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Financing PV Growth

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This chapter presents an overview of the financing of photovoltaic PV growth. Solar energy is free, but the equipment to collect it and convert it to electricity is not. PV systems are highly capital intensive, hence the method and cost of financing will affect the economic viability and the affordability of PV systems to the end users (see Reference [1]).

24.1 HISTORICAL DEVELOPMENT OF PV FINANCING

Programs for the financing of photovoltaics began in the late 1980s. The practice of financing photovoltaics has evolved slowly and has not been entirely successful to date:

1987: The Indian Renewable Energy Development Agency (IREDA) was founded; today, it is still the only major national institution that is dedicated solely to the financing of renewable energy.

1989: The World Bank established The Solar Initiative as a way of drawing attention to the environmental and developmental benefits of solar energy (see Reference [2]).

1990: The Solar Electric Light Fund (SELF) began pioneering projects in India, Sri Lanka, Nepal, China, Indonesia, Solomon Islands, Brazil, Zimbabwe, Senegal, Uganda, and South Africa, demonstrating the viability of Solar home systems (SHS) in the developing countries and setting the stage for many PV programs around the world.

1992: The Sustainable Development conference was held in Rio, leading to additional funding of the Global Environment Facility (GEF).

1994: The world's first PV loan program by a bank was established by KM Udupa, chairman of Malaprabha Grameena Bank, the rural lending affiliate of Syndicate Bank, in Hyderabad, India.

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1995: The Pocantico Conference was convened by the Rockefeller Brothers Fund to debate strategies on mobilizing PV financing in the developing countries.
1996: The Japanese government announced a national PV strategy that included a 50% subsidy for residential rooftop applications, substantial increases in government funding of PV R&D, and government subsidies of interest rates to encourage banks to lend for PV applications. In Europe, Triodos Bank established its Solar Investment Fund (SIF), a $3 million fund focused on end-user financing in the developing countries. In the United States, a joint task force of the World Bank Group and charitable foundations led to plans for the Solar Development Group (SDG) and the proposed SolarBank Program.
1997: The Shell–Eskom joint venture was established in South Africa, providing nongrid electric service to rural households using a "fee-for-service" strategy. The World Bank closed a GEF-supported PV loan facility in Indonesia and laid out plans for PV loan programs in China, Argentina, and other countries.
1998: The PV Market Transformation Initiative (PVMTI) was launched in India, Kenya, and Morocco, sponsored by the International Finance Corporation (IFC) and funded by the Global Environmental Facility (GEF). In the United States, Astropower became the first successful Initial Public Offering (IPO) by a venture capital–backed PV company.
1999: Germany launched its 100 000 Roofs PV Program with a "feed-in tariff" for PV electricity and a national program of low-interest loans, which has been successful.
2000: The IFC's Renewable Energy and Energy Efficiency (REEF) Fund, a $100 million equity fund for such projects in the developing countries, raised its initial capital. In the United States, the Renewable Energy Development Institute (REDI) formalized its PV loan brokerage operation.
2001: The Solar Development Group, including the $20 million Solar Development Foundation (SDF) and the $29 million Solar Development Capital (SDC) fund, was launched by the World Bank, IFC, GEF, US Foundations, and European governments and donor agencies, to fund PV enterprises in the developing countries.
2002: Low-interest loan programs have begun to appear around the world, from California to Kenya.

Historical information from around the world suggests that financing will play a pivotal role in creating and sustaining the growth of PV market demand:

Developing countries: PV companies in India, Indonesia, South Africa, and the Dominican Republic report that only 2 to 5% of prospective purchasers can afford to buy a PV system with cash, while approximately 50% could buy if provided with reasonable third-party financing (please see Section 24.5 for details).
Germany: The KfW made low-interest loans available in conjunction with a DM 0.99 feed-in tariff, igniting a booming PV market that increased from nearly 0 MW in the year 1998, to 40 MW in the year 2000, and an estimated 75 MW in the year 2001 (see Reference [3]).

Indeed, the evidence suggests that market demand for photovoltaics can increase by tenfold with the availability of reasonable end-user credit, from approximately 5% of end users who can pay cash, to 50% of end users who could buy if credit on reasonable terms is made available.

24.2 CAPITAL REQUIREMENTS

The worldwide rate of PV installations grew at approximately 15% per year in the early 1990s, and accelerated to an average growth rate of 30% per year in the late 1990s. What will be the future growth rate of PV markets, and how much capital will be needed to fund the growth of PV markets and industry?

24.2.1 Market Drivers

Photovoltaics are becoming a factor in the development of the rural areas of the world where over 35% of the world's population – 56% of the rural population – live without the benefit of electricity from the utility grid, totaling some 2 billion people or 400 million households (see Reference [4]). There, photovoltaics have energy value.

The second major driver of PV growth is the public policy on environment and sustainable development. Climate Change is driving global action through the Kyoto protocol and the separate US Climate Change Strategy. As a result of environmental concerns, we are seeing accelerated growth of PV markets in Japan, Europe and, to a lesser extent, the United States. Much work still needs to be done to monetize environmental values and turn market potential into reality (see Reference [5]).

24.2.2 Growth Outlook

What level of growth can be expected in the future? Scenarios of 25 and 50% annual growth bracket the likely range of outcomes. As illustrated in Figure 24.1, the difference between 25 and 50% compounded growth is substantial:

25% Growth Rate: At a growth rate of 25% between the years 2000 and 2010, the annual amount of PV installations will reach 2500 MW per year by 2010.
50% Growth Rate: At a growth rate of 50% between the years 2000 and 2010, the annual amount of PV installations will increase to over 16 000 MW per year by 2010.

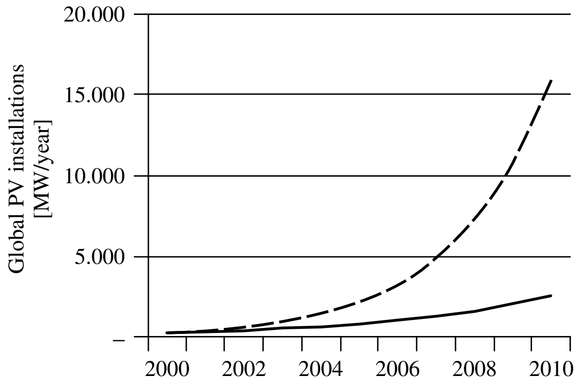

Figure 24.1 PV growth scenarios

24.2.3 Capital Requirements

How much capital will be needed? Table 24.1 presents estimates of the amounts of capital that will be required to support the two scenarios of PV market growth. In the year 2010, modules are assumed to cost \$1.50/Wp, and systems to cost \$3.00/Wp (in 2000 constant dollars). If so, the global PV industry will be doing between \$3.8 and \$23.8 billion of module shipments, and between \$7.7 and \$43.6 billion of system installations in the year 2010, under the 25% and 50% growth rate scenarios, respectively. The amounts of capital that will be required to support these levels of growth are estimated as follows:

PV factory investment requirements: The investment cost of PV factory capacity is on the order of \$2 to \$3 million per MW/year of capacity in the year 2001. This is expected to decline to \$1 million per MW/year of capacity as the scale of the new factories continues to increase (i.e. a 100 MW/year factory will cost \$100 million to build). Assuming that the PV factory capacity will require an investment of \$1 million per MW/year over the next 10 years, the amount of capital to be raised for investment in PV factories will be between \$3.1 and \$19.0 billion.

Working capital requirements: The operations of the factories and sales distribution channels for PV equipment must also be financed, including inventory and receivables. Assuming that 60 days of work-in-process inventory, 60 days of finished goods inventory, and 90 days of receivables need to be financed, the PV industry will require between \$1.9 and \$11.9 billion for working capital financing.

End-user financing requirements: Market indicators suggest that as much as 80 to 90% of the PV market will require end-user financing. Assuming that grid-connected systems represent 50% of the world market, and that 80% of the end users receive an average 80% loan, and assuming that off-grid rural electrification represents 30% of the world market, and that 50% of those end users receive an average 80% loan, then the end-user financing requirement to support PV industry growth will be \$20.6 to \$82.8 billion over the next 10 years.

Table 24.1 Global capital requirements to fund PV growth

	25%/Year growth scenario	50%/Year growth scenario
Annual amounts in 2010:		
PV shipments	2561 MW/year	15 858 MW/year
Module revenues	\$3.8 billion/year	\$23.8 billion/year
System revenues	\$7.7 billion/year	\$43.6 billion/year
Cumulative amounts 2000–2010:		
PV shipments	11 700 MW	47 000 MW
Module revenues	\$23.4 billion	\$94.0 billion
System revenues	\$46.8 billion	\$188.1 billion
Global capital requirements (US \$):		
PV factory investment	\$3.1 billion	\$19.0 billion
Working capital	\$1.9 billion	\$11.9 billion
End-user financing	\$20.6 billion	\$82.8 billion
Total capital required	\$25.6 billion	\$113.7 billion

Source: Eckhart, Overview, 2001

In sum, the PV industry must mobilize at least $25 billion in capital to support a 25% annual growth rate, and as much as $114 billion in capital to support a 50% growth rate, over the next 10 years.

24.3 FINANCIAL CHARACTERISTICS OF PV

This section addresses the characteristics of PV that are essential considerations in the financing of end-use applications, over and above standard lending issues like credit worthiness of the borrower.

Geographic location: The average amount of solar energy hitting the Earth is about 1 kW/m^2. The amount of solar insolation varies by latitude and by regional weather patterns. There is an approximate 2:1 variation in the amount of solar insolation across most of the inhabited world. A 1 kW PV system would generate a 900 to 1000 kWh per year in Germany, and as much as 1800 to 2000 kWh per year in desert locations like Arizona or South Africa. The amount of sunlight varies on an annual cycle, and also as much as +/−10% year to year due to atmospheric and weather conditions (see Reference [6]).

Facility design and cost: The cost of a PV system includes the cost of PV modules (typically 40 to 60% of the total), balance-of-system (BOS) equipment (such as batteries, controllers, inverters, switches, fuses, etc.), and services (design, architecture, engineering, procurement, construction, installation, and postinstallation O&M). PV system costs have come down steadily over the past 25 years, and are now typically $5 to $15 per installed watt. Financiers should be given evidence that the buyer has shopped for a quality system, from a qualified supplier, at a reasonable price.

System efficiency: System efficiency is the key operational characteristic of a PV system, measuring its conversion of solar insolation at the site to output DC or AC electricity. Most of the publicity about PV efficiencies refers to PV cell efficiencies, typically ranging from 5 to 10% for amorphous silicon, 8 to 12% for CIS and CdTe thin-film technologies, 12 to 18% for crystalline silicon, and 25% and higher for cells that are used in concentrator systems (see Reference [7]). The efficiencies of PV cells in research laboratories are even higher and they are improving steadily. But the key for financing is not the latest development in PV cell research; it is the typical, guaranteed output of an entire PV system in its end-use application. The conversion efficiency of the entire system is affected by the efficiency of the cell, reduced somewhat when placed in a module, then further reduced by losses in the wiring and BOS equipment. Thus, PV system efficiencies are about 60 to 80% of PV cell efficiencies (i.e. the efficiency of a system using 16% efficient cells is likely to be in the range of 10 to 13%).

