# Best Practices Guide:

# Economic & Financial Evaluation of Renewable Energy Projects

Prepared for:
Energy and Environment Training Program
Office of Energy, Environment and Technology
Global Bureau, Center for Environment
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## Acronyms

| | |
|---|---|
| ADB | Asian Development Bank |
| AED | Alternative Energy Development, Inc. |
| ALGAS | Asia Least Cost Greenhouse Gas Abatement Project |
| ASTAE | Asia Alternative Energy Unit (the World Bank) |
| BCR | Benefit-Cost Ratio |
| BTU/lb. | British Thermal Unit per pound |
| CBA | Cost Benefit Analysis |
| CDM | Clean Development Mechanism |
| DANIDA | Danish Development Assistance Agency |
| DGIS | Dutch Ministry of Development Cooperation |
| EE | Energy Efficiency |
| EIRR | Economic Internal Rate of Return |
| EPC | Engineering, Procurement and Construction (Contract) |
| FIRR | Financial Internal Rate of Return |
| GEF | Global Environment Facility |
| GHG | Greenhouse Gas (emissions) |
| IDB | Inter-American Development Bank |
| IFC | International Finance Corporation |
| IIE | Institute of International Education |
| IPP | Independent Power Producer |
| IRR | Internal Rate of Return |
| JI | Joint Implementation |
| LPG | Low Pressure Gas |
| MDB | Multilateral Development Bank |
| mph | miles per hour |
| m/s | meters per second |
| NPV | Net Present Value |
| O&M | Operation and Maintenance |
| PV | Photovoltaic |
| RE | Renewable energy |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USAID | United States Agency for International Development |

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# Introduction

The United States Agency for International Development (USAID) Global Center for Environment has designed the Best Practices Guide Series to provide technical information on the topics of energy efficiency and renewable energy and the environment to support international initiatives and promote the use of clean and innovative technologies. This series of Guides is adapted from coursework that is designed to develop technical leadership capacity in energy development and greenhouse gas emissions reduction that are both friendly to the environment and beneficial to economic growth. Sponsored by the USAID through a contract with the Energy Group of the Institute of International Education (IIE), Alternative Energy Development, Inc. (AED) developed the *Best Practices Guide: Economic and Financial Evaluation of Renewable energy Projects.* This *Guide* synthesizes the major conclusions and procedures for utilizing the analytic tools presented during the course and in training course materials. It is for financial decision-makers, project developers and others involved in the financing or development of renewable energy projects. It provides the analytic tools and technical understanding of renewable energy projects necessary to evaluate their economic and financial viability and to effectively structure such projects to meet requirements for project finance and market support

AED is an international consulting firm addressing the environmental implications of energy production and use. AED identifies, evaluates, promotes, and implements clean energy production and use projects, energy conservation and efficiency initiatives, environmental management alternatives, and greenhouse gas mitigation options. AED's staff of internationally experienced engineers, economists, and environmental specialists headquartered near Washington, DC serves clients at home and around the world by fielding teams of consultants when and where they are needed. Technical services include among others, economic and financial analysis of energy alternatives; environmental and resource management; energy project design, development and finance; Joint Implementation projects; climate change studies and greenhouse gas abatement strategies; and Clean Development Mechanism pilot studies.

# Chapter 1

# Introduction to Renewable Energy Technology

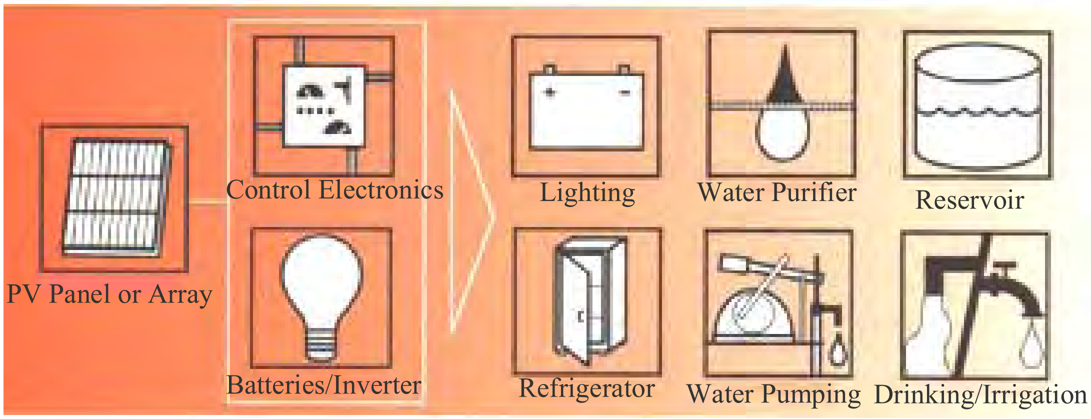
All energy, with the exception of geothermal resources, is derived from the sun. Fossil fuels are just solar energy stored in organic material converted to hydrocarbon fuels by pressure and temperature over geologic time. Unlike hydrocarbon fuels, solar energy is pollution free and for all practical purposes, inexhaustible—the sun will continue to shine for the next billion years or so. The principal technologies used to extract energy from the various natural processes generated from the radiant energy of the sun include:

- Solar photovoltaic
- Solar thermal
- Wind (derived from the sun's radiant heating and movement of the earth's atmosphere)
- Biomass (conversion of biological matter into energy)
- Hydropower (derived from the sun's hydrological cycle)

Most of these technologies can produce mechanical and thermal energy directly, but they are being used more frequently to produce electric power. Each technology and how it is used to produce electric power are briefly described here.

Solar radiation is used to generate electricity using two technologies; photovoltaic (PV) and solar thermal. ***Photovoltaic systems*** convert sunlight directly into electricity, without converting it to heat first. Conversion efficiencies are typically in the 12% - 20% range without concentrators, and 22% - 28% with concentrators. These systems generate electricity directly from solar cells made from semiconductor materials. The solar cell is specially treated to give one layer (the n-layer), a negative charge and the other layer (the p-layer) a positive charge when sunlight enters the cell structure. This sets up a cell barrier between the semiconductor layers, creating a current and a voltage across the cell. Sunlight striking the cell excites electrons, which move across the cell. The electron flow is conducted by metallic contacts placed on the cell in a grid-like fashion. PV cells are electrically and physically linked together into modules. The entire structure, along with the supporting elements, is called an array. Each module is given a peak power rating according to the output under standard test conditions. Arrays are typically designed to meet the electricity requirements for specific applications.

Modules usually provide electricity in the form of direct current (DC) at 12 or 24 volts. The relative simplicity, lack of moving parts, and the promise of little or no maintenance make photovoltaics an attractive technology. Ideal conditions for generating electricity using photovoltaic cells are long, clear, cold, sunny days. In order to provide electricity during the night and on cloudy days batteries are used to store some of the electricity generated during the daylight hours. Complete systems including batteries, inverters and control systems are needed for most applications as shown below.




Research and development advances have lowered PV costs dramatically. Costs are still high, but continue to drop. Capital cost is currently US$4,500 - 10,000/kW (compared to wind at about $1,000/kW). Cost is sensitive to the size of the order. Because energy costs (per unit) are usually very high, at about US$0.40 /kWh, PV is not widely deployed. Yet, its advantages often make it appropriate in off-grid applications.

***Solar Thermal*** systems are comprised of a collection component, working fluid circulation system, storage component, and controls. These function together to convert solar radiation into heat, which can be used in various applications. Collection component types include:

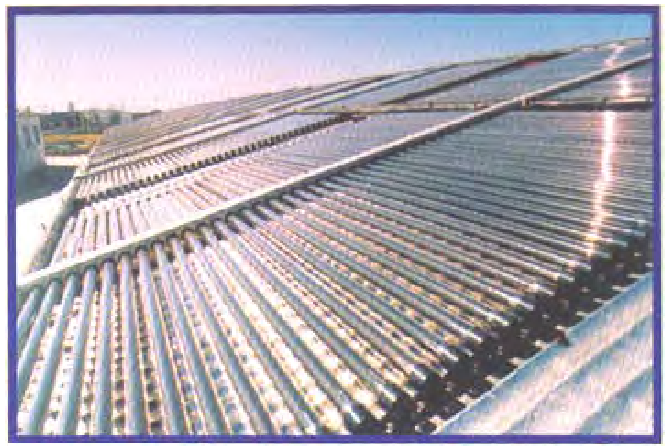
Flat-plate hydronic collectors
Flat-plate heat-pipe collectors
Evacuated-tube heat-pipe collectors
Parabolic-trough collectors
Paraboloidal-dish collectors
Power-tower collector systems

This guide will focus mainly on the first three, which have a greater possibility of being deployed on small-scale levels at reasonable costs.

*Flat-Plate hydronic collectors* have a delivery temperature typically between 110 F and 160 F (43.3 C - 71.1 C). They are primarily appropriate for domestic water heating. They function using a thermosyphon, where natural circulation takes placed based on the density of hot or cold water. Efficiency is typically around 30% - 35%.

*Flat-Plate heat pipe collectors* use a thermosyphon via a phase change of the working fluid, and have similar delivery temperatures to hydronic collectors, with efficiency of 28% - 32%. These are also appropriate for domestic water heating.

*Evacuated-tube heat pipe collectors* use a vacuum tube in order to reduce heat loss and therefore improve efficiency. The water (or other fluid) is inside a clear glass tube surrounded by a vacuum, and efficiency is typically 45% - 70%, which makes higher temperatures and cold-weather use possible as a result.



Energy generated from solar thermal is usually consumed directly by the end user, such as in domestic hot water heating or space heating or cooling. Sometimes in larger applications energy can be stored and used for other applications, such as mechanical energy.

Cost characteristics for solar thermal are calculated based on the application and are expressed in terms of capacity because there are negligible operating costs.

The cost of capacity for water heating:

| | |
|---|---|
| Flat-plate hydronic | 4.00 US$/(liter/day) |
| Flat-plate heat pipe | 3.50 US $/(liter/day) |
| Evacuated-tube heat pipe | 5.00 US$/(liter/day) |

The cost of energy for electricity using a *parabolic trough* varies, but ranges from about 0.11-0.17 US$/kWh for a stand-alone system to about 0.08-0.10 US$/kWh for a natural gas hybrid system. *Paraboloidal dish* electrical energy is expensive but is expected to be more cost effective in the future at about 0.07 US$/kWh (projected in 2010). *Power towers* are also quite expensive but are also expected to come down in cost in the future to about 0.05 US$/kWh (projected in 2010)

***Wind energy*** uses the force of moving air to power wind turbine/generators. These units usually consist of a tower, rotor (the blades, hub, and shaft), gear box, generator, control equipment, and power conditioning equipment. Wind energy systems produce electricity by using the rotational energy of the rotor to drive a generator. A gearbox is normally used in larger machines to increase generator speed. Wind systems include some sort of braking system to protect the system from high winds and extreme weather conditions. Since the speed of wind driven power systems varies the electrical frequency, synchronous generators or induction generators are used. Wind speed varies globally, regionally and locally and often follows seasonal patterns. The duration and force of the wind is critical to successful operation of wind turbines.

