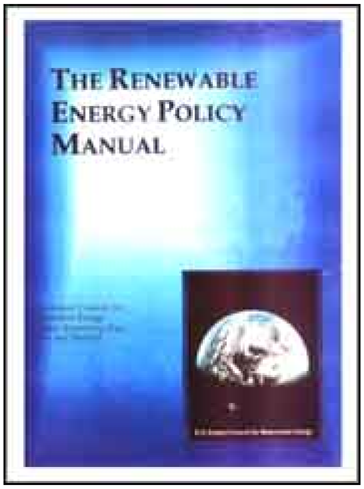
The Renewable Energy Policy Manual



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U.S. Export Council for Renewable Energy
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PREFACE

United *States Export Council* for *Renewable Energy* (*US/ECRE*), *a trade group representing six United States renewable energy trade organizations, commissioned the preparation of this Manual in order to assist energy policy makers in formulating policies designed to enable private-sector investment in renewable energy generation facilities. The objective of the Manual is to improve the climate for investment in a nation’s renewable energy sector by consolidating information about the renewable resources, identifying barriers to private-sector investment in renewable technologies and suggesting how these barriers may be bridged.*

US/ECRE invites readers to contribute their comments regarding the content of this Manual. The policy recommendations contained in this document are based on the experience and research of the authors. Incorporation of a wide range of experiences from around the globe will substantially improve its quality, accuracy and effectiveness.

The Manual is intended for use by a broad range of energy policy strategists - officials in the executive and legislative branches of government, utilities and other agencies or businesses with a role in formulating energy policy. Mindful that the development of energy policy always involves weighing competing considerations, policy strategies in the Manual are set forth in context of narratives or discussions designed to provide the reader with insight into the underpinning considerations so that generalized policy strategies may be more easily adapted to local circumstances. In evaluating whether to include a given analysis or strategy, the authors have elected to focus on those issues which may be determinative of whether a developer or investor will opt to invest in renewable resources in a country. Policy strategists may find that by asking whether a proposed energy policy promotes or discourages investment is a sound way to evaluate whether that policy will produce the desired effect.

Due to the rapid legal, technical and economic developments now occurring in the renewable energy industry around the world, US/ECRE recognizes the need of a sourcebook that provides energy policy specialists with up-to-date policy guidelines. For that reason, this Manual is published in a single, loose-leaf volume that can be updated on a regularized basis.

CONCEPTUAL APPROACH

An undertaking that attempts to provide renewable energy policy guidance to policy strategists who operate across a spectrum of national energy systems inherently contains both the flaws and the strengths of "universal" or general concepts. Readers are asked to apply broad conceptual ideas in a specific national context. The authors have used operative or normative words with the objective of describing concepts neutrally - without implying conceptual bias. This objective is difficult to achieve - especially for multi-language translations. When possible, normative words are defined the first time they are used in the text.

... be consistently mindful of the difference between means and ends.

The authors have articulated the thesis that policy strategists must consistently be mindful of the difference between means and ends.

- The term **"goal"** is used in the sense of the end toward which effort is directed - the terminal point.
- The term **"objective"** is used in the sense of steps toward the goal - *i.e.,* sub-goals.
- The term " policy" is used in the sense of a government statement of the goals (or ends) selected from among alternatives and in light of given conditions to guide and determine present and future decisions. Within context the term "policy may be used to mean the definite course of action or method of action to guide decisions. Policy issues meriting special consideration by decision makers are highlighted by a check (" ").
- The term **"strategy"** is used in the sense of the science and art of employing political, economic, scientific and psychological forces to afford maximum support to adopted policies.
- The term **"mechanism"** is used in the sense the process or the technique elected from among alternatives to achieve objectives.
- The term **"program"** is used in the sense of a specific application of a mechanism.

Communicating ideas to policy strategists with a diverse range of national issues and backgrounds requires equal care on the part of the writer as well as the reader not to superimpose unintentional layers of meaning or to allow ambiguous meanings. Readers are invited to contact US/ECRE with suggestions which may avoid such flaws.

INTRODUCTION: Trends in Energy Policy, Deregulation, Energy Markets and Technology

During the last quarter of the twentieth century, two developments have served as catalysts for change in the national energy policies of countries throughout the globe:

- **steadily increasing demand for electric energy created requirements for new capital investments which exceeded the ability of governments to provide; and**

- **concern about local and global environmental degradation resulting from the burning of fossil fuels and their effect on global warming, acid rain and other air pollution problems created pressures to spend funds to address these issues.**

These two catalysts have affected the institutions and energy framework of virtually every country. In the majority of countries, the predominant electric institution is the electric utility monopoly - characterized by some degree of government ownership and control. In many of these countries, self-generation supplements the electric supply. To the extent that existing institutions have been unable to create new sources of funding for new electric-sector capacity and new sources of funding to cope with environmental imperatives, governments are turning to the private sector.

Power from renewable resources is especially well suited to the rapidly changing electric industry

Power from renewable resources is especially well suited to the rapidly changing electric industry. Renewables tend to be modular. Solar and wind technologies in particular have a short lead-time from installation to operation, they provide a flexible option for adding generating capacity in *“**distributed**”* (decentralized) and community-scale applications. Biomass, geothermal and hydro (that does not require building a dam) can also be constructed fairly rapidly. The primary long-term benefit of grid-connected renewables such as biomass, hydro and geothermal is that once a renewable project has been constructed, and fully depredated, it becomes a permanent, environmentally clean, and low cost component of a country’s energy system. Renewable fuels, once developed, are essentially free, and their use reduces dependence upon imported fuels. In effect, the construction of a renewable energy project provides future generations a low cost, energy facility that produces power with minimal environmental degradation. In the wholesale-supply market, renewable resources provide not only basic electricity but the added benefits of fuel diversity, environmental benefits, and long-term price stability.

Renewable technologies provide a means for using sustainable domestic resources, promoting increased electrification, and minimizing the impact on the global environment.

Renewable generating facilities are commonly built and operated by the private sector contributing its expertise and additional sources of investment capital. However, in order for a government to generate private-sector money, the economic and political environments and the legal system of the country must allow private-sector investors to invest in, and make a profit from the building of new generation, transmission and distribution facilities. This course of action implies some degree of private-sector ownership and control and the relinquishment of existing government ownership of the utility monopolies.

Fundamental and sweeping legal, regulatory and institutional reforms have been required in order to enable a partial or total shift from public-sector to private-sector ownership and control of the electricity sector. Among the more significant reforms have been the creation of legal regimes enabling the sale of government ownership in electricity facilities and the restructuring of the electricity business.

