonstration

4. ***The* Department of Energy and associated National Laboratories could increase efforts to develop or adapt energy efficient technologies for developing country use in close cooperation with the U.S. technical community.**
5. **In order to integrate industrial country research, development and demonstration more closely with the needs, conditions, and expertise of the developing countries, special institutes (analogous to the Consultative Group for International Agricultural Research institutions) for that purpose could be established in the developing world.**

Information dissemination

6. **Ways could be examined of improving developing country access to, coordinating, and expanding, technology databases, especially in defined areas of priority need (e.g., in electrical power generation and transmission and distribution system efficiency; renewable; oil and gas exploration and development; clean coal power generation; energy environmental control technology; and transport system efficiency).**

Training and technical assistance

7. **AID could be encouraged to hold more regionally based or in-country training, thus stretching available budgets, extending the language coverage of the courses, and strengthening the growing number of energy institutions in the developing countries.**
8. **The U.S. executive directors of MDBs could be requested to ensure that energy sector loans, as appropriate, incorporate provisions for training.**
9. **The donor agencies could be encouraged to pay particular attention to training needs in the electricity sector of developing countries.**

institutional reform in developing countries

10. **DOE could provide additional support for Integrated Resource Planning and related regulatory reform to the bilateral and multilateral donor agencies, including drawing on the substantial experience of the various State and regional authorities (e.g., the California Energy Commission and Pacific Northwest Coordinating Council) and utilities, which have been at the forefront of this effort.**
11. **The growing interest in privatization in the electric utility sector of developing countries could be encouraged, again drawing on U.S. experience.**

Providing incentives for the adoption of improved energy technologies

12. ***The* multilateral donors, AID, and U.S. negotiators in debt negotiations could be encouraged to include energy pricing issues in their economic reform efforts. This is an opportune time as many of the developing countries are expressing interest in moving towards market-based systems.**
13. **AID could be requested to make greater efforts to provide technical assistance on pricing reform and the development of energy efficiency standards, drawing on U.S. experience.**

Financing issues

14. **Consideration could be given to increasing the share of energy in total bilateral and, which is low in relation to other major donors.**
15. **AID and the MDBs and other bilateral agencies could be requested to investigate ways of overcoming the initial higher costs of energy efficient equipment to end users, and to consider mechanisms for bundling a large number of small projects into larger projects consistent with MDB scale of operation.**

U.S. trade and investment

16. **Existing trade and investment support programs (including those of the United States and Foreign, Commercial Service, Trade and Development Program, and U.S. Trade Representative for energy could be expanded.**
17. **Additional efforts could be made in existing trade support programs to respond to the special needs of small to medium scale companies.**
18. **The extent to which the present trade and investment support agencies are able to support new forms of finance such as project and nonrecourse finance could be investigated.**

Poverty and rural energy needs

19. **Bilateral and multilateral donor agencies could undertake additional activities to improve access of both the rural and urban poor to improved forms of energy.**
20. **Donor organizations could examine ways to seek more effective means to deliver technical assistance to the urban and rural poor, including through NGOs and nonprofits with demonstrated ability to deliver technical assistance and financing at the local level.**

Protecting the environment

21. **AID and EPA could be requested to provide additional technical assistance to developing countries for environmental planning. Efforts could be made to ensure an effective degree of coordination under EPA's leadership of U.S. environmental activities in the developing countries.**
22. **in connection with longer term issues of global sustainability, the appropriate level of funding for family planning, how these funds should be distributed, and under what restrictions, if any, they should be distributed could be further examined.**

Setting a good example

23. ***The* United States could set a good example to the rest of the world by improving energy efficiency at home.**
24. **The State Department, as requested by Congress, could ensure that U. S. facilities abroad, particularly those in developing countries, are highly energy efficient and take advantage of renewable energy sources where feasible. U.S. embassies, office buildings, and residences could serve as show pieces for advanced U.S. energy efficient technologies, such as highly efficient air conditioners, heat pumps, household appliances, insulation standards, solar systems, and cogeneration.**

countries may need considerable adaptations to developing country conditions. Examples of potential areas for RD&D include high reliability rural off-grid power using indigenous fuels and renewable energy, and more efficient end use devices such as lighting systems and refrigerators.

The Department of Energy (DOE), with the associated National Laboratories, is the center of energy research and development in the U.S. Government (see box 8-D). DOE is currently active in fossil energy technology, notably clean coal technology. DOE has agreements with a number of countries for cooperative R&D carried out through exchanges of information and research personnel. In addition, DOE's National Laboratories work directly with public and private organizations in developing countries. For example, Oak Ridge National Laboratory has undertaken studies on institution building, technical assessments, energy efficiency improvements, and fossil energy options in a wide range of developing countries. Lawrence Berkeley Laboratory focuses on global climate change and energy efficiency in buildings, working especially with China and Association of Southeast Asian Nations (ASEAN) countries. Argonne National Laboratory is active in energy system planning. Los Alamos has specialized in geothermal energy R&D, directed at Central America and the Caribbean nations. Sandia National Laboratory, working through its Design Assistance Center, has worked in transferring photovoltaic technologies to Latin America. The National Renewable Energy Laboratory (formerly the Solar Energy Research Institute) conducts research in a wide range of renewable energy technologies.

Further cooperation between U.S. Government agencies and between these agencies and the MDBs is possible (see option 4 of table 8-2). DOE, for example, could develop simplified procedural mechanisms and an experience/technology inventory, whereby other agencies and MDBs might more readily access DOE laboratories' resources.

In order to integrate industrial country energy RD&D more closely with developing country needs and to give the developing countries greater influence in defining their R&D agendas, consideration could be given to establishing or supporting special institutes for that purpose (see option 5 of table 8-2). An example of an analogous effort for agriculture is the Consultative Group for International Agricultural Research (CGIAR). This is an the agricultural research network which links a series of research institutes in different parts of the world. An energy "CGIAR" could set up centers of research and development, technology demonstration and evaluation, and pilot projects in developing countries.

Such centers could be staffed by scientists from both the industrial and developing countries, and draw on existing institutions with relevant experience. Feedback between the developing countries and technology research institutions in such a system could be much closer than is often the case at present, taking advantage of developing countries' greater local knowledge and growing expertise in energy technologies. These centers could help create in the developing countries an institutional ability to conduct successful R&D and achieve its commercialization. The centers could be funded through a variety of sources-bilateral and multilateral donors, foundations interested in energy and rural development, and some industries who might find work on the adaption of their products to developing country conditions a stimulus to future sales. Debt swaps could also be used as a source of funds.[4]

Information Dissemination

Despite efforts to improve access to information on energy technology, there are still reports from developing countries of inability to obtain, assess, and utilize technical information.

Responsibility for information dissemination is now divided among several U.S. agencies, including the Departments of Commerce and Energy. The Trade and Development Program has an ''Industrial Equipment Familiarization Program" that assists foreign buyers to locate U.S. technology. Several private sector organizations are also active. For example, the U.S. Export Council for Renewable Energy (US/ECRE) provides information on small scale, renewable energy systems, and the International Institute for Energy Conservation (IIEC) provides information on energy efficiency technologies. Several U.S. utilities have provided information and assistance to 'sister' utilities in developing

[4]George E. Brown, Jr. and Daniel R. Sarewitz, "Fiscal Alchemy: Transforming Debt Into Research," *Issues in* Science and Technology, vol. VIII, No. 1, Fall 1991.