Cost effective, large-scale wind turbines, as shown here, require an annual average wind speed of 13 mph (5.8 m/s) at 10 meters height, while small wind turbines require only 9 mph (4 m/s). In many areas, small wind turbines are being combined with other sources of generation, such as photovoltaic systems and diesel generators, in order to form more reliable hybrid systems. Wind energy has become quite competitive in the past ten years and on a larger-scale (> 10 MW wind farms) is often cheaper on a per kilowatt-hour basis. Advances in technology, especially blade design, are largely responsible for the improvements in cost.

The typical assumed lifetime is about 20-25 years for a modern turbine design, during which period capital costs will be amortized. Economies of scale apply to capital costs, though the price range increases as the turbine size increases. A rule of thumb for costs is US$1,000 per kW capacity on average, with the marginal tower cost at US$1,500 per meter. Installation costs include: foundations, transportation - road construction (typically US$15,000 or less), utilities - telephones and other communications, substation - transformer, controls, and cabling. Costs vary according to soil condition and the distance to power lines.

Operation and maintenance costs generally increase throughout the life of a wind power project. Costs range from about US$0.008 to US$0.013 per kWh generated, and increase at a rate of about 2.5% per year. The high end (US$0.013/kWh) would include a major overhaul of equipment such as rotor blades and gearboxes, which are subject to a higher rate of wear and tear. Other operation costs include plant monitoring, and 6-month equipment inspections.

The income potential from wind energy is based on annual energy production, which in turn is dependent on average annual wind velocity. Energy production is also a function of turbine reliability and availability.

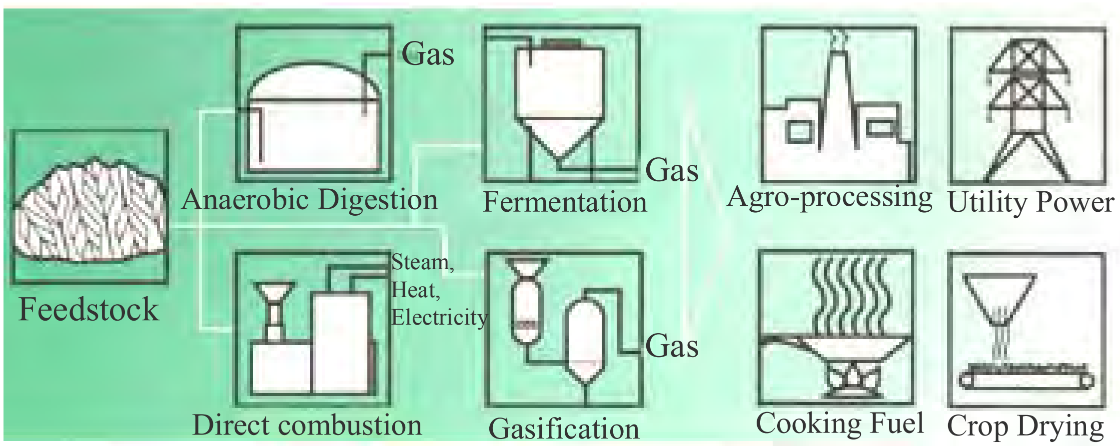
***Biomass*** refers to carbon-based (organic) material, which can be converted to energy, ultimately through some form of combustion. Essentially, chemical energy stored in biomass through photosynthesis is released through combustion and the heat energy produced is used for work. Heat can be used directly – such as in process steam – or can be converted into mechanical and then electrical energy. Biomass conversion covers a range of technologies and feedstock (fuel). The technologies used are either direct thermal conversion or biochemical conversion. Feedstock includes wood and wood waste, agricultural crop residues, aquatic plants, municipal solid waste and sewage sludge. Practically any hydrocarbon can be used as feedstock. Thermal conversion technologies include:

- Direct combustion
- Gasification
- Pyrolysis
- Liquefaction

Biochemical conversions technologies include:

- Anaerobic digestion
- Fermentation

Some of the various uses of biomass for energy are shown below.

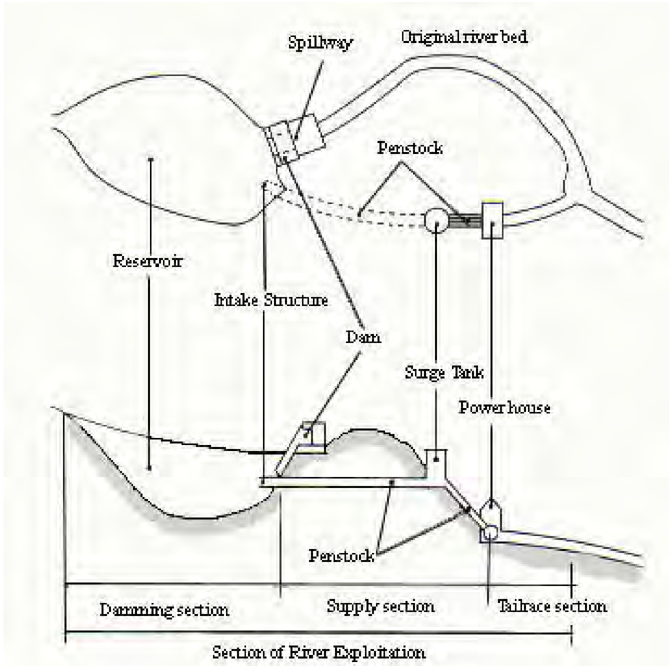



The net energy output of any biomass conversion process is determined by the energy content (BTU/lb) and moisture content of the feedstock and the conversion efficiency of the specific process. The two major advantages of biomass conversion are that feedstock sources are ubiquitous and generated by life processes (agriculture, waste generation) and the energy can be produced without advanced technology.

Large agro-industries (sugar, rice, paper) can facilitate an efficient, profitable, year-round biomass project, replacing fossil fuel use in their operations. In many cases biomass is already utilized though it may be at quite low efficiencies. Opportunities for increasing efficiency through the use of high-pressure boilers and higher efficiency steam turbines are prevalent, especially in the sugar processing industry. Most of the basic equipment already exists and many projects can be done at relatively low cost by simply adding new components.

As a rule of thumb, capital costs for cogeneration systems, are approximately US$900 - $1,200/kW installed. Interconnection costs, such as installation of lines to nearest substation and upgrading of substation equipment, are additional costs. Operation and maintenance expenses will be similar to those of a conventional power plant, at about US$5/MWh of generation. Depending on the cost of capital, the equalized cost of energy should be in the range of US$0.04 – 0.06/kWh.

***Hydropower*** converts the potential and kinetic energy of water to electrical energy, using a hydraulic turbine/generator. In typical hydroelectric power systems water is conveyed through a pipeline or canal to the turbine. The energy in the water is used to rotate the turbine/generator and leaves the turbine at a lower pressure. Power generation is increased by the height of the water elevation, the flow of the river or stream, and the size of the watershed. Small hydropower generators, illustrated here, are usually run-of-the-river systems that use a dam or weir for water diversion, but not for reservoir storage. The amount of pressure at the turbine is determined by the actual flow of the steam or river and the head, or the height of the water above the turbine.




Harnessing the flow of a river can have uses other than power generation, including irrigation, flood control, municipal and industrial water supply, and recreation.

Hydropower is characterized by high up-front costs, very low operating costs, and long life cycles. Because of the high capital costs, projects are sensitive to financial variables (construction delays, interest and discount rates). Hydro projects usually have long lead times, due to requirements for greater certainty in resource assessment. Many projects take as long as ten years to analyze and develop. As a result, payback periods are long and investors must have long investment horizons. Other significant cost variables include the site (distance to transmission, ease of access) and environmental and social considerations (water use, displacement of homes).

Typical costs for a small hydro plant are shown in the table below.

| Item | Head 5-225 m | Power 5 –1,300 kW |
|---|---|---|
| | Minimum Cost $/kW | Maximum Cost $/kW |
| Plant ex-factory 33% | 330 | 1,520 |
| Installation and Commission 9% | 90 | 410 |
| Civil Engineering 36% | 360 | 1,650 |
| Electrical Engineering 6% | 60 | 280 |
| Design and Management 7% | 70 | 320 |
| Contingency 10% of above | 90 | 420 |
| Total | 1,000 | 4,600 |

Cost parameters (U.S. technology) for larger plants (30+ MW) with an operating life of 50+ years and a capacity factor of 40-50% are as follows:

| | |
|---|---|
| Capital cost: | $1700-2300/kW |
| Operation cost | $0.004/kWh |
| Maintenance cost | $0.003/kWh |
| Total cost: | $0.024/kWh |

**Hybrid Systems**

Renewable energy technologies use, and are at the same time limited by, the various forces of nature to produce energy. The sun does not shine all day, the wind does not always blow, and droughts occur. Combining renewable technologies generally increases the reliability and often the efficiency of energy production. This combined use of renewable energy technologies is described as a hybrid. Hybrid systems can also use fossil fueled energy. Each technology is capable of complementing or circumventing the gaps in power generation, physical limitations or economic efficiencies of the various technologies. Hybrid systems are used whenever large amounts of reliable energy are needed at all times. They are more costly and complex, but make up for this disadvantage by their reliability.

Renewable energy sources are among the oldest sources of energy used and new and modern technology has enhanced and improved the use of this energy for the production of electricity as well as for the production of thermal and mechanical energy.

# Chapter 2

# Renewable Energy Applications and Changing Market Potential

Recent technical developments and reductions in the cost of all major categories of renewable energy technologies have been substantial. Some sources suggest that the application of all renewable technologies have expanded by nearly three orders of magnitude over the past 15 years. Renewable energy technologies such as photovoltaics (PV), solar thermal, wind, and biomass are now being used successfully for both subsidized and commercial small-scale applications. Wind power is increasingly being used for large-scale commercial power generation projects.

Rising oil prices have also been a factor in the increased use of renewable energy. As oil and gas prices increase, renewable energy becomes more cost effective. An example of how two renewable energy sources can displace oil and gas fuel for some typical applications is shown in Figure 1.