Useful lifetime: The useful lifetime of a PV system is important because it determines the amount of time a financier can allow for repayment of a loan or lease. PV modules typically come with warranties of 10 to 25 years – assuring the owner of 80% to 90% of the module's rated output over the warranty period. From a lender's point of view this is a positive factor in financing. With such guarantees, the modules will have future value as collateral. The weak link in the financing of PV systems is, however, the fact that the useful life of BOS equipment is much shorter and less predictable. BOS equipment often comes with warranties of 90 days to one year, and useful lives can range from three to five years for batteries, and from 5 to 10 years for electronic inverters, converters, and controllers. The key to the long life of the full system is therefore ongoing maintenance and repair by a qualified supplier.

Operations and maintenance cost: Whereas photovoltaics have a reputation of being "maintenance free," this only applies to the PV modules. PV systems actually require regular checking and maintenance like any electrical system. Financing should be contingent on there being a plan and/or contract for ongoing maintenance service by the installer or another qualified electrical contractor.

Residual value: The residual value of a PV system is the amount that it can be sold for ("liquidated") at the end of the loan or lease. A lender wants assurance that the system's value is never less than the outstanding balance on the loan. A leasing company needs assurance of good residual value, since this is what the leasing company will own at the end of the lease. Lack of evidence on the collateral/residual value of PV equipment is one of the weak points in PV financing today.

Tax treatment: A key issue for financing is how photovoltaics is treated for tax purposes. This typically includes sales and property tax abatements, income tax deductions and credits, and accelerated depreciation schedules. These factors can be instrumental in determining the economic viability of a PV system and the timing of cash returns to the owner.

Regulatory treatment: A factor that is increasingly important is how photovoltaics is treated in government regulations. A key regulatory issue for grid-connected applications is whether photovoltaics qualifies for net metering. That is, whether electricity generated by the PV system can be applied to offset retail electricity purchases from the utility. If photovoltaics qualifies for net metering, then the value of the PV's output electricity equals the retail rate, typically 8 to 15 ¢/kWh in Europe and the United States, and over 20 ¢/kWh in Japan. If photovoltaics do not qualify for net metering, then the electricity is only worth the wholesale "avoided cost" rate, which is typically 2 to 5 ¢ per kWh. As of the year 2002, over 30 US states and several countries like Germany and the Netherlands, have adopted net metering or equivalent regulatory treatment.

Economics of the application: The previous factors related to the PV system. But what really separates photovoltaics from other power-generation technologies is the degree to which photovoltaics becomes an essential element of an end-use application – such as providing "essential electricity" for remote telecommunications, water pumping, home lighting, and other off-grid applications, or providing "clean electricity" for homes, commercial buildings, and other on-grid applications. A key question for the financier is whether the end-use application is economically viable, and the degree to which the use of photovoltaics makes it more or less so. Please see Section 24.4 for additional discussions on PV economics.

Codes and standards: Financing should be conditional on a PV system meeting all applicable codes and standards, and this will vary by end-use application, whether the PV system is integrated into the structure of a building, on the roof of a residential home, or in a field serving a remote application. The key US national standards include the National Electric Code and special standards for interconnection to the utility grid that have been promulgated by the Institute of Electrical and Electronic Engineers (IEEE) and Underwriters Laboratories (U/L). There is also a need to meet all applicable local building and electrical codes, which vary by locality (see Reference [8]). European standards organizations have promulgated a similar set of codes and standards for photovoltaics within the European Union. For solar home systems in the developing countries, the PV Global Acceptance Program (PV/GAP) establishes a testing certification protocol. The adoption of these codes and standards is one of the keys to future financing of PV, as they will build credibility with lenders and investors.

On the basis of the above, one sees that the characteristics of photovoltaics present a complex case. The financial merits of photovoltaics depend on location, cost and quality of the system, efficiency output of the system, useful lifetime, O&M cost, residual value, tax treatment, regulatory treatment, viability of the end-use application, adherence to codes and standards, and credit worthiness of the end user.

24.4 FINANCING PV FOR GRID-CONNECTED RESIDENCES

A major opportunity for PV growth in European, Japanese, and US markets is the grid-connected, residential rooftop system, typically 1.0 to 4.0 kW each. Approximately 110 MW of grid-connected systems were installed in Japan, 75 MW were installed in Germany, and 15 MW were installed in the United States in the year 2001.

24.4.1 Impact of Loan Terms on End-user Cost

Table 24.2 illustrates how the terms of financing can drive monthly payments on a PV system. The example uses a 2.5 kW residential grid-connected PV system costing $8.00 per installed watt (Wac). Credit card type debt (10 year, 18% interest) on a $20 000 residential rooftop PV system would yield payments of $437/month. The monthly payment drops to just $121/month if the PV system is included in a new home mortgage or financed with a low-interest loan.

It is clear from the above analysis that the preferred way to finance a residential PV system is the primary home mortgage loan, if possible. A longer-term loan results in lower monthly payments, but increases interest paid and hence the total amount of money paid for the system. As a rule of thumb, the cost of money is approximately equal to the cost of the PV system with an 11-year, 11% loan. A longer-term loan or a higher interest rate would cause the interest payments to be more than the cost of the PV system, illustrating once again the impact of financing on the viability of photovoltaics.

Table 24.2 Monthly payments on a 2.5-kilowatt rooftop PV system

Loan type	Term [Years]	Interest rate [%]	Monthly payment [$/month]
Credit card	7	18	437
Credit line	10	12	295
Home equity loan	15	8	195
Home mortgage	30	6	121

24.4.2 Types of Residential Financing

There are many financing alternatives available in the residential sector that could be applied to the financing of a PV installation:

Unsecured loan: Credit cards have become a significant source of financing, even though interest rates are typically 12 to 24%. Commercial lenders also provide unsecured signature loans and personal lines of credit at interest rates of 10 to 20%. Terms vary from one to ten years.

Equipment secured loan: There is some use of contractor-originated Retail Installment Contracts that hold security on the equipment until the contracts are paid off.

Home mortgage loan: Real estate secured loans are by far the most common and available form of credit to the residential sector. Loan products range from 5- and 10-year home equity loans, to 15-, 20- and 30-year primary mortgage loans, carrying either fixed or variable interest rates.

Energy-efficient mortgage (EEM) loan: In the United States, the EEM is offered by many of the national residential lenders and is designed to allow additional income credit from energy savings to be used in qualifying for a loan. This program is also called Energy Star. Japan and several European countries have similar programs.

Subsidized and targeted loan programs: Certain population groups – including, for example, low-income, minority, and veterans – are eligible for special terms and rates from a variety of specialized lenders. Also, there are special loan programs for designated locations such as rural areas, economically depressed areas, and inner-city urban areas. Government support for these programs ranges from direct loans, to loan guarantees, to interest subsidies.

Utility financing programs: A number of electric utilities have established special loan programs for energy efficiency and renewable energy. In the United States, the Sacramento Municipal Utility District (SMUD), the Los Angeles Department of Water and Power (LADWP), the Long Island Power Authority (LIPA), and the City of Austin Electric Department – all being nonprofit municipal utilities – have established PV financing programs (see Reference [9]). In Austin, the loans are unsecured, ranging from $1000 to $9000, with terms of three to ten years, at interest rates of 4.00 to 5.99%. The US cooperative utilities are also looking at PV financing programs. In Germany, municipal utilities created the first real market for photovoltaics between the years 1997 and 1998, applying the "Aachen model" of long-term power purchase contracts.

Government loan programs: A number of states in the United States are establishing clean energy funds, typically administered through the in-state utilities and banks. In New York, a $130 million fund has been established. Idaho's Renewable Energy Loan Program finances residential PV in amounts ranging from $1000 to $10 000, subject to the application having a 10-year payback or less. California has established a special alternative energy financing trust and a new Power and Consumer Finance Authority. This is also happening around the world. In Germany, KfW has established a national loan program for residential installations, offering 10-year loans at a 2% interest rate. In Japan, interest rates on loans for residential PV systems are subsidized. In India, IREDA has an ongoing program of lending for photovoltaics and other renewables.

24.4.3 Lender's Issues

Decisions about whether to make a loan will depend principally on the borrower's ability and willingness to repay the loan, indicated by past credit history and income. Loans secured by appreciating assets, such as real estate, have the longest terms and lowest interest rates, because the value of the collateral serves as additional protection of the loan. Lenders should ask several key questions in qualifying a loan:

- Is this installation economically advantageous for the borrower? The lender should understand whether the borrower is installing the PV system for economic or for environmental reasons.
- Can the system be easily installed by qualified contractors? Does it meet all of the applicable building codes and safety standards?
- How long will the system perform? Is there a warranty on the system? Is there a guarantee on performance over the life of the system?
- What will be the ongoing or recurring costs of operation, maintenance, repairs, and potential removal of the system?
- What are the energy-cost savings that the borrower will receive from owning the PV system? Are these savings certain enough to count as "income" for loan qualification purposes?
- What is the current market value of the system? How does this change over time? What is the likely residual value of the system at the end of the loan period?
- What are the risks on repayment? Technical? Economic? Others? Are the risks well known and understood?

24.4.4 Borrowers' Experience

A market research report prepared by the Regional Economic Research for the California Energy Commission (see Reference [10]) revealed the following:

- The main concerns singled out by residential consumers ranked system reliability, life, safety, and ongoing costs as more important than the initial cost of the system.
- The majority of residential end users (54%) preferred some form of loan financing over investing their savings – with 35% preferring a home equity loan, 22% a personal loan, and 7% a first mortgage.
- Residential end users were more likely to consider installing a solar system when: roofing the home (60%), remodeling (54%), and purchasing a home (50%) – all times when financing is normally utilized. Only 31% stated that they would be more likely to consider installing a solar system as a "stand-alone" purchase.

Market research by the US National Renewable Energy Laboratory (NREL) indicates that 60% of respondents are willing to pay at least $25 extra per month for a rooftop PV system, 38% are willing to pay an additional $50 per month, and 15% are willing to pay $100 more per month. Regarding financing, 46% prefer long-term loans, while 36% prefer short-term loans (see Reference [11]).

24.4.5 Example Calculation

A 2.5-kW rooftop PV system costing \$8.00/Wac installed will cost \$20 000. Assuming an excellent location yielding a 22% capacity factor, the system will produce 1927 kilowatt hours per kW installed, per year, or 4818 kWh/year for the 2.5 kW system. The following is a brief assessment of the financial merits under several cases:

No incentives: If the government does not allow net metering, the value of the electricity will only be the wholesale rate that the utility pays for bulk energy. The PV system is not likely to be given capacity credit, so the value will be energy only, or about 2 to 4 ¢/kWh. The value of the output is therefore \$96.36/year to \$192.72/year. The system will have a simple payback in 103 to 207 years.

Net Metering: If net metering applies, then the value of the electricity is the retail rate (tariff), say, 10 to 15 ¢/kWh. In this case, the value of the output is \$481.80/year to \$722.70/year. The system will have a simple payback in 28 to 42 years.

Subsidy: If the government now provides a subsidy in the amount of \$4.50/Wac, leaving the owner's cost equal to \$3.50/Wac or \$8750, and net metering still applies, then the value of the output is still \$481.80/year to \$722.70/year, and the system will have a simple payback of 12 to 18 years, probably within negotiating range for an environmentally motivated end user.

Low-cost financing: The cost of financing will increase the total cost to the end user, and hence lengthen the payback period or rate of return on investment. A 10-year, 12% loan will add 72% to the total outlay by the owner, increasing system cost from \$8750 to \$15 486. The simple payback will be lengthened from 21 to 32 years. Conversely, if the interest rate is dropped to 5%, the financing will add only 15% to the total outlay by the owner, increasing system cost from \$8750 to \$10 105. Simple payback will be lengthened to 14 to 21 years, much more favorable than the higher-rate financing. While third-party financing lengthens the payback period, it makes the purchase more affordable by more people, based on monthly payments (see Reference [12]).