Box 8-D—The Department of Energy

The Department of Energy has a number of international activities. These include over 30 direct agreements with private or public organizations in developing countries (mostly the Newly Industrialized Countries)[1] as part of its international energy research and development cooperation activities. These bilateral agreements usually consist of collaborative R&D and exchanges of technical information, accounted for almost entirely as "in-kind contributions of staff effort. " Although there is joint research on geothermal energy (in Mexico, for example) and renewable, most of the present bilateral agreements involve fossil fuels. In addition, through the Assistant Secretary for Fossil Energy, DOE supports a $1.1 million program aimed at stimulating the export of coal-based technologies to developing countries, emphasizing clean coal technologies. Of this total, $750,000, plus funds from AID and TDP, support prefeasibility studies by U.S. companies. The Assistant Secretary for Fossil Energy also chairs a Coal Export Initiative Program for the coordination of governmental agencies involved in coal export issues. Agreement to share information on clean coal was reached with Chile and Costa Rica and all 75 AID countries were assessed as possible candidates for cooperative efforts in the field of power generation and/or industrial utilization for clean coal.

A recent initiative-the Export Assistance Program--was announced to add to the Department's expertise in promoting exports of U.S. energy goods, services, equipment and technology, working with ongoing activities of the Departments of Commerce and State, and the U.S. Trade Representative. The Program will be managed by a new office within the Office of International Affairs and Energy Emergencies, headed by a Deputy Assistant Secretary who will serve as a U.S. energy industry international advocate and contact for information and action. Promotional trips to Venezuela and Chile have already been made, and an annual Latin American Energy Forum is in the planning stage.

DOE's National Laboratories work directly with public and private organizations in developing countries as well as in cooperation with U.S. governmental and multilateral groups. The National Labs spend about $10 million annually to provide energy assistance to developing countries, and from 1986-1988, worked on 36 diverse projects. In addition to some DOE funds, the laboratories receive substantial support from AID, the World Bank, the International Atomic Energy Agency, the Environmental Protection Agency and other outside sources.

The Department of Energy also leads the Committee on Renewable Energy Commerce and Trade (CORECT), a multi-agency committee initiated by an Act of Congress[2] that includes AID, the Departments of Commerce, State, and Treasury, the Export-Import Bank, Overseas Private Investment Fund, the Trade and Development program, the U.S. Trade Representative and the Small Business Administration. CORECT promotes trade of U.S. renewable energy technologies through a variety of activities: (see below). CORECT's current funding level is about $1.5 million. CORECT helps fund the U.S. Export Council for Renewable Energy, formed by 9 national renewable energy trade associations to promote exports, which in turn provides industry direction for the Committee.

CORECT's activities include:

- Financing Energy Services for Small-Scale Energy Users (FINESSE)-Financing Task Force. The World Bank and CORECT are working closely together on this effort to improve credit accessibility for small-scale energy users who may be unable to attract the attention of multilateral donors and are unable to support the high interest rates of commercial banks.
- Pacific Rim Initiative. This initiative has involved identification of markets and was followed by identification of specific project opportunities, initially focusing on Indonesia and the Philippines.
- One-Stop Application. CORECT is coordinating the U.S. government agencies necessary to develop a simplified form and procedures for obtaining support from Eximbank (team leader), the Trade and Development program, Small Business Administration, Overseas Private Investment Corporation and AID.
- Integrated Electric Utility Program. The goal of this program is to encourage the consideration and use of decentralized energy systems for delivering electric power in developing countries.
- Design Assistance Center of Sandia National Laboratory. The Design Assistance Center at Sandia works with industry and users in the photovoltaics area to provide feasibility studies, system specifications, procurement document preparation, design evaluation, and education and training assistance.

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[1] Lawrence Berkeley Laboratory, *Energy Technology for Developing Countries: Issues for the U.S. National Energy Strategy* (Berkeley, CA: December, 1989), p. 20. LBL lists Brazil, India, South Korea, PRC, Venezuela and Egypt as Newly Industrialized countries.

[2] The Renewable Energy Industry Development Act of 1983.

SOURCE Office of Technology Assessment, 1992.

countries. The United Nations serves an informational function in development countries. For example, the UN Industrial Development Organization provides information on industrial energy conservation.

Ways of improving access to and coordinating these databases and of expanding these services could be explored. Of particular importance are areas such as electrical power generation, transmission and distribution system efficiency, small scale renewable, oil and gas exploration and development, clean coal power generation, energy environmental control technology, and transport system efficiency (see option 6 of table 8-2).

Training and Technical Assistance

Training and technical assistance are integral parts of technology transfer. Without good training, efforts to transfer technology hardware are frequently ineffective. The transfer of renewable energy and energy efficiency technologies requires skills to evaluate their appropriateness, cost-benefit, applications, and local manufacturing prospects. Implementation of rural and small scale energy technology transfer, in particular, requires sustained and concentrated attention to improve local human capability: foreign technical assistance is generally both less effective and too expensive to be a practical long term vehicle for support.

AID sponsors an Energy Training Program that includes academic advanced degrees and in-service and industry fellowships. A recent evaluation of the project[5] found widespread satisfaction with the program among former attendees, while also suggesting several new directions. These include training in environmental assessment and management, general management training, local/indigenous resource utilization, coal resource development and contracting, and energy project financing.

Energy training programs might be expanded to meet the needs of non-English speaking participants, Neither the French-speaking West African countries nor the Latin American countries appear to be adequately supported in AID training. One option is to hold more regionally based or in-country training. This would stretch available budgets and stimulate the growing number of energy institutions in the developing countries. Private voluntary organizations (PVOs), many of which have long histories of operations in developing countries, can play a role here. In recent years, AID has enrolled PVO support on an increasing scale, taking advantage of their experience and generally lower costs. Training programs might benefit from the wide experience of U.S. companies in training associated with their foreign operations in developing countries.

Increased emphasis on training can yield important benefits to the United States. It creates awareness of U.S. technology and services. At times when capital project aid is severely constrained, training may be one of the more cost-effective, long term trade strategies.

In the MDBs, training is largely associated with specific projects or, as in the case of the World Bank's Economic Development Institute, as part of specially designed economic development courses. Considering the importance of investment in human capital, much greater attention to this function appears warranted. It has been observed in many projects, for example, that training funds are often either not used fully by governments or not used effectively, due to a lack of government priority on training or lack of a training plan. Most existing loans could incorporate a more comprehensive treatment of training needs.

The deteriorating performance of the electric utility sector is attributed in part to poor management and maintenance. This suggests the need for greater attention to training across the entire spectrum of activities, from power operational efficiency, to billing and collection of revenues, to diesel maintenance and lineman training.

While promotion of operational efficiency improvement may appear more appropriate for agencies with large capital programs such as the World Bank, areas that require intense technical assistance, training, and institutional development may in fact be much better suited to an aid agency with grant funds like AID. Expanded cooperation in these areas between AID the World Bank, and other MDBs, could be beneficial (see options 7, 8, and 9 of table 8-2).

