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# Financial Incentives for Renewable Energy Development

*Proceedings of an International Workshop, February 17–21, 1997, Amsterdam, Netherlands*

*E. Scott Piscitello*
*V. Susan Bogach*

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# FOREWORD

The Government of China (GOC) is giving increased attention to developing its vast wind, solar, and other renewable energy resources in order to provide least-cost energy services to remote areas and, in the longer term, to diversify energy sources and the growth of pollution from coal-fired power plants. China's national wind resources exceed 250 gigawatts (GW) and include several sites with world-class potential. Solar radiation is plentiful, especially in the sparsely populated northwestern part of the country where over 2 million households are without electricity. While China has had considerable success in promoting renewable energy under central planning, it is developing renewable energy policies suitable for the socialist market economy.

International experience shows that government policy support is the key to moving commercial renewable energy development forward in its initial stages. Government-supported financial incentives, in particular, play an important role in helping to develop commercial markets and reduce the financial life-cycle costs of renewable energy technologies. Other necessary policy support elements include effective long-term planning, careful establishment of priorities, and coordinated programs involving a variety of government and commercial institutions, such as long-term research and development, and technology transfer programs.

The experiences of other countries in the use of financial incentives to promote renewable energy development were discussed at a workshop designed to assist GOC in developing changes, where necessary, to China's present system of incentives for commercial renewable energy development. The workshop focused on grid-connected wind power and off-grid solar photovoltaics as examples. This Discussion Paper presents the proceedings of this workshop.

The Asia Alternative Energy Program (ASTAE) sponsored the workshop. The Program, jointly sponsored by the World Bank and other donors, has the mandate to stimulate environmentally sustainable and commercially viable renewable energy and demand-side management investments in Asia. The workshop was made possible by financial support from the Netherlands Alternative Energy Policy and Project Development Trust Fund.

Yukon Huang
Country Director
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# ABSTRACT

The World Bank is providing technical assistance to the Government of China (GOC) to help develop recommendations for changes, where necessary, to China's present system of financial incentives for commercial renewable energy development. As part of the technical assistance, the World Bank held a workshop in February 1997. This workshop brought together senior GOC officials, Bank staff, and senior government officials from six countries with experience in designing and implementing financial incentives for commercial renewable energy development. In addition to China, the six countries represented were Denmark, Germany, India, the Netherlands, the United Kingdom and the United States.

The workshop focused on experience with financial incentives for grid-connected wind power systems and off-grid photovoltaic systems. Incentives offered in each of the countries were summarized along with their results in terms of installed capacity, technology costs, and manufacturing infrastructure. The collective experiences of the countries were further examined to indicate future directions for developing financial incentives for market-based renewable energy development.

# PREFACE

This document presents the proceedings of a five-day workshop organized by the World Bank Asia Alternative Energy Program (ASTAE). The workshop explored recent international experience with financial incentives for encouraging commercial renewable energy development, so as to assist the Government of China (GOC) in making recommendations for incentives applicable within the Chinese context. The workshop was held in Amsterdam in February 1997 as part of the World Bank's broader Financial Incentives Policy for Renewable Energy Development Technical Assistance with GOC.

Workshop participants included a delegation of senior Chinese government officials from the State Council, State Economic and Trade Commission (SETC), State Planning Commission (SPC), State Science and Technology Commission (SSTC), and the Ministries of Finance, Electric Power, and Agriculture. Other participants included government officials responsible for renewable energy policy in the United Kingdom, Germany, the Netherlands, Denmark, the United States (California), and India.[1] The World Bank was represented by staff from ASTAE, as well as the China Country Operations and Industry and Energy Divisions. (See the list of participants in the Annex.)

Mr. Paul Hassing, of the Netherlands' Directorate-General for International Cooperation (DGIS), Ministry of Foreign Affairs, opened the workshop. His remarks set the tone by framing the discussion in terms of the near- and long-term environmental benefits of renewable energy development.

The first half of the workshop focused on the financial incentives offered for wind power development in each of the countries represented. Financial incentives for photovoltaic (PV) systems were discussed in the following session.[2] As India was the only participating country offering incentives for off-grid PV applications, Bank staff presented information on the incentives for PV solar home systems in Indonesia and Mexico. Bank staff also outlined the fiscal impacts of financial incentives and the factors that need to be considered by governments in making decisions about them. Finally, closing addresses were delivered by the leaders of the Chinese delegation and the World Bank team, as well as DGIS.

Following the workshop, the Chinese delegation visited the Hague (February 24, 1997), Bonn (February 25-26), and London (February 27-28) for further discussion of the financial incentive policies in those countries.

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[1] With the exception of the representative from India, these officials have reviewed relevant portions of these Proceedings.

[2] The United Kingdom and Denmark do not offer incentives for photovoltaics.

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The workshop was part of a technical assistance activity to assist the Government of China that was financed by the Asia Alternative Energy Program (ASTAE) through its Netherlands Alternative Energy Policy and Project Development Trust Fund.

Acknowledgments are due to the following government representatives who made presentations at the workshop on financial incentive policies for renewable energy development in their countries: Robert Meir (United Kingdom), Pramod Kulkarni (California, United States), Per Anderson (Denmark), Ajit Gupta (India), Roland Mayer (Germany), Erik Lysen and Kees Kwant (Netherlands), and Li Junfeng (China). Acknowledgments also go to World Bank staff and consultants who made presentations on fiscal considerations in developing financial incentive policies, and on international experience with financial incentives for off-grid photovoltaic systems and wind power: Anjali Kumar, Anil Cabraal, and David Lindley.

Acknowledgments are also owed to Robert P. Taylor, who guided the World Bank team, and to Zhao Jiarong who led the Chinese team at the workshop.

Liu Hongpeng and Wang Xiadong served as interpreters and contributed to the discussions, bringing their experience with energy development in China.

Finally, acknowledgments are due to Maria Aquino-Escay for the workshop organization as well as initial word processing, and to Genet Telahun, Meredith Dearborn and Norma Leon for word processing, editorial and production assistance.

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ASTAE | Asia Alternative Energy Program |
| BMBF | German Federal Ministry of Education, Science, Research and Technology |
| CFE | Commission Federal de Electricidad |
| $CO_2$ | Carbon Dioxide |
| CRED | Center for Renewable Energy Development |
| DGIS | Netherlands' Directorate-General for International Cooperation |
| DtA | Deutsche Ausgleichsbank |
| DTI | UK Department of Trade and Industry |
| ERI | Energy Research Institute |
| GEF | Global Environment Facility |
| GOC | Government of China |
| GW | Gigawatt |
| IEA | International Energy Agency |
| IIE | CFE's Electrical Research Institute |
| IPP | Independent Power Producers |
| IREDA | Indian Renewable Energy Development Agency Limited |
| kW | Kilowatt |
| kWh | Kilowatt-hours |
| kWp | Kilowatts peak |
| MNES | Indian Ministry of Nonconventional Energy Sources |
| MW | Megawatt |
| MWp | Megawatts peak |
| NFFO | Nonfossil Fuel Obligation |
| NFPA | Nonfossil Purchasing Agency |
| NOVEM | Netherlands Agency for Energy and the Environment |
| OFFER | Office of Electricity Regulation |
| PRONASOL | Mexico's National Solidarity Program |
| PURPA | Public Utility Regulatory Policy Act |
| PV | Photovoltaic |
| REC | Regional Electricity Companies |
| SEB | State Electricity Board |
| SMUD | Sacramento Municipal Utility District |
| VAMIL | Netherlands's Accelerated Depreciation of Environmental Investments Program |
| VAT | Value-Added Tax |

# CURRENCY EQUIVALENTS

(March-April 1997)

US Dollars = Currency Equivalent

US$1.00 = 6.48 Danish kroners

US$1.00 = 1.64 German marks

US$1.00 = 35.72 Indian rupees

US$1.00 = 1.93 Dutch guilders

US$1.00 = 0.63 British pounds

# SECTION 1. INTRODUCTION

The Government of China (GOC) is giving increased attention to renewable energy development. In the longer term, this will contribute to diversifying energy sources and curbing pollution problems caused by the coal-dominated power sector. Recognizing that in the short to medium term many renewable energy technologies will have financial life-cycle costs above those from conventional alternatives, GOC requested technical assistance from the World Bank for developing recommendations for financial incentives for commercial renewable energy development. Such financial incentives may be justified by longer-term environmental benefits, but need to be carefully designed and implemented.

To help focus the technical assistance in the Chinese context, financial incentives for wind farms and photovoltaic (PV) solar home systems were selected as examples of grid-connected and off-grid renewable energy systems, respectively. The decision to focus on these technologies is consistent with the findings of the World Bank's sector work with GOC[1] and the proposed World Bank/Global Environment Facility (GEF)-assisted China Renewable Energy Project (FY99).

As part of the technical assistance, the World Bank held a workshop in Amsterdam February 17-21, 1997 to present and discuss financial incentive policies that have been used in selected countries, their impacts, and their applicability to China. The workshop brought together senior GOC officials, World Bank staff, and senior government officials from six countries (Denmark, Germany, India, the Netherlands, the United Kingdom, and the United States) that share China's commitment to development of commercial markets for renewable energy technologies via financial incentives and other policies.

These Proceedings summarize the main findings of the workshop. Financial incentive policies to commercialize renewable energy continue to evolve and to be modified in each country, in response to changing priorities and market conditions as well as experience gained. In this sense, these Proceedings represent a "snapshot" as of mid-1997. The Proceedings are intended to document international experience to assist GOC in developing financial incentives for renewable energy development. The Proceedings should be useful to policymakers and stakeholders in other countries as well.

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[1] See *China: Renewable Energy for Electric Power,* World Bank Report No. 15592-CHA, September 1996.

Section 2 of these Proceedings summarizes the financial incentives offered by each of the six invited governments and their results as discussed in detail at the workshop. An analysis of the experiences is presented in Section 3 showing the present direction of financial incentive policies. Included in this section is a discussion of the countries' rationales for moving in these directions based on experience with previously applied financial incentives, and the evolution of renewable energy technologies. Section 4 provides detailed accounts of the incentives offered in the six invited countries, as well as two developing countries not represented at the workshop that offer incentives for off-grid photovoltaic applications.

# SECTION 2. CROSS-COUNTRY SUMMARY OF FINANCIAL INCENTIVES FOR RENEWABLE ENERGY AND RESULTS

## Introduction

Each of the countries involved in the workshop, including China, has developed policies to promote renewable energy technologies and systems. Strategic objectives include diversifying energy resources, reducing local and/or global environmental impacts of energy use, satisfying unmet energy demand, and developing export industries. The governments also recognize that the financial life-cycle costs of today's renewable energy systems often exceed those of conventional alternatives. As a result, governments are providing financial incentives to help overcome the financial incremental costs of renewable energy systems. In most cases, the financial incentives are structured and applied in ways that aim to reduce the cost of renewable energy systems, thereby building toward a future where the technologies are financially viable. Financial incentives are also being provided to counterbalance those provided to conventional alternatives (that is, to provide a level playing field), and to account for environmental costs and benefits not considered in conventional economic comparisons and pricing methodologies.