**Figure 1. Comparison of Energy Sources and Applications**

| ENERGY SOURCE | Refrigeration | Lighting | Pumping | Communication |
|---|---|---|---|---|
| Photovoltaic | Small scale only<br>*Expensive for larger scale* | Appropriate | Sometimes appropriate<br>*Expensive for large volumes or deep wells* | Appropriate |
| Kerosene | Appropriate for small scale | Appropriate for small scale<br>*Fire Hazard* | Not appropriate | Not appropriate |
| Low Pressure Gas (LPG) | Appropriate for small scale | Appropriate | Not appropriate | Not appropriate |
| Gasoline generator | *Expensive* | Appropriate for short duration<br>*Expensive* | Appropriate | Appropriate for short duration<br>*Expensive* |
| Diesel generator | Appropriate for large scale | Appropriate for large scale | Appropriate | *Expensive for small applications* |
| Small wind turbine | Appropriate for medium and small scale | Appropriate | Appropriate for some cases | Appropriate |

In addition, cross sector applications have been given recent attention by multilateral lending agencies in order to better address the needs of the roughly two billion people who lack access to reliable energy sources.

Cross-sector applications of renewable energy include:

- Health posts and clinics
- Schools
- Project facilities and other buildings and equipment
- Community water supplies (including disinfection)
- Community refrigeration and ice-making
- Crop irrigation
- Agriculture (post harvest management/food processing)
- Livestock watering
- Roads (illuminated signs, emergency phones, street lighting, signals)
- Telecommunications and rural telephones

Renewable energy technologies offer commercial and operational advantages as well. These advantages are particularly important in remote areas not served by electric utility companies. Even when conventional utilities offer service, there are some advantages to renewable energy technologies, which include:

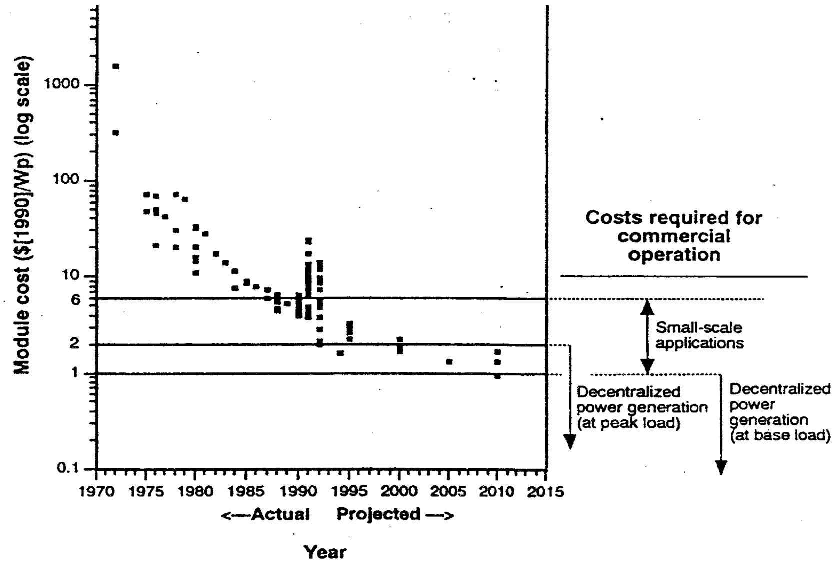
1. Modularity, providing redundancy and resilience in the event of failure of utility supply;
2. Low or no fuel requirements;
3. Life-cycle costs which can be less than for equivalent service from fossil fuel options;
4. Hybrids (PV and/or wind plus diesel generators) which can provide 24-hour high-quality power; and
5. PV and wind equipment that often require less maintenance and provide greater reliability than diesel generators in many field conditions.

Several direct and indirect savings and other economic benefits can accrue from the use of renewable energy technologies to displace fossil fuels. Several of these are as follows:

- Fuel cost savings
- Reduction in fuel delivery costs
- Reduction of hazardous air emissions
- Reliability of power supply
- Lower operating costs
- Economies of scale
- Spillover effects from induced investments in power supply
- Waste recycling
- $CO_2$ emission reduction
- Carbon sequestration
- Increased salvage value of power generating equipment

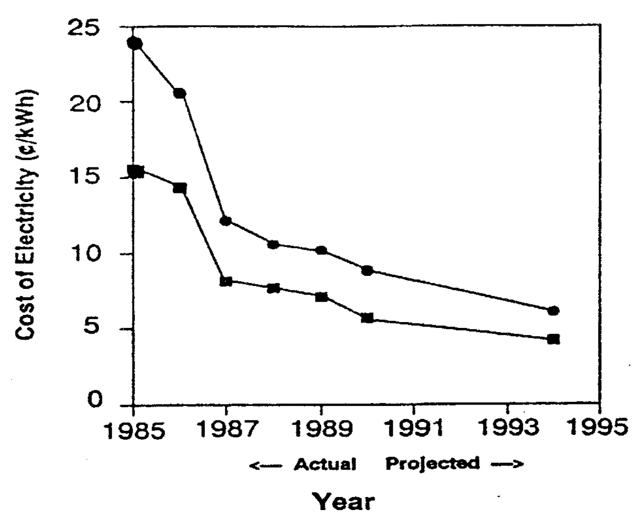
Recent technical developments and reductions in the cost of all major categories of renewable energy technologies have been substantial. The sustained drop in photovoltaic module costs, from 1970 and projected to 2015, are shown in Figure 2. A profile of the declining cost of electricity from wind turbines is shown in Figure 3.

**Figure 2. Actual and Projected Photovoltaic Module Costs, 1970-2015**




*Note:* The range of costs marked on the graph show PV module costs required to compete with small-scale applications and with decentralized power generation (assuming supply costs of 8 to 10¢ per kWh (at base load) and 16.5¢ per kWh (at peak load), which include generation, transmission, and distribution). The ranges are approximate and assume balance-of-system costs will come down commensurately with module costs. (Balance-of-system costs are not shown, but are assumed to be roughly the same as module costs.) The "spread" in points reflects the spread in costs of different technologies, which are at different stages of development. The size of the module used also affects cost, as does the size of the order. *Source:* K. Ahmed, *Renewable Energy Technologies: A Review of the Status and Costs of Selected Technologies*, World Bank Technical Paper 240, Energy Series (Washington, D.C., 1994), p. 69 and Annex 10.

**Figure 3. Cost of Electricity from Wind Turbines in California, 1985-1995**




KEY: ● 12 % discount rate ■ 6 % discount rate

*Source:* Alfred J. Cavallo and others, "Wind Energy: Technology and Economics," in Johansson and others, eds., *Renewable Energy: Sources for Fuel and Electricity* (Washington, D.C.: Island Press, 1993).

In spite of the long-term decline in costs for installed capacity of renewable energy technologies, and a large demand for renewable energy in developing countries, large-scale investments remain elusive. Several factors have been identified that can improve the market potential for renewable energy.

First, there is a need to provide grant or technical assistance funds to identify renewable energy programs and to conduct project preparation so that they can be incorporated within subsequent implementation loans. The resources needed for project preparation are typically one to three percent of total project costs and may not always be recovered, especially for those projects that prove to be unfeasible or fail to obtain funding. Resources for such work are often available through multilateral development banks, the Global Environment Facility (World Bank), bilateral grant aid, developing countries themselves, private investors and electric utilities. A list of potential financing sources is provided at the end of this guide.

Second, market potential can be enhanced by increasing the awareness within the energy industry of the possibilities created by new and more cost efficient renewable technologies. This can be accomplished by providing education and training to people in the energy industry, financiers and regulators.

Third, structural reform of the energy sector in many countries can provide the opportunity for commercial supply of electricity, private investment and hopefully improve the returns on renewable energy investments.

Finally, to ensure long-term success of a renewable energy investment program there must be adequate attention to the preparation and financing of the program at the outset followed by continuous training, maintenance and support services for the life of the project. Too many promising renewable energy projects have failed because of these services were neglected or never adequately provided for.

# Chapter 3

# Barriers to Commercializing Renewable Energy Technologies

There is no one basic project finance strategy for renewable energy projects. Renewable energy projects vary considerably in scale, capacity, energy resource characteristics, sale of output, status of technology and a host of other factors. As a consequence, financial strategies require innovation and flexibility to overcome a range of barriers specific to renewable energy projects. Some of the major financing barriers include:

*High Capital to O&M Cost Ratio*

Renewable energy systems tend to have little or no fuel, operation and maintenance (O&M) costs but their initial unit capital costs tend to be much higher than fossil generation systems. The higher ratios of capital cost to O&M cost are significant because they indicate that renewable energy projects carry a disproportionately heavy initial burden that must be financed an amortized over the life of the project. Additionally, the initial high capital cost of renewable energy projects is a barrier to project financing.

*High Project Development to Investment Cost Ratio*

The ratio of project development costs to project investment is also higher for renewable energy projects. This is due to the nature of renewable energy projects, which are often dispersed, small in scale and lack established infrastructure to assist in project development. Legal, regulatory and engineering transaction costs are also generally higher, more complex and do not benefit from the economies of scale common to large conventional projects.

*Small Total Investment Requirements*

Renewable energy projects are generally smaller in scale and therefore require smaller total investments. As a consequence many commercial banks, utilities and established independent power producers (IPPs) are not interested in pursuing these smaller investments. The time and resources they must spend to undertake “due diligence” are high, as are the perceived risks.

*Difficulty Guaranteeing Project Cash Flow*

Guaranteeing a project’s cash flow is an essential element needed to secure project financing. To guarantee costs usually requires long-term fuel supply contracts and possibly a plant-operating contract. For revenues, this suggests that a solid power (or energy services) purchase agreement is a necessary element. Renewable energy projects often have to deal with many fuel suppliers (as in the case of solar, wind, hydro, etc.) and are not able to guarantee that the “fuel” will be available when needed since it may depend upon environmental conditions. Additionally, renewable energy projects tend to have multiple “power purchasers” most of which are not in a financial position to provide enforceable long-term guarantees to purchase the output of the project.

*Weak Basis for Non-Recourse Financing*

Small, independent and newly established renewable energy project developers often lack the institutional track record and financial inputs necessary to secure non-recourse project financing.

*Inaccurate Perception of Risk*

Many renewable energy technologies are newly commercial and are, subsequently, not widely known among project financiers. Moreover, information about renewable energy systems is not readily available and accessible to potential investors, although this is changing rapidly with greater Internet access. The reality is that many renewable energy technologies are rapidly making commercial inroads in the marketplace.

*Weak Project Developers*

On a global scale, renewable energy projects tend to be developed by smaller entities with weak financial positions. They are frequently unable to leverage the financial resources needed and as a result are unable to attract equity investors or secure debt financing.

All of the above characteristics of renewable energy projects serve as barrier to project finance in one form or another. Overcoming these barriers with innovative, sound project appraisal and investment strategies are key features addressed in the project guidelines that follow.