[5]Development Sciences, Inc., "An Evaluation of the Conventional Energy Training Program and the Energy Training Program for the U.S. AID Office of Energy,' Washington, DC, Jan. 12, 1990, pp. 23-24, 31-34.

Improving the Institutional Framework

In many developing countries there are numerous opportunities for improving the economic and institutional framework for energy sector development. The present system, particularly in the electricity sector, often discourages energy efficiency and small scale decentralized energy facilities. The decision process is usually biased towards large scale supply options even when efficiency improvements and small scale renewable are more beneficial. Furthermore, private sector investment has had little role in electricity sector development. These issues are of growing concern because of the serious deterioration in the electricity sector in many developing countries and the prospect of a major shortfall in the financial resources available for supply expansion.

The Regulatory Framework

Decisions on how to provide energy services are made independently by suppliers and users. This leads to a "disconnect" in the system, which discourages energy efficiency. On the one hand, purchasers faced by high interest rates and low incomes opt for low first cost, typically low energy efficiency equipment. Moreover, frequently subsidized electricity prices provide users with little incentive to invest in efficiency. Suppliers of electricity, on the other hand, face a number of incentives, financial or otherwise, that encourage supply expansion rather than efficiency improvements.

One means of overcoming the system obstacles to energy efficiency is the use of Integrated Resource Planning (IRP)--an expanded form of least cost planning--in project design.[6] Traditionally, least cost planning techniques focused on a limited range of large scale conventional supply technologies, such as coal-or oil-fired generation. Forecasts of electricity demand were seen as a given, not subject to influence. This process has now been expanded in many utility service areas in the United States to include consideration of demand. Thus, energy efficiency investments are balanced on a cost-benefit basis with new supply additions, including nonconventional supply options such as privately generated renewable energy. This system can be used in both publicly and privately owned utilities, and its value is being increasingly recognized by analysts and policymakers in developing countries.

It is important to realize that Integrated Resource Planning systems will require substantial reform in the regulatory structures if they are to be effective. Furthermore, support activities such as data gathering, metering, demonstration, standards, financing, and incentives will need to be developed.

United States agencies are already providing advice on the long term planning of the energy sector, often at the instigation of Congress. For example, legislation has directed AID to focus on IRP (termed "least cost energy planning"), end use energy efficiency, and renewable energy. These elements are contained in two of the AID Office of Energy Programs: the Energy Policy Development and Conservation Project and the Energy Conservation Services Project. The implementation of these congressional directives could be examined.

The United States could make further contributions to establishing appropriate regulatory systems in the developing countries. U.S. State and regional utility regulatory apparatus have played a leading role in the development and application of IRP (as in California and the Pacific Northwest). Programs of demand-side management have been operating for several years. In these programs, utilities give financial incentives (rebates and special rates) to consumers to make greater investments in high efficiency equipment.

The Department of Energy has an Integrated Resource Planning program, whose annual appropriations were recently increased from $1 to $3 million. This program works closely with the national laboratories to provide U.S. utilities with data and analysis. The results of these activities could be further incorporated into bilateral energy programs, and could contribute to MDB programs (see option 10 of table 8-2).

Realistically, effective implementation of IRP will require additional resources. These include grant or technical assistance funds to perform the necessary surveys, studies, and pilot demonstrations and provide guidance of regulatory reform. Such support is of particular importance as developing-country utilities do not have prior experience with

[6]Integrated Resource Planning should be distinguished from least-cost supply-side planning that includes supply-side options only. The term Integrated Resource Planning, covering both the supply and end use of energy, will be used here.

this approach to planning, and are likely to have very limited experience with efficiency programs in general. They may also be highly risk averse, with very limited financial and staff resources available for experimentation, and no established regulatory structure to oversee and stimulate full implementation of these innovations. Risk sharing by the MDBs or bilateral donors could also be an effective means to stimulate demand-side actions.

The role of the World Bank is critical in this area. Recognizing this key role, Congress has already instructed the executive directors of the MDBs to promote end use energy efficiency and renewable energy in decisions on new projects, and to incorporate IRP in their project planning. The implementation and effectiveness of these directive may need to be examined.

Role of the Private Sector

Much of the energy sector, particularly the electricity sector, is government owned, controlled, and operated in the developing countries. There is increasing interest in developing countries, however, in opening up part or all of the energy sector to private investors (see option 11 of table 8-2). This interest is based on a number of considerations:

- the need to attract funds both from domestic and foreign investors for system expansion,
- the need to introduce an element of competition into this sector and achieve better utilization of existing capacity, and
- the desire to gain access to new technologies.

A considerable effort has already been made to increase the role of the private sector in electricity.[7] These efforts vary from-outright sale of State owned facilities to the private sector (as in Chile) to the more typical opening of the grid to small private generators as was done in the United States under the Public Utility Regulatory Policies Act (PURPA)[8]. [9]

U.S. and multilateral agencies are assisting in this process. The AID Office of Energy, for example, supports private sector energy initiatives by providing information on PURPA type legislation, helping to develop private energy policies and projects, cost-sharing feasibility studies, and collecting and disseminating information.[10] There may however, be a gap in complementary in-country or AID mission programs, where the actual delivery of technical assistance, training, and other resources is most important.

The United States is a leader in the field of private power production, with valuable experience under PURPA of providing access to the grid to small private producers. Like IRP, PURPA-type legislation changes utility rules to help correct the bias in favor of large conventional generating facilities. The benefit of this experience could be made readily available to developing countries under AID or other programs.

The World Bank also has programs to promote privatization. A privatization group, applicable to all industries but of particular importance to energy, assists in developing the legal and statutory framework for regulation of private investments. The program helps in the formulation of divestiture policies for the public sector and provides technical assistance as needed to support privatization. Bank lending and cofinancing arrangements are also designed to support privatization as appropriate. Assistance is given in structuring agreements that serve as the security package for investors, lenders, and governments. Critical to the success of privatization and private capital mobilization are programs that guarantee payments for investors if their power purchase contracts are not honored. Agencies such as MIGA can play a role here.

A major element of the broad private sector power strategy is development of the local capital market,

[7]James B. Sullivan, ''private power in Developing Countries: Early Experience and a Framework for Development' *Annual Review of Energy 1990*, vol. *15, pp. 335-363.*

[8]The Public Utilities Regulatory Policies Act of 1978 (PURPA) requires utilities to purchase electricity from qualifying facilities at avoided cost.

[9]The appropriate system and the mix of public and private elements in it will, however, be country specific. A recent World Bank review found that public ownership could be as effective as private ownership, and that good performance was generally found to be related to management capacity and the degree of autonomy. Common features of successful power companies were found to be their relative autonomy of management, procurement and staffing functions; sound professional and nonpolitical organizational structure; appropriate tariff policy that takes economic costs into account; and operation on sound commercial principles. W. TepLitz-Sembitzky, ''Regulation, Deregulation or Deregulation: What Is Needed in the LDCs,'' Energy Development Division, World Bank, Energy Series Paper #30, World Bank, July 1990.