## Wind Power

**Status.** At the end of 1996, the total installed capacity of grid-connected wind power systems worldwide was nearly 6,200 megawatts (MW), according to the International Energy Agency (IEA).[1] China and the other six countries participating in the Amsterdam workshop collectively represent over 90 percent of this figure (see Table 1). However, the timing and pace of development in each country have varied, often with the availability, size, and transparency of financial incentives. The first large-scale wind power market occurred in California, where 1,700 MW of wind farms were developed between 1983 and 1991. Denmark has steadily developed its 785 MW by adding 50 to 100 MW per year since 1985. India has developed over 85 percent of its 820 MW capacity since 1994, although development has slowed recently. Germany added nearly 800 MW of its 1,576 MW of capacity between 1994 and 1996.

[1] This number represents the net cumulative installed wind power capacity and accounts for turbines that have been taken out of service.

**TABLE 1: WORLDWIDE INSTALLED GRID-CONNECTED WIND POWER CAPACITY (AS OF 12/31/96)**

| Country | Installed Capacity | |
|---|---|---|
| | MW | Percentage of Total |
| United States | 1,794 | 29 |
| Germany | 1,576 | 26 |
| India | 820 | 13 |
| Denmark | 785 | 13 |
| Netherlands | 305 | 5 |
| United Kingdom | 264 | 4 |
| China | 57 | 1 |
| Other | 571 | 9 |
| **Total** | **6,172** | **100** |

*Source:* International Energy Agency.

Since the early 1980s, wind turbine manufacturers from each of the countries listed in Table 1, with the exception of China, have been pursuing these markets. The industry is led by Danish firms, which hold approximately 60 percent of the manufacturing market. Other participants include manufacturers from Germany, the United States, the Netherlands, and the United Kingdom. Many of these companies have established joint ventures in India to manufacture/supply turbines to the local market and surrounding region. Competition among the turbine manufacturers has contributed to reductions in wind turbine and project development costs. In Denmark for example, prices have fallen from 15 US cents/kilowatt-hour (kWh) in 1984 to less than 5 US cents/kWh in 1996, and are predicted to fall below 4 US cents/kWh by 2020.

**Financial Incentives.** Each of the countries listed in Table 1 has developed policies for renewable energy development that include a package of financial incentives to encourage investment. The financial incentive package for each country is carefully crafted to suit its economic, legal and fiscal systems. The types of incentives used include concessional import duties, excise tax benefits, corporate and personal income tax benefits (including tax exemptions, holidays, credits, and deductions, as well as accelerated depreciation), subsidies against investment costs, low-interest loans, and premium power purchase prices.[2] Table 2 summarizes the incentives offered for wind power by each country and the results in terms of installed capacity, prices paid for wind farms and their output, and local manufacturing.

The workshop demonstrated the experience with and growing knowledge of financial incentives for wind power, and their progression toward applying more cost-effective financial incentives to promote wind power development and to reduce development costs. Each of the six governments is reevaluating its incentive system as wind power costs continue to decline, and as budgets for providing financial incentives

[2] In many countries, power from conventional energy resources is also entitled to financial incentives. For example, in Germany power produced from black coal receives an estimated subsidy of 3.0 US cents/kWh. Virtually all countries offer generous tax incentives for petroleum exploration and development.

diminish, and, in some cases, as the power sector is restructured. Governments are developing incentives that minimize expenditures and maximize cost reduction.

**TABLE 2: FINANCIAL INCENTIVES FOR WIND POWER DEVELOPMENT, FEBRUARY 1997**

| Country | Denmark | Germany | India |
|---|---|---|---|
| **Incentives** | | | |
| Primary Incentive Offered, February 1997 | • Premium buyback rates for life of plant (9.4 cents/kWh compared to 6.2 cents/kWh cost for new coal plant). | • Premium buyback rates for life of plant (10.5 cents/ kWh; 90% of average national end-user tariff). | • 100% depreciation in yr 1.<br>• 5-year income tax holidays.<br>• Favorable electricity wheeling and banking policies. |
| Payment of Incentive | • Through general consumer tariff.<br>• From collected $CO_2$ and electricity taxes. | • Paid by utility purchasing electricity from wind farm. | • From general central and state government budgets (i.e., forgone government revenue). |
| Other Incentives | • Portion of income from wind project is tax-free.<br>• Accelerated depreciation.<br>• Until 1988, offered subsidies against investment costs. | • Corporate and personal income tax deductions.<br>• Subsidized loans.<br>• Previously offered additional energy payments or subsidy on capital cost. | • Concessional import duties.<br>• Excise and sales tax exemption.<br>• Standard (6.3 cents/kWh) buy back rates with 5% annual escalation for life of plant.<br>• Infrastructure at plant site. |
| **Results** | | | |
| Installed Capacity (end 1996) | • 785 MW. | • 1,576 MW. | • 820 MW. |
| Price Reduction | • From 15 cents/kWh (1984) to 4.6 cents/kWh (1996, min.). | • Decreased by a factor of 5 since 1989. | n.a. |
| Manufacturing | • Worldwide leader.<br>• 1996 production = 700 MW, 70-90% exported.<br>• Approximately 60% of world market. | • Strong manufacturing base including subsidiaries of Danish manufacturers. | • 22 local joint ventures to manufacture/supply turbines. |
| Other | • From 1985 to 1994 $155 million in $CO_2$ and electricity tax revenue forgone.<br>• From 1980 to 1988 $42.0 million paid for subsidies against investment. | • One utility paid over $122.0 million in premium electricity payments in 1996.<br>• Combined with research and development programs, central government has spent over US$2.0 billion promoting wind power development. | • Most projects developed by industrial firms seeking tax benefits and self-generation of electricity.<br>• Only 15% of electricity sold to utilities.<br>• Some projects built quickly to obtain tax benefits. |
| **Trends** | | | |
| | • Government plans to continue to reduce financial incentives as competition and technology development reduce costs. | • Government considering options to limit premium electricity payments. | • Moving away from incentives based on investment a costs and toward production incentives. |

*Note:* All costs expressed in terms of 1996 US dollars.

## TABLE 2: (CONT'D)

| Country | Netherlands | United Kingdom | United States (California) |
|---|---|---|---|
| **Incentives** | | | |
| Primary Incentive Offered | • Premium electricity buyback rates (6.0 cents/kWh versus 4.1 cents/kWh for electricity from fossil plants) for 10 years for plants under 2 MW.<br>• Additional 1.5 to 2 cents/ kWh "green electricity payment."<br>• Accelerated depreciation up to 100% in first year.<br>• Additional tax deduction of 42-52% of capital cost. | • Premium buyback rate for 15 years, based on competitively bid prices. (1997 prices 5.0-6.1 cents/ kWh; average 5.6 cents/kWh; average power pool price = 3.8 cents/kWh). | • Since 1992: Federal 1.5 cents/kWh production tax credit; 10% wind investment tax credit.<br>• 1983-91: Utilities required to issue standard 15-30 yr power purchase agreements with option of high fixed prices for initial 10 years. |
| Payment of Incentive | • With collected $CO_2$ taxes.<br>• With voluntary payments from electricity consumers.<br>• From forgone corporate income tax revenues. | • With proceeds from levy on sale of all electricity from fossil fuels (less than 1.1% of end-use tariffs). | • Since 1992: From general federal budget.<br>• 1983-91: Through general consumer electricity tariff. |
| Other Incentives | • Subsidized loans, usually 1.5% below market rates.<br>• Other tax incentives.<br>• Previous projects received capital subsidies. | | • 1983-91: Multiple federal and state tax benefits including accelerated depreciation. |
| **Results** | | | |
| Installed Capacity (end 1996) | • 305 MW. | • 264 MW. | • 1,794 MW (total US). |
| Price Reduction | • 30% reduction in wind energy prices between 1991 and 1995. | • From 18 cents/kWh (1991) to 5.6 cents/kWh (1997), although contract length differed. | • From $2,000/kW (1982-83) to $1,050/kW (1993). |
| Manufacturing | • 6% of world turbine manufacturing market.<br>• 20% of world turbine blade manufacturing market. | • Over 80% of turbines installed in the UK have been imported. Limited development of local manufacturing. | • Modest wind turbine manufacturing industry. |
| Other | • Land availability limits development | | • After initial 10 years, standard power purchase agreements entered into from 1983 to 1991 pay only short-run avoided costs (2-3 cents/ kWh). As contracts enter this phase, many facilities are closing or reducing output. |
| **Trends** | | | |
| | | • Expect incentives for wind power to be removed within 5 years. | • Developing new financial incentives. New incentives are for a limited time and for technologies expected to be competitive in the near future without financial incentives. Also considering energy production incentives. |

Source: Workshop presentations.

## Photovoltaics

**Status.** Worldwide production of photovoltaic cells has risen from nearly 34 megawatts peak (MWp) in 1988 to approximately 90 MWp in 1996. In the past, manufacturing facilities in Japan and the United States each provided 30 to 35 percent of global production, with the balance coming from Europe and India. However, manufacturers in the United States have more than doubled their production capacity since 1992 (from 18 MWp in 1992 to 40 MWp in 1996), and now provide nearly 45 percent of all cells, more than any other country.[3] In terms of markets, it has been estimated that over one-fourth of the cells produced in 1996 were used in the Pacific Rim region, including China, Indonesia, and Japan. Other markets include Europe (22 percent), the United States and Canada (17 percent) and Asia (India, Pakistan, Afghanistan; 15 percent). End-uses of cells produced in 1996 were estimated to included industrial applications (telecommunications, cathodic protection, etc.; 36 percent), off-grid home applications (including solar home systems; 33 percent), grid-connected applications (14 percent), consumer products (such as products for recreational vehicles; 12 percent); and indoor products (such as calculators; 5 percent).[4]

Prices paid for photovoltaic systems have declined with the increased production levels. Although the multiple applications of photovoltaics make it difficult to compare system costs, data from California's Sacramento Municipal Utility District's (SMUD's) Photovoltaic Program offers one example of cost reduction. The SMUD PV Program promotes a range of photovoltaic applications including grid-connected roof-mounted systems (SMUD's PV Pioneer Program) and grid-connected ground-mounted installations at substations and parking lots. Each year, SMUD issues a request for proposals to provide the installed roof- and ground-mounted systems on a turnkey basis. Bid prices have fallen from US$7.70/watts peak (Wp) in 1993 to US$5.36/Wp in 1996. SMUD estimates that bid prices will continue to fall to less than US$4.25/Wp and US$2.50/Wp in 1998 and 2002, respectively.

**Financial Incentives for Photovoltaics.** With the exception of the United Kingdom and Denmark, each of the invited countries also offers financial incentives for photovoltaic systems. Only India, however, offers support specifically for off-grid PV applications, the primary application of interest in China. California's previously offered incentives could be applied to either grid-connected or off-grid applications, while Germany and the Netherlands offer financial incentives for grid-connected PV systems only. Other developing countries that offer financial incentives for off-grid PV applications include Indonesia and Mexico. Table 3 shows the financial incentives

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[3] *The Solar Letter*, February 14, 1997.

[4] Strategies Unlimited.

offered for off-grid PV systems in India, Indonesia, and Mexico, including the number of systems supported and implementation details.