# Chapter 4

# Economic Appraisal of Renewable Energy Investments

Sound economic evaluation of the proposed project during pre-feasibility and feasibility analysis is a fundamental requirement, particularly when the project requires a bank's assistance and financial commitment. With respect to the financing of renewable energy technologies, there are four key characteristics that help to define the project's scope and objectives:

- *Scale*: Scale or capacity of the renewable energy project will determine the level of financing that is needed;
- *Consumers*: Consumers will determine the risks and difficulties associated with guaranteeing the project revenue. For instance, it is more difficult to determine the credit worthiness of a large number of small consumers as opposed to a single buyer.
- *Technology Status*: Renewable energy projects based on mature and commercially proven technologies are much easier to finance than those utilizing experimental technologies.
- *Weather*: Renewable energy projects rely on weather conditions for their output (e.g., sunlight, wind and rain). There is no recourse when projects fail due to drought or other weather conditions. With no weather guarantee there can be no guarantee of power sales and similarly, no guarantee of predictable revenue. During project appraisal it is critical to take into account the respective risks and resulting variation in the average expected revenue stream due to historic weather conditions.

The following table illustrates the range of renewable energy technology and possible project characteristics with respect to scale (large, medium, small, or micro); whether the project is grid-connected, isolated-grid or non-grid; the status of technology and the predictability of weather conditions driving the project.

**Figure 4. Renewable Energy Technology and Characteristics Used to Determine Project Scope and Objectives**

| Renewable Energy Project Type | Scale | Consumers | Technology Status | Historic Weather Conditions |
|---|---|---|---|---|
| Biomass | L/M/S | G/IG | M/NC/E | K/P |
| Geothermal | L/M | G | M/NC | K |
| Hydropower | L/M/S/Mi | G/IG/NG | M | P/U |
| Wind power | M/S/Mi | G/IG/NG | M/NC | P/U |
| Solar Thermal | L/M | G | NC/E | P/U |
| Solar PV | S/Mi | G/IG/NG | NC/E | P/U |

**Scale:** L = Large >20 MW; M = Medium 1 – 20 MW; S = Small 100 kW – 1MW; Mi = Micro < 100kW
**Consumers:** G = Grid connected; IG = Isolated; NG = Nongrid
**Technology Status**: M = Mature; NC = Newly Commercial; E = Experimental
**Historic Weather Conditions**: K = Known; P= Predictable; U = Unknown

**Appraisal and Selection of Renewable Energy Projects**

The appraisal stage of the project cycle should provide information and analysis on a range of issues associated with the potential undertaking: the administrative feasibility of project implementation must be fairly assessed; the marketing and technical appraisals of the project must be provided to evaluate its feasibility; the financial capability of the project to survive the planned life must be appraised; the expected economic contribution to the growth of the economy must be measured; if publicly funded, an assessment must also be made to determine if, and how, the project assists in attaining the social objectives set out for the country, along with an analysis to determine if the project is cost-effective in meeting these objectives; and, finally, the project must be assessed in terms of its environmental impacts and the environmental costs and/or benefits that might be derived from the proposed project.

Currently, the distinctions between pre-feasibility and feasibility studies have become blurred. This is due to the fact that costs for such studies have continued to increase and thus time devoted to two distinct studies is less likely, and also because there is much more accurate engineering, financial and market data available than in the past. Generally, the best source of data about a specific kind of renewable energy project can be gleaned from comparable in-country projects. Successful projects should be carefully studied for lessons learned.

Typical generic issues that the appraisal must answer include:

- Do we have the administrative capacity to carry out the project?
- Is there a demand for the project?
- Do we have information about the market?
- Can we get sufficient technical data to define the type of equipment needed?
- Does the country (if public sector) or the company (if private sector) have the financial capacity or access to sufficient funds to carry out the project?
- Can the project be carried out on schedule?
- If in the private sector, how will this investment contribute to overall profit?
- If public sector, how will this project contribute to the economic growth of the country? What are the distributional benefits?
- Who benefits and by how much, who pays and by how much? Are there other social objectives achieved (stabilization, diversification, environmental conservation)?
- What are the technical options and what can they do?
- What are the levelized costs (capital, operating, maintenance, replacement) of the renewable energy options in comparison to convention energy sources?
- What is required to ensure reliable and sustainable operations?
- What advantages and disadvantages do renewable energy technologies have relative to fossil fuel-based options?
- Do renewable energy systems make sense where the grid is present?
- Are there standardized or model procurement packages for various renewable energy systems?

The feasibility evaluation can be initially viewed as an internal project appraisal effort. For a renewable energy project in particular, the study should, at a minimum thoroughly address and document the evaluation of the following major items in a logical sequence:

- Electricity demand

- Technology
- Financial conditions
- Economic conditions
- Institutional resources
- Infrastructure
- Risk (technical, financial and institutional)
- Sensitivity (define project/option viability and parameters)

**Using the Time Value of Money**

Money has a value that is related to time. The purpose of investments is to set aside a sum of money now in expectation of receiving a large sum in the future. By using the discounted cash flow approach, and assigning a value to the cost of capital, it becomes apparent that the cash flow in the early years of a project has greater value at the present time than the same amount in the later years of a project.

The discount rate is very important for a renewable energy project analysis. The selection of a discount rate can depend on many factors. Usually the rate depends on the *opportunity cost of capital*, which is defined as the foregone production or potential return when capital is invested in one project rather than another. The equation for calculating the discount factor is shown in Figure 5.

**Figure 5: Equation For Calculating The Discount Factor**

$$\text{Discount Factor} = \frac{1}{(1+i)^n}$$

Where $i$ = the interest rate or cost of capital
$n$ = years from project implementation

Since renewable energy investments are measured by the consumers' implicit discount rates, they require a high rate of return on investment, indicating high risk. These investments may appear risky to the consumer due to lack of information and resulting uncertainty. However, for society, renewable energy is a low-risk investment that deserves a low discount rate.

In finance theory the time value of money is thought to increase with greater risk and uncertainty. *If the project being evaluated does not have an internal rate of return equal to or better than this discount factor, then the project should not be undertaken.*

There are three important points that should be remembered when using a discount rate:

1. Only one discount rate can be used in any single economic analysis

2. The discount rate used does not reflect inflation; all prices used in the analysis are real or constant dollar prices; and

3. A rigorous analysis of non-monetary impacts (non-market values including changes that might be irreversible) should be undertaken.

This last point is important for renewable energy projects, since they offer significant non-monetary benefits.

# Chapter 5

# Cost-Benefit Analysis

Traditionally, the appraisal process was undertaken in order to rank projects on a systematic basis. Over time, the process has become more sector-focused, allowing data generated during the feasibility study to feed back into the design process. This allows projects to be structured so as to maximize potential financial and economic return. All investments should be subject to a systematic process of capital appraisal with two goals in mind:

- Provide a basis for selection or rejection of projects by ranking them in order of profitability or social and environmental benefits; and

- Ensure that investments are not made in projects that earn less than the cost of capital (generally expressed as a minimum rate of return).

The first step in any economic evaluation is to project the cash flow. The cash flow of a project is the difference between the money generated (revenue) and ongoing costs (expenses) of the project. The definition of cash flow is different from accounting profit. The cash flow, for instance, ignores depreciation and the interest charges, since they are accounted for in other ways. Figure 6 summarizes the main differences between the cash flow and the accounting profits.

**Figure 6: Cash Flow Versus Accounting Profit**

| | **Cash Flow** | **Accounting Profit** |
|---|---|---|
| Revenues | When cash comes in | When sales occur |
| Operating expense | When cash goes out | When expenses occur |
| Depreciation | Not included | Included |
| Capital allowances | Tax shield included as cash flow | Included in tax accounts |
| Taxes | When tax is paid (one year time lag) | When tax is incurred |

***Cost-benefit analysis*** (CBA) comprises, not one, but a set of analytical tools used to assess the financial and economic viability of a proposed investment. Some of the analytical tools that can be used include:

- Benefit-Cost Ratio
- Net Present Value (or Discounted Cash Flow)
- Internal Rate of Return
- Least Cost Planning
- Payback Period
- Sensitivity Analysis

The ***benefit-cost ratio*** (BCR) is the ratio between discounted total benefits and costs. Thus if discounted total benefits are 120 and discounted total costs are 100 the benefit-cost ratio is 1.2: 1. For a project to be acceptable, the ratio must have a value of 1 or greater. Among mutually exclusive projects, the rule is to choose the project with the highest benefit-cost ratio. The disadvantages of the BCR is that it is especially sensitive to the choice of the discount rate, and can provide incorrect analysis if the size or scale of the various projects being compared is great.

The ***net present value*** (NPV) approach (also referred to as discounted cash flow approach) uses the time value of money to convert a stream of annual cash flow generated by a project to a single value at a chosen discount rate. This approach also allows one to incorporate income tax implications and other cash flows that may vary from year to year. The discounted cash flow or net present value method takes a spread of cash flow over a period of time and "discounts" the cash flow to yield the cumulative present value.

When comparing alternative investment opportunities, the NPV is a useful tool. As might be expected, when comparing alternative investments, the project with the highest cumulative NPV is the most attractive one. The only serious limitation with this approach is that it should not be used to compare projects with unequal time spans.

**Figure 7. Net Present Value Equation**

**Net Present Value**

Net Present Value measures the present-value of money exclusive of inflation.

*For example: the value of all dollars received from 1993 through 1996 would be worth less than having those same dollars in 1993. This is due to interest that could be gained by investing that money in 1993.*

$$\$\,(1993) = \frac{\$\,(1999)}{(1+f)^n}$$

Where:
$n$= number of years (1999-1993=6)
$f$ = annual interest rate, 1993-1999

The REAL (inflation-corrected) interest or discount rate (r) is:

$$(1 + r)\,(1 + f) = 1 + r_n$$
$$r_n = r + f * r + f$$

The ***Internal Rate of Return*** (IRR) and the net present value approach are very similar. As outlined, the NPV determines today's values of future cash flow at a given discount rate. On the contrary, in the IRR approach one seeks to determine that discount rate (or interest rate) at which the cumulative net present value of the project is equal to zero. This means that the cumulative NPV of all project costs would exactly equal the cumulative NPV of all project benefits if both are discounted at the internal rate of return.

In the private sector, this computed ***financial internal rate of return*** (FIRR) is compared to the company's actual cost of capital. If the FIRR exceeds the company's cost of capital, the project is considered to be financially attractive. The higher the IRR compared to the cost of capital, the more attractive the project. On the other hand, if the IRR is less than the company's cost of capital, then the project is not considered to be financially attractive. For projects financed in whole or in part by the public sector, the discounted cash flow may need to be adjusted to account for social benefits or economic distortions such as taxes and subsidies, economic premium for foreign exchange earnings that accrue from the project or employment benefits. The resulting statistic would be the ***economic internal rate of return*** (EIRR) and would be compared with the country's social opportunity cost of capital. If the EIRR exceeds the social opportunity cost of capital the project would provide economic benefits to the society.