A number of countries have instituted a new electricity structure designed to rely on the open market: known as an ***"unbundled, competitive electricity market."***

In an "***unbundled***" electricity market, the electric power industry is divided into three distinct functions: generation, transmission and distribution. This division allows ***"arms-length"*** ("competitive") sales of electricity or services among companies in the three sectors. The continuation of government ownership in any of these three sectors varies from one legal regime to another as does the authorization for cross-sector ownership. Independent power producers ("IPPs") are allowed to enter the market freely in order to provide competition for the previously government-owned companies. Although details vary from one country to another, this model system typically relies on competitive forces to establish electricity market prices and on private-sector owners to conduct long-term planning. Since no one in this market structure has any "***obligation to supply,***" in the usual utility sense of being required to plan and acquire adequate generating capacity to meet future demand, new capacity will be built only when somebody thinks that new capacity will provide a favorable return on investment relative to projected prices.

Among the 193 nation states and 57 overseas territories and dependencies, there are countless combinations and permutations of electricity systems.

Such sweeping reforms have not been universal. Indeed, this is not a monolithic world, and among the 193 nation states and 57 overseas territories and dependencies there are countless combinations and permutations of electricity systems. Although the electric utility monopoly is still the predominate electric power industry model, this situation is changing rapidly. The level of government participation in different countries falls along a shifting spectrum defined (i) on the one extreme by total government ownership and control of the utility; (ii) in the middle by government regulation of privately-owned companies; and (iii) at the other extreme, by less regulated privately-owned generation and regulated transmission facilities which may be off-grid or allowed to supplement the grid supply. In many countries the electrical energy sector is characterized by a mix of government-owned, government-regulated, and privately owned systems.

The wide variety of electricity systems operating and organizational structures existing worldwide makes it challenging to formulate issues and strategic recommendations of universal applicability. What is an obstacle to attracting private investment in a system of vertically integrated state-owned utilities is not necessarily relevant in a privatized system organized along one of the variations of the totally unbundled, competitive model.

In the competitive market for private-sector capital, keep in balance the country's need to develop its own indigenous resources and to assure its energy sector is developed in an environmentally friendly manner.

This *Manual* seeks to identify those issues that are the most relevant to countries that are seeking to attract private capital to their electricity sector - and in particular to the renewable energy sub-sector. In some cases, the relevancy of an issue will depend upon the structure of a country's national electric system. In other cases, the issues and recommendations may have more universal application. Where the issues are specifically related to system structure, an attempt has been made to identify the structure that is being discussed and to indicate the applicability of the discussion to countries that incorporate that particular structure.

The international financial community has significant capital available for investment in energy projects. But an increasing number of countries are vying for this capital - and capital is not infinite. Countries seeking investment dollars are entering into a competitive market in which countries will compete for international debt and equity investments. To be competitive in this milieu, a country will be required to demonstrate a legal, political and commercial host environment that reduces risk and provides investors with good reason to believe they will receive a fair and reasonable rate of return on their debt or equity investment.

The policy makers whose task it is to create an environment in which the private sector shoulders the task of moving a country's electric power system into the twenty-first century are challenged to identify and bridge the local barriers which impede the development of electricity from renewable resources. This *Manual* is designed to assist these policy makers.

- **Chapter I (Renewable Energy Overview)** is a primer on the essentials of renewable energy resources - their costs and benefits.

- **Chapter II (Identifying Goals and Objectives in the Electricity Sector)** presents a top-down analytic approach. Electric sector objectives flow from national goals and by understanding both, the policy maker is situated to determine how to employ renewable energy resources to achieve goals and objectives.

- **Chapter III (Encouraging Private-Sector Investment)** discusses the hurdles to private-sector investment in renewable resources in urban and rural environments and explores mechanisms available that the energy policy strategist may use to overcome those hurdles.

- **Chapter IV (Government's Role in the Electricity Sector)** recognizes that in virtually every jurisdiction, legislation and regulation are the two primary tools for achieving public interest goals. This chapter explores how legislation may remove legal, economic and social barriers to the development of renewable technologies as well as provide a framework for the ownership and financing of renewable resource infrastructure projects. The chapter further offers insight into how regulatory guidelines contribute to a stable and predictable market for both international and domestic investment in renewable energy.

- **Chapter V (Universal Electrification Policy)** deals with how the policy maker may use renewable energy to provide a sustainable, long-term level of electrification to isolated areas.

- **Chapter VI (Program Implementation)** analyzes the institutional issues that are at the heart of sustainability, and provides guidelines for the policy maker designing a renewable energy program country-wide.

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CHAPTER 1. RENEWABLE ENERGY OVERVIEW

What are “Renewable Resources”?

The term “renewable” is generally applied to those energy resources and technologies whose common characteristic is that they are non-depletable or naturally replenishable.

Renewable resources include solar energy, wind, falling water, the heat of the earth (geothermal), plant materials (biomass), waves, ocean currents, temperature differences in the oceans and the energy of the tides. Renewable energy technologies produce power, heat or mechanical energy by converting those resources either to electricity or to motive power. The policy maker concerned with development of the national grid system will focus on those resources that have established themselves commercially and are cost effective for on-grid applications. Such commercial technologies include hydroelectric power, solar energy, fuels derived from biomass, wind energy and geothermal energy. Wave, ocean current, ocean thermal and other technologies that are in the research or early commercial stage, as well as non-electric renewable energy technologies, such as solar water heaters and geothermal heat pumps, are also based on renewable resources, but outside the scope of this *Manual.*

For the purposes of establishing a legal regime governing and encouraging private-sector investment in renewable resources and technologies, the policy strategist will make use of three conceptual approaches. As well as the foregoing **technical** definition, both **political** definitions and **legal** definitions, factor into a policy definition of what resources deserve discrete treatment as “renewable resources”.

Broadly define “Renewable Resources, then clarify that definition by defining each specific renewable resource **(*e.g., “‘geothermal energy’ means the heat of the earth.”*)**

From the political perspective, renewable energy resources can be divided into numerous categories depending upon the political goals or objectives under consideration. For example, in a given country, renewable resources may be distinguished by categorizing those which are well established versus those which are underdeveloped; those which have immediate development potential versus those which do not; and those with potential rural versus those with urban customer bases. The political perspective of the policy maker in one country may be to justify different treatment for established resources such as large hydroelectric from nascent resources such as geothermal. In another country, the reverse may be true. Likewise, all of the renewable resources may be treated differently for urban application than for rural application.

Avoid operational definitions. For example, if different types of hydropower are to be treated differently for political or legal reasons, address such treatment in operational language, not by definition.