[10]The major centrally funded programs within AID for implementing these objectives are the Bureau for Science and Technology, Office Of Energy, Private Sector Energy Development (PSED) project, and some aspects of AID centrally funded projects such the Renewable Energy Applications and Training Project, Energy Conservation Services Project, and Biomass Energy Applications and Training.

both to supply needed local currency inputs and also to vest continued control in local hands. The International Finance Corporation, part of the World Bank family, is one of the few donor program devoted to the encouragement of developing-country private sector activities. The International Finance Corporation is a natural vehicle to stimulate the development of private sector energy supply and end use energy service initiatives.

Providing Economic Incentives

In addition to institutional barriers, economic systems frequently do not provide sufficient incentives to encourage the rapid diffusion of energy efficient technology or small scale renewable. High interest rates faced by consumers discourage purchase of initially high cost yet efficient equipment. Heavy reliance on indirect taxes often means high tariffs on imported equipment. The operation of energy markets is hampered by price controls, price distortions, and cross subsidies. Subsidized prices may make energy more affordable to low income groups, but do not encourage efficient use of energy or provide adequate revenues for system maintenance or expansion.[11]

Issues of energy pricing are frequently addressed in programs of general macroeconomic and energy sector reform by international and bilateral agencies. In recent years, the World Bank has increased the scale of its structural adjustment programs, which now account for 15 percent of total World Bank lending. While designed to improve the health of a country's economy generally, such programs often include specific requirements to reform energy and other pricing systems and to improve the working of capital markets. World Bank energy sector loans typically include energy pricing reform.

Congress has also instructed AID to pay attention to energy pricing in its energy programs. The renegotiation of developing country public and commercial debt can be used as a vehicle for leveraging economic and energy sector reform (see option 12 in table 8-2). In so far as these actions reduce inflation and real interest rates and make energy prices reflect their long term supply costs, they improve the incentives to adopt energy efficient equipment and renewable.

Efficiency standards have played an important role in U.S. energy policy, but have received less attention in developing countries. U.S. experience could be useful to developing countries as they formulate energy efficiency (and environmental) standards. Efficiency standards could also be useful to developing countries to offset the impact of energy price reforms-a politically sensitive issue. If higher efficiency equipment can be introduced at the same time that energy prices are raised to reflect their true cost, the total cost of the service to the consumer need not rise (see option 13 in table 8-2).

Financing Issues

The lack of finance is often perceived to be a major barrier to the introduction of energy efficient and renewable energy equipment as well as to supply expansion. On the supply side, funds for energy sector development come from both public (about two-thirds) and private (one-third) sources. On average, about one-half of total investments for energy supply is in the form of foreign exchange (see table 8-2).

Bilateral aid from all sources accounts for only a small part of total developing-country energy investments. Although AID budgets have remained steady in real terms in recent years, the U.S. share of global foreign aid has declined. Any increase in overall aid budgets would run counter to efforts to control Federal spending, but the continuation of current trends will reduce U.S. influence in the development assistance forum and in related trade issues. Increased aid could reverse this trend and possibly leverage increased contribution from other bilateral donors. Alternatively, the share of energy in the existing AID budget could be increased, reflecting rising concern about global environmental issues, the reduction of global poverty, and the increasing demands on current budgets from new programs directed to Eastern Europe (see option 14 of table 8-2).

The MDBs already operate large energy programs in which they are presently, partly in response to congressional initiative, raising the energy efficiency component and incorporating environmental considerations. In addition, the Global Environmental Facility could, if interpreted more broadly to include efficiency projects, increase the resources

[11]Indeed, insofar as inadequate revenues lead to shortages or unreliable supplies of energy and consequently reduce job opportunities, subsidies can ultimately darnage those elements of the population they were designed to protect.

Table 8-3-Estimate of Investment in Commercial Energy Supplies in Developing Countries, Early 1980's (billions of 1982$)

	Electricity	Oil and gas	Coal	Total
Foreign exchange: external borrowing	11	4.2	0.5	1 9.7a
Foreign exchange: other	0	16.3	0.5	16.8b
Local	19	10.5	3.0	32.5
Total	30	31.0	4.0	65,0

[a]Of which:
- export related 5.1
- multilateral 3.9
- bilateral 1.5
- financial institutions 5.2

15.7

[b]Residual, assumed private investment and expenditure of countries own foreign reserves.

SOURCE: Based on data in World Bank, Energy *Transition in* Developing *Countries*, Washington, DC, 1983, pp. 68,69.

available for energy efficiency and small renewable energy projects. The increasing demands on World Bank and AID for funds for the countries of Eastern Europe and the Soviet Union, however, could come at the cost of assistance to developing countries.

Though public sector funding has provided about one-third of the foreign exchange costs of overall energy supply investments and a large part of electricity investments, there is general agreement in many developing countries that the private sector must play a larger role in the future. The interest in more private sector participation stems from both the shortage of public funds to finance development and the belief that competition from privately owned facilities will improve energy sector performance,

The United States has a number of long standing programs to encourage U.S. private sector investment and trade. In addition, the U.S. supports a variety of activities to bolster investment reforms and build local capital markets in developing countries. Activities in this area include: investment reform developed by the Inter-American Development Bank under the Enterprise for the Americas Initiative, IFC programs, and World Bank and International Monetary Fund economic adjustment projects. While designed for broader purposes, progress in this area will also benefit the energy sector.

High levels of debt in developing countries (currently about $1.3 trillion)[12] limit the resources available for investment in energy and other development sectors, and discourage private sector investment. Official debt traditionally accounts for a high share (75 percent or more) of total debt of the poorest countries. Most OECD governments, including the United States, have provided, and are continuing to provide, debt relief to poor African countries.

Among the middle income highly indebted countries, however, the share of official debt rose from 22 percent in 1982 to 37 percent in 1988 as private borrowing fell sharply in the 1980s.[13] Private debt still, however, accounts for the largest part of developing-country debt. In recent years, this debt has been reduced somewhat either under the Brady Plan or market based conversion procedures .14

Debt forgiveness, renegotiation, or restructuring provide an opportunity for conditionality-debt written down and interest forgiven to the extent that debtor governments undertake to fulfill certain agreed conditions such as increasing domestic energy prices. Debt for nature conversions are often a part of these transactions. The debt for nature model could equally be applied to debt for energy efficiency. Similarly, debt swaps could be used to fund support of energy technology research, development, and demonstration.[15] Additional require-

[12]Karin Lissakers, **"Debt and Energy," contractor report prepared for the Office of Technology Assessment, January 1991, Table 1.**

[13]K. Lissakers, Ibid.

[14]The Institute of International Finances estimates that **debt obligations** were reduced **by $18 billion** in 1988 though **debt equity swaps,** other local **currency conversions and private sector restructuring. Institute of International Finance, Inc., "Improving the Official Debt Strategy: Arrears Are Not the Way, " Washington, DC, 1990, figure 2.**

[15]Brown, **op. cit., footnote 4.**

ments could include establishing domestic revolving finds for energy conservation investment. Debt restructuring, by improving the investment climate, encourages the repatriation of capital (as has recently taken place in Mexico) and the resumption of new foreign investment (as in both Mexico and Brazil). This is increasing resources available for investment in energy.

The financing problem concerns not only the total amount of resources available, but also the tailoring of these resources to energy sector needs and opportunities. For example, World Bank lending usually consists of a small number of large scale conventional supply projects rather than a large number of small projects, as typical of energy conservation and small scale renewable projects.[16] Changes in funding procedures will be needed to better match the requirements of new types of projects.