The analysis has shown that – with net metering, feed-in tariffs, tax credits, capital cost subsidies, and low-interest financing – residential rooftop PV can yield a payback in the range of 10 to 20 years, potentially enough for those who are motivated by the environment and sustainable development.

24.4.6 Improving the Financing of Residential PV

Several things can be done to improve the fit between photovoltaics and the home-mortgage lending industry. First, the debt/equity ratio should be relaxed, allowing a higher faction of debt on a PV-powered home, reflecting the fact that the owner is prepaying the utility bill for 20 to 30 years. Second, the cost of the PV system should automatically increase the appraised value of the home. Third, the amount of savings on the borrower's utility bill should be added to the income for the purpose of the loan qualification calculation, reflecting the borrower's lower cost of living with the PV option. With these practices, the lending industry would become an enabler of, rather than a constraint on, PV growth.

24.5 FINANCING PV IN RURAL AREAS OF DEVELOPING COUNTRIES

Financing programs for PV in the rural areas of developing countries is the focus of the World Bank, the IFC, aid agencies from the OECD nations, charitable foundations, and a number of special-purpose funds such as the Solar Development Group and the proposed SolarBank Fund.

24.5.1 Rural Applications

There are four principal applications for photovoltaics in the rural areas of developing countries (see Reference [13]):

Solar home systems (SHS): This basic battery-based electrical system with a solar PV charger includes a PV module – typically 20 Wp in Kenya, 35 Wp in southern India, and 50 Wp in Indonesia and the Philippines – plus a battery, charge controller and wiring, receptacles, outlets, and switches for lighting and communications. Financing can be justified on a cost basis, the monthly payments for the SHS are less than a family's existing costs for kerosene, candles, and dry cell batteries (see Reference [14]), but the stronger basis for lending is the upliftment of family lifestyle and income that generally accompanies rural electrification. A 35-W solar home system costs US $300 to $750, depending on the manufacture, import duties and taxes (if applicable), the quality of components, and installation. Financing is just beginning to be made available through banks, nonbanking finance companies, microcredit lenders, cooperatives, and other sources. Typical financing for an SHS in a developing country is a 1- to 3-year loan at 18 to 36% interest, or a fee-for-service payment that approximates a lease.

Water pumping for irrigation: The financing of a PV-powered water pump for irrigation can be justified on the basis of the economic impact on the farm, typically the addition of a third crop to what was a two-crop farm, or higher yield per acre as a result of irrigation. A 900-W PV pumping system can cost $5000 to $8000, a cost that can be recovered in as little as one year in some extraordinary cases, and can be the least-cost option on a life cycle–basis for many remote farms, especially when compared to the costs of diesel power. PV-powered water pumping is heavily subsidized in most cases today, ranging from 100% grants from European donor agencies to a 50% subsidy from the government of India.

Microenterprise ("Productive Uses"): There are many applications for photovoltaics in small businesses. Financing can be established through microcredit models of group lending, and justified on the basis of the expected cash flows of the microenterprise businesses. PV systems can extend the operating hours with lighting, improve working conditions with lighting and fans, power mechanization and product preservation (drying and refrigeration), and enable communications. PV systems for the microenterprise range in cost from $300 for a minimal PV lighting system to $10 000 or more for a system that is capable of running a significant level of factory motors or refrigeration (see Reference [15]).

Institutional uses: Photovoltaics is being applied for lighting, communications, water supply and refrigeration in schools, health/medical clinics, and community services. A 1000-W PV system for a school or clinic can cost $10 000 or more, fully installed.

Such PV systems are typically paid for by government programs, often supported by grants from donor agencies. These applications will require new forms of institutional financing as PV utilization increases in the future beyond the ability of grant agencies to pay.

24.5.2 Impact of Financing on Market Demand

Evidence from Asia, Africa, and Latin America indicates that market demand for PV systems in the developing countries increases by a factor of ten (10x) with the provision of reasonable levels of end-user financing:

Latin America: The pyramid in Figure 24.2 illustrates an estimate that was made by Soluz Inc., a leading PV company operating in Latin America, suggesting a tenfold increase in market demand if financing is available.

Indonesia: A PV developer in Indonesia estimated that the market would expand from 30% of the population for cash sales to 70% for the fee-for-service option (see Reference [16]).

India: A PV company in India has concluded that 5% of rural people in southern India can afford to pay cash, while 50% could afford to buy a PV system if they had a 1 to 2 year loan at market rates (see Reference [17]).

Sri Lanka: A leading microcredit lender in Sri Lanka concludes that over 50% of the people can afford an SHS with reasonable credit (see Reference [18]).

South Africa: The national utility Eskom conducted a field-survey-based market study in preparation for the Shell–Eskom joint venture and found that nearly 50% of the rural families in the Eastern Cape could afford monthly payments of 47 Rand (then about US $10.00) per month, whereas very few could afford to pay for the system up front (see Reference [19]).

The findings are consistent around the world, that at least 50% of all rural households can afford to pay for a PV system given reasonable credit terms or the equivalent through a fee-for-service approach.

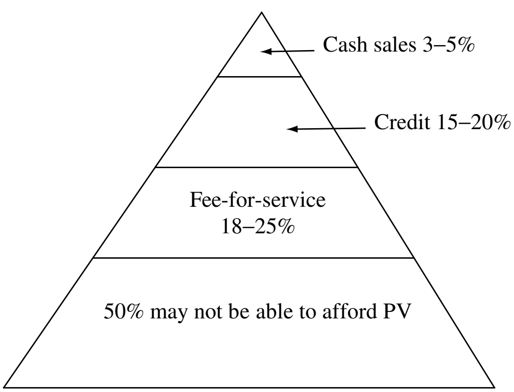

Figure 24.2 Affordability of PV systems by rural people in Latin America

24.5.3 Examples of PV Financing in Rural Areas

The financing of photovoltaics is beginning to occur around the world. The following are some current examples.

Bank Lending: SELCO India (Pty) Ltd, a solar PV installation and service company that has installed over 5000 solar home systems in southern India, has built working relationships with a number of area banks such as Syndicate Bank, and nonbanking finance companies (NBFCs) like Manipal Finance. SELCO has provided cash deposits as partial guarantees to several of the lenders, encouraging them to become involved in PV financing, and has provided interest rate buy-downs in other cases. Loans are typically 80% of the system cost, at 14 to 18% interest, repaid over one to three years. Even such short-term lending has sparked a market in southern India.

Microcredit lending: In Sri Lanka, a microcredit lender named Sarvodaya Economic Enterprise Development Services Limited (SEEDS), has embarked on a successful PV-lending program with its members. SEEDS loans 80% of the cost of the system. Loans are repayable in one to five years. Interest rates are in the mid- to upper-twenties (local borrowing rate plus a spread for SEEDS operation). Repayment is flexible – monthly or seasonal, depending on the income stream of the borrower. The loan recovery rate in SEEDS' program has reached 94%. SEEDS expects to finance as many as 50 000 solar home systems between the years 2001 and 2005. This work in Sri Lanka has built upon and perfected the pioneering work by Grameen Bank in Bangladesh (see Reference [20]).

NGO financing: In Bangladesh, Grameen Shakti, the PV affiliate of the Grameen Bank, is an example of a nongovernment organization that is involved in both the financial and technical aspects of PV dissemination. Grameen Shakti offers three financing options (it charges a "service charge" instead of "interest" because of local custom):

- 85% loan, repaid over a period of three years, having a 12% service charge (interest cost);
- 75% loan, repayable over two years, having an 8% service charge;
- Cash: The buyer receives a 4% discount on the system price by paying cash up front (not taking a loan).

Cooperative financing: In Santa Cruz, Bolivia, Cooperativa Rural de Electrificación (CRE) is a rural electric co-op that began installing PV systems in 1995 for customers who could not be reached by the grid. By 1998, CRE was serving 1300 PV customers, charging a flat monthly electric service fee. CRE owns the PV systems and maintains them.

Fee-for-service model: Several pioneering programs are being implemented using a fee-for-service model – charging a flat monthly fee for the use of a solar home system that is owned and maintained by a service company. Prepayment meters are commonly used on the battery's charge controller, which provides a revenue control mechanism. Users purchase prepayment cards each month at a local shop. In Indonesia, Total Energie, the French PV systems integrator, has completed a fee-for-service trial serving some 5000 customers. In South Africa, Shell-Eskom, a 50/50 joint venture of Shell International and Eskom, the national electric utility in South Africa, has installed 6500 solar home systems and is working toward an initial business trial of 50 000 units when approved as a "concession" by the central government. The model has been adopted as a national strategy by the South African government. South Africa has set a goal of 100% electrification using grid and nongrid (PV) alternatives by the year 2010. A third major application of the fee-for-service model is in Argentina under a World Bank loan.

Rental/Leasing (Entrepreneurial Model): A variation on the fee-for-service approach is leasing. In the Dominican Republic, Soluz Dominicana, an affiliate of the US-based Soluz, Inc., has established a pioneering model using a leasing approach. Soluz charges $10 to $20 per month per SHS. Over 2000 systems are in service. Maintenance is provided by the company.

Tax-driven leasing and other financial engineering: In India, nonbanking finance companies (NBFCs) did some "financial engineering" in the 1997 to 2001 period to create a single-payment lease structure for PV-powered water pumping. The NBFC collected a single, up-front lease payment from the farmer, typically 30% of the system cost. The NBFC then took out a 10-year, 85% loan from IREDA, bearing 2.5% interest. Finally, the NBFC absorbed the 100% first-year depreciation that is available for PV in India, yielding 34% after-tax cash value. The three inflows totaled approximately 150% of the cost of the PV system. The extra 50% was deposited at 12 to 18% interest, from which the IREDA loan is repaid in 6 and 10 years. This model yielded the NBFC a cash-positive deal from day one and a good profit. The net result was a win–win situation: the government's objectives for additional use of photovoltaics were met, the available incentives were fully absorbed by the financial community, and farmers got water-pumping systems that they otherwise could not afford. Nonbanking finance companies such as Sundaram Finance and Srei International participated in this approach. This example illustrates how governments can mobilize private sector capital through tax and loan policy. It also illustrates how unstable government policy can cripple PV markets – financing of PV water pumps through this technique came to a halt when IREDA stopped making PV loans at the 2.5% rate of interest, thus eliminating the interest arbitrage that the NBFCs had built into the model.

As seen above, the financing of photovoltaics in rural areas of the world's developing countries is beginning to occur in a number of ways – bank loans, microcredit lending, NGO programs, cooperative financing, fee-for-service models, rental/leasing, and tax-driven leasing. This is a period of renovation. Considerable efforts will be needed to promulgate the use of successful models and build a higher level of acceptance of PV financing by the financial community.