From the legal perspective, existing laws such as land use, water, mining, and hydrocarbon laws need to be scrutinized to determine their potential jurisdiction over and applicability to renewable resources. It is important to define what technologies are to be considered “renewable” for the purposes of any piece of legislation. Such legislation can define “renewable resources” as appropriate, given the state of development of the natural resources in that country. If a court, legislator or executive interprets a law strictly, the term “renewable resources” as used in a piece of legislation means what that specific piece of legislation says it means, but only for the purposes of that specific legislation. Thus, if a law defines coal as “renewable”, but omits wind, this legal definition will prevail without reference to the technical characteristics of either fuel. In most legal regimes, however, the term “renewable energy” is used to distinguish naturally replenishable fuels from those fuels of which the earth is endowed with fixed stocks. The main examples of stock-limited resources are the fossil fuels (principally coal, petroleum, natural gas, tar sands and oil shales) and the nuclear fuels (principally uranium, thorium, deuterium and lithium).

Can all Renewables be governed by a common policy?

Policy makers should be cognizant of the similarities as well as the variations among renewable energy resources.

From the perspective of the policy strategist, it may be important to determine whether and to what extent energy plans, laws and regulations may be developed using the generic concept “renewable resources”:

- *Are the differences among the renewable resources and their applications such that legislation may properly address renewable resources technology by technology?*
- *Are there sufficient commonalities that renewable resource development may be handled as a generic issue?*

The commercial renewable energy technologies

Establish an objective, specific to each renewable resource, which is designed to achieve national goals.

Fundamentally, the answer depends on why the question is being asked, and in which country the policy is being applied. There are, however, guidelines which may prove useful to policy strategists making this determination in any country. Essentially, **form must follow function.** In other words, it is essential that the policy strategist understand the nature of each of the renewable resources and the nature of the process by which each of those resources is developed.

The resources are fundamentally different. Although any resource that relies on the heat or motion of the earth, the moon or the sun (or the sun's radiation) to produce power for human consumption is a renewable resource, the ways one harnesses the resources are sufficiently different that laws and regulations governing these resources usually deal with each resource on an individual basis - treating each resource as unique. At present, the major commercial grid-connected renewable resources are hydroelectric, geothermal, biomass, wind energy and solar. In the majority of legal regimes, hydroelectric and geothermal resources are identified as owned in common by the people of the country and husbanded by the government for their benefit.

- ***Geothermal resources*** require extraction (and reinjection). Drilling for geothermal resources involves many of the same discrete considerations involved with drilling for petroleum (hydrocarbons) and individual treatment is prudent.

  Geothermal resources

- ***Hydroelectric resources*** are inextricably linked with surface water rights, including potable water, navigation, irrigation, navigation and recreational rights. The historical complexities of sorting out these juxtaposed rights usually dictate individual treatment of hydroelectric resource issues.

  Hydroelectric resources

- ***Wind energy and solar*** draw on resources - wind and sun energy - generally thought of as being free for the taking. The principal resource issue with both of these renewables is surface land. Therefore there is no general technical requirement for individual treatment.

  Wind energy and solar

- ***Biomass*** is a broadly inclusive term, often encompassing wood and wood waste, agricultural waste and residue, energy crops, and - sometimes - landfill gas resources. Resource availability and cost can be highly variable, and resources may require management of a type not frequently required for other renewables. Individual treatment is one method of addressing this complication.

  Biomass

What are the renewable energy applications?

Renewable energy applications generally break down into two categories or applications, ***"on-grid"*** and ***"off-grid".***

- A ***"grid"*** may be defined as an integrated generation, transmission, and distribution system serving numerous customers. Characteristically, a grid is a portfolio of generating units operating under the control of a central dispatch center. Grids may be national, regional or local (in the latter case they are typically referred to as *"mini-grids"*).

- ***"On-grid"*** and ***"off-grid"*** are terms which describe how electricity is delivered. Technically, every one of the commercial renewable resources can be and have been installed both on-grid and off-grid. Furthermore, although larger megawatt installations tend to be on-grid, large renewable plants may profitably be built *"inside the fence" - a* term describing a self-generator, a plant built to supply a single customer such as a mine, a manufacturing plant or an agribusiness. Hydroelectric, biomass and geothermal facilities tend to be economical at capacity levels well in excess of one megawatt (1 MW) and, therefore, are typically - but not necessarily - developed and financed as *"base load"* electricity resources (*i.e.,* the normally operated generating facilities within a utility system) and connected to a grid. Solar arrays and "wind farms" also can be grid-connected.

- ***"Off-grid"*** applications, in general, serve only one load, such as a home or small business. Off-grid applications can take many forms, from photovoltaics for an individual village home to centralized windmills to power a village water pump or a commercial battery charging facility. These off-grid applications are most generally used in remote or rural settings.

- ***"Mini-grids"*** have begun to be developed by system engineers over the past few years, for isolated communities. These systems may integrate wind, solar energy and, in some cases, diesel generators and/or storage systems to provide power from a mix of resources to more than one customer, typically a village or cooperative.

For more discussion of off-grid and mini-grid issues, see below, Chapter 5a (*Universal Electrification Policy: Renewable Technologies* & *Universal Electrification Efforts*). *The following charts illustrate common on-grid. and off-grid applications for which renewable energy is best suited.*

On-Grid Uses						
	Hydro	**Wind**	**PV**	**Geo-thermal**	**Bio-mass**	**Solar thermal**
Bulk Power	•	•	•	•	•	•
Grid support	•	•	•	•	•	•
Demand-side management	•	•	•	•	•	•
Distributed generation	•	•	•	•	•	•
Cogeneration				•	•	•

On-Grid Uses

- In addition to generating bulk electricity, the renewable energy technologies can serve a number of other valuable on-grid roles.

  - For grid support, a power station is constructed somewhere along a transmission line to remedy high resistance in the line. This reduces transmission losses and prevents expensive substation equipment from being degraded by excessive heat (this application is a type of *"distributed generation"*).

  - In distributed generation, as opposed to central station generation, power plants are smaller and they exist at more locations on the grid.

This reduces transmission costs. Distributed generation tends to yield the largest returns in locations where it averts the need to increase transmission capacity.

- Biomass and geothermal are well-suited to regeneration.

• This table is not exhaustive. There are many other uses of each technology.