**TABLE 3: FINANCIAL INCENTIVES FOR OFF-GRID PHOTOVOLTAIC SYSTEMS**

| | India | Indonesia | Mexico |
|---|---|---|---|
| Systems Being Supported | • Solar home systems.<br>• Street lighting systems.<br>• Decentralized power stations.<br>• Solar lanterns.<br>• Solar pump sets. | • Solar home systems. | • Solar home systems. |
| Scale of Support | • 3/92 - 12/96: 4.8 MWp. | • 200,000 systems (anticipated) under Bank/GEF-assisted project.<br>• 10 MWp. | • 24,000 systems (as of February 1996). |
| Primary Incentives Offered | • Subsidies against investment.<br>• Subsidized loans.<br>• 100% accelerated depreciation. | • $125 or $75 grant per system sold, depending on location. | • Federal and state government subsidies against installed cost (50 and 30%, respectively). |
| Recipient of Incentive | • End-user. | • Suppliers/dealers. | • Private companies and non-governmental organizations hired by electric utility to install systems. |
| Payment of Incentive | • Central government's Ministry of Nonconventional Energy Sources (MNES). | • Global Environment Facility. | • Central government's National Solidarity Program (PRONASOL). |
| Implementation/ Conditions for Incentive | • Dealers market systems directly to end users. Systems also sold at MNES "showrooms".<br>• State agencies provide subsidies against investment, and monitor implementation including technical performance of systems.<br>• IREDA provides limited annual subsidized loans.<br>• Systems must meet MNES technical specifications.<br>• Subsidies for certain systems limited to designated users. | • Suppliers/dealers receive grant after system is installed.<br>• Solar home systems must meet technical specifications.<br>• Dealers must offer installment payment plans and a consumer protection package to end-users.<br>• Dealers must provide documentation to a Project Support Group. | • End-users submit application for solar home systems to local government.<br>• Local government forms electrification committee and submits request to PRONASOL.<br>• PRONASOL selects sites on basis of remoteness, distance from grid, and lack of near-term grid connection plans.<br>• Utility contracts with private companies to install solar home systems.<br>• Local governments and participating communities provide 20% of project costs, including in-kind resources. |

*Source:* Workshop presentations.

Table 3 highlights fundamental differences among the approaches for financial incentives for off-grid PV systems. India and Mexico, for example, offer large subsidies against investment. India also offers subsidized loans to end-users. These incentives, however, are not structured to encourage PV suppliers/dealers to reduce costs or maintain

the systems once sold. Under the World Bank and GEF-assisted Indonesia Solar Home Systems Project, financial incentives are given in the form of initial cost buydown. This incentive is intended to remove barriers created by the lack of established high-volume supplier/dealer delivery mechanisms. The value of the incentive is based on the incremental economic costs of solar home systems over the conventional alternative. The Government of Indonesia also has several programs that offer zero interest loans to households purchasing solar home systems.

# SECTION 3. FUTURE DIRECTIONS OF FINANCIAL INCENTIVES FOR RENEWABLE ENERGY

## Introduction

Approaches to financial incentives for grid-connected wind farms and PV solar home systems are evolving toward a similar direction and are following similar interrelated trends. In many countries, the approaches are also being applied to the general development of renewable energy systems. The direction is evolving as a result of the growing experience with financial incentive policies. Governments are now considering policies in terms of their costs; the way that the cost burden is shared (for example, among different levels of government, utilities, electricity consumers and general taxpayers); and their effectiveness in achieving results (such as installed capacity, cost reduction, local manufacturing). Most policies to encourage renewable energy are moving in the following directions:

- Incentives are clearly intended to be temporary measures.
- Performance-based incentives are being used to encourage efficient projects.
- Competition is being explicitly or informally integrated into the implementation of financial incentives, to promote reduced technology and project development costs.
- The size of financial incentives is being targeted to match incremental life-cycle financial costs.
- Incentives are being developed with consideration of the potential for changing market conditions.

These trends are explained below, with references to the specific financial incentives offered by each of the six invited countries.

## Direction of Financial Incentives

**Incentives are Intended to be Temporary Measures.** In order to (a) help reduce renewable energy technology and project development costs to levels that are competitive with conventional alternatives and (b) minimize government expenditures/loss of revenue, financial incentives are being developed as temporary measures. The incentives are either gradually reduced during a predefined period and/or removed entirely at once. Clearly defining the time frame of the financial incentives' applicability allows project developers to structure projects and develop appropriate strategies. Failure to define the time limit may result in industries that become dependent on the financial incentives, which, in turn, become politically difficult to remove.

The move toward defining financial incentives as a temporary measure is demonstrated in California's new approach for wind power, which offers incentives that will be gradually reduced and removed over four years. The approach will help California limit the cost of these and other financial incentives to their US$540.0 million budget. Although the framework for the United Kingdom's Nonfossil Fuel Obligation (NFFO) does not specify a time frame, it has created an implementation process in which developers and manufacturers are aware of the temporary availability of financial incentives. NFFO only supports those technologies that "in the not-too-distant future ... can compete without financial support," and the Government has indicated that it expects incentives for wind power to be removed within five years. Individual "Orders" are subject to government approval and can cease or be modified at any time. Therefore, technologies may be removed from future NFFO Orders if their development costs (a) do not decline or (b) have declined to the point where incentives are no longer required.

In Germany, the Electricity Feed Law guarantees premium electricity payments (10.5 US cents/kWh in 1997) to wind-farm developers for the life of the facility. This provision of the Law applies indefinitely. Utilities in regions with adequate wind resources are faced with increasing expenditures that cannot be passed on to consumers. The lack of an end-date for the financial incentives has contributed to generally higher turbine prices in Germany relative to international prices. German manufacturers and foreign companies with production facilities within Germany have become reliant on the premium buyback rates, and subsequent utilities' efforts to modify the Law have proved politically difficult to achieve.

**Performance-Based Incentives are Being Used to Encourage Efficient Projects.** Financial incentives provided on the basis of performance promote projects that are efficient from a planning, development, technical and cost basis. For grid-connected projects, performance-based incentives are typically provided on a per-kilowatt-hour (kWh) basis. Financial incentives offered on a per-kWh basis have contributed to efficiently designed, developed, and operated wind power projects in the United Kingdom, Denmark, and the Netherlands. In general, the projects are characterized by high availability and capacity factors, as well as low operating costs. Financial incentives offered against capital costs (such as investment subsidies and accelerated depreciation) have sometimes resulted in installed capacity with lower availability and capacity factors. In India, many projects have been built by local companies seeking to take advantage of tax benefits. Similarly, many of the early projects in California were developed by individuals and corporations with little wind power experience, but with strong appetites for short-term returns on investment. It should be noted that India and California are presently revising their policies for encouraging wind power development toward performance-based incentives.

The metered electricity sold from a grid-connected renewable energy facility to a utility offers a convenient basis for providing performance-based financial incentives.

Off-grid projects, however, do not enjoy this mechanism. An alternative that has been applied to solar home systems projects is the provision of grants on a systems-sold basis. Such programs have included monitoring mechanisms for ensuring that systems operate appropriately after installation. In the World Bank/GEF-assisted Indonesia Solar Home Systems Project, for example, a Project Support Group has been established to monitor performance and respond to complaints from end-users regarding system performance and to monitor the quality of dealers' after-sales service.

**Competition is Being Used to Promote Reduced Technology and Project Development Costs.** Competition helps to reduce technology and project development costs as well as the budget required to support the incentives.

Some form of competition has been integrated into the financial incentives for wind power in each of the six countries invited to the workshop. In the United Kingdom, for example, NFFO Orders for wind and other renewable energy generating capacity are satisfied through competitive bidding procedures. Developers bid for premium power purchase rates, with awards made to the lowest bidders. These procedures have contributed to the decline in wind power purchase prices from 18 US cents/kWh in 1991 to 5.6 US cents/kWh in 1997 (see Section 4 for the other contributing factors). California is presently considering a similar approach in which proposed facilities would compete for premium electricity buyback rates. In other countries, incentives are available to all developers, although competition in the general market place (such as for turbine sales) has helped reduce costs. This is particularly true in Denmark and the Netherlands where land availability and planning consent have effectively limited wind power development.

Competition is also a key element of the financial incentives being offered to PV solar home systems dealers in Indonesia. All dealers meeting specified criteria may obtain grants from GEF for each system installed. Although dealers are not required to pass the grant on to end-users, it is expected that those that do will obtain a greater market share in the near term, and enjoy increased profits in the medium term. In addition, information on price and performance disseminated by the Project Support Group will also encourage suppliers to be more competitive.

**The Size of the Financial Incentive is Being Targeted to Match Incremental Financial Life-Cycle Costs.** Maintaining financial incentives at or near the additional cost of developing a renewable energy project compared to a conventional alternative helps to reduce development costs and limits the total expenditures for incentives. In addition, use of a single mechanism allows the size of the financial incentive to be more closely matched to incremental financial costs. Examples of incentives that generally follow this trend include those of the United Kingdom and the Netherlands. In the United Kingdom, developers bid the prices required for development; the only financial incentive offered is a premium power purchase price compared with the price for

conventional power. This approach, when combined with competition and other elements of NFFO, has resulted in a dramatic fall in the required per-kWh incentive.

In the past, California's buyback rates for electricity from wind power facilities were not targeted at incremental project development costs. Initially, power purchase prices exceeded life-cycle development costs, thereby causing a rapid increase in grid-connected renewable energy facilities and increasing rates to customers. An overcapacity situation, brought on in part by the lucrative buyback rates, led California to withdraw this incentive to new developers. California is now in the process of revising their financial incentives for wind power to more closely match power development costs as determined through detailed technology assessments. Germany has faced similar difficulties with power purchase rates for wind, which are set at 90 percent of the national average end-use tariff (10.5 US cents/kWh in 1997). One utility, as a result, had to pay US$122.0 million in premium electricity payments to wind power developers in 1996 alone.

The principle of targeting financial incentives to match incremental financial life-cycle costs also applies to off-grid PV systems. In India and Mexico, where financial incentives have been used to cover a percentage of development costs, there has been little incentive for suppliers/dealers to reduce system costs. In Indonesia, however, the financial incentives (that is, grants delivered after systems are installed) are set at the incremental costs of solar home systems compared to the costs of kerosene for lighting and automotive batteries for television, radio, and so on. The incentives also vary by geographic region, based on estimated supply costs in the regions.

**Incentives are Being Developed with Flexibility With Respect to Changing Market Conditions.** The level of financial incentives offered needs to be flexible to account for changes in project development costs (including technology costs). When financial incentives are based on the cost of conventional alternatives, flexibility also needs to be maintained with respect to changes in these costs.

Incentives offered for wind power development in the United Kingdom and Denmark maintain flexibility with respect to changing market conditions. In the United Kingdom, distribution utilities pay renewable energy facilities the avoided costs of obtaining electricity from a power pool; the difference between the avoided costs and the price that renewable energy developers require is paid from a levy on all electricity sales. As wind power development costs have fallen (due to increased expertise, reduced risk, competition and other factors), the premium has been reduced. The premium would similarly be adjusted if the cost of energy from conventional facilities were to change. Denmark uses a similar combination of utility payments based on avoided costs plus incentives paid from government-collected taxes. Although the power purchase rate for wind farms is generous (9.4 US cents/kWh), the government has reduced the incentive in the past as developers' costs have fallen. The incentive would also be modified if

international coal prices (that is, the primary variable in Denmark's avoided costs) were to change.