**Figure 8. Internal Rate of Return Equation**

**Internal Rate of Return**

Internal Rate of Return (IRR) is the discount rate (r) at which the net present worth (NPW) of present and future cash flows equals zero.

$$\mathbf{P = 0 = \sum \frac{F_n}{(1+r)^n}}$$

Where P and $F_n$ are known, solve (by iteration) for IRR.

For uniform annual savings (D) over n years resulting from a present capital expenditure (CC):

$$\mathbf{P = 0 = CC - \frac{D}{CRF_{n,irr}}} \quad \text{or} \quad \mathbf{CRF_{n,irr} = \frac{D}{CC}}$$

Where **CRF =[1- (1 + r)$^{-t}$]**

***Capital Recovery Factor*** (CRF) is the ratio between the uniform annual savings and the present value of the cash flow stream. This is the minimum value of savings, which makes the investment cost effective.

***Payback Period*** is the easiest and most basic measure of financial attractiveness of a project is the simple payback period. The payback period reflects the length of time required for a project's cumulative revenues to return its investment through the annual (non-discounted) cash flow. A more attractive investment is one with a shorter payback period. In development settings, however, there is little reason to assume that projects with short pay back periods are superior investments. Also, the criterion has a bias against long gestation projects such as renewable energy.

**Figure 9. Simple Payback Formula**

| **Simple Payback** |
|---|
| Simple payback (SPB) is the time required for the sum of the cash flows from the annual savings to cover the initial cost (without discounting). This is an indicator of liquidity and risk. $$SPB = \frac{CC}{D} = \frac{\text{CAPITAL COST}}{\text{ANNUAL SAVINGS}}$$ |

The ***Least-Cost Analysis*** method is used to determine the most efficient way (the least cost) of performing a given task to reach a specified objective or set of benefits measured in terms other than money. For example, the objective might be to supply a fixed quantity of potable drinking water to a village. The examination of alternatives might entail wind pumping, run-of-river off-take, impoundment, etc. One would calculate all costs, capital and recurrent, to achieve the objective, apply economic adjustments and discount the resulting stream of costs for each alternative examined. The one with the lowest NPV would be the one most efficient (least cost).

***Sensitivity Analysis*** refers to the testing of key variables in the cash flow pro-forma to determine the sensitivity of the project's NPV to changes in these variables. For example, in a renewable energy project proposal, one may increase fuel costs or fuel transport costs, remove import restrictions on solar panels, lower labor costs, increase land acquisition by different rates to determine the corresponding impact on the NPV. It is useful to test a variable in the cash flow pro-forma that appears to offer significant risk or probability of occurring. The analysis becomes another useful tool when combined with others to improve the decision making process.

Figure 10 illustrates, in very simple format, how each of the various CBAs are calculated. The four-year project assumes a discount rate of 10%.

**Figure 10. Sample Calculation of BCR, NPV, Discounted Cash Flow and IRR**

| Year | Cost | Benefit | Discount rate 10% | Discounted Cost | Discounted Benefit | Discounted Net Benefit | Discount Rate 23% | Disc.Net Benefit at 23% |
|---|---|---|---|---|---|---|---|---|
| 0 | 100 | 0 | 1 | 100 | 0 | -100 | 1 | -100 |
| 1 | | 30 | 0.909 | | 27.3 | 27.3 | 0.813 | 24.5 |
| 2 | | 40 | 0.826 | | 33.1 | 33.1 | 0.661 | 26.7 |
| 3 | | 50 | 0.751 | | 37.6 | 37.6 | 0.537 | 26.9 |
| 4 | | 50 | 0.683 | | 34.2 | 34.2 | 0.437 | 21.8 |
| | | | | 100 | 132.0 | 32.0 | | 0.1 |

**Benefit-Cost Ratio** is Discounted Benefit/Discounted Cost or 132/100 = 1.32:1.0

**Net Present Value** is Discounted Benefit less Discounted Cost or 132 – 100 = $32

**Discounted Cash Flow** is the Discounted Net Benefit or $32

**Internal Rate of Return** is that Discount Rate when the Discounted Cash Flow = 0 which is 23%

**Payback Period** occurs early in year 3 when benefits begin to exceed $100.

***Multi-criteria analysis***—While each tool is sufficient to provide data needed to make efficient decisions, multi-criteria analysis (combining one or more tools with other project data and benefits) can be helpful in evaluating future financial performance. For example, other criteria might include the distribution of benefits, ease and speed of implementation and replicability that might be combined with one of the quantifiable tools illustrated above.

# Chapter 6

# Structuring Renewable Energy Projects for Financing

**Structuring the Investment Proposal**

Financial structuring is the means of allocating the risks and returns of a project among the various project participants. The basic principle is that the expected returns to a given investor should be commensurate with the risks the investor is willing to take. Risk adverse investors are provided with low but more assured returns while risk taking investors are provided with the opportunity to earn higher but less assured returns. While a wide variety of instruments can be used to finance renewable energy projects, the following three categories characterized the major types:

1. *Equity*—High risk financing that expects high returns. An equity investment can be made in support of a specific project or equity funds can be provided to the company carrying out the project. Equity investors maintain the right to get involved in the decision making process of the project or company in order to protect their investment.

2. *Debt*—Medium risk with modest expected returns. In contrast to equity investors, lenders who provide debt financing to a project do not own shares in the project. They provide capital for the purpose of earning interest. Because lenders must be repaid before distributions can be made to shareholders, lenders bear less risk than equity holders. For this reason, potential return to lenders is limited to risk-adjusted market interest rates.

3. *Grants*—No expected returns. Governmental and international organizations offer grants (donations) to promote environmental and developmental policies. Renewable energy projects are often eligible for these funds.

Of course each of the above types of investment capital are usually combined to capitalize the initial investment.

**The Power Purchase Agreement and other Instruments for Securing an Efficient Investment**

While every project financing has its own special features, the basic structure is often either:

- A limited or non-recourse loan, repayable out of project cash flows; or
- A purchase of an interest in the project output (translated into sales proceeds) in consideration for the payment up-front of a capital sum either as a "forward purchase" or a "production payment".

The latter element, known as the power purchase agreement (PPA), establishes the power sales obligations between the private producer and the power purchaser. The PPA commits the producer to specified conditions (e.g., maximum output, total electrical generation in kilowatt hours) over a defined period and commits the purchaser to compensate the producer by an established amount and fixed tariff rates whenever the facility is available and capable of generating power.

Because the PPA usually provides the only revenue stream for repayment of debt and return to investors, it is important to the lender. Consequently, the terms and conditions of this agreement will be heavily influenced by the lender's desire to enhance the potential revenue and minimize risk. In this case, the risk to be avoided is the reduction or termination of the revenue stream, regardless of the causes. The greater the real or perceived risk to the power producer, the higher the price the purchasers can expect to pay.

The task of establishing specific performance guarantees, future adjustments to the tariff, and penalties or bonuses for exceeding or failing to meet performance guarantees are the heart of the PPA and usually require lengthy discussions. Stakeholders in the project will include not only the purchaser, producer and lending institutions but also the construction contractor, equipment suppliers, and O&M organizations.

All of the various contractual arrangements and key agreements, contracts and government undertakings that seek to reduce the lenders' and investors' risk by establishing legally binding obligations, financial structures, and operational procedures are known as the Security Package. Lenders look to the Security Package to provide security for the loan, and in the event of breach of any of the agreements they may seek the right to take over the company and install their own managers within the framework of the agreements. The main agreements that make up the Security Package include, among others, the following:

- Implementation agreement
- Power purchase agreement
- Land conveyance agreement
- Ownership structure and agreements
- Equipment and fuel supply (if any) agreements
- Construction contract
- Operation and maintenance agreement.

# Chapter 7

# Assessing the Investment Risk of Renewable Energy Projects

Renewable energy projects involve risk for all parties—the project developer, the power purchaser, and lenders. Generally, project developers take risks that are foreseeable and manageable or for which they are adequately rewarded. However, when developers are unable to provide guarantees to satisfy lenders, the lenders will seek government or sovereign guarantees. The ability of all parties to understand the nature of the risk and agree on how risks are to be shared is often the key to developing a successful project.

Risks fall into several different categories. The major types of risk and potential mitigation activities include:

***Credit risk***—Lenders will be interested in assessing the creditworthiness of all of the parties associated with the venture; they are likely to undertake several activities to determine the track record and management skills of the parties to determine their reliability, expertise and credit standing. For example, the borrower may be required to make available cash guarantees to the contractor for the engineering, procurement and construction (EPC) contract, and vice versa, the EPC contractor usually is required to submit a performance bond.

***Construction and development risk*** is the risk that the borrower and contractors may not complete the project in time, according to specifications, capable of delivering the expected output within the programmed budget. The bank usually looks to the methodology and assumptions of the feasibility study to assess this risk. Risk mitigation efforts should be undertaken during pre-inspection, warranty period, plant shake-down and trials. Large EPC contractors have a stake in efficient, error-free operation of equipment and are willing to share risk in this area. The lender and owner usually require performance bonds and completion guarantees from suppliers, contractors and subcontractors. The project sponsor can take out commercial insurance and secure export credit guarantees for equipment. Another means of risk-sharing for construction and development is the use of turn-key projects.

***Operating/Commercial risk*** is the risk of the local or international market, likely competition, access to market both in terms of physical access (breakdowns in transport and communication) and commercial access (the ability of potential purchasers to buy the service without interference from the central government). The use of obsolete and the introduction of new technology might limit market competitiveness. This might be a special consideration in the rapidly evolving technology for renewable energy projects.

***Political Risk***—Strictly speaking, political risk refers to confiscation, expropriation or nationalization of project assets. More broadly, such risk may involve changes in the existing political order that can result in commercial and financial risk as a consequence of:

- Imposition of new taxes, tariffs, export restrictions;
- Devaluation of the currency;
- Foreign exchange transfer restrictions;

- Imposition of more stringent environmental regulations; and,
- Taxes or prohibition of repatriation of profit and debt service.

Power projects are considered to be especially vulnerable to political risk since they may be considered crucial to the country's infrastructure or security. The principle mitigation measure against political risk is insurance take out on a commercial basis or with official agencies, such as export credit departments or multilateral development banks.