The total life cycle costs of energy (particularly electricity) efficient equipment are generally lower than those of inefficient equipment. The first costs of efficient equipment to end users, however, are usually higher, even though total systemwide capital costs—including both utility and end user capital investment-are lower. This is an important deterrent in countries where capital is scarce and expensive. Further, adoption of electricity-using energy efficient equipment shifts investment from utilities that usually have easy access to relatively low cost capital to the individual consumer who usually faces higher interest rates. This situation calls for innovative financing mechanisms. These could include the development of intermediary institutions or service companies to finance the initial higher capital cost to the end user through the subsequent electricity savings; or action by the utilities (through loans, rebates, etc.) to assume part of the higher initial costs to the consumer (see option 15 of table 8-2).

A second characteristic of energy efficiency is the need to influence a large number and variety of consumers, from large energy intensive industries to individual householders. This wide range underlines the importance of broad incentive measures such as energy price reform, equipment or appliance standards, and innovative financial mechanisms. There will also be new supply side actors—promoters of private power schemes and small scale decentralized renewable. Some of these actors are likely to be smaller in scale then traditional suppliers, and will lack the traditional suppliers knowledge of the special conditions of developing country markets, financial resources, and established relations with large banking systems. Special banking facilities grouping a series of small projects together in a way that would make them suitable for traditional banking procedures would be useful (see option 15 of table 8-2). There may also be a need to redistribute funds within the usual project cycle, with a larger share of the resources in the prefeasibility and feasibility stage than is usual in well-established systems.

Ultimately, it is the developing countries themselves that provide the bulk of resources for energy sector investment. At present, these resources come from the public sector as most energy supply facilities (the electricity sector, oil and gas in many countries) are public sector enterprises. Many developing countries are experiencing severe financial stringency, however, and are unlikely to be able to meet the increasing financial demands of the energy supply sector from traditional sources. This is particularly acute in the electricity sector, which in many developing countries is running at heavy financial losses. Given the scale of investment requested, the developing countries will need to both improve the revenue situation of public supply enterprises and attract private capital into the energy sector. Many of the new initiatives (e.g., energy efficiency improvements, new power generation, and development of new natural gas or renewable energy resources) might best be undertaken by the private sector.

[16] Multilateral organizations find it easier to fund large rather than small projects because: 1) A loan for a given amount consisting Of a large number of small projects is inherently more information and management intensive, and therefore collectively have higher staffing requirements than a similar loan covering only one project. 2) Small projects require budgets and staff from multiple program areas, which is often difficult to achieve in existing organizational structures, 3) Many new smaller-scale technologies may not be known to staff or, even if known, may be felt to be too risky given the existing state of knowledge and experience to recommend to recipient countries. 4) Small scale technology generally does not involve large scale projects and therefore may not be politically attractive to borrowers. 5) Project appraisal methodologies are incompletely developed and have a bias against renewable technologies and conservation. The lack of integrated least cost energy planning at the national level results in bias towards supply investments. 6) Conservation involves direct intervention into specific industry production processes, which runs counter to World Bank funding policies.

REDEFINING PRIORITIES

priorities in foreign policies are constantly changing, especially in the present climate of global political and economic uncertainty. In recent years, a number of issues of U.S. policy concern have emerged that are closely connected with energy. These include: U.S. trade and international competitiveness; environmental problems; and growing poverty in many developing countries despite rapid rates of economic growth.

Enhancing U.S. Trade and Investment Opportunities

Much U.S. technology transfer to developing countries occurs through private sector exports of machinery and equipment and the transfer of equipment and know-how associated with private foreign investment. U.S. based companies account for a significant part of the oil and gas exploration in developing countries. They are also taking a keen interest in new opportunities for foreign investors in gas and electricity development in the developing countries.

Expanding markets for energy technology in developing countries offer an important opportunity for U.S. industry and exporters.[17] In recent years, however, the U.S. share of global markets for major items of energy equipment has been declining (see table 8-4). Several factors have contributed to this decline. U.S. investors and exporters frequently encounter difficulties operating in developing countries. Some of the smaller U.S. companies lack experience in international markets. A lack of open markets in energy technology and market distortions, including anticompetitive practices by OECD competitors and greater direct financial support by other governments, compounds the difficulty. These practices hurt not only the United States, but may also be disadvantageous to the developing country. In some cases, the developing country may be obliged to accept less than optimal technologies or may accept a wide range of incompatible equipment, complicating training and spare part problems.

Trade and Investment Support Programs

A number of programs have been developed to support the U.S. private sector in technology transfer. These programs cover: trade and investment support through market information, finance, and insurance facilities; trade policies to establishing fair and open competition in export markets and protection for U.S. exporters; and removal of restrictions on certain commodities and markets (see box 8-E).

One option for Congress would be to expand such programs (see option 16 of table 8-2). Support could be increased for the overseas activities of the United States and Foreign Commercial Service (US& FCS), which is responsible for much of the overseas export promotion undertaken by the Federal Government.[18] Compared with many of its trading partners, the United States devotes only modest resources to export promotion abroad. For example, Japan has about 5,000 overseas commercial officers, the UK and France 400 or more, compared with the United States' 200, despite its much larger economy.

The Trade and Development Program could also be increased in size to better match the efforts of U.S. competitors. There are several areas where TDP might expand their promotion of energy projects. For example, it appears that the demand for TDP financial support for definitional missions and prefeasibility studies is substantially in excess of TDP resources, even without a substantial outreach and promotion effort. Given the high multiplier in trade and/or investment benefits from TDP expenditures and the substantial industry support for these activities, funding could be increased.

These trade support programs have in general responded to the increased interest in conservation technologies and renewable, and environmental impacts of energy technologies, but could do more (see option 17 of table 8-2). Many programs were originally set up to promote exports made in connection with large conventional supply projects.

[17]One report, ''Opportunities in the Worldwide Overseas Power Generation Market,'' prepared for the U.S. Agency for International Development Office of Energy by RCG/Hagler Bailly Inc., estimates that over the next 20 years, the United States could sell about $94 billion of power equipment to the developing world (page 4). A companion report, "U.S. Exports of Oil and Gas Exploration and Production Equipment and Services,'' RCG/Hagler Bailly, Inc., for U.S. Agency for International Development, draft, Exhibit 2, suggests a market for U.S. exports of oil and gas exploration and production equipment and services of an additional $110 billion, of which a substantial share would occur in developing countries. Expanding markets in energy conservation equipment could also result in large U.S. exports.

[18]This option is also discussed in U.S. Congress, Office of Technology Assessment, *International Competition in Services*, OTA-ITE-328 (Washington, DC: U.S. Government Printing Office, July 1987), ch. 10.