California's experience with implementing the Public Utility Regulatory Policy Act (PURPA) further highlights the importance of properly considering changing market conditions. In the early 1980s, Californian utilities offered 15- to 30-year standard power purchase contracts to renewable energy facilities. The first 10 years of the contract offered high fixed energy payments based on the then-expected annual short-run marginal costs. In 1983, for example, these forecast costs ranged from 5.2 US cents/kWh in 1983 to 10.3 US cents/kWh in 1993. After many contracts were signed, short-run marginal costs dropped from the high anticipated levels to 2 to 3 US cents/kWh. Utilities (and their customers) were then forced to pay premium electricity payments to renewable energy facilities. After the first 10 years, the contract paid the utility's actual (that is, not forecast) short-run marginal costs. Because of the abrupt transition to low, market-determined prices, many wind farms are reducing output or stopping operations as contracts enter their eleventh year.

# SECTION 4. COUNTRY FINANCIAL INCENTIVE POLICIES FOR RENEWABLE ENERGY

## A. DENMARK

### Overview

As a means of meeting the objectives of their national energy plan, Denmark offers relatively generous financial incentives for wind power development. However, incentives are not offered for photovoltaic manufacturing or applications. Incentives for wind power apply to individual and private cooperative developers. They have been reduced over time in line with wind energy's declining costs. The incentives have contributed to approximately 785 MW of installed wind generating capacity in Denmark and have helped the country to become the global leader in wind turbine manufacturing.

### Context for Renewable Energy Financial Incentives

Since 1976, Denmark has had four national energy policy papers, each of which has contained policies to support renewable energy development in general, and wind power in particular. The reasons for supporting renewable energy development varied with major energy policy issues of the time. In 1976, renewable energy development was viewed as a means for securing energy supplies. In 1981, the energy strategy focused on offsetting rapidly rising energy prices. In 1990, environmentally sustainable development in the energy sector was a key theme. Finally, in 1996, the strategy focused on reducing greenhouse gas emissions. The 1996 plan, Energy 21, establishes the following targets for wind power development and national greenhouse gas emission reductions:

- installed wind power: 1,500 MW by 2005, 5,500 MW by 2030.
- greenhouse gas emissions: year 2000 emissions at 1990 levels, year 2005 emissions 20 percent below 1988 levels.

Over 80 percent of the installed wind generating capacity in Denmark is owned by private individuals or private cooperatives. Financial incentives for these developers have effectively limited the capacity they can develop and therefore prohibit certain economies of scale. Financial incentives for wind power development may therefore be high relative to what they would be if individual projects were larger. Denmark's utilities and their two primary associations (ELSAM, in the western part of Denmark, and ELKRAFT, in the east) own the remaining wind power capacity. Large private-sector independent power

producers (IPPs) are not involved in wind power development in Denmark, but are involved in the broader power sector.

**Financial Incentives: Wind Power**

Electricity rates in Denmark are comprised of two components: (a) the utilities' costs of generating and delivering electricity (approximately 6.2 US cents/kWh,[1] assuming coal-based power) and (b) carbon dioxide ($CO_2$), electricity, and value added taxes. The average tariff in 1996 was 9.3 US cents/kWh. Individual and private cooperative developers of wind projects selling power to the grid are eligible to receive premium electricity payments of approximately 9.4 US cents/kWh calculated as 85 percent of the utility's generation and transmission costs (5.2 US cents/kWh), plus a 4.2 US cents/kWh production incentive. Utilities are required by law to unconditionally purchase the electricity from wind turbines at these rates. As a result, there are no power purchase contracts between utilities and developers.

Utilities are allowed to recover the cost-based portion of the buyback rate (that is, 5.2 US cents/kWh) through the general consumer tariff. Although the electricity consumers ultimately pay for this portion of the wind power purchase price, it is less than they pay for coal-based power. The collected $CO_2$ and electricity taxes are each partially used to pay for the 4.2 US cents/kWh production incentive and represent forgone government revenue.

Other financial incentives offered to shareholders of private cooperatives (not individual developers) include favorable tax policies on the income generated from selling wind-generated electricity. More specifically, the initial US$450 of income from a wind power project each year and 40 percent of the remaining income is tax-free. The remainder is considered taxable personal income.

There are limitations to the wind farm developments to which the above incentives apply. Private individuals, for example, are only allowed to grid-connect one turbine, and this must be placed on the owner's land. Similarly, each shareholder in a private cooperative is limited to receiving financial incentives on 30,000 kWh/year (equal to the output of an 8.5 kW wind turbine, assuming a 27 percent capacity factor). The shareholders of the cooperative must live in the same municipality as where the turbine is installed.

Between 1980 and 1988, individual and private cooperative wind power developers were eligible for subsidies against investment costs. The payments totaled 30

[1] US$1.00 = 6.48 Danish kroners.

percent of investment costs in 1980. They were reduced to 15 percent in 1984, and eventually eliminated in 1989 in favor of production-bsaed incentives.

In general, financial incentives for wind power development are not offered to Denmark's two electric utilities. The utility-owned capacity that has been developed came from agreements between the utilities and the Federal Danish government (for example, 200 MW from 1985 to 1995; an additional 200 MW by 1999). However, utilities do receive approximately 1.5 US cents/kWh for electricity generated from wind turbines as reimbursement for the general $CO_2$ tax on electricity.

**Results: Wind Power**

According to the International Energy Association (IEA), Denmark had an installed wind power generating capacity of approximately 785 MW at the end of 1996. The majority of this capacity has been developed since 1988 at an average rate of approximately 80 MW per year. Between 1985 and 1994, the Danish government had forgone an estimated US$155.0 million of tax revenue in the form of wind power production incentives paid to individual and private cooperative developers. Between 1980 and 1988, the cost of federal government subsidies against investment offered was US$42.0 million.

It has been estimated that the electricity production costs from wind turbines in Denmark dropped from over 15 US cents/kWh in 1981 to 4.6 US cents/kWh in 1996, at the best sites. Financial incentives applied in a transparent commercial project development framework have helped to create the competition among turbine manufacturers required to achieve these cost reductions. To minimize public expenditures and to promote further cost reductions, the Government has reduced the financial incentives over time. For example, 30 percent subsidies against investment costs were initially offered to wind power developers in 1980. The subsidy was reduced in 1983, 1984, and 1988 before being abolished in 1989. Production incentives have also declined and are expected to be further reduced to help meet the Government's year 2000 cost targets for wind energy of less than 4 US cents/kWh.

Domestic financial incentives have also contributed to a strong wind turbine manufacturing base in Denmark. Other factors include a committed research, development, and demonstration program and exchange rates that allowed manufacturers to take advantage of California's development opportunities in the 1980s. It has been estimated that Danish wind turbine manufacturers account for 60 percent of the global manufacturing industry. In 1996, turbine manufacturing exceeded 700 MW for the second year in a row, with 70 to 90 percent of the machines being exported.

## B. GERMANY

### Overview

Germany offers financial incentives for grid-connected wind turbines and photovoltaic systems. Those offered for wind turbines are among the most generous in the world. They have resulted in significant wind power development and a strong manufacturing base. The lucrative incentives have allowed German turbine manufacturers to develop units with improved efficiencies and reliability, although the prices for these units remain high relative to the global market. Financial incentives for photovoltaics have focused on providing grants and premium electricity buyback rates to owners of grid-connected, roof-mounted PV systems.

### Context for Renewable Energy Financial Incentives

The German electricity industry is comprised of 730 electric supply/distribution companies, each with exclusive rights to generate and distribute electricity to its region. Nine transmission companies deliver electricity between distribution companies. The present trading price for electricity between generating companies and distribution/supply companies is approximately 5 US cents/kWh. Nationally, the generation mix is comprised of coal[2] (55 percent) and nuclear (29 percent) power facilities, natural gas (7 percent), hydro (5 percent), oil (1 percent), and other sources including renewable energy (3 percent).

Policies for promoting renewable energy development in Germany originate from the government's goals of (a) contributing to the improvement of the global climate by reducing man-made emissions and (b) promoting the long-term contribution of renewable energy to the German energy mix. Although there are no federal targets for renewable energy development, the government made a commitment to reducing $CO_2$ emissions by 25 percent from 1990 by the year 2005.

### Financial Incentives: Wind Power

The primary mechanism for promoting commercial wind energy development is the Electricity Feed Law of 1991. The law requires distribution utilities to purchase electricity generated from wind turbines in their service territory at 90 percent of the average national electricity tariff to all consumers in the preceding year, for the life of the renewable energy facility. (Electricity generated with other renewable resources are purchased at 65 to 90 percent of the national average end-use tariff.) There are no limitations regarding the amount of electricity the utility must purchase. In 1997, the

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[2] Power production from black coal is estimated to receive subsidies equivalent to 3.0 US cents/kWh.

average price paid to wind developers will be approximately 10.5 US cents/kWh,[3] over twice the electricity sales price between distribution utilities.

Under the Electricity Feed Law, distribution companies are unable to pass the incremental cost of purchasing wind-generated electricity to their consumers and, therefore, incur the financial burden of the incentive. For example, PreussenElectra, a distribution company that purchases approximately one-third of the wind-generated electricity in Germany, paid over US$122.0 million in premium electricity payments for wind power in 1996. As a result, distribution utilities are presently lobbying the German government for changes to the Electricity Feed Law that will allow the premium cost of purchasing wind power to be passed to its customers or shared with other utilities. In addition, the federal government has proposed to limit premium electricity payments to the first 20,000 kWh produced for each kW of installed wind-generating capacity. At a 30 percent capacity factor, for example, the owner of a wind turbine would receive premium payments for just over its first 7.5 years of operation. After the first 20,000 kWh, the facility would receive a purchase price equivalent to the electricity trading price between distribution utilities.

The following additional financial incentives available for wind power represents forgone revenue to the Government:

- **Corporate and Personal Income Tax Deduction:** equal to 10 percent of wind energy investment per year for 10 years.
- **Subsidized Loans:** Available from the state-owned Deutsche Ausgleichsbank (DtA) through local commercial banks. Loans cover up to 100 percent of project costs with interest rates at 1 to 2 percent below market rates and fixed for the loan period. Ten-year repayment periods are typical and may include up to 5 years' grace.

Previous financial incentives for wind-power developers under the 250 MW Wind Program included energy payments of 3.7 to 4.6 US cents/kWh (in addition to those from the local distribution utilities) from the Federal Ministry of Education, Science, Research, and Technology (BMBF) and up to 25 percent of total investment costs (up to US$300/kW). In lieu of these payments, private individuals and farmers (as distinct from corporate developers) could receive direct subsidies of up to US$55,000 for wind power investments.

**Results: Wind Power**

By the end of 1996, 1,576 MW of wind power was installed in Germany with additions of 505 MW in 1995 and 426 MW in 1996. All of the capacity has received the

[3] US$1.00 = 1.64 German marks.

premium electricity price made available under the Electricity Feed Law as well as the income tax benefits. In addition, DtA has committed over US$1.5 billion for wind energy projects between 1990 and 1996, enough to support over 1 GW of installations. Over 400 MW have received support from the 250 MW Wind Program.[4]

The financial incentives and other policies for promoting wind energy (such as permitting benefits, export programs, research and development) have resulted in a strong turbine manufacturing base in Germany. In particular, the financial incentives have allowed German firms to develop turbines with higher efficiencies and reliability. Two firms, Enercon and Tacke, sold over 45 percent of the turbines installed in Germany in 1996.