24.6 SOURCES OF INTERNATIONAL FINANCING

24.6.1 International Aid and Donor Funding

In the past, the programs to fund photovoltaics in the developing countries have been sponsored by donors and aid agencies. OECD countries provide about $50 billion per year in Official Development Assistance (ODA). These amounts include funds channeled by individual countries through multilaterals, such as the United Nations Development Program (UNDP). More recently, in line with GEF grants and World Bank financings, donor agencies have shifted increasingly towards the support of *financing*, rather than grant *funding*, of solar PV and other renewables. Illustrative examples of such programs include the following:

United States of America: USAID has been funding the Renewable Energy Project Support Operation (REPSO) through Winrock International, resulting in a number of early stage financial support actions in India, Brazil, Indonesia, and elsewhere. USAID explored the possibility of establishing an $18 million fund in South Africa for the Productive Uses of Renewable Energy (PURE Fund), focused on business uses for photovoltaics. In 1999, the US Export–Import Bank established a $50 million allocation to China, earmarked for renewable energy exports, including photovoltaics.

Germany: Kreditanstalt für Wiederaufbau (KfW), the German bank for reconstruction, has extended a DM 120 million loan to India's IREDA including DM 30 million allocation for photovoltaics.

Netherlands: The Ministry of Economic Affairs has supported a number of PV programs around the world, including a 20 000 unit solar home system program in Bolivia and a 30 000 unit program in China, supplied by Shell Solar. A new project in the Philippines is reportedly in the pipeline.

France: The French government had a special tax deduction for investments in the former French colonies, resulting in a subsidized flow of capital to PV projects in such countries. The French electric utility, Electricte de France (EdF) is involved in the financing of fee-for-service programs in Brazil, Indonesia, Morocco, and South Africa.

Spain: In 2001, the Spanish government extended a $48 million soft loan to the Philippines for the installation of 2 MW of photovoltaics in 100 villages, comprising approximately 150 000 homes, all to be supplied by BP Solar Madrid. One-half of the funds will be loaned under the credit conditions of the OECD: a 10-year loan at just-below market rates. The other half will come from the Spanish Development Aid Fund (FAD): a 30-year loan, with a 10-year grace period, with an interest rate less than 1.0% (see Reference [21]).

Australia: USAID extended a $30 million soft loan to Indonesia in 1998 for the installation of 50 000 solar home systems supplied by BP Solar Australia.

Japan: The Japanese aid agency, Overseas Economic Cooperation Fund (OECF), was reported to have begun providing aid in support of photovoltaics in developing countries in the year 2000. Reports suggest that the program might be substantial in scope and scale. OECF has prepared a $100 million funding package for India's IREDA for renewable energy on lending, including photovoltaics.

Others: The aid agencies of Austria, Denmark, Italy, Sweden, Switzerland, and the United Kingdom have funded a variety of PV programs in the developing countries, generally of the grant-for-demonstration kinds of activities. This kind of aid is being coordinated in Europe by the new EC directorate for international aid.

24.6.2 United Nations

UNDP supported demonstrations of solar home systems, PV water pumping, PV-powered health clinics, and other projects in the developing countries, generally with GEF grant support. UNDP-sponsored projects include

Bolivia: rural electrification with renewable energy
China: renewable energy capacity building

Ghana: renewable energy for rural, social, and economic development
Malawi: barrier removal to Malawi renewable energy
Peru: PV-based rural electrification
Sri Lanka: renewable energy capacity building
Uganda: PV pilot project for rural electrification
Zimbabwe: PV for household and community use.

UNEP has recently sponsored a new PV program in Africa, supporting early-stage financing of solar energy ventures (or, "enterprises"). This program has been funded by the UN Foundation, under the guidance of UNDESA.

The World Health Organization (WHO) funds a program for PV-powered refrigeration for storing medicines in remote areas of Africa.

24.6.3 World Bank Solar Home System Projects

The World Bank, with grant support from the GEF, has funded 12 projects around the world providing basic "energy services" such as lighting, radio, television, and operation of small appliances, using solar home systems in rural households that lack access to electricity grids, including

Argentina: renewable energy in rural markets project
Benin: off-grid electrification project
Cape Verde: energy and water sector reform project
China: renewable energy promotion project
India: renewable resources development project, through IREDA
Indonesia: solar home system project
Lao: PDR rural electrification project
Sri Lanka: energy services delivery project
Togo: off-grid electrification.

There are three more projects pending approval of the World Bank:

Peru: PV-based rural electrification
Guinea: rural energy development
Mexico: renewable energy for agriculture.

Most of the World Bank's early experience with photovoltaics and other renewables came from its Asia Alternative Energy Unit ("ASTAE"), funded by a number of donor agencies since 1992. A key finding from ASTAE's early work was that "the lack of term financing was not the sole obstacle to renewable resources or end-use energy efficiency development. The absence of adequate regulatory and institutional arrangements, local technical capacity, and appropriate energy service delivery infrastructure can pose equal or greater barriers to alternative energy development" (see Reference [22]).

On the basis of this experience, the World Bank is concluding that future PV projects will seek to incorporate six elements: support private sector and NGO delivery models, pilot consumer credit delivery mechanisms, pay first-cost subsidies, support policy development and capacity building, enact standards and establish certification, testing, and enforcement institutions, and conduct consumer awareness and marketing programs.

24.6.4 International Finance Corporation (IFC)

IFC, an institution of the World Bank Group, promotes economic development by encouraging private sector investment activities in developing countries. With regard to PV financing, the IFC participates in several PV financing programs:

Photovoltaics Market Transformation Initiative (PVMTI): PVMTI is an initiative of the IFC and the GEF to accelerate the sustainable commercialization and financial viability of solar photovoltaic-based energy services in India, Kenya, and Morocco. The IFC has designated Impax Capital and IT Power Ltd, both of the United Kingdom, as the external management team for PVMTI.

Small and Medium Scale Enterprises (SME) Program: This special unit of the IFC's environmental division makes small loans to entrepreneurial ventures and projects in the developing countries, and has made two financings in photovoltaics, in Vietnam and the Dominican Republic.

Solar Development Capital (SDC): SDC is a 10-year, $28.75-million fund that makes minority equity, quasi-equity, and debt investments in PV-related businesses in developing nations. SDC seeks to invest in companies involved in distribution, consumer financing or leasing, manufacturing, or other aspects related to accelerated PV use in rural areas.

Solar Development Foundation (SDF): This is an approximately $19 million nonprofit foundation that provides technical and business assistance to enterprises in preparation for larger-scale private investment, and can provide "seed" finance for business development activities on flexible terms.

Renewable Energy and Energy Efficiency Fund (REEF): REEF was a pioneer financing fund focusing on renewable energy and energy efficiency projects and companies. As of November 2001, REEF was capitalized at a level of $65 million of equity plus a debt facility from the IFC. The external management team was headed by Energy Investors Funds. REEF was disbanded in late-2002.

24.6.5 Global Environment Facility

The Global Environment Facility (GEF) has been a central source of funding for PV in the developing countries. Since 1991, the GEF has provided grant funding for 25 off-grid PV projects in 20 countries, all through the World Bank Group and the United Nations, accounting for about $210 million of GEF allocation, and about $1.4 billion in total project costs, as summarized in Table 24.3. Lessons learned from the GEF's early implementation experience are summarized in a formal review of the program, with several key conclusions (see Reference [23]):

- Local financiers should be encouraged to carry some of the credit risk, not simply act as administrative conduits, in order to increase postproject sustainability and replication.
- Small PV dealers face sufficient business and technology risks that they are reluctant to assume consumer credit risks and incur the costs of credit administration and collections.
- Microfinance may work well in countries that have well-established microfinance institutions, but NGOs do not necessarily have the commercial orientation or business skills for rapid delivery of credit. Scale-up and outreach can become problematic.

Table 24.3 PV projects funded by the Global Environment Facility

Program	Year	Project	Agency	GEF funds [$ millions]	Total funds [$ millions]	Status
India	1991	Alternative energy	WB	26.0	186.0	Implementing
Zimbabwe	1991	PV for households and communities	UNDP	7.0	7.0	Completed
Indonesia	1995	Solar home systems	WB	24.0	118.0	Cancelled
Uganda	1995	PV pilot project, rural electrification	UNDP	1.8	3.6	Implementing
Ghana	1996	Renewable energy rural development	UNDP	2.5	3.1	Implementing
Sri Lanka	1996	Renewable energy capacity building	UNDP	1.5	1.5	Implementing
Sri Lanka	1996	Energy services delivery	WB	5.9	55.0	Implementing
Argentina	1997	Renewables energy in rural markets	WB	10.0	120.0	Implementing
Bolivia	1997	Rural electrification with renewables	UNDP	4.5	8.5	Implementing
China	1997	Capacity building for renewable energy	UNDP	8.8	28.0	Implementing
Lao PDR	1997	South provinces renewables project	WB	0,7	2.1	Implementing
Benin	1998	Decentralized rural energy	WB	1.1	5.7	Pending approval
Cape Verde	1998	Energy & water sector reform	WB	4.9	65	Implementing
China	1998	Renewable energy development	WB	35.0	445.0	Implementing
Peru	1998	PV-based rural electrification	UNDP	4.0	9.2	Implementing
Togo	1998	Decentralized energy	WB	1,1	5.7	Pending approval
Guinea	1999	Rural energy	WB	2.0	10.0	Pending approval
Malawi	1999	Barrier removal for renewables	UNDP	3.4	10.7	Pending approval
Mexico	1999	Renewable energy for agriculture	WB	8.7	26.0	Pending approval
SME	1994	Small and medium scale enterprises	IFC	1.6	4.8	Implementing
PVMTI	1996	PV market transformation initiative	IFC	30.0	120.0	Implementing
REEF	1996	Renewable energy & energy efficiency	IFC	30.0	130.0	Implementing
SDG	1998	Solar development group	IFC	10.0	50.0	Implementing

Source: Martinot, E. *et al.*, "The GEF Solar PV Portfolio: Emerging Experience and Lessons," Global Environment Facility, August 2000

- Credit collection can be costly if rural customers are dispersed over large territories with poor transport infrastructure. Businesses organized for marketing, installation, and service may not be well suited for credit collection.
- Some customers with seasonal income (i.e. paddy farmers with semiannual harvests) may require repayment schedules tied to semiannual income rather than to monthly incomes.

In 2001, the GEF broadened its mandate from a source of primarily grant funds through the United Nations and the World Bank Group, to the possibility of providing a broader array of investments, loans, guarantees, and other forms of financial support through a more diverse network of intermediaries.

24.7 FINANCING THE PV INDUSTRY

The PV industry will need to assemble a substantial amount of capital to support its growth. Capital is needed to expand manufacturing capacity and to fund working capital for inventories and receivables, all of which must be financed ahead of sales and profits in a growing industry. There are several sources of financing for the PV industry:

Major corporations: This is a dynamic time in the PV industry. Approximately 75% of worldwide PV market share is held by the operations and subsidiaries of major corporations – Sharp, Kyocera, BP Solar, Siemens, Sanyo, ASE, Shell, and Mitsubishi. It is typical for such large corporations to require a 20% or greater rate of return on internally invested capital, and this has not been achieved in the past. Many PV businesses have lost money, causing companies to quit the business. Companies that have left the PV business include Westinghouse, IBM, Motorola, Xerox, Texas Instruments, Exxon, Shell (US), Arco, Mobil, and others. More recently, with the global movement towards green energy, several major corporations have increased their commitments, including BP in 1996 and Shell International in 1997. The most recent casualty was Siemens, selling its solar division to Shell. Lacking improved profitability, the industry may see a continuation of entries, exits, and reorganizations by major corporations.