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Table 8-4-Share of United States in Selected Global Exports
(as a **percent of the total world market)**

	1976	1980	1985	1987
Steam boilers:				
Us.	**17.8**	**19.2**	**14.9**	**11.3**
Japan	**11.0**	**21.8**	**36.0**	**29.0**
Germany	**25.1**	**18.0**	**9.6**	**14.5**
Heating, cooling equipment				
Us.	*23.0*	**20.7**	**17.9**	**14.1**
Japan	*10.8*	**14.9**	**18.2**	**15.9**
Germany	*17.6*	**15.5**	**15.6**	**17.3**
Pumps for liquids:				
Us.	**21.3**	18.8	**19.3**	**13.5**
Japan	**6.0**	7.9	**10.2**	**8.8**
Germany	**25.5**	23.2	**23.8**	**29.1**
Pumps:				
Other U.S.	**24.1**	20.4	**16.4**	12.4
Japan	**5.8**	9.1	**14.8**	13.2
Germany	**22.9**	19.8	**22.8**	22.2
Switchgear:				
Us.	**14.2**	**13.4**	**15.9**	**13.1**
Japan	**10.0**	**12.3**	**15.8**	**17.1**
Germany	**24.2**	**22.6**	**20.6**	**22.7**
Electric distributing equipment:				
Us.	**11.6**	**10.0**	**16.2**	**16.3**
Japan	**13.8**	**17.5**	**15.1**	**11.5**
Germany	**15.7**	**15.0**	**12.3**	**13.9**
Electrical machinery:				
Us.	**17.2**	**16.0**	**16.6**	**13.0**
Japan	**12.7**	**15.5**	**21.5**	**21.4**
Germany	**23.7**	**18.4**	**15.8**	**18.2**

SOURCE: United Nations, Department of international Economic and Social Affairs, Statistical Office, *Statistical* Yearbook(NewYork, NY: United Nations, 1988), various issues.

These were primarily done by large corporations accustomed to dealing in foreign markets and aware of the official programs available. Exports of renewables and conservation equipment and services, however, may in many cases be made by small companies, unfamiliar with foreign markets and government programs. Program responses to this new clientele include providing increased prefeasibility and feasibility funding needed by small companies, and simpler application procedures. CORECT for example, is promoting a standardized application form for all of its member agencies.

Another development, which may require changes in existing programs, is the growth of project or limited recourse financing arrangements (see option 18 of table 8-2), projects in which the U.S. investor does not receive formal sovereign guarantees. This is an attractive form of financing for developing countries as it does not add to their official debt burden. As purchases of energy equipment and services looking increasingly to sellers to organize financing, it is important to establish a framework within the U.S. system that facilitates this financing. Both TDP and OPIC appear to be moving in this direction. OPIC, for example, has taken the initiative in establishing several equity investment funds. These could serve as model mechanisms to stimulate commercial capital flows to the developing countries. Broadening Eximbank's authority to support project finance could also assist in stimulating new U.S. energy sector technology transfer and investment.

Ensuring Competitive Markets **for U.S. Exports**

U.S. exporters and investors may encounter uncompetitive practices in developing-country markets. The U.S. Trade Representative conducts bilateral and multilateral trade negotiations to reduce or eliminate trade and investment barriers. These include: lack of guarantees for intellectual property rights, restrictive import licenses, and high tariffs (see box 8-F). USTR resources could be expanded to better respond to these and many other trade related issues now facing the nation. Additional responsibil-

Box 8-E—Programs for U.S. Trade and Investment

The *Agency for International Development (AID)* supports prefeasibility funding studies and sponsors reverse trade missions and an energy and environmental training program for host country nationals. AID maintains a private power database, which includes a compilation of information relevant to private sector power activities for selected countries. [1]It consists of information in five categories: government policy, private project opportunities, project commitments, country specific points of contact, and a general country private power related bibliography. The primary intended beneficiaries of this information are U.S. project developers.

The *Department of Energy* supports exports through its Export Assistance program and CORECT and by other means (see Box 8-D).

In the *Department of Commerce, the Office* of International Major Projects (OIMP) functions as a facilitator for U.S. architectural, engineering, and construction industries in the promotion of exports for major projects overseas, mainly in developing countries, in addition to the export assistance activities of the United States and Foreign Commercial Service. The *Trade and Development Program* (TDP) in the U.S. International Development Cooperation Agency (whose focus is primarily on large public sector projects) provides support for definitional missions, feasibility studies, technical symposia, orientation visits by high-level government officials, and plans to initiate training activities. In addition, TDP operates an Investor Assistance Program, which offers feasibility study support on a cost-sharing basis, and the State Initiative Program, which is authorized by Congress up to $5 million to develop a cooperative program with State agencies. The program has concentrated on information dissemination, including, for example, support to the California Energy Commission in its export promotion activities. The *U.S. Trade Representative* formulates overall trade policy and conducts bilateral and multilateral trade negotiation, including the removal of barriers to U.S. exports,

U.S. private investment and exports are also supported by a number of autonomous agencies. The *Export-Import Bank (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 through direct loans, guarantees, and insurance. The 1990 Foreign Operations Appropriations Act (Public Law 101-167) instructed Eximbank to direct not less than 5 percent of its financial assistance in the energy sector to renewable energy projects. This goal has probably been exceeded. In fiscal year 1989, the Eximbank provided final commitments to support $2.1 million in renewable energy projects (i.e., hydroelectric, photovoltaics) and had pending commitments for an additional $11.8 million. Assuming pending commitments are finalized, Eximbank's fiscal year 1990 support for renewable energy projects would represent 7.4 percent of its total energy sector support. The *Private Export Funding Corp.* (PEFCO) is closely related to Eximbank although it is a private corporation owned by 62 investors, mostly commercial banks. It makes medium and long term loans to borrowers in foreign countries for U.S. goods and services, using unconditional Eximbank guarantees.

The *Overseas Private Investment Corporation (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. 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. 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.

In addition to federally sponsored programs, several States have initiated programs centered on export promotion. The geographical focus varies from State to State. New York tends to pursue trade in Europe and Japan, California and the Pacific Northwest are turning more to the Pacific Basin, and Florida focuses on Latin America. California has been especially active in export promotion through various programs, including one that guarantees export loans given by commercial banks and supports trade missions, and others through the California Energy Commission. Since 1986, the California Energy Commission (CEC) has supported an Energy Technology Export Program, designed to facilitate exports by California firms.

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[1]Philippines, Pakistan, Costa Rica, Jamaica, and India, with plans to add Thailand and Indonesia.

SOURCE: Office of Technology Assessment, 1992.

Box 8-F—Examples of Import and Other Regimes Affecting the Transfer of Technology in Selected Developing Country Markets

Brazil: U.S. merchandise exports to Brazil in 1989 were $4.8 billion, with imports of $8.4 billion. Brazil's import policies have been characterized as forming substantial pervasive barriers to U.S. exports. Restrictive import licensing policies have been particularly effective barriers. Tariffs have recently been reduced, from about the range of 40 to about 25 percent ad valorem, taking into account exemptions. Government procurement in many cases is still restricted to national firms; the United States has in response prohibited U.S. Government awards to Brazilian suppliers. Brazil has various export subsidy programs, and lacks intellectual property protection for some classes of goods. Provision of services by non-Brazilian firms is also restricted in some areas, for example in construction engineering and architectural, data processing, and telecommunications areas. Foreign investment is prohibited in several areas including petroleum production and refining, public utilities, and various other "strategic" industries.