According to BMBF, since 1989 levelized wind energy costs in Germany have decreased by a factor of 5 to the current cost of approximately 6 US cents/kWh (assuming a 23 percent annual average capacity factor). This decrease has been caused, in part, by competition for German market share between several emerging German turbine manufacturers and suppliers from Denmark and other countries. However, the same incentives that have attracted manufacturers and developers from around the world may also have contributed to turbine prices and development costs that are generally higher than those internationally.

**Financial Incentives: Photovoltaics**

The primary financial incentive for promoting photovoltaic applications in Germany occurred under BMBF's 1,000 Roofs Program from 1991 to 1994. This Program supported over 2,000 grid-connected, roof-mounted photovoltaic installations with rated capacities of 1 to 5 kWp. Systems with battery storage systems were not supported. Under the Program, the federal government provided 50 to 60 percent of the installed costs while states provided 0 to 20 percent; homeowners paid the balance. Separate meters were required for electricity generation and consumption. Grid-connected PV systems, including those not supported by the 1,000 Roofs Program, are also supported under the Electricity Feed Law with utilities required to purchase the electricity at 10.5 US cents/kWh in 1997 (the same energy price available to wind facilities).

Under an effort similar to the 1,000 Roofs Program, the Federal Ministry of Economics has provided subsidies against investment costs of up to approximately US$4/Wp for the installation of 10 to 30 kWp PV systems on commercial buildings with

[4] The Program rates turbine capacity at 10 meters/second; industry rates turbine capacity at 13 to 15 meters/second.

a maximum subsidy per system of US$40,000. The program was operative between 1990 and 1996 and was supported with an annual budget of approximately US$10.0 million.

In addition to the Electricity Feed Law, 20 localities have introduced buyback rates ranging from US$0.25 to US$1.35/kWh (most at US$1.22/kWh) under 10- to 20-year contracts. For existing installations, buyback rates are escalated at no more than 1 percent annually. Each year, the electricity price offered to new photovoltaic installations is adjusted to reflect and promote cost reduction. The incremental energy prices paid by the localities under these programs are passed on to general electricity consumers.

**Results: Photovoltaics**

Installed photovoltaic capacity increased from under 1.7 MWp in 1990 to over 17 MWp in 1996. Approximately 5.3 MWp has been supported under the 1,000 Roof Program. Prices have fallen during the same period. For example, in 1992 the price of a 2 kW grid-connected, roof-mounted PV system was US$14.6/Wp; by 1996, the price was reduced to US$10/Wp. German-owned Siemens Solar and ASE represent the largest of the German PV manufacturers.

## C. India

**Overview**

Wind power and photovoltaic systems have received a number of financial incentives from the central and state governments of India including tax incentives, soft loans, and subsidies against investment costs. The incentives have resulted in significant installed wind generating capacity (820 MW) and deployment of photovoltaic systems (8 MW) for rural applications. As a result of the government-supported markets, India has attracted overseas companies to establish local wind power and photovoltaic manufacturing joint-venture companies.

**Context for Renewable Energy Financial Incentives**

The Government of India supports renewable energy development for a number of reasons including reducing energy shortages, lowering the cost of satisfying energy and electricity demands, reducing dependence on fossil fuels, and addressing environmental concerns. Financial incentives are provided to help achieve these objectives and to counterbalance subsidies available to conventional energy systems.

For the recently completed Eighth Five-Year Plan (1992-97), the Government established a number of financial incentives for meeting renewable energy development goals, which included a total installed wind capacity of 1,000 MW (an initial goal of 500 MW was attained and subsequently increased) and 3 MWp of cumulative photovoltaic

installations. For the Ninth Five-Year Plan, the Government hopes to achieve cumulative installed capacities of 2,000 MW for wind and 100 MW for photovoltaics.

**Financial Incentives: Wind Power**

In 1992 the central government introduced a series of financial incentives for promoting wind power development, including:

- **Accelerated Depreciation:** 100 percent of investment costs may be deducted from taxes during the project's first year.
- **Central Excise Tax Exemption:** Electricity generated from wind turbines is not subject to the central government's excise tax on output.
- **Sales Tax Exemption**.
- **Income Tax Holidays:** Revenue generated during a new facility's first five years are not subject to central income tax.
- **Concessional Import Duties:** Concessional duties are permitted on 10 wind turbine components that have yet to be produced locally on a large scale to international quality standards. These components include blades, gear boxes, and brake assemblies. Conventional import duties are applied to other imported components (such as towers, generators, nacelles). Complete imported wind turbines receive a concessional 25 percent customs duty. The Ministry of Nonconventional Energy Sources (MNES) annually reviews the list of components receiving concessional import duties.

In 1992, the central government also issued guidelines to states for financial incentives to promote grid-connected renewable energy facilities, regardless of generating capacity and capacity factor. Seven states have adopted some form of the guidelines, which include the following provisions:

- **Power Wheeling and Banking Policies:** The state electricity board (SEB) will transmit electricity provided by a renewable energy facility within the state for captive use or for third-party sales. Electricity may be withdrawn up to one year after being fed into the grid. SEB's wheeling charge to the generator for this service is 2 percent of the total electricity provided to the grid.
- **Power Sales:** A renewable energy facility can sell electricity to SEB at a standard rate of 6.3 US cents/kWh[5] (based on 2.25 Rupees/kWh) with an annual escalation rate of 5 percent for the life of the project.
- **Electricity Duty Exemption:** Electricity generated and consumed by the owner of the renewable energy facility is exempt from state electricity consumption taxes.

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[5] US$1.00 = 35.72 Indian rupees.

- **State Sales Tax Exemption:** MNES guidelines recommend sales tax benefits for the renewable energy facility, although a level of benefit is not specified.
- **Incentives Available to Other Industries:** Incentives available to "new industrial units" and to "industrial units in backward areas" should also be available to renewable energy facilities.
- **Infrastructure:** States should provide basic infrastructure to wind farm sites, including approach roads, cranes, and power during the construction period.

In addition to the MNES recommendations, several states provided additional incentives to private wind power developers. Examples include:

- **Andhra Pradesh:** Provides 20 percent of the total project cost up to approximately US$70,000 (25 lakhs)[6] and long-term land leases for projects up to 20 MW.
- **Karnataka:** Provides 50-year land leases.
- **Kerala:** Provides 5 percent of the total project cost up to approximately US$14,000 (5 lakhs), "financial assistance" from the State Industrial Development Corporation up to approximately US$250,000 (90 lakhs), and consultancy services.

Considering the limitations on the existing banking systems to support accelerated commercialization of renewable energy technologies, the Government of India established the Indian Renewable Energy Development Agency, Limited (IREDA) in March 1987. IREDA operates a revolving fund for manufacturers and developers to support commercially viable renewable energy projects. For wind power projects, loans are available to cover up to 75 percent of the total project cost at 19 percent interest with a repayment term of six years, including a one-year grace period.

For the Ninth Five-Year Plan the Government is considering moving away from investment-type incentives and toward incentives that encourage production of electricity from wind turbines. It is anticipated that these incentives will be provided in a generation planning framework that reserves renewable energy capacity additions or mandates fossil-fuel power additions to include renewable energy power blocks. SEBs will be mandated to purchase electricity from these facilities and power purchase rates will be based on calculated avoided costs rather than a rate specified by the state government.

**Results: Wind Power**

At the end of 1996, India had a total installed wind generating capacity of 820 MW, including approximately 50 MW of government-sponsored demonstration projects. Over three-quarters of the total capacity is in Tamil Nadu. In comparison, at the beginning of the Eighth Five-Year Plan, the total installed capacity in India was only

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[6] 1 Lakh = 100,000 Rupees.

32 MW. The capacity additions are directly attributable to the incentives offered by the central and state governments. In fact, as the end of the Eighth Five-Year Plan approached and the future of the incentives became less clear, wind power development slowed considerably. There have been minimal wind power capacity additions in India since March 1996.

The vast majority of the wind power projects have been developed by Indian companies seeking to benefit from the various tax incentives and from the prospect of generating their own electricity. In fact, only 15 percent of the electricity generated by renewable energy installations (including wind facilities) is sold to SEBs. Some projects, however, have been poorly conceived and planned and were built quickly to obtain tax credits before the end a particular tax year.

Investment costs for wind projects in India have been quoted to range from US$975 to US$1,100/kW with energy costs from 5.6 to 7.7 US cents/kWh.

India has developed a local manufacturing base to serve its wind power market. Development of the manufacturing industry has been bolstered by limiting concessional import duties to components that cannot be locally produced in sufficient quantity and to international standards. Foreign turbine companies have established over 22 local joint ventures to manufacture/supply turbines, 12 of which have received quality certification from MNES. Presently, a few manufacturers can produce an entire wind turbine locally.

**Financial Incentives: Photovoltaics**

Many of the incentives introduced in 1992 for wind power also apply to photovoltaic systems, including:

- **Accelerated Depreciation:** One year, 100 percent depreciation of investment costs.
- **Central Sales Tax Exemption:** Plant and equipment, including silicon, cells and modules, and most PV systems, are not subject to central sales tax. Most states have also waived sales tax on these items.
- **Concessional Import Duties:** Materials, such as polysilicon and silicon ingots and wafers, receive a 10 percent concessional import duty. Cells, modules, and entire PV systems carry a 35 percent concessional duty.

IREDA offers soft loans to end-users and manufacturers of solar photovoltaic equipment. For end-users, interest rates vary from 2.5 to 5 percent, with an eight-year repayment term including a two-year grace period. Manufacturers can obtain financing at 10.3 percent interest and the same repayment terms as end-users. It should be noted that interest rates were reduced to these levels as a result of fewer IREDA commitments than expected for photovoltaic systems. Table 4 indicates financial incentives against investments provided by MNES for a number photovoltaic systems.

**TABLE 4: FINANCIAL INCENTIVES AGAINST INVESTMENT PROVIDED BY MNES FOR PHOTOVOLTAIC SYSTEMS**

| Photovoltaic System | Subsidy | Eligibility |
|---|---|---|
| Solar home systems | 50% of ex-work costs. | All users. |
| Street lighting systems | 50% of ex-work costs. | Users in designated geographic areas (desert areas, islands, unelectrified villages, etc.) and other designated users. |
| Power plants—decentralized | 50% of ex-work costs | |
| Power plants—grid connected | 67% of costs. Not to exceed approx. US$5.50/Wp. | Projects by private PV module and cell manufacturers, or state and private utilities. |
| Solar lanterns | US$42/lantern. | All users. |
| Solar pump sets | Approx. US$3.50/Wp. Not to exceed approx. US$4,170. | All users. |

*Source:* Ministry of Nonconventional Energy Sources, Government of India, *Opportunities and Guidelines for Foreign Investors in Nonconventional Energy Sector.*

## Results: Photovoltaics

Table 5 details the installed photovoltaic systems in India as of September 1996.