Electric utility companies: There has always been an affinity between photovoltaics and the utility companies. For example, Alabama Power was a major investor in Chronar, which closed. Idaho Power acquired a number of PV-systems integration firms between the years 1997 and 1999, only to exit the business and sell the group to Schott in the year 2001. Siemens Solar was half-owned by a German utility, EoN. The former Mobil Solar was acquired by RWE in 1994, a German utility, creating ASE Americas. General Public Utilities established GPU Solar, a joint venture with Astropower, focusing on grid-connected IPP power projects, commercial systems, and residential rooftop systems. The PV industry can expect to receive additional capital investment from the utility industry.

Capital Markets: The public stock markets in Europe and the US began to show interest in clean energy and distributed power generation in the period between 1998 and 2000. The areas of popular stocks in the United States include fuel cells, microturbines, and photovoltaics. In Europe, where the markets reacted earlier, the favorites have included wind power (in which Denmark and Germany lead the world industry), solar photovoltaics, hydropower, and other renewables. There are three publicly traded PV stocks in the United States: Astropower, Evergreen Solar, and Spire Corporation; and several in Europe. The outlook is positive in the near future, as the supply of money for green energy stocks is increasing, including the formation of mutual funds specializing in clean/green energy, such as Winslow's Green Growth Fund.

Venture Capital: The Venture Capital (VC) industry has invested in PV deals over the past 25 years, generally losing their investments, and never achieving their traditionally accepted financial goal of a 40% rate of return. This may be changing in recent years with successful Initial Public Offerings (IPOs) by Astropower and Evergreen Solar in the United States and Solar World in Germany. Other venture-capital-backed PV companies, not yet publicly traded, include Solar Electric Light Company (SELCO), First Solar, and Global Solar in the United States, Solar Fabrik in Germany, and Solar Century in the United Kingdom. There is a tremendous influx of new venture start-ups in photovoltaics, especially in Europe and Asia where there are booming markets. Venture capital funds that have invested in photovoltaics include Arete Ventures (the Utech Funds) and Nth Power Technologies in the United States; Swiss Re, the Sarasin Fund, and UBS Energy Fund, all in Switzerland; and Gerling Insurance in Germany. Other US VC funds that have expressed interest in new energy technologies include the Commons Fund, Beacon Energy Funds, Energy Ventures Group, Kinetic Ventures, and Perseus Capital.

24.7.1 Financing Working Capital in the Distribution Channels

One of the more challenging aspects of financing PV growth will be how to capitalize the distribution channels to reach the widely dispersed end-use markets. There are several sources of financing for these firms:

Local lenders: Small business financing is inherently a local lending business. The vast majority of funds for financing the working capital requirements of the PV distributors and dealers will be from local banks, NBFCs, and microcredit lenders.

PV manufacturers: Most of the major PV manufacturers have extended credit programs for their best distributors and dealers.

World Bank/IFC: The IFC and GEF have collaborated on the deployment of two programs, PVMTI and SDG, to finance "PV enterprises" in developing countries. Over 200 such businesses have been identified by SDG as of mid-2001. The number of firms that will be required to support worldwide development of PV markets will, according to E&Co, be as high as 16 000 companies.

24.8 GOVERNMENT INCENTIVES AND PROGRAMS

A wide range of government incentives and programs has been adopted for photovoltaics around the world, stimulating demand for PV systems and affecting the financing of photovoltaics.

24.8.1 Potential Impact of Financing as a Government Policy Option

Looking at financing in the context of government policy shows that low-cost financing programs can actually have more impact on PV markets *in the immediate future* than technology research or manufacturing cost reductions. For example, Figure 24.3 illustrates the monthly payments for the 2.5 kW grid-connected, residential rooftop PV system. The PV system is assumed to cost \$8/watt (\$20 000 total cost), with a total system

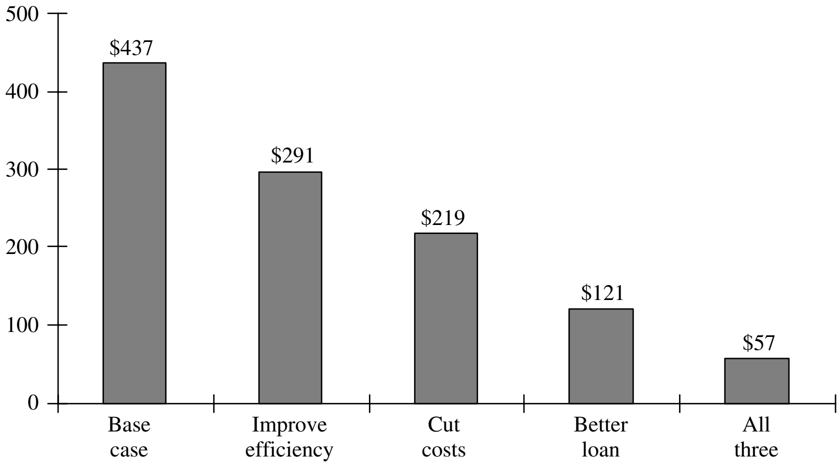

Figure 24.3 Monthly payments on a 2.5 kW residential PV system

efficiency of 10%. In the base case, financing is assumed to be a 7-year 18% loan, resulting in a monthly payment of $437. Then, three improvements are evaluated (see Reference [24]):

Research programs to improve efficiency: By improving the efficiency of the system, its size can be reduced while still generating the same output, thus reducing the cost. For a 50% increase in system efficiency, from 10 to 15%, the monthly payment will be reduced to $291 per month. However, it may take ten years or more before technology research can achieve these results in commercial products.

Cost reduction through manufacturing scale-up: By scaling up manufacturing, automating factories, and generally reducing the production cost per unit, total system costs can be reduced. Assuming a 50% reduction in system cost, from $8.00/Wac to $4.00/Wac, the monthly payment of the system can be reduced to $219 per month. Achieving this result might take approximately five years, as new factories are planned, built, and put into operation.

Better financing: A third way of reducing monthly payments is by applying lower-cost, longer-term financing. Here, the 7-year, 18% loan is replaced with a 30-year, 6% loan. Monthly payments come down to $121 per month, due to the change in financing alone, and this can be done immediately.

All three initiatives: The best public policy will be to accomplish all three cost reductions, but the immediate impact of lower-cost, longer-term financing is apparent.

As shown above, the provision of lower-cost, longer-term financing can have a more immediate impact on the affordability of solar PV systems than research and manufacturing programs, and will probably be the catalyst that creates the jump in demand that, in turn, causes photovoltaics to drive down the learning curve. Thus, financing may be the element that will break photovoltaics out of its long-standing “chicken and egg” dilemma.

24.8.2 Direct Subsidies ("Buy-downs")

Governments have used different measures to place a value on the public benefits of photovoltaics. Subsidies are tending to be about 30 to 50% of the cost of the PV system. The following is a summary of subsidies that are in use today:

Japan: The program was launched in 1996 with direct subsidies to the amount of 50% of the cost for residential rooftop, grid-connected PV systems. The subsidy is paid to the installation company, not the end user, to foster maximum impact on creating a competitive installation industry and minimum distortion of buyer behavior. The subsidy has since been reduced to 33% in 1999, 25% in 2000, 15% in 2001, and less than 10% in 2002. The Japanese PV market has boomed, reaching over 90 MW or 35% of the world PV market in the year 2000, and there are projections that over 30 000 systems – as much as 130 MW – may be installed in the year 2001 (see Reference [25]).

India: The Ministry of Nonconventional Energy Sources (MNES) has a program in which 10-W to 20-W PV lanterns and 900-W PV water pumps are eligible for a 50% subsidy. The subsidies are distributed through state-level nodal agencies that pass the funds down through the bureaucracy. Thus, it is a matter of working a government "system" to receive the funds. Subsidies are paid only if there is budget available. The net effect has been to create a small market that is "capped" by the availability of subsidy funds. The subsidy program, with its minimum technical specifications, has spawned a subculture PV industry that makes inferior grade equipment just for what is called *the subsidy market*. The Indian subsidy program not only illustrates the power of a subsidy program to create a market but also how to cap it and create distortions (see Reference [26]).

California: The State of California enacted a \$3.00/W "buy-down" for PV systems, initially until the year 2002. The subsidy was subsequently increased to \$4.50/watt and extended for ten years to 2012, but there were still no financing programs. The program had little effect on the market at first; according to the California Energy Commission, only about 235 residential PV systems were installed in the years 1998 to 2000. A power shortage and sharp increase in electric tariffs in the years 2000 to 2001 created a crisis atmosphere, greater public interest in energy and environmental solutions, and, subsequently, renewed demand for PV systems and other power equipment.

Other countries: Many other countries are adopting PV subsidies. Argentina embarked on a concession approach that included embedded subsidies, but the program has not been fully implemented. Mexico adopted a set of programs that added up to a 90% subsidy for rural photovoltaics. Brazil's PRODEEM program provided massive subsidies, but ended up with a high percentage of nonworking systems. South Africa is considering subsidies as high as 80 to 100% of the cost of a basic 50-W solar home system, in conjunction with the national concession program for nongrid electrification. Morocco's PV program is delayed, awaiting the resolution of the subsidy amount and distribution method, reportedly about 50% of the system cost.

While PV subsidy programs are being implemented around the world, there is a growing body of evidence and opinion that subsidies ultimately do more harm than good for market development. The common argument in favor of subsidies is that they have an immediate impact on demand – which is the mutual goal of the elected officials who enact them and the companies that lobby for them. The argument against the use of subsidies is that they create artificial markets and the opportunity for corruption while they are in place, that they cap markets to the level of the subsidy budget each year, and that they eventually bring markets to a halt when they are terminated.

24.8.3 Soft Loans (Interest Subsidies)

The use of interest subsidies has been an effective public policy tool for housing. It might also be used for photovoltaics. These are flexible instruments, allowing the sponsoring government or institutions to correct interest rates without severely distorting market forces. They assure financing while spreading the subsidy over the life of the program. This avoids market manipulation and windfall events often related to direct subsidies. A typical soft loan will have low-interest rates, longer terms than normal, grace periods during which payments need not be made, and other features. There are several examples of soft loan incentives in the PV markets today:

India: The Indian Renewable Energy Development Agency (IREDA) offers favorable loans for photovoltaics: 85% of system cost, 10-year repayment period, 2-year grace period, at 2.5 to 5.0% interest rates. The comparable loan from a national bank would be a 5-year loan at 12.5% interest rate with, no grace period. A comparable loan from a nonbanking finance company would be at 18 to 23% interest rate.

Germany: Kreditanstalt für Wiederaufbau (KfW), the German bank for reconstruction, is providing PV loans as part of the country's 100 000 roofs initiative. Loans can be up to 100% of system cost up to 5 kW, and 50% of cost for larger systems. The interest rate is 4% below prevailing market rates. Combined with the national feed-in tariff of DM 0.99 per kWh, users can make a profit through the use of PV in Germany. The program is highly successful.

Japan: In conjunction with its subsidy program, the government of Japan subsidizes the interest rate on PV loans, with subsidy payments going to the lenders. The resulting net interest rate to the end user is near zero percent.

New York: The New York State Energy Research & Development Administration (NYSERDA) began offering interest subsidies for PV loans made by New York banks in the year 2000. NYSERDA buys down the interest rate on loans by making an up-front payment to the lender to the amount of the present value of lost interest. The amount of the interest subsidy is presently 4.0%, bringing interest rates down from 9.5 to 5.5%.

There are precedents for applying interest subsidies. The use of interest subsidies, soft loans, and third-party (government) guarantees has been used extensively in housing finance programs around the world, lowering the real cost of owning a home while minimizing distortions in the home buyer–seller marketplace.