India: In 1989, U.S. merchandise exports to India were $2.5 billion, versus imports of $3.3 billion. India is characterized as having a complex and comprehensive web of market access barriers, which are a serious barrier to U.S. firms. Indian tariffs are exceptionally high, with a weighted average level of 118 percent. Import licensing requirements are considered particularly effective trade barriers. They are limited to end users, not distributors, and require in many cases a certification that the product is not available from domestic sources. Government procurement discriminates against foreign suppliers. India appears to have expanded its export subsidy program. The USTR has judged that intellectual property protection in India is inadequate. Policies also severely limit potential U.S. investment. Criteria in many cases are unpublished, and decisions are made on a case-by-case basis.

Pakistan: The United States had a trade surplus with Pakistan in 1989, with merchandise exports of $1.1 billion, versus imports of $523 million. Both import bans and high tariffs inhibit U.S. exports. Export subsidies of various types are common. Intellectual property protection is judged to be inadequate, with the USTR continuing to seek improvements. Investment barriers face foreign investors, both in terms of a location policy promoting dispersal, an indigenization policy requiring a gradual deletion of imported components, and cumbersome approval policies. Technology licensing restrictions also exist through limits on license fees and approval procedures.

SOURCE: Office of the U.S. Trade Representative "Foreign Trade Barriers" 1990 Trade Estimate Report, US Government Printing Office, 1990.

ities arising out of the proposed U.S.-Mexican Free Trade Area, and the Enterprise for the Americas reinforce this argument.

The issue of "level playing fields" in international energy technology export markets and international competitiveness has become of major concern to Congress and the American people in recent years. There are widespread perceptions and reports of our frequent inability to offer terms in export markets as attractive as those of our competitors (Japan, Germany, France, Italy, the UK) because of the use of 'mixed credits' and the practice of tied aid. Mixed credits occur when apart of the total costs of a commercial export transaction is covered by confessional rates, thus resulting in a lower average cost to the recipient country. The advantage of mixed credits to the donor country is that it frequently secures an export order; the disadvantage is that this order is partly subsidized by the taxpayer. The recipient country benefits from goods that are cheaper than they would be in the absence of mixed credits. The disadvantage to the recipient country is that it may accept the cheapest offer even if for technical, maintenance, or other reasons another choice would have been preferable. Tied aid occurs when donors provide aid to developing countries on condition that the necessary goods and services are bought from the donor country rather than through open competitive bidding on the world market.

While there appears to be general agreement on the competitive advantage that mixed credit and tied aid has given other nations vis-a-vis U.S. exporters, the extent of this impact is controversial (see box 8-G). Various limiting terms and conditions governing tied-aid credits have been negotiated by the United States to reduce the incidence of trade-distorting credits by competitors. The "Arrangement on Guidelines for Officially Supported Export Credits' agreement of March 1987, amended in July 1988, governs OECD member practices. The "arrangement requires, for example, that tied-aid credit packages should include a substantial grant element (a minimum 35-percent grant for middle-income LDCs and a 50-percent grant for low-income

LDCs). The OECD rules also require advanced notification of tied-aid credit deals. The purpose of these arrangements is to discourage mixed credit financing by increasing their cost to the donor country.

The United States has recently initiated a more active policy. In 1986 Congress authorized a 2-year, $300 million **tied-aid** War Chest as part of the Export-Import Bank Act Amendments (Public Law 99-472). Due to the failure to establish clear violations, a limitation of the fund to defensive purposes only, and a generally negative view of use by the Administration, the War Chest was seldom used up to 1989. In September 1990, in support of negotiations on tied-aid credits, the Administration indicated that it had decided to use all available budgetary resources, including the War Chest. In fiscal year 1991, $500 million[19] has been allocated to a tied-aid pool for enhancing U.S. industrial competitiveness. The focus is to be on Indonesia, Pakistan, the Philippines, and Thailand. Project sectors targeted include electric power as well as telecommunications, transportation, and construction equipment. Two recent energy projects for which the War Chest has been used are the Uruguay Power Project (versus a French 35 percent grant tied-aid credit offer, with the U.S. bidder ultimately winning this contract); and the Philippines Barge-Mounted Power Plant, where the offer is opposing Japanese and British confessional offers.

Even in the absence of tying, U.S. exports of energy technologies might still encounter difficulties. U.S. competitors allocate a large share of their aid funds to the energy sector and to capital infrastructure. In contrast, the United States directs a larger fraction of aid for structural development and policy reform. AID capital project support has largely disappeared except for the programs in Egypt and Pakistan. In these two cases, the large-scale use of Economic Support Funds occurs without tying to U.S. procurement.

Effective tying may also require the development of complementary institutional structures. In its current form, tying has been found to be ineffective in some cases in stimulating new markets for U.S. goods, and has sometimes complicated and hindered project operations.[20] A recent GAO[21] report found evidence of U.S. source and origin requirements requiring "countless waivers in Egypt for lack of interest on the part of U.S. suppliers or unavailability of certain commodities from U.S. sources. Furthermore, the Cargo Preference Act to ship in U.S. flag vessels cost up to 5 times that of non-U.S. flag vessels and at times caused lengthy delays while shipments were consolidated for shipment in U.S. vessels. Increasing the project element in economic security funds also requires substantially more up-front planning and analysis.

Reducing Poverty and Improving Social Welfare

The reduction of poverty is a central aim of U.S. foreign assistance. Despite rapid rates of economic growth experienced in the developing countries from the 1950s to the end of the 1970s, the numbers of people living in poverty in the developing world continued to increase. In recognition of the need for special programs targeted at the poor, Congress directed AID to pay increased attention to the development problems of the poorest of the poor. Fulfilling this policy objective has implications for energy, which is an essential component in meeting basic needs. While reliable supplies of high grade commercial fuels are essential for raising productivity and living standards, they are currently used primarily by the modern urban sector of the economy. However, many of the developing world's population live in rural areas with low standards of living based largely on low resource farming. Rural populations have little access to commercial fuels and technologies and only limited connection with the modern economy.

Additional attention to energy for rural development could be considered (see option 19 of table 8-2). Rural industry is a major user of biomass energy in rural areas and an important source of rural employment and cash income; its energy needs also

[19] $100 million from EXIM's tied-aid credit fund, $300 million in EXIM-guaranteed commercial loans, and $100 from AID Economic Support Funds.

[20] 'Delivery time of U.S. equipment has been long, and inoperative U.S. vehicles, pumps, and other equipment litter the Sahel for Want Of spare parts, maintenance stills, or operating funds. . . In addition, these "buy American" requirements have led to use of inappropriate capital-intensive technologies . . . [and] greatly diminished its value to them [less developed countries].' U.S. Congress, Office of Technology Assessment, OTA-F-308, Continuing *the* Commitment; *Agricultural Development in the Sahel* (Springfield, VA: National Technical Information Service, 1986), p. 105.

[21] U.S. General Accounting Office "Foreign Assistance; AID Can Improve Its Management of Overseas Contracting" GAO/NSIAK-91-31, October 1990, pp. 23-24.

Box 8-G—Tied Aid

According to one study[1] the tied-aid affected market for telecommunications, power generation, computers, and transportation is considerable, estimated to be about $10 to $12 billion per year, with losses to U.S. exporters on the order of $2.4 to $4.8 billion. Furthermore, according to this report, long run costs could be much greater. An earlier Eximbank report,[2] on the other hand, estimates a substantially lower figures, $400 to $800 million per year.