**TABLE 5: INSTALLED PHOTOVOLTAIC SYSTEMS AS OF SEPTEMBER 1996**

| Application | Units | Installations |
|---|---|---|
| *Rural Applications* | | |
| • Solar lanterns | number | 101,500 |
| • Solar home systems | number | 48,000 |
| • PV Pumps | number | 2,500 |
| • Street lights | number | 31,200 |
| • Community center systems | number | 900 |
| • Power plants—decentralized | number | 180 |
| *Subtotal - Rural* | MW | 8 /a |
| *Industrial/Commercial Applications* | | |
| • Telecommunications | number | 16,000 |
| • Adult Education Centers | number | 2000 |
| • Railway signaling stations | number | 1200 |
| • TV transmitters | number | 200 |
| • Offshore oil/gas platforms | number | 90 |
| *Subtotal - Industrial/Commercial* | MW | 14 /a |
| **Total** | **MW** | **22 /a** |

/a Approximation.

*Source:* Workshop presentation.

According to MNES, photovoltaic module prices have declined from US$6.20/Wp in the 1992-93 fiscal year to US$4.60/Wp in 1995-96. The present price for a 30 Wp solar home systems is slightly more than US$300.

The relatively strong government-supported photovoltaics market has resulted in 7 local cell manufacturers and 12 module manufacturers. During the 1995-96 fiscal year, cell production reached 4.0 MW. Module production was approximately 8.0 MW, representing 12 percent of world module production.

## D. THE NETHERLANDS

### Overview

The Netherlands offers a mix of financial incentives for wind power and photovoltaic system development. These incentives are aimed at lowering energy and systems costs through tax benefits, low interest financing, and modest guaranteed energy payments. Certain photovoltaic applications are also eligible for subsidies against investment. Voluntary premium end-use tariffs have also been used to promote renewables in general. The incentives have resulted in local turbine and photovoltaic system manufacturers and moderate levels of installed capacity.

### Context for Renewable Energy Financial Incentives

The Netherlands Government's Third White Paper on Energy integrates environmental considerations into the nation's energy policy through 2020. The Paper includes targets for 750 MW installed wind power by 2000 and 2,000 MW by 2007 (including offshore units). Annual fossil fuel energy savings from photovoltaic systems is expected to increase from 1995 levels by a factor of 20 by 2020.

### Financial Incentives: Wind Power

Wind energy projects of up to 2 MW generating capacity are guaranteed fixed price energy payments of at least 6.0 cents/kWh[7] for 10 years from local distribution utilities (levelized costs of generating wind power in the Netherlands are estimated to range from 5 to 8 US cents/kWh depending on wind speeds). Approximately 4.1 US cents/kWh are financed by the utility and are equivalent to what they pay for conventional electricity. The remainder is paid for from a 1.9 US cents/kWh $CO_2$ tax charged to residential and commercial electricity customers for consumption between 800 and 50,000 kWh/year. The Netherlands Ministry of Finance retains the collected $CO_2$ tax, which is not used to pay for electricity generated with renewable energy.

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[7] US$1.00 = 1.93 Netherlands Guilders.

In addition to the guaranteed 6.0 US cents/kWh buyback rate, wind projects may also receive a 1.5 to 2.5 US cents/kWh "green electricity" payment from distribution utilities. These payments are financed from electricity consumers' voluntary payments for "green electricity" and are subject to negotiation between the wind power developer and the utility. The utilities however are obliged to use any collected voluntary payments to purchase electricity generated with renewable energy.

Wind projects, as well as other renewable energy investments, are eligible to receive low-interest debt financing from "Green Funds." Financing from these sources is available at interest rates typically 1.5 percent below market rates. The Funds are managed by the Central Bank and are raised by issuing calls for private capital. Interest on the invested capital is tax-exempt.

In addition to Green Funds, and mandatory and negotiable electricity payments, wind power projects receive the following financial incentives:

- **Accelerated Depreciation:** Wind turbines are among the list of renewable energy-related equipment subject to accelerated depreciation under the Netherlands' Accelerated Depreciation of Environmental Investments Program (VAMIL). This allows depreciation levels of up to 100 percent in the first year of installation, at the discretion of the developer.
- **Tax Deductions:** In addition to the VAMIL accelerated depreciation, a percentage of investments in renewable energy technologies, including wind turbines, may be deducted from taxable profit. Tax deductions range from 42 to 52 percent of investments extending up to approximately US$26.0 million.

The Government of the Netherlands is presently considering reduced value-added tax (VAT) for specific renewable energy equipment. In particular, renewable energy equipment would be subject to a 6 percent VAT relative to the conventional 17.5 percent tax.

Previously wind power projects received subsidies against investment costs from the Netherlands Ministry of Economic Affairs. For example from 1986 to 1990, subsidies of up to 45 percent of capital costs were provided on a US$/kW basis. Between 1991 and 1995, the subsidy was changed to US$150/square meter of swept rotor area and limited to 35 percent of investment costs.

**Results: Wind Power**

Presently, there are 305 MW of installed wind generating capacity in the Netherlands. It has been noted that wind power development has been limited by (a) the lack of guaranteed energy buyback rates for installations exceeding 2 MW and (b) siting constraints.

Despite the limited installed capacity, wind energy costs reportedly decreased by 30 percent between 1991 and 1995. In addition, a modest Dutch turbine manufacturing/ assembly industry has developed in Holland, led by NedWind, WindMaster, and Lagerwey. Presently, Dutch manufacturers hold approximately 6 percent and 20 percent of the world turbine and blade manufacturing markets, respectively.

**Financial Incentives: Photovoltaics**

Many of the financial incentives available for wind power are also applicable to photovoltaic systems, including fixed and green electricity payments, low-interest loans from Green Funds, and tax incentives. Photovoltaics are also included in the list of renewable energy products for which a reduced VAT (6 percent compared to 17.5 percent on other goods) is being considered. Financing of systems may be also added to home mortgages.

Roof-mounted and grid-connected photovoltaic systems receive 40 to 50 percent investment subsidies from the Netherlands Agency for Energy and the Environment (NOVEM), 30 to 40 percent from the local distribution utility, and 0 to 10 percent from the local municipal government. The remaining cost of the installation is paid by the homeowner. The expectation is that future cost reductions will allow homeowners to pay for 100 percent of system costs in the 2010-20 time frame.

**Results: Photovoltaics**

As of 1995, the installed capacity of photovoltaic systems in the Netherlands totaled 2.5 MW; 2.1 MW are in stand-alone applications. Between 1991 and 1996 prices decreased by a factor of over 3. Shell Solar Energy (formerly R&S, Renewable Energy Systems), the sole Dutch photovoltaic cell manufacturer, has developed an in-country manufacturing capability of 2.5 MWp/year, which is expected to increase to 5 MWp by 1998. Further expansions of the manufacturing capacity in the Netherlands are likely.

## E. United Kingdom

**Overview**

The United Kingdom provides financial incentives for wind power development through the Nonfossil Fuel Obligation (NFFO). NFFO only supports those technologies that the government considers to have potential for large-scale commercial development without subsidies. Photovoltaics are not supported by NFFO or other means, although its potential for commercial development is reviewed periodically. Other renewable energy technologies including small hydro, biomass, and landfill gas are supported, however, under NFFO.

NFFO is designed to create an initial market for identified renewable energy technologies "so that in the not-too-distant future the most promising renewables can compete without financial support." As a result, NFFO is a short- to medium-term mechanism. Under NFFO, renewable energy projects selected in a competitive bidding procedure on the basis of bid prices receive an output subsidy against the electricity generated (pence/kWh) to pay for the difference between the projects' bid price and the price at which generation facilities sell power to distribution/supply companies. The subsidy is paid for with the proceeds of a levy on the sale of electricity generated with fossil fuels and is charged to all consumers.

Competitive bidding for premium buyback rates occurs through periodic "rounds." This maintains the Government's flexibility to modify contract terms, technology focus, and other parameters as technologies develop.

**Context for Renewable Energy Financial Incentives**

Promotion of renewable energy in the United Kingdom is aimed at: (a) ensuring a diverse, secure and sustainable energy supply; (b) reducing environmental impacts; and (c) encouraging an internationally competitive domestic renewable energy industry. The government has set a nonbinding goal of 1,500 MW of installed renewable energy-generating capacity by the year 2000, enough to generate approximately 3 percent of total generation.

In England and Wales, the electricity sector is comprised of multiple generating companies, including IPPs, one transmission company, and 12 Regional Electricity Companies (RECs), which are obligated to distribute and supply electricity to customers within their authorized service areas. There are additional supply companies that pay fees to RECs for use of their distribution equipment (poles, wires, transformers, and so on). Beginning in 1998, all consumers will be allowed to select their electricity supplier.

In general, generating companies sell their electricity to the RECs through the Electricity Pool. The Pool neither buys nor sells electricity, but rather serves as a market tool for competitive electricity sales. Every half-hour, generating companies bid the sale of a certain amount of electricity at a certain price (pence/kWh). The RECs then purchase the electricity, beginning with the least expensive bids, to satisfy their anticipated demand. The price paid by RECs to the generating companies, referred to as the pool price, in 1996 averaged approximately 3.8 US cents/kWh.[8]

[8] US$ 1.00 = 0.63 British pounds.

**Financial Incentives: Wind Power**

Wind power is one of a number of renewable energy technologies supported through the NFFO process. Because renewable energy facilities are not financially viable at pool prices, the United Kingdom has mandated RECs to satisfy periodic Parliamentary "Orders" (promulgated approximately every two years) to secure electricity generated from renewable energy resources. RECs satisfy an Order by contracting with independently owned renewable energy facilities, which are selected competitively on the basis of their bid price (pence/kWh). RECs may also satisfy the Order by owning and operating renewable energy plants. Details of the competitive bidding process are given below.

The contracted renewable energy facilities receive their bid price with RECs paying the portion of the bid price up to the pool price. The difference between the pool price and bid price is paid from the proceeds of a levy on sales of electricity generated with fossil fuels and charged to all customers regardless of class. These arrangements distribute the incremental costs of the renewable energy facility across England and Wales, rather than concentrate the charges near the renewable energy resources and facilities.

The detailed steps involved in the NFFO process include:

- **Government Announcement:** The UK Government announces its intention to make an Order for RECs to secure electricity generated from renewable energy resources. The announcement includes the approximate size (that is, generating capacity) of the Order, the anticipated applicable period, and the technologies likely to be included. The announcement does not indicate how much of the anticipated Order is to come from each technology (that is, does not indicate the size of each "technology band").
- **Bidding Documents:** In order to comply with the Order, bidding documents for proposed renewable energy facilities are released on behalf of the RECs by the Nonfossil Purchasing Agency (NFPA). These documents include all terms and conditions affecting bidders.
- **Receipt of Bids:** Bids are submitted in the form of completed questionnaires. Technical questionnaires are submitted to the potential project's host REC, and subsequently passed to the Office of Electricity Regulation (OFFER), the Government's independent regulatory agency for the sector. Completed questionnaires regarding commercial and financial information are submitted directly to OFFER.
- **Making the Order:** OFFER provides the Government with details regarding the approved proposals including a supply curve for each renewable energy technology that shows the cumulative capacity of the bids versus their bid price. After consulting with the RECs and OFFER, the Government decides the size (MW) of each technology band (that is, essentially by selecting a point on each technology's supply

curve), and promulgates the Order. In determining the size of the Order, the Government considers the fact that some awarded facilities may not receive local planning consent and will therefore not be developed.