Off-Grid-Uses						
	Hydro	**Wind**	**PV**	**Goo-thermal**	**Bid-mass**	**Solar thermal**
Mini-grid power for village, island, industry, military, tourism, etc.	•	•	•	•	•	•
Individual systems for house, clinic school, store, more	•	•	•		•	•
Water pumping, water treatment	•	•	•		•	•
Unattended loads (e.g., telecom)	•	•	•	•		•
Space heating, water heating	•	•		•	•	•
Process heat, cogeneration				•	•	•

Off-Grid Uses

• This chart is not comprehensive, but lists some of the common off-grid applications for which renewable energy is best suited.

- Power and heat for remote villages, islands, tourist facilities, industrial and military installations, houses, clinics, schools, and stores.

- Water pumping, disinfection, and desalination.

- Communication stations, navigational aids, and road signals.

• For most types of energy applications, on-and off-grid, one or more of the renewable energy technologies is cost-competitive.

• Worldwide, millions upon millions of dollars are wasted by utilities, governments, businesses, and individuals that ignore opportunities to improve cost-effectiveness through the use of renewable energy.

• Energy decision-makers can improve their energy costs and performance by giving full and informed consideration to the renewable energy sources every time they choose an energy technology.

a. POLICY BENEFITS OF RENEWABLE ENERGY FACILITIES

Cost-benefit analysis is a generally accepted method of evaluating the value of competing energy sources.

Although a complete list of the benefits of renewable technologies can be very extensive, they can be categorized under four headings: environment, diversification, sustainability and economics.

Renewable resources are environmentally benign.

Renewable energy facilities generally have a very modest impact on their surrounding environment. The discharges of unwanted or unhealthy substances into the air, ground or water commonly associated with other forms of generation can be reduced significantly by deploying renewables. Clean technologies can also produce significant indirect economic benefits. For example, unlike fossil-fuel facilities, renewable facilities will not need to be fitted with scrubbing technology to mitigate air pollution, nor will a country need to expend resources in cleaning up polluted rivers or the earth around sites contaminated with fossil-fuel by-products. Furthermore, they provide greenhouse gas reduction benefits and should a worldwide market for air emission credits emerge as has been predicted, countries with a strong portfolio of renewable energy projects may be able to earn pollution credits which can be exchanged for hard currency. Finally, having a clean environmental profile enhances the attractiveness of renewable projects in the eyes of investors, especially the multilateral development agencies, many of whom operate under guidelines that require the promotion of non-polluting technologies.

Renewable resources promote energy diversification.

Development of a diverse portfolio of generation assets reduces both a country’s dependence on any one particular form of technology or fuel and its vulnerability to supply disruption and price increases.

The primary long-term benefit of renewable technologies is that once a renewable project has been constructed, and fully depredated, it becomes a permanent, environmentally dean, and low cost component of a country’s energy system. In effect, the construction of a renewable energy project provides future generations a low cost, energy facility that produces power with little or no environmental degradation.

Renewable resources are sustainable.

Renewable technologies are designed to run on a virtually inexhaustible or replenishable supply of natural “fuels.” Expanding a nation’s electricity supply by attracting investment to renewable energy projects is, by defintion, a strategy for sustainable growth, since operation of the facilities does not deplete the earth’s finite resources.

Renewable energy facilities enhance the value of the overall resource base of a country by using the country’s indigenous resources for electricity generation. Moreover, since these facilities operate on “fuels” that are both indigenous and renewable (as distinguished from imported fossil fuels), they may reduce balance-of-payment problems. Reduced dependence on fuel imports reduces exposure to currency fluctuations and fuel price volatility. The construction and operation of renewable projects normally generate significant local economic activity, often in previously “resource poor” areas of a country. Renewable energy projects thus act as engines for regional economic development. In the case of large scale, on-grid projects, easements will need to be purchased and local workers hired to construct and operate the facility. Frequently, a local industry such as a sugar mill or a paper mill (when biomass technology is employed) will be associated with the development, enhancing the opportunities for joint ventures between local landowners and private investors who may supply technological expertise. Smaller scale facilities often attract local private sector involvement. Local involvement, in turn, stimulates new economic activity in a multiplier effect and adds value to the local tax base.

***Appendix A** provides concise descriptions of renewable energy technologies, their applications and environmental impacts. Readers interested in gaining additional knowledge with respect to any of these technologies should also consult US/ECRE's sponsoring trade associations, also set forth in **Appendix B** of the Manual.*

b. COST-EFFECTIVENESS OF RENEWABLE ENERGY

The ultimate question for the policy strategist is whether power generated from a renewable energy source is affordable given the service it is providing.

Universally, the goal of electric power generation planners is to deliver electricity to the maximum number of customers at the lowest possible price. The political acceptability of power generated from any source will depend upon the ultimate tariff to the consumer relative to the benefits delivered.

Does renewable energy generate affordable power?

On a total cost basis, a new, renewable energy, generating facility is often cost competitive with a conventional fuel facility provided that the cost calculation considers long-term fuel costs - and even more so when one considers environmental costs and benefits. Since this generalization is not true in every situation confronting the policy planner, the policy planner will need to apply cost-effectiveness criteria adapted to each situation.

What are the applicable cost-effectiveness evaluation criteria?

Any given electric generating technology (including renewables) may be cost effective in one market or application and not in another. There is no simple calculus a policy maker can apply, but a number of established criteria will assist in determining the financial viability of renewable energy generation.

The quality and quantity of the resource. Quality and quantity of renewable resources may be determined by a government-conducted resource assessment, but private-sector developers commonly have their own pre-feasibility and feasibility studies which can be more accurate measures of the commercial viability of a given project. The measures of resource quality and quantity are unique to each resource, but for each of the renewables, resource quality and quantity affects the energy input to, and the effective capacity of a generation facility. In geothermal resource development, for example, the temperature of the resource and the dissolved impurities determine the requisite production equipment. The cost of production equipment, in turn, affects the installed cost and the per-kilowatt-hour cost of delivered power. In biomass, the quality and BTU content of the fuel will influence installed costs, and operations and maintenance costs.

The location of the resource. Proximity of a resource to a customer base directly impacts costs, as does proximity to an existing infrastructure (roads, transmission lines, etc.), to industry support facilities (concrete plants, etc.), and to the developer's technology manufacturing base. In the case of geothermal, the depth of the resource is a major cost factor. For the hydro, wind and solar technologies, climatic variations (rainfall, cloud cover, intense storms) affect cost. For biomass, transportation distances between the fuel source and the generating facility may significantly affect the electricity cost.

Government-imposed costs. For the private-sector developer, time is money. The time expended in responding to bid proposals, in obtaining requisite permits, licenses and concessions, and in negotiating contracts increases the costs of renewable projects. The policy maker should consider policies that organize and simplify the local institutional processes. Such policies may prevent adding major costs and time delays to what would otherwise be a highly cost-effective facility. Similarly, government-imposed taxes, fees, tariffs and royalty payments are all passed to the electricity consumer and effect the kilowatt-hour cost of delivered power.