An interest rate subsidy as low as one-half percent (i.e. lowering the mortgage interest rate from 7.0 to 6.5% on a 30-year mortgage) will actually pay for a residential PV system completely, as reported by Alden Hathaway at the Environmental Resources Trust. For example, for a $300 000 home mortgage loan, the interest payments will be $425 277 over 30 years. At the lower rate of 6.5%, total interest payments will be just $389 197. After taking taxes into account, assuming that the interest is tax deductible and using a 40% combined federal and state tax rate, the difference in after-tax interest cost is \$21 648, roughly the full cost of a 2.5 kW PV system.

24.8.4 Income Tax Deductions and Credits

Tax incentives are preferred by many government officials because they can get the intended economic benefits to the intended users without the need to establish an implementing bureaucracy. They are opposed by other officials who see the tax system as a method for raising funds to run the government, not as a means of implementing social policy. They can also be written with sunset provisions, ostensibly to protect the budget from runaway spending, but also to provide elected officials with an opportunity to get publicity for enacting it again and again. Tax credits and deductions therefore appear to be less stable and reliable as market incentives or subsidies. Nonetheless, there are several tax-based incentive programs in place today:

India: PV qualifies for 100% depreciation in the first year for corporate (not individual) taxes. This, in conjunction with IREDA's 2.5% loans, created a PV leasing industry in the period between the years 1997 and 2001.

United States of America: The US tax code allows a 10% tax credit against corporate taxes and five-year accelerated depreciation for photovoltaics. The combination of these incentives will drive the preferred financing of photovoltaics in the United States towards leasing. The US Congress is also considering a 15% tax credit on personal income taxes.

Government subsidies and incentives have increased in recent years with tremendous impacts on the immediate size of PV markets in Japan and Germany. The impacts in India appear to be mixed, with subsidies creating markets but also capping them at the levels of the annual budgets. Likewise, subsidies (tax credits) have had mixed results in the United States.

24.9 FUNDING GOVERNMENT RESEARCH AND DEVELOPMENT

Government funding of research and development (R&D) has traditionally been used to bridge the gap between work that is "too high risk for companies to undertake" and "commercial viability."

Photovoltaics present a case study of a successful publicly funded R&D activity. PV R&D efforts were focused on lowering manufacturing costs in volume production, improving the performance (efficiency) of the devices, and extending the operational lifetime of components and systems. Aggressive goals have been set to make photovoltaics economically competitive with traditional sources of electricity (see Reference [27]). Many countries around the world have been involved in such activities in an effort to supplement traditional energy supplies with renewable energy sources.

24.9.1 PV Programs in the United States

US-government programs in photovoltaics originated from the Conference on PV Conversion of Solar Energy for Terrestrial Applications, sponsored by the National Science

Foundation (NSF) held in Cherry Hill, New Jersey in October 1973 (see Reference [28]). The program was the responsibility of the National Science Foundation, and then was transferred to the Energy Research and Development Agency (ERDA), which became part of the US Department of Energy (DOE) in 1977.

The first US program was the Low Cost Silicon Solar Array Project, later renamed the Flat-Plate Solar Array Project. The Jet Propulsion Laboratory was assigned management responsibility based on their long experience with space PV power systems. The newly created Solar Energy Research Institute (SERI) was charged in 1978 with the responsibility for thin-film materials and the Sandia National Labs for the concentrator PV programs. The DOE PV Program features significant cost sharing by its industry partners.

SERI became the National Renewable Energy Laboratory (NREL) in 1990, which has championed such programs as the amorphous silicon partnerships, the Photovoltaic Manufacturing Technology (PVMaT), the Thin-film Partnership, the building-integrated (PV-BONUS) program, the Utility Photovoltaic Group (UPVG), and the Million Solar Roofs (MSR) Program. The National Center for Photovoltaics (NCPV) was established to integrate the programs at NREL and Sandia.

US program funding is shown in Figure 24.4, which indicates the rapid buildup of the program in the 1970s, followed by a sharp reduction in the 1980s, and subsequent increase in the 1990s. As reported by DOE, the government's investment in photovoltaics since 1974 is estimated to be $1.7 billion.

24.9.2 PV Programs in Japan

From 1974 to 1983, the Japanese R&D program focused on low-cost solar cell production including mass production of raw silicon (Si) material, poly-Si, ribbon crystal, and amorphous silicon (a-Si).

During the second decade of the program from 1984 to 1993, in addition to material R&D efforts, mass production technologies and solar photovoltaic system technology were pursued, together with cell technology such as a-Si-based stacked solar cell and flexible substrate solar cells.

The New Sunshine Project has been in existence since 1993 in which a variety of new programs have been organized on the promotion and cost reductions of PV systems. Examples include field demonstration and testing of PV systems on public facilities and a subsidy program for private houses. The budget for the R&D portion of the Japanese PV Program is shown in Figure 24.4. It should be pointed out that the R&D portion represents only a small portion of the total Japanese PV effort. In FY 2000, the total effort, including subsidies, was approximately six times the R&D portion of the budget.

24.9.3 PV Programs in Europe

The UNESCO conference "The Sun and the Service of Mankind" held in Paris in 1973 was the starting point for the development of renewable energy in Europe (see Reference [29]). The first European Commission technology program for renewable energy was established by the Council of Ministers in 1975. The European Commission's PV program focused

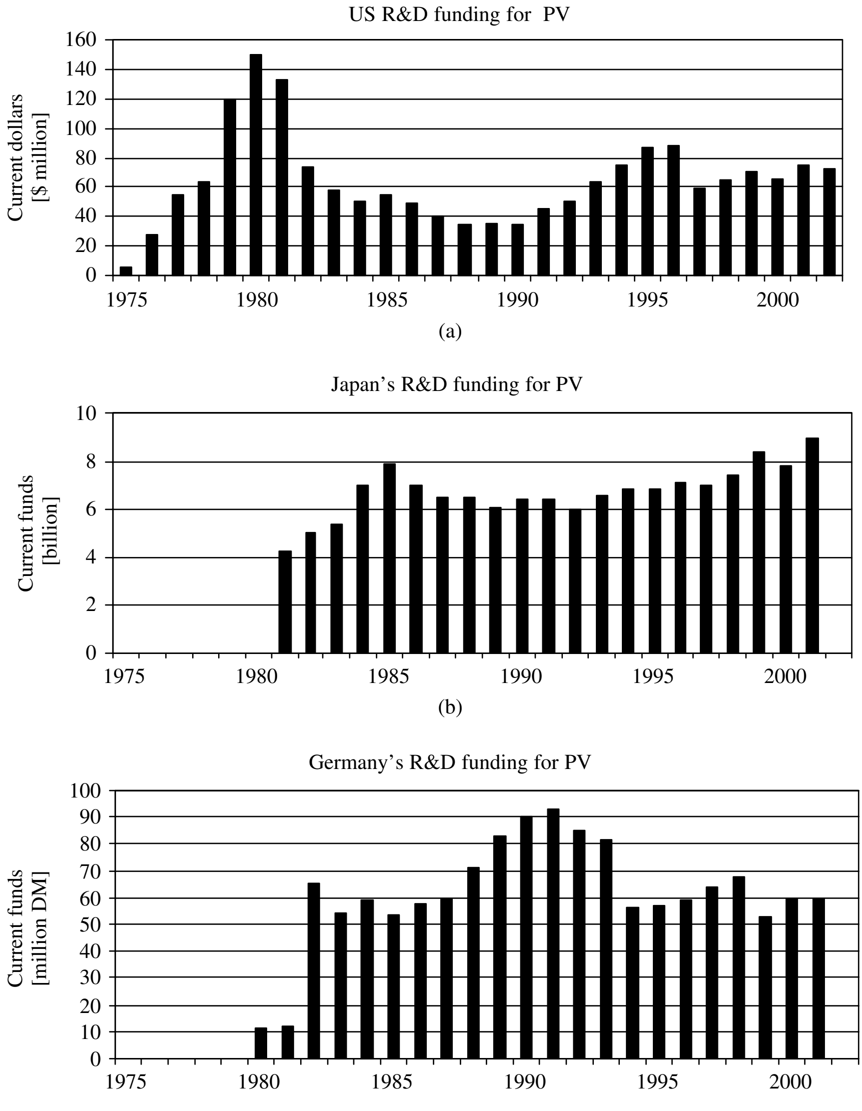

Figure 24.4 Research and development funding for solar photovoltaics. (a) US R&D funding for photovoltaics; (b) Japan's R&D funding for photovoltaics; and (c) Germany's R&D funding for photovoltaics

initially on crystalline silicon and pilot system development. From 1979, the demonstration programs focused on remote and stand-alone applications. Later grid-connected and building-integrated systems were incorporated into the program.

The total budget for EU members on PV R&D between 1974 and the present is about $1.5 billion. Germany has furnished about 65% of the total. Figure 24.4 shows the recent budgets for the German PV R&D program. Like Japan, Germany also budgeted commercialization and subsidy programs. Germany's 1000-roofs program was one of the hallmarks of their efforts. Significant efforts in the Netherlands, Italy, Spain, Switzerland, and France have also contributed to the European PV R&D efforts.

24.9.4 Future PV R&D Programs

Predicting the role for public sector funding of R&D is difficult at best. Fortunately, there appears to be good reason to follow the role of other high-technology programs that have come before. Possibly, the best is what has happened with the development of integrated circuits, which had strong government support during its development. Although one could predict that such support would decline and perhaps be phased out as products came out through the end of the development pipeline, the opposite has occurred. Successful research programs breed future successes in terms of new technologies and approaches. Since research is defined as exploring the unknown, there will always be paths to follow for those technologies that have been shown to be useful and successful. Such is the case for photovoltaics.

24.9.5 Sources of R&D Funding

The R&D programs of each country generally only fund organizations within the respective country. The following are the major funding organizations:

United States:
U.S. Department of Energy
Office of Solar Electric Technologies
1000 Independence Avenue, S. W.
Washington, DC 20585

Japan:
NEDO
Solar Energy Department
Sunshine 60 Bldg.
3-1-1 Higashi Ikebukuro
Toshima-ku
Tokyo 170-6028
Japan

Germany:
Bundesministerium fuer Wirtschaft Technologie
53107 Bonn
Germany

The Netherlands:
Novem
P.O. Box 8242

3503 RE Utrecht
The Netherlands

Italy:
ENEA
Renewable Energy Department
CR Casaccia
1300 sp Anguillarese
0006 S M di Galeria (ROMA)
Italy

This chapter has described the financing of PV growth. Financing might be the last "missing link" in the solution to a solar-driven world economy. Our financial systems and practices are built to support a different economic model – central station power plants and the grid system (see Reference [30]). Mobilization of massive amounts of capital to support solar photovoltaics and distributed generation has been, and will for the immediate future be, institutionally complicated. Solutions are coming, though slowly. Now in the year 2002, however, it appears that we are turning the corner towards the financing of a brighter, solar-powered future.

ANNEX

CONTACTS IN PV FINANCING

This Annex exhibit provides a listing of some of the key organizations that are involved in the financing of photovoltaics around the world, by no means covering all, but a list that should prove useful over the coming decade. It is presented by region.

INTERNATIONAL/GLOBAL

Environmental Enterprises Assistance Fund (EEAF)

EEAF, formed in 1990 by USAID, Winrock International and the Rockefeller Foundation, is a specialist in providing debt and equity financing to environmental entrepreneurs in renewable energy and other environmentally beneficial industries.