- **Satisfying the Order:** Acting on behalf of the RECs, NFPA enters into standard power purchase contracts with successful bidders (that is, bidders whose bid price is below that selected by the Government on the technology supply curves). The power purchase price for contracts is the renewable energy facility's final bid price. Fifteen-year contracts have been awarded under the third and fourth NFFO Orders (that is, the last two Orders) with power purchase prices indexed to inflation.

RECs pay the portion of the contract power purchase price equal to the power pool price; the remainder is paid from the proceeds of the fossil fuel levy. The levy is raised by the RECs and other supply companies by applying a charge on end-use tariffs. As of April 1, 1997 the levy was 2.2 percent on end-use tariffs, although less than half is expected to go to renewable energy projects (the remainder will be used to support nuclear stations still under public ownership; prior to this date, the levy was 11 percent, but was also used to cover incremental costs of operating nuclear power stations). OFFER collects the levies from the supply companies, processes the funds, and transfers funds to NFPA.

**Results: Wind Power**

Four NFFO Orders (NFFO 1-NFFO 4) have been placed by the Government to date, each of which has included wind power. Overall, RECs have entered contracts with nearly 180 wind power projects totaling over 1,330 MW of name plate generating capacity. However, according to the United Kingdom's Department of Trade and Industry (DTI), as of February 1997, only 36 wind projects (165 MW) were operating. Many contracted projects are not operating because of difficulties in receiving local planning consent. NFFO 3 projects have until 1999 to commission their projects before beginning their 15-year contracts. Furthermore, the fourth NFFO Order was promulgated only recently, on February 6, 1997. Table 6 provides details related to each Order.

Despite the limited operating wind capacity in the United Kingdom, wind energy prices have declined dramatically throughout the NFFO process. For example, the average (capacity-weighted) contract price for NFFO 2 wind projects was 18 US cents/ kWh, more than three times that for NFFO 4. Reasons for the decline in wind energy prices include:

- **Increased Contract Length:** Contract terms have been extended from up to 7 years for NFFO 2 to 15 years for NFFOs 3 and 4. Guaranteed payments over an extended contract length facilitate long-term financing, extends debt repayment periods, and reduce bid prices.

**TABLE 6: IMPACT OF THE NONFOSSIL FUEL OBLIGATION (NFFO) ON WIND POWER**

| | NFFO Order | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Total |
| Date | 1990 | 1991 | 1994 | 1997 | |
| Number of contracts | 9 | 49 | 55 | 65 | 178 |
| Capacity contracted (MW) | 28 | 197 | 340 | 771 | 1,336 |
| Number of projects generating as of 02/97 | 7 | 26 | 3 | 0 | 36 |
| Capacity operating (MW) as of 02/97 | 27 | 123 | 15 | 0 | 165 |
| Anticipated operating capacity (MW) | 27 | 123 | 170 | 385 | 705 |
| Contract length (years) | <8.25 | <7 | 15 | 15 | |
| Bid price range for contracted bids (¢/kWh) | n.a. | 11.5-19.8 | 6.4-7.7 | 5.0-6.1 | |
| Capacity weighted average contract price | n.a. | 18.0 | 6.9 | 5.6 | |

*Source:* Workshop presentation.

- **Reduced Risk:** Perceived risk, which is reflected in required returns, has been reduced by the transparent NFFO process and increased confidence in the technology. Under NFFO 1, for example, wind power developers required returns of approximately 25 percent; by NFFO 4, the required returns had been reduced to around 10 percent.
- **Competition:** The NFFO process has enhanced competition and helped to reduce prices. Competing on the basis of bid price fosters cost-effective project design and implementation. Periodic NFFO "rounds" allow decisions regarding technology bands (that is, the technology's contribution to an Order) to adjust to changes in market conditions. Costs are also controlled by deferring decisions regarding the size of each technology band until all final bids are received and evaluated.
- **International Technology Learning:** Because it is not specifically targeted at domestically manufactured wind turbines, the NFFO process has been able to benefit from technological learning and economies of manufacturing in Denmark, Germany, India, and California.

While the open policy regarding foreign-manufactured turbines has helped reduce wind energy prices, it has deterred the development of a broad manufacturing base. Although British blade and turbine manufacturers do exist, over 80 percent of turbines installed in the United Kingdom have been imported. In addition, the periodic nature of the NFFO Orders constrains developers to a "stop-and-go" project development cycle.

## F. UNITED STATES (CALIFORNIA)

### Overview of and Context for Renewable Energy Financial Incentives

Financial incentives for renewable energy development in the United States are set at both the federal and state levels. In many cases, policy frameworks are set by the federal government with states required to design and implement policy details. As a result, financial incentive policies for renewable energy development in the United States vary greatly among individual states. States often formulate financial incentive policies to promote development of a resource within their particular borders, but which is not as prominent in other states (such as financial incentives for energy from biomass in Georgia, Alabama, and other states located in the southeastern United States). The State of California, however, developed strong financial incentive policies that have succeeded in promoting a broad range of renewable energy resources, including wind and solar resources. California was therefore chosen as a focus for the financial incentives offered for renewable energy development in the United States. Examples of incentives used in other states are documented at the end of this section.

In reaction to the oil crisis of the 1970s, the State of California adopted energy policies for (a) promoting energy diversity; (b) reducing dependence on fossil fuels; (c) using indigenous energy resources; and (d) promoting environmentally benign energy sources. These principles led to a series of financial incentive policies for renewable energy development that has resulted in significant installed capacity. By the early 1990s, renewable energy facilities comprised approximately 10 percent of the installed generating capacity in California.

Due to an oversubscription by renewable energy facilities in the late 1980s and 1990s, financial incentives for renewable energy development were removed. At the same time, California was and is continuing to move toward deregulating its electric utility industry. Despite uncertainties regarding future evolution of the deregulated industry, energy prices are expected to remain below those at which renewable energy facilities are financially viable. As a result, California is presently developing new financial incentives aimed at maintaining its existing renewable energy facilities as well as promoting further development of the most promising technologies in the deregulated power market.

### Financial Incentives: Wind Power

The majority of the wind power development in California occurred between 1983 and 1991, primarily in response to a number of state and federal financial incentives. The most important of these incentives was the Federal Public Utility Regulatory Policy Act (PURPA), which required utilities to purchase electricity from renewable energy facilities at their avoided costs. Implementation of the federal law, including the definition of avoided costs, however, was delegated to individual states. Of all states, California's implementation of PURPA was the most generous to renewable

energy developers. Standard contracts were offered to developers and included 15- to 30-year terms with high fixed-price energy payments for up to the initial 10 years. Energy payments for the remaining contract years are based on the host utility's short-run avoided costs; capacity payments could be fixed for the entire contract length.

Other incentives that contributed to wind power development in California between 1983 and 1991 included:

- federal investment tax credits (10 percent);
- federal energy tax credits (15 percent);
- state energy tax credits (25 percent); and
- accelerated depreciation (5 years).

Due to an oversupply of generating capacity, California utilities were no longer required to offer high fixed-price energy payments beginning in 1991. The utilities were still required to offer standard power purchase contracts, but at much lower prices. In addition, several of the tax incentives were either modified or removed in 1986. However, the Federal Energy Policy Act of 1992 offered a federal 1.5 US cents/kWh *production tax credit*. Escalated annually, this payment presently stands at 1.6 US cents/kWh. It is available for the first 10 years of operation for new wind facilities installed prior to June 1999. Publicly owned utilities that do not pay income tax are eligible for a similar 1.5 US cents/kWh production incentive *payment*.

California is in the process of developing financial incentives for renewable energy development that would supplement those available through the federal government. The guiding principles for developing the new incentives are that they (a) be applied only to technologies and applications that are expected to compete in future markets without financial incentives; (b) assist new as well as existing renewable energy projects; (c) encourage competition; (d) provide short-term assistance; and (e) create sustainable consumer-driven markets. The new incentives will be financed from a US$540.0 million fund raised via a surcharge on electricity bills for all customers of the state's three largest investor-owned utilities. The surcharge will be in effect from January 1998 through December 2001, and is equal to approximately 0.067 US cent/kWh. To avoid indefinite application of incentives and to limit costs, the same four-year window applies to disbursing the funds. At least 40 percent of the US$540 million must be used to support existing industry and a minimum of 40 percent used for new installations.

Wind projects can benefit from the US$540.0 million allocation in the following ways:

- **Existing Wind Farms:** All existing facilities will be paid the difference between their estimated production costs (3.5 US cents/kWh) and the general market price for electricity (that is, a power pool price). If the power pool price falls below 3.5 US

cents/kWh, then the fund will pay the developer 3.5 US cents/kWh less the pool price, but no more than 1 US cent/kWh. If the power pool price is 3.5 US cents/kWh or greater, then the facility will not receive a payment from the fund. A total of US$70.2 million of the US$540.0 million is reserved for this mechanism.

- **New Wind Farms:** Developers of all renewable energy facilities will be allowed to bid for new projects solicited by the State; developers of different renewable energy technologies (wind, biomass cogeneration, and so on) will compete against each other. Bids will consist of energy to be delivered and the subsidy required for that production level. Developers bidding the lowest required subsidies will be selected. Approximately US$160.0 million has been set aside for this incentive.
- **Electricity Consumers:** Beginning in 1998, electricity consumers will be able to select their electricity supplier. Consumers who choose to purchase electricity from wind power and/or other renewable energy facilities will be eligible for rebates from the US$540.0 million fund. Approximately US$75.0 million has been reserved for the rebate incentive.

**Results: Wind Power**

Between 1985 and 1991, installed wind power capacity in California increased from approximately 500 MW to nearly 1,700 MW. Nearly all of this growth can be attributed to the standard offer contracts and high fixed-energy payments offered under the State's implementation of PURPA. Development of new facilities stopped as such contracts and terms ceased to be offered. In addition, nearly all facilities have either reached or are approaching the eleventh year of their standard offer contracts. As power purchase prices accordingly shift from high fixed payments (which in many cases exceeded 10 US cents/kWh) to short-run avoided costs (that is, 2 to 3 US cents/kWh), several wind farms are stopping operations or reducing output. In fact, installed wind power generating capacity in California peaked in 1991 at 1,680 MW. By 1995, installed capacity had declined to approximately 1,525 MW.

Prices for the installed wind farms in California has declined dramatically from US$2,000/kW in 1982-83 to approximately US$1,050/kW in 1993. The present cost of generating electricity with wind resources has been estimated to range from 5 to 7 US cents/kWh depending on wind resources, financing terms, and other factors. The United States Department of Energy has established cost goals of 2.5 US cents/kWh for wind power by the year 2000 (assuming favorable financing).

The wind power market created by the incentives offered in California during the 1980s has resulted in a modest American wind power manufacturing industry. In general, the industry has suffered from the lack of continuous and reliable domestic wind power markets, including associated financial incentives.

**Financial Incentives: Photovoltaics**

Financial incentives for photovoltaic systems in California have mirrored those offered for wind power. During the 1970s and 1980s, photovoltaic systems were eligible for the provisions of PURPA, and federal and state tax credits, including accelerated depreciation. In addition, solar assets were not subject to California state property taxes. In 1992, the federal energy tax credit for PV systems became permanent and publicly owned utilities generating electricity with grid-connected PV systems became eligible to receive the 1.5 US cents/kWh production incentive payment from the federal government. Unlike wind power however, the 1.5 US cents/kWh production *tax credit* was not made available for privately developed grid-connected systems.