The development process is sufficiently similar that for many purposes the renewable resources may be treated similarly. The development process employed by hydroelectric, geothermal, wind energy, biomass and solar renewable technologies may be described and analyzed in three discrete stages: ***"reconnaissance", "exploration"*** and ***"exploitation".*** Each technology may use different terms for these three stages, but the concepts are similar.

- ***Reconnaissance*** is an activity which determines by visual observation and scientific studies whether an area may be a source of commercially exploitable resources. It does not affect the present surface use of the land.

- ***Exploration*** is an activity which demonstrates the dimensions, position, characteristics and extent of resources by scientific studies. It may affect the present surface use of the land. An extensive outlay of capital may be required for exploring the potential of some renewable resources such as geothermal and, to a lesser degree, wind and hydro resources. Where resource exploration is expensive, this may necessitate that exclusive rights to the relevant renewable resources in the area be awarded to the explorer. These rights may be granted for a limited term, but if exploration proves the commercial viability of the resource, a private-sector developer will require that the temporary exploration rights be converted to long-term exploitation rights.

- ***Exploitation*** is an activity which enables electricity to be produced from renewable resources, either through the intermediate production of steam or the direct production of electricity from a chemical or mechanical process. Exclusive, long-term rights are prerequisite to the sustainability of this production.

The expense associated with each phase of resource development has a direct impact on the cost-effectiveness of the electricity produced. The first generation facilities developed in any resource area are almost always going to cost more per kilowatt hour produced than will later facilities, since most of the reconnaissance and exploration costs will be included in the cost of the first facility. If, however, there is some assurance of a market for power from additional facilities, should the initial facility prove feasible, the reconnaissance and exploration costs may be allocated over more kilowatt hours thus reducing the initial cost. By allocating initial reconaissance and exploration costs over multiple projects, the per kilowatt hour cost may be significantly reduced.

Financing costs. For renewables, the bulk of a project's total lifetime cost is represented by the initial capital cost, and will be incurred before the project ever comes on line. The cost of a renewable energy is in the technology effort exerted at the outset of a project and all of the renewables share ***"front-end-loaded"*** cost profiles. Consequently, the majority of new generation facilities are funded through project financing, whereby the principal and interest (and profit) are paid from the proceeds of the project.

Cost of Electricity

Power purchase agreement. The **"power purchase agreement"** - the power and capacity contract between the owner of a generating facility and its customers - rather than the credit-worthiness of the developer, collateralizes the loan. Since renewable energy projects are front-end-loaded, the costs of capital significantly affects installed cost. High risk factors associated with initial projects developed in new resource areas also translate into higher costs of capital. The challenge for the country policy maker - especially in a country which seeks to attract initial projects to a new resource area - is to implement new mechanisms to lower financing costs. Development of such mechanisms may prove more productive if done in consultation with the private-sector developer. For example, in some situations, municipal customers may have access to tax-exempt or low interest bonds that can be used to finance energy projects at a lower cost than if they were financed with conventional borrowing.

In a rapidly advancing technological era, the most prudent course for a decision maker is to avoid reliance on old information as to whether a given renewable technology can fulfill a given energy need.

System costs. The cost or cost-savings of integrating a given renewable energy generator into a system is difficult to quantify. By diversifying the energy supply mix, a system can protect or buffer the ratepayer from the potential financial risks and volatility of changing fuel prices, changing environmental requirements, and common design flaws that can result in large operational and maintenance costs. Reliance on imported fuels may be eliminated and balances of payment problems thereby reduced. With the exception of biomass, there are no intrinsic fuel costs for an established renewable energy generating facility. Consequently, an established renewable facility serves as a hedge against inflation in an inflationary market.

For an example of a renewable facility as an inflationary hedge one may examine the history of the older hydroelectric power dams. The following chart illustrates the renewable technologies which are currently available in the marketplace.

Important Characteristics			
	Options	**Status**	**Capacity**
Small hydro	Low to high head turbines and dams. Run of river.	Virtually all are commercial.	Factor Intermittent to base load.

Wind	Horizontal and vertical axis wind turbines. Wind Pumps.	Commercial. New designs under development.	Variable, 20 to 40%.
Solar	Photovoltaic. Active thermal (low to high temp for heat or electricity). Passive thermal.	Most commercial. Some under development or refinement.	W/o storage: <25%, intermittent W/thermal storage: 40 to 60%, intermediate.
Geothermal	Cycles: Dry steam, Flash, and Binary	Commercial. Exploration and drilling improvements underway.	High, base load.
Bioenergy	Combustion. Fermentation. Digestion. Gasification. Liquefication.	Many commercial. More under development or refinement.	US wood plants average 95+%. Intermediate, peaking also possible.

Important Characteristics of the Renewable Technologies

- All six renewable energy sectors offer technologies which are proven and are available in the marketplace. All can be purchased today in forms that are reliable and cost-competitive.

- “Capacity Factor” summarizes the output patterns.

  - Geothermal and most biomass plants provide baseload energy.

  - Most hydro and some biomass plants are highly dispatchable, offering a range of options from baseload to peaking.

  - Run-of-river hydro is intermittent, but variations in its output tend to be slow and predictable.

  - Solar ranges from intermittent to intermediate, depending on how well it matches the pattern of energy usage.

  - Wind is intermittent, but studies have found that most grids can add an intermittent source up to 15% of their capacity without requiring any compensatory action. Higher shares from intermittent sources are usually easy to accommodate.

CHAPTER 2. IDENTIFYING GOALS & OBJECTIVES IN THE ELECTRICITY SECTOR

Energy policy is an extension of national policy. National policy is the touchstone in evaluating, establishing and defending a national renewable energy policy. Therefore, it is essential that renewable energy objectives be a logical extension of national goals.

In identifying the national goals relevant to establishing renewable energy policy objectives, identify the key goals for the nation and how the electricity sector fits among its priorities. Most nations engage in a planning process that expresses a vision for its economy. This vision generally includes the improvement of the quality of life for all of its citizens. Many nations have recognized that in order to attain this objective of a better life, it is necessary to develop a broad strategy based on human development and international competitiveness. To fulfill such broad-based strategies, nations will, among other avenues, look to their electricity sectors to help fuel the desired economic growth and enhancement of the general well being of the population.