Contact: Brooks Browne, President
Address: EEAF
1655 N. Fort Myer Drive
Suite 520
Arlington, VA 22209
USA
Phone: 703 522 5928
Fax: 703 522 6450
E-mail: *eeaf@igc.apc.org*

Global Environment Facility (GEF)

The Global Environment Facility (GEF) is the chief funder of renewable energy in developing countries and, as such, will have a significant impact on expansion of the field. GEF is a major force in promoting renewable energy and the chief driver and catalyst among development agencies.

Contact: Mohamed T. El-Ashry, Chief Executive Officer and Chairman
Address: 1818 H Street, N.W.
Washington, D.C. 20433
U.S.A.
Phone: 202-473-0508
Fax: 202-522-3240
Web site: *www.gefweb.org*
E-mail: *harcher@worldbank.org*

International Finance Corporation (IFC)

IFC is an institution of the World Bank Group and promotes economic development by encouraging private sector investment activities in developing countries.

Address: Corporate Relations Unit
International Finance Corporation
2121 Pennsylvania Avenue, NW,
Washington, DC 20433 USA.
Phone: +202-473-7711
Fax: +202-974-4384
E-mail: *Webmaster@ifc.org*
Web site: *http://www.ifc.org*

Photovoltaics/Market Transformation Initiative (PV/MTI)

PVMTI is an initiative of the International Finance Corporation (IFC) and the Global Environment facility (GEF), to accelerate the sustainable commercialization and financial viability of solar photovoltaic-based energy services in India, Kenya, and Morocco. The IFC has designed Impax capital and IT Power Ltd. as the external management team for PVMTI.

Contact: Vickram Widge
Address: Environment Division
International Finance Corporation
2121 Pennsylvania Avenue, NW
Washington DC 20433

Renewable Energy and Energy Efficiency Fund (REEF)

REEF is a pioneer financing fund focusing on emerging markets, renewable energy, and energy conservation, and efficiency projects and companies. As of April 2001, REEF was capitalized at a level of $65 million equity plus debt facility from the International Finance Corporation.

Contact:	Kenneth R. Locklin, Managing Director
Address:	Energy Investors Fund 727 Fifteenth St, NW 11th Floor Washington, DC 20005 USA
Phone:	202 783 4419
Fax:	202 371 5116
E-mail:	*klocklin@eifgroup.com*

Solar Development Capital

Solar Development Capital is a 10-year, $28.75 million fund that makes minority equity, quasi-equity and debt investments in solar photovoltaic (PV) and PV-related businesses in developing nations. SDC seeks to invest in companies involved in distribution, consumer financing or leasing, manufacturing, or other aspects related to accelerated PV use in rural areas. Some senior debt may be placed with microcredit institutions. Offices in the United States. and Netherlands:

US Contact:	JD Doliner
Address:	Solar Development Capital 1655 North Fort Myer Drive Suite 520 Arlington VA, 22209-3109
Phone:	+1-703-522-5928
Fax:	+1-703-522-6450
Web site:	*www.solardevelopment.org*
E-mail:	*sdcf@mindspring.com*
European Contact:	Hans Schut
Organization:	Solar Development Capital
Address:	Utrechtseweg 60 Postbus 55, 3700 AB Zeist, The Netherlands
Phone:	+31-30-693-65-00
Fax:	+31-30-693-65-66
Web site:	*www.solardevelopment.org*
E-mail:	*sdc@triodos.nl*

Solar Development Foundation (SDF)

Solar Development Foundation provides technical and business assistance to enterprises in preparation for larger-scale private investment, and can provide ‘seed’ finance for business development activities on flexible terms. Business development services may include: market research, communications and market testing (pilot-scale operations); training; business planning assistance; development of end-user financing mechanisms, and so on.

SDF provides relatively soft debt and grant funding for its business development services with the expectation that the PV and other off-grid renewable electricity businesses that it assists will to attract follow-on investment.

Contact: Candace Smith, Chief Operating Officer, and Phil Covell, Managing Director
Organization: Solar Development Foundation
Address: 1655 North Fort Myer Drive, Suite 520
Arlington VA, 22209-3109 USA
Phone: +1 703-522-5928
Fax: +1 703-522-6450
E-mail: *sdcf@mindspring.com*
Web site: *www.solardevelopment.org*

Solar Electric Light Fund (SELF)

Acting as a catalyst, SELF provides both financial and technical assistance for solar energy and wireless communication systems in the developing world. SELF raises seed funding for in-country NGO's and financial institutions, which provide microloans for the purchase of solar home systems (SHS). SELF has launched solar rural electrification programs and enterprises in India, China, Vietnam, Indonesia, Nepal, South Africa, Brazil, Uganda, Sri Lanka, Tanzania, and the Solomon Islands.

Contact: Robert A. Freling, Executive Director
Address: 1775 K Street, NW Suite 595
Washington, DC 20006
Phone: 202-234-7265
Fax: 202-328-9512
Web site: *http://www.self.org*
E-mail: *solarlight@self.org*

Solar International Management, Inc. (SolarBank Program)

The SolarBank Program is being developed as a future wholesale capital fund with sub-funds within each country. India and South Africa are the prototype countries. SolarBank Funds will supply capital to banks, nonbanking finance companies, cooperatives, societies, microcredit lenders, NGOs, rural finance groups, and others. It will also provide technical support, training, and special programs to its participating lenders.

Contact: Michael T. Eckhart
Address: Suite 400,1825 I Street NW
Washington DC, 20006.
Phone: +1 202-429-2030
Fax: +1 202-429-5532
E-mail: *info@solarbank.com*
Web site: *http://www.solarbank.com*

UNDP Sustainable Energy & Environment Division (SEED)

The Administrator of UNDP made a strategic decision to strengthen UNDP's environment and sustainable development capacity by establishing a new division within the Bureau for

Policy and Programme Support (BPPS): the Sustainable Energy and Environment Division (SEED). Since its origin, SEED has worked to support UNDP's overall efforts to help countries successfully design and carry out programs, which integrate the protection and regeneration of the environment and the use of natural resources. Assistance is provided by means of grant aid for technical assistance and investment projects.

Contact: Mr. Roberto Lenton, Director,
Address: SEED,
304 East 45th Street,
New York, N.Y. 10017, USA.
Phone: +1-212-906-5705
Fax: +1-212-906-6973
Web site: *http://www.undp.org/seed/*

UNEP Collaborating Centre on Energy and Environment

Financing Institution. Promotes and facilitates environmentally conscious energy planning throughout the world and especially in developing countries. UCCEE is funded jointly by UNEP, the Danish International Development Agency (DANIDA), and Risoe National Laboratory.

Contact: Mr. Gordon A. Mackenzie, Senior Energy Planner
Address: UCCEE
Risoe National Laboratory, Bldg. 142, Frederiksborgvej 399,
P.O. Box 49,
DK 4000 Roskilde, Denmark.
Phone: +45-46322288
Fax: +45-46321999
E-mail: *gordon.mackenzie@risoe.dk*
Web site: *http://www.uccee.org*

Winrock International

Winrock International is a private, nonprofit organization that works with people in the United States and around the world to increase economic opportunity, sustain natural resources and protect the environment.

Contact: Frank Tugwell, President
Address: 1621 North Kent St. – Suite 1200, Arlington, VA 22209-2134
Phone: 703-525-9430
Fax: 703-243-1175
Web site: *www.winrock.org*
E-mail: *information@winrock.org*

EUROPE

ASN Bank

Banking for renewable energy projects.

Address: PO Box 30502, 2500 GM Den Haag

Country: Netherlands
Phone: +31 703 569 333
Fax: +31 703 617 948

Clean Energy Fund

Finance for power generation with clean and renewable energy.

Contact: Peter Dunev
Address: 33 St James Street, London SW1A 1HD
Country: UK
Phone: +44 20 7930 1030
Fax: +44 20 7930 1080

D&B Capital

Financial services to the clean and renewable energy sector.

Address: 33 St James's Street, London SW1A 1HD
Country: UK
Phone: +44 20 7 930 1030
Fax: +44 20 7 930 1080

Ernst & Young Renewable Energy Unit

Specialists in RE corporate finance, business planning, taxation, and modeling advice.

Contact: Jonathan H Johns
Address: Broadwalk House, Southernhay West, Exeter EX1 1LF
Country: UK
Phone: +44 1392 284300
Fax: +44 1392 284301

European Bank for Reconstruction and Development

The European Bank for Reconstruction and Development (EBRD) was established in 1991. It exists to foster the transition towards open market-oriented economies and to promote private and entrepreneurial initiative in the countries of central and eastern Europe and the Commonwealth of Independent States (CIS) committed to and applying the principles of multiparty democracy, pluralism, and market economics.

Contact: Beverley Harrison
Address: European Bank for Reconstruction and Development
One Exchange Square
London EC2A 2JN, United Kingdom
Phone: +44 20 7338 6000
Fax: +44 20 7338 6100

E-mail: *harrisob@ebrd.com*
Web site: *http://www.ebrd.org*

European Commission DG XVII

Funding Organization. Links to EC energy programs. European Union in collaboration with EBRD has produced a useful publication related to funding issues for energy-related projects.

Address: 200 rue de la Loi, B-1049, Bruxelles, Belgique.
Phone: +32 22991111
Fax: +32 22991111
E-mail: *ener-info@cec.eu.int*
Website: *http://europa.eu.int/en/comm/dg17/dg17home.htm*

European Investment Bank (EIB)

Funding Organization. One of the objectives of EIB is the investment into energy-related projects in Europe as well as in the developing countries outside Europe. Provides funding for assistance with research, development, demonstration, and implementation of projects related to all aspects of renewable energy.

Address: European Investment Bank (EIB),
100 Bd Konrad Adenauer, L-2950 Luxembourg.
Phone: +35-2-43793122
Fax: +35-2-43793189
Web site: *http://www.eib.org*

Impax Capital Corporation Ltd

Finance and strategy for environmental infrastructure and technology. External manager for the IFC's PV market Transformation Program in India, Morocco, and Kenya.

Contact: Melville Haggard
Address: Broughton House, 6–8 Sackville Street, London W1X 1DD
Country: UK
Phone: +44 20 7 434 1122
Fax: +44 20 7 434 1123

IFU

IFU's objective is to promote economic activities in developing countries by promoting investments in these countries in collaboration with Danish trade and industry. IFU participates mostly as a share capital partner holding also a seat on the board of directors together with the Danish company investing in the project company. IFU can also participate as a cofinancing partner, when an existing company is to be expanded or rehabilitated or when state-owned companies are privatized.

Address: Bremerholm 4, DK 1069 Copenhagen K, Denmark.
Phone: +45 33 63 7500
Fax: +45 33 32 2524
E-mail: *ifu-cph@inet.uni2.dk*
Web site: *http://www.ifu.dk/ifu/brief_ifu.htm*

ING Bank Nederland

Banking division of ING Group, specialists in renewable energy project finance.

Address: PO Box 1800, Bijlmerplein 888, 1000 BV Amsterdam
Country: Netherlands
Phone: +31 20 652 39 54
Fax: +31 20 652 39 73

New Century Finance Limited

Innovative finance for specific projects and working capital for manufacturers.

Contact: Richard W Price
Address: Pantiles Chambers, 85 High Street, Tunbridge Wells, Kent TN1 1YG
Country: UK
Phone: +44 1892 618461
Fax: +44 1892 618567

New Energies Invest Ltd.