***Financial Risk*** involves, among other factors, fluctuations in exchange rates, increase in interest rates, increases in commodity prices that bear on the project, inflation, world commodity prices, protectionism and tariffs. These risks can be mitigated by including hedging facilities in the finance package against exchange rate and interest rate fluctuations, using currency and interest rate swaps, interest rate caps, floors and other financing techniques.

***Regulatory/Legal Risk*** might involve differential access to the legal system. For example, foreign parties may not have equal access to the courts, or foreign judgements may not be enforceable. Also, the rules of fairness and predictability may be quite different in a foreign jurisdiction compared to the U.S. or other investor home country.

***Environmental Risk***—In recent years all new projects, including renewable energy projects, require an environmental impact statement that enumerates and provides assurances regarding environmental standards that will be complied with and/or the fines that will be incurred if such standards are exceeded. For certain types of industries, an environmental performance bond may be required to compensate the community in the event of environmental violations. In addition to an environmental monitoring program, the firm can seek insurance coverage for environmental hazards and accidents. In some instances this coverage is combined with *force majeure* coverage.

***Force Majeure*** refers to risk caused by natural disasters or accidents such as fires, flood, storms and earthquakes. These loses can generally be mitigated through commercial insurance. Often the lender will require the borrower to cover losses from *force majeure* during the construction and start-up phase to cover the debt service and fixed cost of initial loan proceeds.

The key issue with respect to risk is to understand the nature of the risk that pertains to the specific project and to undertake measures to mitigate such risk that are satisfactory to the lender. A simple tool for this purpose is a Risk Matrix, which lists, in columnar format, the:

- Classification or type of risk;
- Reason for the risk;
- Risk mitigation measure adopted;
- Consequences for the lender; and
- Consequences for the investor

# Chapter 8

# Formulating Investment and Financial Plans

An investment plan is an essential part of the loan application; without it, no bank will advance a loan. This plan should convince the lender or investor of the viability of the project. The objective of the investment plan is to maximize the probability of project success and minimize risk by closely examining all the financial aspects of the project. The plan should detail all financial needs as well as all revenues. It should include all projected costs and all projected cash flows. It should lay out, in clear detail, the assumptions of the project.

The investment plan should be easy to follow, and clearly state why the proposed investment should be supported. For a bank, there is only one valid answer: the investment makes financial sense. Too often renewable energy projects have a tendency to emphasize the technology over the financial viability of the investment. Focus is given to the environmental or social benefits that might accrue from the project with less attention given to its commercial potential. While such factors are commendable, the banker's responsibility to shareholders requires that all investments be financially sound. Therefore, an investment plan should address the key financial issues of the project, clearly identifying and predicting important assumptions such as project rate of return, the prospects for self-financing, projected cash flow, and capital structure (of the firm and the project).

While different institutions may differ in terms of detail, the principal components of a renewable energy investment plan are generally consistent. Some of the topics to be presented to a lender are shown in Figure 11.

**Figure 11. Renewable Energy Investment Plan**

| Components of the Investment Plan | Content |
|---|---|
| Project Synopsis | Concise description of the most important aspects of the project (e.g., partners, sponsors, investment cost, requested role of the bank, etc.) |
| The Sponsors | The parties involved: major stakeholders in financial success, and other main parties: contractors, investors and advisors. |
| Market Analysis and Strategy | This analysis has to answer the question: Is there a demand for the project's product? Long term power purchase agreements or steam off-take agreements can provide the evidence necessary. |
| Project Scope | Description of the technical and physical aspects of the project, e.g. who is the vendor, O&M aspects, is skilled staff available |
| Project Implementation | Time schedule with responsibilities for the different tasks |

| | |
|---|---|
| Project Management | Qualifications of the management (industry/project work experience) |
| Regulation and Environmental Information | Key regulations and permissions required. Environmental issues associated with the project |
| Project Costs and Timetable | Estimated cost of implementation and time schedule for disbursements |
| Financing Plan | Preliminary idea about the structure of financing: who will provide how much funds. |
| Financial Projections | Key points from the financial analysis including:<br>• Cash flow analysis<br>• Balance Sheet<br>• Profit/Loss account |

*Source: Adapted from InnoTec Systemanalyse GmbH, "Guide to Financing Energy Technologies in Non-OECD Countries."*

**How to Approach Financing Institutions**

Generally, financing institutions encourage prospective borrowers to approach them at an early stage of a project in order to allow the banking staff to provide advice regarding the procedure and structuring options and to be kept informed of the relevant developments in the project cycle. For the initial stage, the bank will require a complete investment plan describing the project sponsors, the business and project rationale and the type of investment the project sponsor requires.

Depending on the size of the proposed project, the project sponsor may retain the services of a financial advisor. The advisor will be familiar with the country where the project is located and can advise on structures and local conditions as well as having the expertise and contacts to "sell" the project to the lending banks. The financial advisor will prepare, but seldom accept responsibility for, an information memorandum outlining the nature and economic feasibility of the project, setting out the relevant assumptions relating to the project costs, market prices and demand, exchange rates and so on, together with a profile of each of the project sponsors.

In addition, technical experts might be retained to prepare, or at least validate, the project feasibility study. The technical expert will often have a continuing role in monitoring the progress of the project, and providing assurance that performance covenants and tests stipulated in the financial documents are adhered to.

Depending on the complexity of the documentation and international make-up of the parties, the retention of an experienced international law firm may be required. Project sponsors are advised to conduct a review of the legal, tax and regulatory system in the host country as a part of their preliminary feasibility assessment. Often, a local lawyer's opinion is required as a precondition to completion of project documentation. It is advisable to involve the lawyers at an early stage to ensure that the structure of the financing is properly conceived, to ensure that the necessary security arrangements can be put in place and to ensure that anticipated tax and other financial incentives or benefits are indeed available.

Once the Bank's Operations Committee has approved the structure, the project sponsors will negotiate more detailed terms and conditions for the financing and sign a terms sheet, which will form the basis for the legal documents. The Bank usually will require an independent review of the project assumptions and environmental compliance. This is often referred to as due diligence.

**Major Project Success Factors**

Although every renewable energy project is unique, there are some factors that always have a strong influence on project success. To begin with, the lender will be interested in the commercial viability of the proposed project. The market analysis and strategy for providing a service that the local consumer is both willing and capable of paying is crucial. Second, the assessment of risks and their mitigation is essential. Risk mitigation requires mobilizing support from governments, multilateral and bilateral financiers, as well as guarantee and insurance arrangements with parties involved in construction and operation of the project. A prerequisite for satisfactory risk mitigation is a suitable ownership structure, and the evidence of effective risk management is a comprehensive security package.

Lastly, political commitment to the proposed investment is another essential element. Experience shows that energy projects require and "enabling" environment, unambiguous government policies, and co-ordination between government ministries and their agencies. This means that successful renewable energy projects are more feasible in countries where the government adopts clear procedures and limited intervention in the energy market. In addition, project developers should always try to establish reliable relationships with local authorities.

# Chapter 9

# Financial Institutions and Programs

**Sources of Equity Financing**

Sources of equity financing include project developers, venture capitalists, equity fund investors, equipment suppliers, multilateral development banks, and institutional and individual investors.

***Project Developers***—A project developer initiates the project idea and usually invests the "up-front capital" that is necessary to develop a project from a concept to an actual project. The project developer usually leverages up-front capital inputs for a larger equity stake in the project.

***Venture Capitalists***—The venture capitalist specializes in investing in new companies. Because venture capitalists join companies in their earliest and riskiest stages, they expect to earn unusually high returns.

***Equity Fund Investors***—Equity funds provide investment capital in a project in return for a share of the equity of the project. The expected return on equity is generally two or more times greater than return on debt. In return for the higher expected yield, equity investors bear the greatest risks and have rights to distributions from the project only after all other financial and tax obligations are met.

***Equipment Suppliers***—Reliable, experienced renewable energy equipment supply companies often construct, install and operate renewable energy systems and some will offer equipment financing. In addition to turnkey system delivery and operation, the renewable energy technology vendor may offer favorable financing terms.

***Regional Development Banks***— Regional development banks include the Asian Development Bank (ADB), Inter-American Development Bank (IDB) and International Finance Corporation (IFC), and others. They not only provide debt financing, but can also provide minority equity financing,

***Institutional and Individual Investors***—These are organizations or individuals willing to invest in projects on an equity basis expecting to earn high returns on their investments.

**Sources of Debt Financing**

Major sources of debt financing are international and national commercial banks. Other sources of debt financing include multilateral development banks (MDBs) and the IFC, international and national commercial banks, debt/equity investment funds, equipment suppliers, and private investors. These banks can play a major role by syndicating the debt financing of a major project among several banks so as to minimize their own risk exposure on any given project.

*Subordinated debt* is another form of financing that falls between debt and equity. Principally, subordinated debt is provided by a "friendly investor" or project partner and is subordinated to other primary debt in case of project default. In return, subordinated debt usually commands a higher interest rate than normal debt to reflect the higher risks associated with this investment.

## Sources of Grant Financing

Sources of grant financing include the World Bank's Global Environment Facility, international and bilateral agencies, foundations, and national and local agencies.

***Global Environment Facility*** *(GEF)* — The GEF has become an important source of grant financing especially for renewable energy projects. One of its institutional mandates is to support projects that help reduce greenhouse gas (GHG) emissions. As a result, many renewable energy projects are targeted by the GEF in order to improve the competitiveness of these projects relative to conventional fossil fueled energy projects. The GEF is the interim financial mechanism of the United Nations Framework Convention on Climate Change (UNFCCC).

***International and Bilateral Development Agencies*** – Many international and bilateral development agencies such as the United Nations Development Programme (UNDP), the Netherlands Ministry of Development Cooperation (DGIS), Danish Development Assistance Agency (DANIDA), etc., can and do provide grant assistance for renewable energy projects.

***Foundations*** — A number of philanthropic agencies such as the Ford Foundation and the Rockefeller Foundation have, on occasion, provided grant funds for renewable energy projects in order to demonstrate environmental and social benefits.

***National and Local Agencies*** **—** In a number of countries, support for renewable energy projects can also be obtained from national and local agencies. India is a good example. In India there is a national Ministry for Non-Conventional Energy Sources (MNES) as well as State Renewable Energy Development Agencies.

Figures 12 and 13 summarize the major types of investment services provide by multilateral development agencies and private sector investors, respectively.