Along with wind power, PV has been identified by California as one of the renewable energy technologies that can compete in future markets without financial incentives. As a result, some of the proceeds of the US$540.0 million renewable energy financial incentive program may be used to promote PV systems. Proposals are focusing on providing rebates for niche market applications including grid-connected systems for voltage support and deferral of grid upgrades. Initially, rebates could be set at US$3.00/Wp and scheduled to be reduced by US$0.50/Wp/year. In concert with the rebates, long-term (such as 15 to 20 years), low-interest (for example, 5 percent) loans could be made available to system purchasers.

**Results: Photovoltaics**

Over the past 15 years, federal and state financial incentives for PV systems have had negligible effect on the installed capacity of grid-connected applications. The limited installed capacity can be attributed, in part, to the application of "grid-connected financial incentives" to a technology that primarily suits off-grid markets. Off-grid systems have been developed primarily as a result of cost-effective applications for telecommunications, water pumping, and stand-alone systems. As of 1996, there were only 11 MWp of installed systems in California, almost half of which is installed within the Sacramento Municipal Utility District's (SMUD's) service territory. SMUD's primary PV application is grid-connected systems to offset peak electrical demands.

Regardless of the limited deployment of photovoltaic systems in California, large grid-connected installations have shown declining prices. For example, the price for SMUD's PV2 Project in 1987 was approximately US$17/Wp. In 1994, the SMUD APS project cost less than US$6/Wp.

**Incentives in Other States**

While California has historically been the most aggressive state in promoting the development of wind power and other renewables, several other states have been providing their own financial incentives. In addition to a variety of state tax incentives, loans, and grants, states such as Minnesota and Iowa have set legislative mandates for wind energy development including requirements for time-bound capacity additions.

Iowa also requires premium power purchase prices. Minnesota's Integrated Resource Planning mandates a minimum 50 percent reliance on renewable energy and conservation and state law dictates that the Public Utility Commission shall not approve repowering or construction of conventional resources for new capacity unless it is determined that a renewable resource option is not in the best interest of the public. Arizona, Nevada, Maine and Vermont have adopted (but have not yet implemented) renewable portfolio standards where the states require every retail power supplier to purchase a percentage of its capacity requirements from renewable resources (varies by state from 0.5 to 30 percent) or make up the difference by purchasing credits from power suppliers that exceed the specified percentage through a credit trading scheme.

A list of some of the more innovative incentives used by states to promote wind and other renewable energy technologies is provided below. These include "market pull" measures aimed at developing markets (such as standard contracts, auctioned contracts, renewable portfolio standards), "market push" measures targeted toward reducing cost and other barriers (such as tax incentives, low-cost capital programs), and those with elements of both approaches (such as net metering).

- **Customer Selection Programs**, including utility-based green pricing programs, green marketing, certification/disclosure programs, consumer bundling programs.
- **Environmental Programs**, including externality valuation (resource planning, environmental dispatch, monetization), emission taxes, emission caps/marketable permits.
- **Renewable Portfolio Standard** (see description above). States determine which renewable energy technologies are eligible and set the percentage requirements.

One of the most significant new initiatives for PV commercialization in the United States is the recently established Million Solar Roofs Initiative. This initiative seeks to support the manufacturing and installation of 1 million residential and commercial photovoltaic systems in the United States by the year 2010. This will be accomplished through a capital fund that provides consumer incentives for the purchase of rooftop systems, and provision of low-cost end-user financing (up to 20 years at interest rates below 5 percent).

## G. Indonesia and Mexico: Off-Grid Photovoltaic Systems Only

### Introduction

Although four of the six countries participating in the workshop offer financial incentives for photovoltaic systems, only India explicitly addresses off-grid uses including solar home systems, the primary photovoltaic application in China. To expand the discussion of financial incentives for off-grid photovoltaic systems, World Bank staff summarized the financial incentives offered for solar home systems in Indonesia and

Mexico. This section of the Proceedings provides a summary and synthesis of these discussions.

Financial incentives offered for photovoltaic solar home systems in Indonesia and Mexico differ in a number of ways. Both countries view the technology as a means of providing energy services to areas that are not served by an electrical grid. Indonesia, however, provides financial incentives through a commercial framework involving participating banks (including commercial and state-owned lenders) and private-sector solar home systems dealers/suppliers who offer installment-payment plans to customers with "reasonable proximity to urban centers." Grants represent approximately 20 percent of the total system costs. In contrast, Mexico's PRONASOL Program targets the country's poorest regions. The federal and state governments provide grants covering 80 percent of total project costs to private-sector contractors who procure, install, and maintain systems. The remainder of the project costs are expected to be paid by local governments and end-users, often through in-kind resources.

**Indonesia: Context for Use of Solar Home Systems and Financial Incentives**

Nearly 70 percent of Indonesia's 180 million population lives in rural areas spread across the country's 13,600 islands. The rural household electrification coverage is approximately 40 percent, considerably less than its regional neighbors in Thailand (reported 95 percent coverage) and Malaysia (98 percent). In the past, the Government has primarily taken a conventional least-cost grid extension approach to rural electrification with the national utility, PLN, acting as the implementing agency.

The Government has more recently begun to recognize the potential role for off-grid/decentralized rural electrification, such as PV solar home systems, as a complement to grid-extension programs. Underlying the Government's longer-term goal of installing 1 million solar home systems is the recognition that increasing use of solar home systems will help to increase the pace of electrification, at a time when PLN's resources are already stretched implementing conventional rural electrification approaches. The Government also realizes that financial burdens associated with rural electrification can be alleviated by allowing the private sector to deliver the systems to unelectrified areas.

Barriers to large-scale delivery of solar home systems stem from three interrelated factors: (a) high initial technology costs; (b) delivery infrastructure (supplier-dealer chains, service arrangements) that lacks the volume to achieve economies of scale; and (c) lack of credit to system end-users. As part of its efforts to remove these barriers and satisfy the electricity demands in rural areas with solar home systems, the Government of Indonesia requested assistance from the World Bank and GEF. The World Bank/GEF-supported Indonesia Solar Home Systems Project will support the delivery of 200,000 solar home systems via the provision of (i) financing through participating banks to private dealers/suppliers of solar home systems who would, in turn, enable the purchase

of the systems by rural households and commercial establishments on an installment plan basis; and (ii) a GEF grant distributed to dealers/suppliers on an installed-unit basis.

**Indonesia: Implementation of the Solar Home Systems Project and Financial Incentives for Photovoltaic Solar Home Systems**

Under the Indonesia Solar Home Systems Project, proceeds of the World Bank loan will be used to refinance participating banks' loans to private-sector solar home systems dealers. To receive financing, dealers would be required to offer installment payment plans to end-users, thereby addressing the barriers created by the lack of credit to end-users (see previous paragraph). The financing extended by a participating bank to a dealer would be based on the dealer's cash flow requirements as well as the participating bank's assessment of the dealer's performance history and credit worthiness. In addition to the requirement of offering installment plans, dealers would also be required to offer consumer protection, and solar home systems would be subject to meeting technical performance specifications.

In addition to the access to commercial financing, the Solar Home Systems Project also provides GEF grants to dealers/suppliers for each system installed. Although dealers are not required to apply the grant to reducing solar home systems prices to end-users, those that do are expected to receive greater long-term returns. As a result, the grants are expected to help reduce the high initial costs of solar home systems. Grants range from US$75 to US$125 and are only available to dealers after the Project Support Group receives and confirms documentation regarding system installation.

Under the Project, GEF grants are also provided:

- to the Project Support Group for verifying dealers' compliance with technical specifications and use of loan proceeds/grant funds;
- to the Project Support Group for offering consumer protection services to existing and potential solar home system end-users; and
- for preparing a Decentralized Rural Electrification Strategy Study and Solar Home Systems Implementation Plan.

**Mexico: Context for a Renewable Energy Rural Electrification Program**

At present, over 90 percent of all Mexicans are connected to and served by the national electric grid. The remaining 8.2 million citizens are living in approximately 155,000 partially electrified or unelectrified communities, each with a population of less than 2,500. Many of these latter communities are located in remote regions that lack roads and other basic infrastructure as well as opportunities for productive uses of electricity.

Recognizing the need to offer a social safety net during a period of tight government spending, the federal government launched the National Solidarity Program (PRONASOL) in 1989 to financially support infrastructure development in the country's less developed regions. Approximately US$10.0 million of federal and state funds are committed to the program annually. In particular, PRONASOL includes support for rural electrification using local energy resources as a complement to the rural electrification programs of the government-owned electric utility, Commission Federal de Electricidad (CFE). PRONASOL's renewable energy rural electrification projects are further organized into investments for (a) productive applications (primarily agriculture-related) and (b) improvements in quality of life, including photovoltaics for solar home systems, street lighting, lighting of public buildings, vaccine refrigerators, and potable water pumping.

**Mexico: Implementation of PRONASOL and Financial Incentives for Solar Home Systems**

The PRONASOL Program is implemented through a series of community-based projects. One or more communities in a region propose a project to their respective state governments through local government offices. Solar home systems projects are encouraged at the community level by private contractors and local nongovernmental organizations that disseminate information and, in some cases, install a demonstration system. In proposing a renewable energy rural electrification project, the communities must pledge to form a local electrification committee with responsibilities for developing internal financial mechanisms to cover operations, repair and maintenance, and possible future project expansion.

If approved by the state governments, proposals are submitted to the federal government for approval. In reviewing applications for solar home systems projects, the federal government considers the community's "remoteness" and distance from the grid, and CFE plans to connect the community to the grid. Solar home systems projects must also comply with technical specifications developed by the CFE's Electrical Research Institute (IIE) and other national experts. IIE also reviews the installation and performance of approved projects, using its more than 200 local distribution engineers who have been trained in renewable energy rural electrification applications.

If approved, projects seeking to improve quality of life will receive government grants amounting to 80 percent of the total project cost (50 percent from the federal government and 30 percent from the state government). Local governments, communities, and end-users are expected to pay the remaining 20 percent (including in-kind resources).

Tenders for approved projects are issued by state governments, and include the provision of system design, procurement, installation, user training, and after-sales

services. The selected bidder must also provide guarantees for providing after-sales services, which IIE will ultimately review.

Responsibilities of the end-user include: (a) forming and participating in a local electrification committee; (b) operating and maintaining solar home systems; and (c) notifying local government agencies and CFE offices of technical problems with solar home systems.

**Mexico: Results of PRONASOL Program**

As of February 1996, over 24,000 solar home systems have been installed under the PRONASOL Program. In addition, nearly 10,000 photovoltaic-powered telephones have been disseminated and 13 diesel hybrid systems (wind-PV or wind-PV-diesel systems) and small hydro plants have been installed. A variety of projects using renewable energy systems for productive applications have also been developed and installed. In four years, the program has reached over half of the 31 states in the Mexican Republic.

Local manufacture and supply of photovoltaic systems has increased modestly since the beginning of the PRONASOL Program. Most balance-of-systems components are manufactured in Mexico, although some companies continue to import. Modules are imported, although the source has been expanded to include multiple companies from the United States, Europe, and Japan. In addition, international photovoltaic manufacturers are beginning to establish local offices in Mexico with the number of foreign firms tripling between 1993 and 1996.

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