New Energies Invest Ltd. aims to invest into renewable technologies such as solar, wind, geothermal, biomass, small hydro, and fuel cells. The focus is on nonlisted companies, that is, typically New Energies Invest is providing growth capital as private equity. Geographically, New Energies Invest is covering North America and Europe.

Contact: Andreas Knoerzer, First Vice President
Address: c/o Bank Sarasin & Cie., Elisabethenstrasse 62, 4002
BASEL – Switzerland
Phone: +41 61 277 74 77
Web site: *newenergies.ch*

Rabobank Nederland/Groen Management BV

Specialists in renewable energy project financing. Rabobank is a broad-based financial services provider, founded on cooperative principles. It has been a leading lender to wind power projects and other sustainable development.

Address: PO Box 17100, 3500 HG Utrecht
Country: Netherlands
Phone: +31 302 16 49 83
Fax: +31 302 16 19 76

Triodos Bank NV

Triodos is a social bank with renewable energy, wind, and solar investment funds. Triodos is the leading socially responsible lender in the Netherlands, and is the comanager of Solar Development Capital.

Contact: JF Schut
Address: Postbus 55, 3700 AB Zeist
Country: Netherlands
Phone: +31 30 693 6500
Fax: +31 30 693 6555

VTZ Green Money for the Blue Planet Ltd

Financial services based on environmental, ethical, and financial criteria.

Contact: Martin Brenner
Address: Bahnhofsplatz 9, 8023 Zürich
Country: Switzerland
Phone: +41 1 226 45 45
Fax: +41 1 226 45 46

The Wind Fund Plc

Equity investment fund for wind, hydro, and renewable energy projects.

Contact: Simon Roberts
Address: Brunel House, 11 The Promenade, Clifton, Bristol BS8 3NN
Country: UK
Phone: +44 117 973 9339
Fax: +44 117 973 9303

UNITED STATES

ABN Amro Bank NV

Construction and term financing for independent power projects.

Contact: Joseph C Lane
Address: 135 LaSalle Street, Chicago, Illinois 60603
Country: USA
Phone: +1 312 443 2641
Fax: +1 312 750 6387

Commons Capital LP

Commons Capital LP is a venture capital firm investing in private companies, including renewable energy companies that promise strong financial results and significant contributions to a sustainable future.

Contact: William Osborn, Manager
Address: Commons Capital Management LLC
115 Buckminster Road
Brookline, MA 02445
Phone: 617-734-1047
Fax: 617-734-3115
E-mail: *wosborn@aol.com*

E&Co

E & Co was established in 1994 as a nonprofit organization with the strategy of providing enterprise development services and modest amounts of money in the form of grants, loans, and equity investments to economically, socially, and environmentally sustainable energy enterprises in developing countries.

Contact: Michael D. Allen, President
Address: E & Co
383 Franklin Street
Bloomfield, NJ 07003 USA
Phone: 973-680-9100
Fax: 973-680-8066
E-mail: *mike@energyhouse.com*

FAC/Equities A Division of First Albany Corporation

Investment bank specializing in rapidly growing companies including alternative energy firms.

Contact: Eric A Prouty
Address: 53 State Street, 29th Floor, Boston, MA 02109–2811
Country: USA
Phone: +1 617 228 3515
Fax: +1 617 228 3515

GE Capital Corporation

Investor in the alternative energy marketplace providing up to 100% of the requirements for the construction and permanent term financing for projects.

Contact: Craig Reynolds
Address: 1600 Summer Street, 5th Floor, Stamford, Connecticut 06927
Country: USA
Phone: +1 203 357 3872
Fax: +1 203 357 4386

Heller Financial Incorporated

Subsidiary of The Fuji Bank, providing structuring advice and financing for alternative energy and industrial projects.

Contact: Gar Seifullin
Address: 500 West Monroe Street, Chicago, Illinois 60661
Country: USA
Phone: +1 312 441 7616
Fax: +1 312 441 7827

New Alternatives Fund Inc

Mutual fund emphasizing clean energy and the environment.

Contact: Maurice or David Schoenwald
Address: 150 Broad Hollow Road, Melville, New York 11747
Country: USA
Phone: +1 631 423 7373
Fax: +1 631 423 7393

Nth Power Technologies

Nth Power technologies is a leading venture capital fund focusing on high-growth investment opportunities arising out of the restructuring of the global energy marketplace. Nth Power has investments in distributed generation and storage, communications, control technology, transmission system automation, outsourcing, and power quality management.

Contact: Nancy Floyd, Managing Partner
Address: 50 California Street, Suite 840
San Francisco, CA 94161
Phone: 415-983-9983
Fax: 415-983-9984
E-mail: *info@NthPowers.com*
Web site: *www.Nthpower.com*

SAM Equity Partners Ltd

SAM Equity Partners is the private equity arm of Sustainable Asset Management. SAM Equity Partners invests in ventures that are commercializing PV-related technologies and which have a significant presence in Europe or North America. The fund does not invest in projects or in emerging market economies.

Contact: Nicholas Parker, Principal
Address: 3rd Floor, 8 Faneuil Hall Marketplace
Boston MA 02109, USA
Phone: (+1 617) 973 5112
Fax: (+1 617) 973 6406
E-mail: *nick@sam-group.com*
Web site: *www.sam-group.com*

US Agency for International Development (USAID)

USAID is the international aid agency of the US. government. The energy and environmental technology (EET) division within the environment center (ENV) funds a number of PV-related programs.

Contact: Dr. Griffin M. Thompson, Director, ENV/EET
Address: USAID
1300 Pennsylvania Avenue
Washington DC 20523
USA
Phone: 202 712 1772
Fax: 202 216 3230
E-mail: *gthompson@usaid.gov*

ASIA

Asian Development Bank (ADB)

ADB is a multilateral development finance institution, engaged in promoting the economic and social progress of its developing countries in the Asian and Pacific region.

Address: 6 ADB Avenue, Mandaluyong,
0401 Metro Manila, P.O. Box 789,
Manila Central Post Office,
0980 Manila, Philippines.
Phone: +632-632-4444
Fax: +632-636-2444
E-mail: *adbhq@mail.asiandevbank.org*
Web site: *http://www.adb.org/mainpage.asp*

Canara Bank (India)

A public sector bank, it offers loans up to Rs. 25 000, repayment up to 5 years, @ 12.5% p.a.(PRIORITY SECTOR LENDING RATE), for purchase of solar home systems in India, through its branch network. The loan sanctioning authority rests with the branch managers.

Address: H.O. 112, JC Road, Bangalore – 560 002 India
Phone: 91-80-222-1581
Fax: 91-80-229-3517

DFCC Bank (Sri Lanka)

A development bank providing fund and fee based services.

Contact: Mr. Jayantha Nagendran
Address: PO Box 1397, 73/5 Galle Road
Colombo 3 Sri Lanka

Phone: 94 1 440366
Fax: 94 1 440376

IREDA (India)

The financing arm of Ministry of Nonconventional Energy Sources (MNES), Govt. of India, is the principal organization in India, offering a range of services in the renewable energy sector.

Contact: Dr. V. Bakthavatsalam, Managing Director
Address: IREDA-Indian Renewable Energy Development Agency Ltd.,
Core-4A, East Court, 1st floor, India Habitat Center, Lodi Road
New Delhi – 110 003 India
Phone: 91-11-460-1344/66
Fax: 91-11-460-2855.
E-mail: *gen@ireda1.globemail.com*

Grameen Shakti (Bangladesh)

Grameen Shakti (GS) is a not-for-profit rural power company whose purpose is to supply renewable energy to unelectrified villages in Bangladesh.

Country: Bangladesh
Contact: Mr. Dipal Chandra Barua, Managing Director
E-mail: *g_shakti@grameen.net*

IT Power India Pvt. Ltd.

A leading renewable energy consultancy with specialist skills in financing of PV projects. ITPI is the local partner organization for PVMTI. In addition, ITPI assists the Indian PV industry develop financing proposals to IREDA. ITPI has been involved in over 50 renewable energy projects in 17 countries. Areas of interest include financing, business packaging, and technical advisory services.

Contacts: Terence J. Hart and Binu K. Parthan
Company: IT Power Pvt Ltd
Address: #6, Rue Romain Roland
Pondicherry, India
Phone: 91-413-342488/227811
Fax: 91-413-340723
E-mail: *itpi@itpi.co.in*
Web site: *www.itpi.co.in*

Malaprabha Grameena Bank (India)

A public sector bank, it offers loans up to Rs. 25 000, repayment up to 5 years, @ 12.5% p.a.(PRIORITY SECTOR LENDING RATE), for purchase of solar home systems in India, through its branch network. The loan sanctioning authority rests with the branch managers.

Address: H.O. Post Box No. 111, Belgaum Road, Dharwad – 580 008 India
Phone: 91-836-42861
Fax: 91-836-40393

Manipal Finance Corp. Ltd. (India)

Nonbanking Finance Company (NBFC) offers to lease/finance solar PV systems primarily due to Govt. of India's fiscal incentive of accelerated 100% depreciation on renewable energy systems in the very first year. They are also registered with IREDA as financial intermediaries. The terms of financing vary from project to project and solar PV water pumping systems have particularly benefited from leasing companies.

Address: Manipal House, Manipal – 576 119 India
Phone: 91-8252-70741
Fax: 91-8252-70959.

Nagarjuna Finance Ltd. (India)

Nonbanking Finance Company (NBFC) offers to lease/finance solar PV systems primarily due to Govt. of India's fiscal incentive of accelerated 100% depreciation on renewable energy systems in the very first year. They are also registered with IREDA as financial intermediaries. The terms of financing vary from project to project and solar PV water pumping systems have particularly benefited from leasing companies.

Address: Nagarjuna Hills, Punjagutta, Hyderabad – 500 082, Andhra Pradesh, India
Phone: 91-40-335-4159
Fax: 91-40-335-3805.

Syndicate Bank (India)

A public sector bank, it offers loans up to Rs. 25 000, repayment up to 5 years, @ 12.5% p.a.(PRIORITY SECTOR LENDING RATE), for purchase of solar home systems in India, through its branch network. The loan sanctioning authority rests with the branch managers.

Address: H.O. Manipal – 576 119, D.K. District, Karnataka, India
Phone: 91-8252-70252
Fax: 91-8252-70266.

Winrock International India

Winrock International India (WII) is a nongovernmental organization, an affiliate of Winrock International. WII's mission is to "develop and implement solutions that balance the need for food, income and environmental quality."

Contact: Shyamala Abeyratne, President
Address: 7 Poorvi Marg Vasant Vihar, New Delhi, India 110 057 India
Phone: 91 11 614 2965

Fax: 91 11 614 6004
Web site address: *www.winrock.org*
E-mail: *information@winrock.org*

LATIN AMERICA

Inter-American Development Bank (IADB)

The Inter-American Development Bank, the oldest and largest regional multilateral development institution, was established in December of 1959 to help accelerate economic and social development in Latin America and the Caribbean.

Address: 1300 New York Avenue, NW
Washington, DC 20577
United States of America
Phone: 202-623-1000
Web site: *http://www.iadb.org*

AFRICA

African Development Bank

The African Development Bank is the premier financial development institution of Africa, dedicated to combating poverty and improving the lives of people of the continent and engaged in the task of mobilizing resources towards the economic and social progress of its Regional Member Countries.

Address: African Development Bank
01 BP 1387
Abidjan 01, Cote D'Ivoire
Phone: (225) 20.20.44.44
Fax: (225) 20.20.40.06
Web site: *http://www.afdb.org*

REFERENCES

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