**Figure 12. Multilateral Development Agency Support for Renewable Energy Projects**

| ***Type of Service*** | ***World Bank*** | ***IFC*** | ***MIGA*** | ***RDBs*** | ***UNDP*** |
|---|---|---|---|---|---|
| Feasibility Studies / Assistance for Project Dev. | X | X | | X | X |
| Equity Investment | | X | | X | |
| Debt Financing | X | X | | X | |
| Investment Co-financing | X | X | | X | |
| Loan Guarantees | | | X | | |
| Political Risk Insurance | | | X | | |
| Technical Assistance and Training | X | X | | X | X |

**Figure 13. Private Sector Investor Support for Renewable Energy Projects**

| *Types of Service* | *Commercial Banks* | *Venture Capital* | *Institutional Investors* | *Individual Investors* | *Equipment Suppliers* |
|---|---|---|---|---|---|
| Equity Investments | | X | X | X | X |
| Debt Investments | X | | X | X | |
| Debt / Equity Swaps | X | | | | |
| Project Co-financing | X | | | | |
| Equipment Financing | X | | | | X |

**New Agencies and Institutions Supporting Renewable Energy Project Finance**

A number of multilateral, bilateral and private sector programs have emerged in recent years specifically to foster investments in renewable energy projects. Specifically, the multilateral development banks (MDBs) are aware of the need to take action to redirect energy sector investments toward more sustainable development. For example, the World Bank has established the Asia Alternative Energy Unit (ASTAE), which is chartered to develop only renewable energy and energy efficiency projects. Since its inception, ASTAE has helped the World Bank lend over US$500 million for renewable energy projects in the Asia region. The International Finance Corporation (IFC) has recently launched a US$I00 million Renewable Energy and Energy Efficiency Fund (REEF) which is designed to invest in private sector projects. The Asian Development Bank recently approved a US$100 million loan to the Indian Renewable Energy Development Agency (IREDA) for biomass cogeneration projects in India. These and other examples suggest that the MDBs are increasing their level of financial support for renewable energy projects.

Bilateral development institutions have traditionally supported renewable energy projects in developing countries because of the social and environmental benefits associated with these projects. Several bilateral agencies have recently stepped up their support for renewable energy projects in support of programs having global environmental benefits. Renewable energy investments can be supported under the UNFCCC mandate for "Activities Jointly Implemented" (AJI) projects. A number of bilateral agencies, including those in the United States, the Netherlands, Canada, Japan, Norway and Germany have initiated active AJI programs that include support for renewable energy projects.

# Chapter 10

# Implications of Renewable Energy for the Global Environment

**Renewable Energy Technologies and Greenhouse Gas Abatement Strategies**

In 1992, over 155 countries signed the United Nations Framework Convention on Climate Change (UNFCCC) at the United Nations Conference on Environment and Development—the Rio "Earth Summit." The ultimate objective of the Convention as stated in Article 2 is "to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

In order to meet the primary objective of the UNFCCC, signatory countries need to develop action plans to reduce their greenhouse gases (GHGs) emissions. In the majority of the countries, the energy sector is a primary source of anthropogenic greenhouse gases (GHGs), notably carbon dioxide ($CO_2$) and methane ($CH_4$). Thus, implementing the UNFCCC will require changes in the energy mix and production processes in these countries. In this new energy supply structure, renewable energy technologies will play a crucial role due to their low or zero greenhouse gas emissions.

Initial advances in research and development of renewable energy technologies in the 1970s focused on replacement of fossil fuels, then considered a resource that was soon to become depleted in various parts of the world. It was expected that price increases due to scarcity of fossil fuels would restrain world economic growth. While this has not happened, global concern over the rising rate of greenhouse gas emissions and their potential impact on global warming has become a major incentive for replacement of fossil fueled power generation. The widespread use of renewable energy technologies to replace and supplement fossil fuel-based energy systems will reduce the emissions of greenhouse gases and help achieve the ultimate objectives of the UNFCCC. Further, if commercially competitive renewable energy technologies are applied in appropriate cases, the reduction in GHG emissions may be achieved without higher economic costs relative to conventional systems. For applications that are not yet cost competitive, the Kyoto protocol has introduced flexible mechanisms that may be applied to meet the emissions targets. These instruments can be used to improve the potential financial returns from an investment in a renewable energy project or perhaps support the financing of a project that offsets GHG emissions.

**New Opportunities using Flexible Financing Mechanisms**

The most dramatic growth of GHG emissions is expected to come from the energy sectors of developing countries. This is due to the fact that these countries, at present, have low energy consumption rates relative to their per capita GDP. Their development plans are specifically targeted at increasing per capita GDP. In the process, it is almost inevitable that per capita energy consumption will increase. As a result, total GHG emissions from the developing countries are expected to surpass those of the OECD countries some time in the future.

Three flexible mechanisms are included in the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) to assist in meeting the emissions targets articulated in the Protocol: Joint Implementation (JI), Emissions Trading, and the Clean Development Mechanism (CDM).

*Joint Implementation* may be used by Annex I parties to the UNFCCC to jointly fulfill their emissions limitation targets under the Kyoto Protocol. Annex I parties are industrialized and economies in transition countries. *Emissions trading* will allow selling and buying of GHG emissions allowances between Annex I countries to meet their emissions targets. Lastly, under the Clean Development Mechanism (CDM), Annex I countries may cooperate with non-Annex I countries on projects to be implemented in non-Annex I countries that achieve sustainable development and reduce greenhouse gas emissions. The emission reduction credits that accrue from the CDM project can be used by Annex I countries to meet their emissions limitation targets.

JI procedures and the CDM may be utilized to support the financing of qualifying renewable energy projects that will be implemented in developing countries and economies in transition. The mechanisms can provide technical as well as financial assistance. However, the rules and modalities that will govern these flexible mechanisms are still under discussion and negotiation. They are not expected to be operational for several years.

# Annex: Exercise

## Preliminary Design and Financial Analysis for an Off-Grid Rural Electricity Supply Project Using Renewable Energy

The following exercise was designed to provide practical, hands-on training in the design, financial and economic evaluation of typical renewable energy projects. The evaluation can be extended to cover relevant environmental issues as well.

* * * * *

**Introduction**

There are many opportunities for commercial applications of renewable energy to support rural social and economic development. This exercise explores the use of renewable energy options for off-grid communities. It reflects the current commitments of many national and/or provincial governments to substantially expand their rural electrification programs.

The purpose of this exercise is to prepare a preliminary design and financial analysis of an off-grid rural energy supply project based on the conceptual approach described here. The key technical parameters are presented below. Use capital and operating cost data as presented and background materials from other available information. Some readers may draw on similar initiatives from past experience; note however, that the rural energy services enterprise reflects a relatively new approach to the use of renewable energy technologies to provide basic electricity services to rural communities, and the reader will need to make assumptions about the business approach and its financial requirements.

**Off-Grid Electrification**

In many developing countries an immediate opportunity for practical renewable energy applications is off-grid electrification. Most of the technologies involved (PV, small hydro, small wind power, renewable hybrid, etc.) are the least-cost options for sites far from the main grid. The principal conventional alternative is the use of small diesel generators, still generally the most economic solution when loads are concentrated and served by a centralized system. Good wind or hydro resources at a particular site may make small wind power, micro hydro, or hybrid power systems cost competitive on an annualized or life cycle basis. Also, in many communities small diesel generators may not be technically feasible due to the difficulty of providing effective operation and maintenance.

The largest potential off-grid load is household lighting. This load is made up of large numbers of very small and highly dispersed individual loads that can be provided effectively by solar home systems (SHS).

Note that even in projects involving thousands of households, the total megawatts of generating capacity is very small compared with traditional power projects. The decision to implement off-grid projects starts with a public policy to extend at least basic electricity services to unserved populations that are unlikely to obtain electricity connection in the foreseeable future. While many unelectrified communities are suitable for grid extension, many others are too remote from the main grids, and are more suitable for decentralized distributed power systems, including diesel, renewable energy, and hybrid systems.

**The Model Project**

The project described below illustrates the initial phase of a long-term investment program. It targets 1,000 off-grid communities for which grid extension is not feasible. The market in each community is assumed to be:

1. Households, mainly for lighting - about 200 households on average
2. Public service centers - one school and one health clinic per community
3. Economically productive applications - two per community, each requiring 1.0 kWe on average.

These assumptions may be modest, since many communities will have other service needs (water supply, public lighting, telecommunications/rural telephones, etc.) that also require electricity, and there is likely to be more than one or two economically productive applications per community that would benefit from a renewable energy-based electricity supply.

**Calculate:** At 100% market penetration the project will cover a total of _________ households, __________public service centers, and 2,000 economically productive applications.

The household market will be in two categories: houses clustered together, normally around the public centers that can be serviced by centralized micro grids; and separated houses, dispersed over each area serviced by individual PV systems.

To obtain a rough estimate of the project financial requirements use the following assumptions:

- A certain percent (perhaps 10 - 30%) of the households will be connected to local centralized power systems; the remainder will have individual units of 50W - 100W each.

- Micro-grids are powered by diesel generators, centralized PV, wind/diesel hybrids, and by micro hydro units. A reasonable percentage of each of these will be used. Indicate the reason for your estimate.

- Each micro grid will have a peak generating capacity of 50 kWe.

- Individual systems will all be 50W, 75W, or 100W. In a real project, the market will cover a range of system sizes.

- The project will be carried out in three phases over a period of 5 - 8 years, with the second and third phases overlapping. As the unit costs decline, each succeeding phase will cover more communities than the previous phase. ***Specify the period for the project.***

**Calculation:** Present the coverage per phase and the estimated minimum investment costs for each phase.

**Investment Requirements of the Model Project***

| Phase | Number of Communities | Households | Public Centers | Productive Systems | Investment Cost | Duration in Years *illus-trated* |
|---|---|---|---|---|---|---|
| I | | | | | | 2 |
| II | | | | | | 3 |
| III | | | | | | 3 |
| Total | 1,000 | 200,000 | 2,000 | 2,000 | | 5 |

** The estimated investment cost is the economic cost of installed equipment only and does not include duties and taxes. Expenditures for project design and management and technical assistance will increase the financial requirements of an actual project.*

Calculate the total required investment in US$ millions. It is important that the implementation plan be designed so that the budget is obtained not only from public funds but also from monthly payments by customers and, more importantly, from investments by the private sector. Assume that such investments are made through companies that specialize in providing off-grid electrification services (i.e., rural energy services enterprises)

**Implementation**

There are various ways to implement this project so as to leverage the participation of the private sector, in terms of both financing and know how. The three basic approaches are

- Dealer sales of equipment, with consumer financing (CF)
- Leasing of equipment by rural users from dealers or leasing companies
- Fee-for-service approaches by rural energy service companies (RESCOs).

Centralized micro grids offer natural fee-for-service possibilities where a private company[1] could build, own, and operate the systems, charging customers a monthly tariff for the service.