In order for a country to achieve the goal of economic growth and elimination of poverty, it is generally necessary to achieve the objective of improving the availability and reliability of its electricity system. This objective has in turn, sub-objectives such as lowering energy costs for the present as well as for the future, using indigenous resources to prevent an outflow of capital, and complying with national and global environmental standards.

As a threshold action, articulate the hierarchy of national goals, clearly differentiating between the desired ends and the means devised to reach those ends.

How may a national electricity plan be formulated based on underlying national goals?

The following approaches can be helpful in identifying where activities in the energy and electricity sectors can play an integral part in achieving the underlying national goals of any country. In formulating a renewable energy policy, test each potential objective against the national policy goal it is designed to advance.

Determine, within the overall goals of the nation, the importance of developing the electricity sector, and the means for its growth and operation. The following questions are examples only, and not exhaustive. The exercise is to identify the underlying goals of the national policies.

- *What are the government and private-sector investment goals for national growth and development?*

- *What are the relative roles of the government and the private sector in the development, ownership and control of national resources?*
- *What are the goals for development of rural and remote areas?*
- *What are the national goals for the development of new industries?*
- *What are the national goals for resource self-reliance?*

Set forth national, regional or utility electricity objectives in a plan. In countries with highly centralized governments, national electric-sector objectives are typically incorporated in comprehensive national plans. Planning for the national electricity system takes many forms. In decentralized systems, planning - whether such planning is by utilities, central plants, or committees composed of generators, transmitters and distributors - is essential to continuing viability and profitability. A comprehensive national plan is not a key to success, nor is its absence fatal. The United States has never had a national plan for its electricity system, yet its national grid is considered successful. Nevertheless, electric-sector planning remains a valuable tool, and policy strategists will need to determine the role of government in establishing the overall objectives for this sector. In particular, policy makers in countries undergoing shifts from public-sector to private-sector ownership of the electricity sector will need to ensure that, if electric system planning is turned over to the private sector, safeguards are in place. Such safeguards should be designed to ensure that long-term energy security objectives will continue to be achieved, and the growth and diversity of generation, transmission and distribution capacity will be optimized.

A coordinated or comprehensive plan is more easily accomplished in those countries which have strong public controls over the electricity sector. However, such a plan is not inappropriate in a privatized, market setting - especially when a government is seeking to implement broader sustainable development goals. A government’s establishment and promotion of national priorities are neither inconsistent nor antagonistic to a market-driven system.

How may a national renewable energy policy be formulated based on a national energy plan?

As part of its energy policy, a country will determine its objectives with respect to the use of renewable energy resources. These objectives may be expressed as a commitment to having a certain percentage of the overall energy base come from renewables or may be a commitment to having a certain percentage of the available renewable energy resources developed within a certain time frame. In either event, the commitment should be reflective of the country’s strategic goals.

Mindful of national goals, the plan should determine whether renewable resource development is a national energy objective. For example, if replacing government expenditures with private investment monies is a primary objective of the electricity sector, encouraging private-sector investment in renewable- resource development is properly envisioned as a means to that end. On the other hand, if development of indigenous resources is the sector objective, the mix between government-sector and private-sector investment may be different. In many countries, the sector objectives will vary dependent on whether a national policy goal focuses on urban or rural development.

Comprehensive policy statements usually include what, when, where and how a country wants to achieve an objective do as well as what it wants to avoid.

A hypothetical example of such a policy statement follows:

ACHIEVEMENT OBJECTIVES		**AVOIDANCE OBJECTIVES**	
What?	Provide rural citizens with services and the generation of more electricity	***What?***	Environmental damage.
When?	Within "y" years.	***When?***	Bureaucratic process delays
Where?	Urban and remote sectors.	***Where?***	Failure to develop rural sectors.
How?	Through indigenous resources.	***How?***	Rely on imported fuels.
	Through private-sector investment		Using public expenditures on urban electricity development

How do renewable resources fit into a country "generation mix"?

Determine how renewable energy promotion achieves sector objectives

By understanding electricity sector objectives, the policy maker is better situated to determine whether, and to what extent, employing renewable energy resources may achieve these objectives. As part of this analysis, however, the policy maker will require an understanding of which renewable resources are available and at what cost and benefit. Translating electricity sector objectives into a rational generation mix requires constructing a supply/demand/needs analysis. The electricity sector objectives for growth of the electricity system identifies new generation, transmission and distribution needs for both the urban and rural sectors. The policy strategist will want to identify the mix of technologies that might effectively be deployed in meeting the country's energy needs for the short-term and the long-term. Objectives might include development of a sustainable electricity sector with low cost fossil fuels using advanced dean burning technologies, and a given percentage of generation from renewable, indigenous resources. This combination of generation resources is often referred to as a country's "***generation mix***". Multilateral development agencies, various non-governmental organizations, private consultants and existing utilities have provided assistance to countries in analysis and development of objectives for its generation mix.

Select the most appropriate technology by assessing such variables as resource availability, life-cycle cost, demand and environmental considerations.

How does a country develop an infrastructure resource base?

The critical issue for the energy strategist is how to develop human skills and material support infrastructure when a new renewable technology is introduced into a country. *How does one "jump start" a technician and infrastructure resource base?* In general, national institutions must develop (or hire) technical experts who train local technicians. Targeted training enables development of a skilled technical work force. Pre-commercial infrastructure development is more problematic. If a policy planner can identify existing local supply, production and manufacturing capabilities and encourage them to develop additional capacity for supporting renewable technologies, an in-county infrastructure basis may be developed. If no existing infrastructure capabilities are available, usually the only recourse is to work with a private-sector partner to develop import capacity until in-county capacity is achievable.

Develop in-country technical capacity which is essential for on-going system support.

Local implementing institutions generally have a fundamental knowledge of the local market, but they often require hardware, technical assistance, and capital at the initial stages of program or project development from outside institutions. International linkages have been particularly effective in providing scarce capital, management techniques and newly commercialized technologies. The policy strategist may seek to encourage linkages between local institutions and technical laboratories, bilateral aid agencies, product suppliers, project developers, and international non-governmental organizations. If encouraged, such linkages promote technology transfer and develop local skills.

- ***Sustainability*** **is dependent upon the availability of local, competent technical support - both human expertise and quality repair parts.**

In-country technical capacity is essential for on-going system support. Sustainability of any technology installation is dependent upon the availability of local, competent technical support - both human expertise and quality repair parts. Technical skill can be developed through on-the-job experience. Material support capacity will evolve as the level of installations of a given technology allows commercial investment in marketing or manufacturing material in-country.

- ***Technical skill can be*** **developed through training and on-the-job experience.**

How may a public/private partnership advance policy formulation?