Other factors, however, suggest that losses may be greater than those estimated by Eximbank:

- Tied-aid credits (which include a 35 percent grant element) have substantial distributive impacts since they go heavily to middle-income developing countries. Given limited total aid dollars, this allocation subtracts from the confessional resources available for poorer countries.
- The closure of the European and Japanese markets for heavy electrical equipment to foreign competition as matters of national policy, appears to produce financial surpluses to the domestic supply industries of these countries, which are then available to underwrite export sales to the United States and developing-country markets.
- Use of tied engineering and consultancy services, a practice widely used by the Japanese, results in specifications favoring donor's suppliers. Partly as a result, some 85 percent of partially untied development assistance (about 37 percent of Japanese ODA loans) results in procurement from Japan, and for fully untied loans (62 percent of Japanese ODA loans) about 60 percent of procurement is in Japan. Furthermore, Japanese ODA is largely devoted to project assistance and relies heavily on loans (about two-thirds at near market rates).
- Frequent failure of OECD competitors properly to follow notification procedures for tied-aid credits leads to a competitive advantage.

[1] Ernest H. Preeg, "The Tied Aid Credit Issue," Center for Strategic and International Studies, Washington DC, 1989.
[2] Export-Import Bank, "Report t. the U.S. Congress on Tied Aid Credit Practices," Washington, DC, April 1989.

merit attention, The improved economics of decentralized renewable, such as photovoltaics or mini-hydro, suggest renewed emphasis on the institutional obstacles that deter diffusion. The domestic energy needs of the urban poor are currently receiving little attention, even though energy used for cooking contributes heavily to poor urban air quality in many areas.

AID funding of energy projects targeted at the poor is modest. In the decade of the 1980s, for example, total AID energy funding to Africa was just over $1 million annually. Application of the technologies suggested above will require a variety of complementary inputs, which AID could facilitate, including policy reform, credit programs, and technical assistance.

Rural energy receives relatively little attention from the MDBs as well. The World Bank, which earlier in the 1980s had substantial lending programs for rural electrification, has reduced the number of projects in recent years. The recent reorganization of ESMAP may lead to lessened interest in energy projects for the rural and urban poor, As previously constituted, ESMAP contained a special household energy unit that addressed the technical, economic, and social issues related to energy use and supply in lower income urban and rural households and in rural industries. The reorganized ESMAP will deal only with commercial fuels and confine itself to fewer "priority' countries. This reorganization is expected to promote better energy sector planning in the selected countries and be more instrumental in increasing investments, but could result in less of a role than before in rural and household energy supplies.

One of the problems in rural energy projects is securing the high level of technical assistance needed. Donor agencies could examine ways of delivering such technical assistance through non-governmental organizations with demonstrated ability to deliver technical assistance and financing at the local level (see option 20 of table 8-2).

Protecting the Environment

Congress has become increasingly concerned with the problem of achieving sustainable economic growth in developing countries and the growing role of developing countries in global environmental problems. This concern is expressed in directives to AID and MDBs to take into account environmental

impacts in their developing country programs. Progress in these efforts may need to be monitored (see option 21 of table 8-2). There may also be a need to coordinate the activities of the many U.S. agencies and NGOs that have environmental activities in developing countries. The CORECT program or others could serve as a model. The Environmental Protection Agency may be a logical host for such a program (see option 21 of table 8-2).

Environmental protection in many countries is still in its infancy due to competing economic and social priorities, limited resources, and lack of knowledge and experience in environmental management and protection. The policy infrastructure for environmental protection is as yet poorly developed, There is a need for technical assistance and advice to support environmental impact monitoring and mitigation strategies and to establish the government policies and institutions for environmental protection (see option 21 of table 8-2), The United States could help provide technical assistance in these areas.

One of the obstacles to securing environmental protection in all countries is that the cost of environmental damage is typically not included in prices, nor is use of natural resources included in the current system of national accounts. Unsustainable exploitation of forests for timber exports, for example, appears in the current system of national accounts as increases in the gross domestic product, while ignoring any environmental damage associated with this exploitation and the reduction of the natural resource stock. Congress has already instructed the U.S. Ambassador to the United Nations to adopt economic accounting procedures that include natural resource values and services in the UN accounting system. The UN has agreed to incorporate these concepts to the extent possible in its next revision of its standardized national accounts system, which serves as the national accounting model for all market or mixed economies.

Concern over global warming focuses particular attention on large carbon dioxide emitters including both industrial and developing countries-China, India, Brazil, Indonesia, and Mexico. The United States, however, does not have a strong bilateral relationship with all of these countries. Congress recently directed AID to help key low and middle-income countries likely to become major emitters of greenhouse gases whether or not they are currently AID countries. The United States is also cooperating with the Global Environmental Facility through a special AID program.

Population plays a major role in long term environmental sustainability. Under the Foreign Assistance Act as amended in 1965, the U.S. position was that family planning could be considered an important contributor to economic development and improved health and nutrition.[22] Most nations now firmly support family planning assistance. At the World Population Conference held in Mexico City in 1984, however, the United States reversed this position and introduced new restrictions on family planning assistance in AID. Two important international population assistance programs lost U.S. funds-the International Planned Parenthood Federation, and the United Nations Population Fund (UNFPA). According to the UNFPA, more assistance, particularly for family planning services, is needed to ensure the stabilization of the world's population. The additional direct cost of providing contraceptive services would be under $1 billion per year, but several billion dollars per year would also be needed for a range of supporting activities such as education women's programs, and research and development (see option 22 of table 8-2).

Setting a Good Example

U.S. commercial energy consumption per capita is almost 15 times higher than the average per capita consumption for all developing countries, and over 60 times higher than in the poorest developing countries. Strong efforts to improve efficiencies, and the use of renewable energy at home are needed to provide credibility to U.S. policies in developing countries (see options 23 and 24 of table 8-2).

Evidence of energy efficiency gains in the United States is provided by the leveling of energy consumption after 1973—a marked **change** from **the** previous steady annual increases. Since 1986, however, energy consumption has been rising steadily, in virtual "lockstep" with the gross national product

[22]P.J. Donaldson and C.B.Keely, ''Population and Family Planning: An International Perspective, '' Family Planning Perspectives 20(6):307-311 ,320 (November/December1988; U.S. Congress, Library of Congress, Congressional Research Service, "International Population and Family Planning Programs: Issues for Congress, ' IB85 187 (Washington, DC: Mar, 30, 1990); U.S. Congress, Office of Technology Assessment, *Changing by Degrees: Steps to Reduce Greenhouse Gases, OTA-O-482* (Washington, D. C.: U.S. Government Printing Office, February 1991).

and posting substantial increases in per capita consumption. Further efforts to achieve perceptible and measurable improvements in energy efficiencies in the United States would reinforce policies designed to improve energy efficiencies in developing countries. Such actions to improve efficiency at home would have collateral economic, energy security, environmental, and competitiveness benefits for the United States. Also, an expanding market for energy efficient technologies lowers manufacturing costs, thus adding to U.S. competitiveness. A particularly useful initiative could be to ensure, as requested by Congress, that U.S. facilities in developing countries are highly energy efficient and take advantage of renewable energy sources where feasible. U.S. embassies, office buildings, and residences could serve as showpieces for advanced U.S. energy efficient technologies.