A remote household needing a separate household system is in a different situation. The single household system (SHS) could be provided either through direct sale or through fee-for-service where the system is installed for a down payment or installation fee, and a monthly fee. In this model the service provider owns the system and provides maintenance and parts replacement. For a community or group of communities, one approach would be for a RESCO to provide fee-for-service to both centralized (minored) and dispersed customers.

The most suitable approach depends on the specific market: the capability and willingness-to-pay (WTP) levels of different market segments, composition and magnitude of the loads, household density, and potential for attracting the interest of equipment vendors or private service providers to the particular locality. The difference between household incomes and WTP profile on the one hand and the monthly cost of service or equipment amortization on the other determines how much in public subsidies may be needed. On average, an off-grid community will have a few households that can afford service without assistance, more which can afford service with some

[1] This entity could also be the existing rural electric cooperative. In the discussion, the term "company" is used to refer to both the REC and an external private sector company.

long-term financing assistance or limited subsidies, and a large group that requires substantial subsidies.

The government must decide to what extent this last group would be included in its program to improve electricity access. The reader should decide whether the government would opt to include only the first and second groups in its off-grid programs.

For this conceptual project, it is envisioned that:

- A RESCO would provide fee-for service to a group of communities in order to achieve economy of scale and make the business more attractive (i.e., profitable).
- The RESCO would charge a monthly tariff based on the level of service and the actual cost of providing service (e.g., different tariffs for households using SHS and those connected to the minored with AC service).
- Through a competitive bidding process the RESCO will be granted exclusive rights to serve the market area for a long period (e.g., 15 years). The amount of subsidy requested from the government will be a selection criterion. Exclusivity guarantees the size of a potential market for the long term and reduces somewhat the investment risks in this high-risk, minimally profitable business;
- The RESCO will be free to employ whatever technologies (diesel, renewable energy) and system configurations (centralized, individualized) to deliver the level of service its customers want.
- Special regulatory procedures will ensure that the RESCO delivers an agreed quality of service and that tariffs are consistent with costs.

**Cost Sharing**

Assume that that electrification of public service centers will be fully subsidized (or the actual monthly cost of providing service, including profits for the RESCO, will all be paid by the government). Households connected to minigrids will be charged a tariff commensurate with their share of the life-cycle cost of the installation and O&M. Depending on income and WTP levels, some subsidy may be provided. ***Make an explicit assumption about the degree of subsidy that would be required by income category.***

Dispersed households with SHS will be charged a connection fee (about 10% of the installed cost of the unit) and a monthly fee. The fee will reflect the life cycle cost of the system (installed cost, replacements, O&M) over the service period, less whatever subsidy is provided by the government or external donors. The subsidy must not exceed the difference between actual life cycle cost of the unit and the WTP level. In all cases, it is preferred that subsidies be applied to capital costs and that customers pay the full cost of O &M, the recurring costs. Excessive subsidies, even if public or donor resources are freely available, tend to distort the market.

For productive applications, user equity or down payments can be raised to 20% to 25% of installed costs. It is important to explore financing through existing programs of the DBP (especially Window III) for, say, 50% of the cost, with the balance preferably be financed by the RESCO; in effect it will be assuming part of the risk.

One imaginative approach is being proposed by a new RESCO (Shell Renewables / Community Power Corporation) in the Philippines. The RESCO will take an equity position in a productive use enterprise, such as coconut milling, providing some business and management support to assure its profitability, and then supply the required electricity services to the business. ***Would such an approach be relevant to your model project? Why?***

Depending on the size and composition of the actual project package, the RESCO may be asked to finance 15% - 30% of the total investment cost for all market segments. No RESCO will take on an off-grid electrification project if a reasonable return on equity is not in sight. Before the competitive bidding such calculations must be provided as part of the bidding package. The remaining investment would be financed by the government in the form of subsidies and indirect loans to the users. The portion of the investment cost typically financed by external borrowings by the government is about 40%, which represents roughly the foreign exchange component of off-grid equipment. ***Calculate the external loan component for this model project.***

In similar projects financed by the World Bank in several countries (e.g., Indonesia, Argentina), the governments were able to obtain supplementary grant financing from the Global Environment Facility (GEF). The grant was used to buy down, on a declining schedule, the high first cost of certain renewable energy systems and to finance activities designed to reduce market barriers for new technologies. Properly justified, these grants can be substantial and can finance many activities like public information campaigns that are too expensive for small private companies. The two most important barriers for off-grid electrification are (a) lack information on which to base investment decisions and (b) rural customers not aware of the available choices, their costs, and benefits. GEF grants have financed activities that directly address these barriers.

The government may also realign bilateral funds proposed for pilot renewable energy projects so that they are used as part of the subsidy package for well-designed private sector off-grid electrification. Many pilot projects provide heavy subsidies to rural customers, benefiting particular households but distorting the market and preventing the entry of private investors.

**The Exercise**

1. Assume that the implementation approach is that of a RESCO. Describe the business setup and approach.

2. After determining the physical and capital investment aspects of the project (including the number, sizes, and costs of each type of renewable energy system), and the timing of their implementation, prepare a simple financial analysis of the project assuming a specific business approach. Include in the cost analysis the requirements for operation and maintenance (including labor costs for technicians and others).

3. Determine the required financing from investors (equity), lenders (debt), grant (e.g. GEF), and possible subsidies (government, from internal and/or international sources). Assume an end-use customers willingness and ability to pay as a component of the revenue stream.

4. Determine what the customers would have to pay as a tariff in order for a return on equity of 15%, 20%, and 25%. Assume 10 and 15-year debt financing at an interest rate of 7%. (The reader may select different terms and conditions for the debt if desired).

5. Determine if such an approach can be profitable, and identify key issues involved in establishing a profitable sustainable RESCO operation. For example, are there specific regulatory or social considerations that must be addressed?

# Resources for Further Information


Ahmed Kulsum. "Appendix 3: The Cost of Electricity from Biomass," in *Renewable energy Technologies,"* The World Bank, 1994.

___________. "The Cost of Biomass Energy," in *Renewable energy Technologies,"* The World Bank, 1994.

Albouy,Yves and Reda Bousba, "The Impact of IPPs in Developing Countries—Out of the Crisis and into the Future," *Public Policy for the Private Sector*, March 1999, World Bank.

Alternative Energy Development, Inc., *Economic and Financial Evaluation of Renewable Energy Projects.* A Training Manual prepared under USAID Contract LAG-1-00-98-00012-00, Washington, DC, October 1999.

____________. *Economic and Financial Evaluation of Renewable energy Projects.* Reference Materials and Documentation prepared under USAID Contract LAG-1-00-98-00012-00, Washington, DC, October 1999.

Anderson, D. and Kulsum Ahmed, *The Case for Solar Energy Investments,* The World Bank, 1994.

Canadian Government, Renewable energy Technology (RETScreen) Renewable energy Project Analysis Software, Canada Energy Diversification Research Laboratory (DEDRL) of Natural Resources, Canada, August 1999. (http://cedrl.mets.nrcan.gc.ca/e/412/retscreen/retscreen_new_1html)

Castedo, Sergio. "Wind Energy Technology," American Wind Energy Association, 1996.

Chance, Clifford "Introduction: What is Project Finance?, *Project Finance,* IFR, London, 1992.

Chronowski, Robert A. "Overview and Management of Biomass Cogeneration Project Development, " Alternative Energy Developmnent, Inc., October 1996.

*Cross Sectoral Application of Renewable energy and Energy Efficiency Technologies,* presentation by AED to the Asian Development Bank Environment Forum, August, 1999.

Gregory, J., et. al., Chapter 7 "Sources of Funds," in *Financing Renewable energy Projects: A guide for development workers,* IT Power in association with Stockholm Environment Institute, 1997.

Hassing, Paul and Matthew Mendis, "Sustainable Development and Greenhouse Gas Reduction," in *Issues and Options: The Clean Development Mechanism,* UNDP, 1998.

InnoTec Systemanalyse GMbH in cooperation with Europlan Ekono Energy Ltd., "Guide to Financing Energy Technologies in Non-OECD Countries, 1995.

Krupnick, A.J. "Using benefit-cost analysis to prioritize environmental problems" *Resources,* RFF, Winter, 1992.

Mendis, Matthew S. "Financing Renewable energy Projects: Constraints and Opportunities," July 1998.

___________. "Innovative Financing Mechanisms for Renewable energy," *Energy,* UN Department of Economic and Social Affairs, Energy and Transport Branch, June 1998.

Munasinghe, Mohan, et. al., "Applicability of Techniques of Cost Benefit Analysis to Climate Change," in *Global Climate Change: Economic and Policy Issues*, M. Munasinghe, ed., The World Bank, 1995.

Northrop, M. F., P. W. Riggs, R. A, Raymond, "Selling Solar: Financing Household Solar Energy in the Developing World," October 1995.

OECD, Chapter 2 "Economics and the Environment," in *The Economic Appraisal of Environmental Projects and Policies: A Practical Guide,* OECD, 1995.

Owens, Gene M., ed., *Economic Evaluation of Environmental Impacts: A Workbook,* Chapter 3: "Impacts Identification and Screening,";

Piscitello, Scott and Susan Bogach, *Financial Incentives for Renewable energy Development,* World Bank, February 1997.

Sagrillo, Mick. "Wind Power: Apples and Oranges, An Update," in *Home Power, No. 47, June/July 1995.*

Jerome Weingart, "Renewable energy Technology Choices: Practical Options for the Coming Decade," extracted from *Philippines Non-conventional Energy Development Program: Policy Framework Action Plan, 1999.*

World Bank and USAID, "Executive Summary", *Submission and Evaluation of Proposals for Private Power Generation in Developing Countries,* Washington, DC, 1994.

World Bank, Global Environment Division, *Greenhouse Gas Assessment Handbook*, September 1998.

World Bank, Industry and Energy Department and USAID, Office of Energy and Infrastructure, "Chapter 4: Risk," in *Submission and Evaluation of Proposals for Private Power Generation Projects in Developing Countries*, April 1994.

## Organizations

Electric Power Research Institute (EPRI)
http://www.epri.com/

Energy Central online information service
http://www.energycentral.com/

United States Energy Information Administration
http://www.eia.doe.gov/

# Financing Resources

Asian Development Bank (ADB)
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(632) 711-3851 (international)
Fax: (632) 741-7961
(632) 632-6816

The African Development Bank
Rue Joseph Anoma
01 B.P. 1387, Abidjan 01
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Tel: (225) 20-44-44
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http://www.afdb.org

European Bank for Reconstruction and Development (EBRD)
One Exchange Square
London EC2 A2EH
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http://www.ebrd.com

International Finance Corporation (IFC)
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http://www.ifc.org

Inter-American Development Bank (IDB)
1300 New York Avenue, NW
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