In most countries, a government/private-sector partnership strengthens the national ability to attract private investment and to implement rational development of national energy resources and national, universal electrification.

- ***Material support capacity*** **will evolve as the size and number of installations of a given technology allows commercial investment in marketing or manufacturing material in-country.**

The political strategist would be well advised to include representatives of all the interested and effected stakeholder groups in the development of a plan. A broadly based task force or advisory group instituted to prepare and develop a plan may include not only representatives of the relevant governmental agencies, ministries and utilities, but also legislators, unions, developers, equipment manufacturers, local officials, NGOs, lending institutions (including multilateral development agencies), bankers, lawyers, engineers, consumers and any other group having a vested interest in the plan. This level of involvement is critical to the success of the plan. If all interested parties have participated in the development of the plan, they will be more likely to become invested in its success. Legislators will generally desire to be involved with the executive branch in moving the planning process forward. Additionally, through the planning process all may become better educated and knowledgeable concerning issues related to the development of renewable energy resources and electrification.

The basic policy mechanism is to incorporate the affected players in establishing

electricity-sector objectives.

Inclusion ensures that all potential objectives have been identified, their pros and cons carefully weighed, and to obtain the political support needed for implementation of any strategic plan.

Early in the electricity policy-making process include representatives of all the interested and affected stakeholder groups.

In national policy planning, many energy and electricity sector policy strategists have effectively involved the office of the national chief executive early in the policy making process. Commitment of the office of the head of state to supporting a plan of renewable energy development enhances chances of achieving planned objectives. In a government environment where there are often competing demands on agencies' limited fiscal and human resources, chances of achieving planned objectives will be greatly enhanced if those involved recognize the support and commitment of the top levels of government.

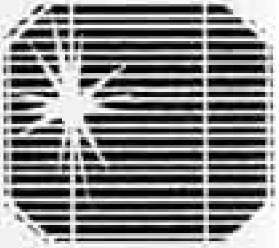
A fundamental institutional objective is to transfer necessary skills to local implementers. Opportunity exists for training at all levels of the sector, from utility leaders to system users.

Renewable energy sector objectives will also address how electricity will be provided to those isolated areas not connected to a national system. This aspect of the plan will address the methodology and technologies which will be utilized to accomplish the identified objectives for these areas. This Manual discusses the specific needs of the rural and remote sectors in later sections.

The Commercial Renewable Energy Technologies

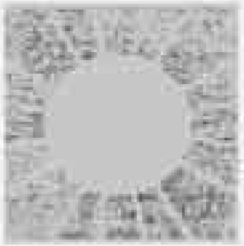
Biomass

Hydro

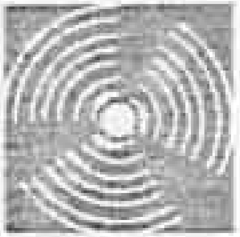


Photovoltaic (PV)

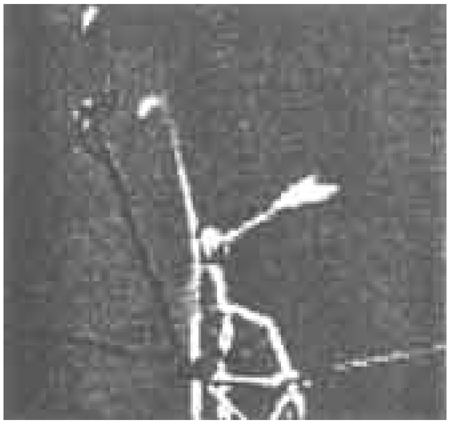
Geothermal

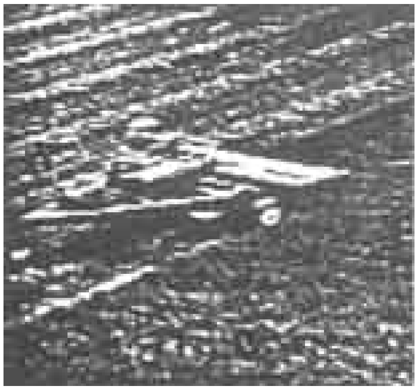


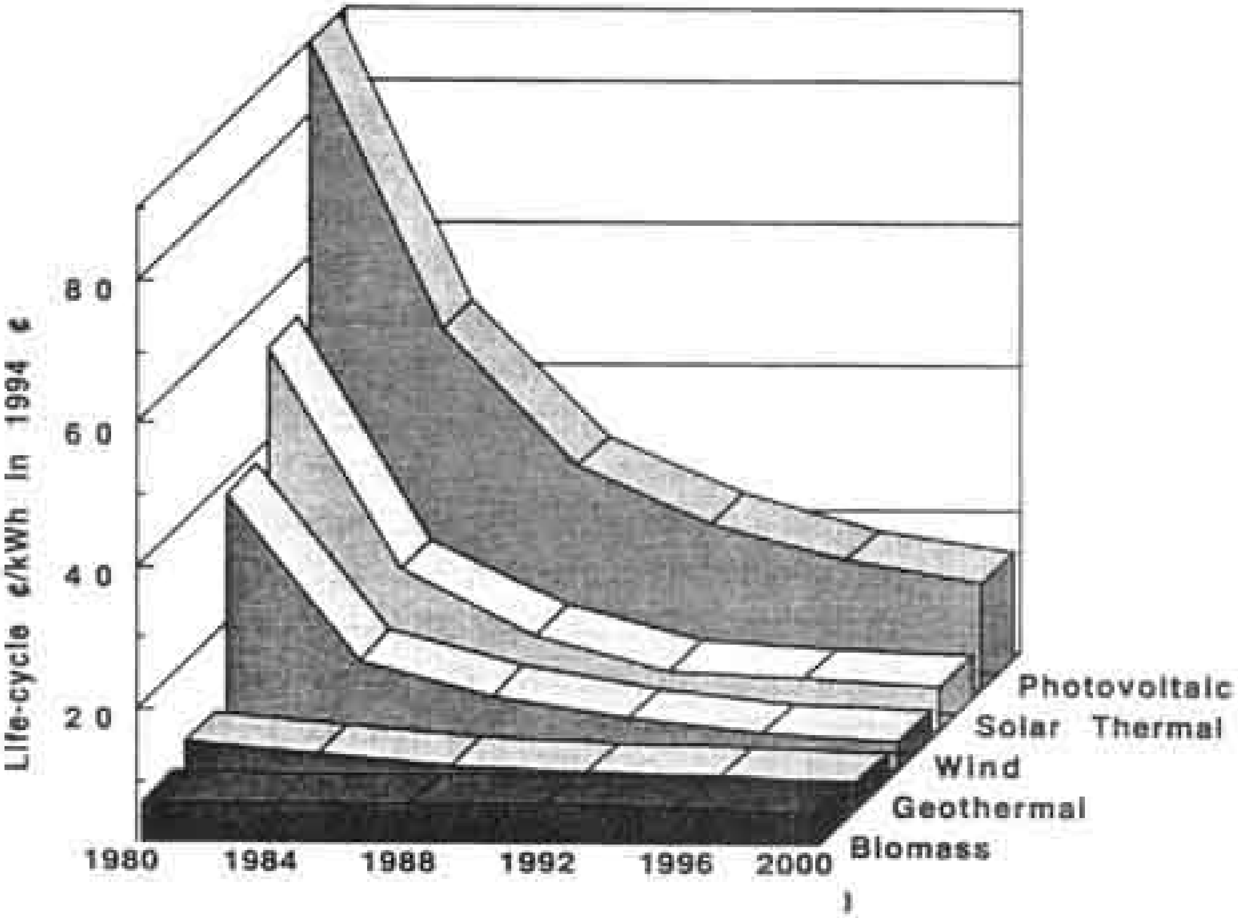
Solar Thermal



Wind






Life-cycle ¢/kWh In 1994 ¢
80
60
40
20
1980
1984
1988
1992
1996
2000
Photovoltaic
Solar Thermal
Wind
Geothermal
Biomass

CHAPTER 3. ENCOURAGING PRIVATE-SECTOR INVESTMENT

If private-sector investment in renewable energy resources development proves either essential or desirable to meet a country's urban or rural electric-sector policy goals, the next step is to identify the hurdles to be overcome.

Policy strategists may prudently follow three lines of inquiry:

- *Does the domestic economic, legal and regulatory regime create an appropriate environment to attract private investment?*
- *Does the domestic economic, legal and regulatory regime create a "level playing field" for the renewable technologies?*
- *Does the domestic economic, legal and regulatory regime impede or enable the development characteristics unique to each of the renewable resources*

How does the policy maker bridge hurdles to renewable energy development?

At the same time as hurdles are identified, the policy strategist will need to identify mechanisms which may address the impediments identified, and thereby enable the achievement of renewable energy policy objectives in establishing a national competitive environment and a level playing field for energy development.

The issue of a ***"level playing field"*** - meaning an environment in which every private-sector player has an equal opportunity to succeed and in which no artificial barrier affects the results - is best analyzed on an individual country basis. In every country the electricity sub-sector is shaped by the resources, economics and history unique to that country.

In general, new technologies are seldom on an equal footing with established technologies; subsidized technologies have an advantage over unsubsidized technologies; and technologies with front-end-loaded capital costs are disadvantaged in an economic regime with a short-term pricing structure. Nevertheless, the policy strategists in each country will need to examine the status quo - the existing state of the electricity industry on the day of the inquiry - to determine whether, and to what extent, barriers exist which unfairly favor investments in oil, gas and coal over investments in the renewables.

The impediments to grid-connected renewable generation and the potential mechanisms to bridge those impediments can be illustrated by comparing the unbundled, competitive electricity market model and the more traditional government utility model. In the case of the unbundled, competitive market, an unlevel playing field may be created if short-term pricing is mandated, *and in the case of the state-owned, vertical utility, an unlevel playing field may be created if the bidding system is biased* (*or slanted*) *in favor of the conventional fuels.*

What are the impediments to renewables in a market system?

The privatization of utility systems has brought a degree of market discipline and economic reality to the electricity business of many nations and has fostered conditions generally conducive to private investment. However, the shift to a short-term market for wholesale electricity may hamper development of new renewable energy generation projects in previously undeveloped resource areas except in those countries that have implemented special policies to offset this result.

Projects that depend oh short-term markets for all or most of their revenues are known as ***"merchant plants".*** Merchant plants are built with the understanding that they have not specifically identified buyers to purchase their output at fixed prices over a long-term (typically 15-20 years). Instead, they sell into the short-term market and receive whatever price the market dictates for that particular week, day, hour or half hour.

An electricity market that offers only short-term prices constitutes an inhospitable climate for building new, renewable energy projects. In the absence of long-term capacity expansion planning, the dynamics of the short-term market cause a country's electric capacity expansion to be based on short-term economic principles. Experience has shown that under these conditions new capacity needs will be met by thermal projects having the lowest capital costs and the shortest lead times for construction. The problem is not that renewable on-grid generation cannot be competitive in such a market, rather that financial markets are resistant to financing capital-intensive facilities unless there is some assurance of a revenue flow that returns principal and interest.

In a short-term market, governments may have to build a bridge to encourage the development of renewable energy projects that deliver long-term benefits.

A short-term market assigns absolutely no value to the fact that a renewable energy generation will essentially be free once its debt has been retired. Consequently, renewable energy generation is vulnerable to the short-term market price choice of a gas-fired combustion turbine despite its high fuel cost and short life.

Developers of inexpensive thermal plants can survive in a purely short-term market environment because:

- thermal plants typically recover their operating cost since a major portion of their cost is fuel related, and since short-term markets tend to track fuel prices;

- the lower debt load on their projects leaves them with a far lower financial exposure to a prolonged slump in market prices; new fossil plants with low per kilowatt capital costs are likely to recover those costs before fuel prices rise to a level that affects their viability; and

- the very short construction lead times of thermal plants provides timing flexibility, permitting them to take advantage of market trends - however, this timing flexibility is also an attribute of some types of renewable resource facilities, such as wind and solar facilities.

Renewable energy generation will essentially be free once its debt has been retired.

In a short-term market system, a major barrier to the acquisition of new renewable resource generation is the lack of buyer (utilities, distribution companies, etc.) motivation. Short-term electricity prices are based on electricity generated by existing plants, the capital costs of which are already absorbed. The initial electricity prices offered by new plants coming on line will invariably exceed the current short-term price for electricity. It is therefore difficult to envision how a short-term market system will enable new generating capacity unless the wholesale buyers in the system project electricity prices for completing generation over a term of years, and contract for energy for that long-term period. Electricity from new renewable generation facilities will frequently be higher than any current short-term market price, but will be competitive (cost-effective) if long-term contracts are considered.

To date, lenders have not been willing to provide debt capital for renewable energy merchant plant projects dependent on short-term markets in countries whose newly established markets have yet to achieve a solid track record. Since lenders require that renewable projects demonstrate steady, predictable cash flows to meet debt-service requirements over a long-term period, the significant price risk created by unpredictable, fluctuating short-term prices effectively preclude financing under present market conditions.

What mechanisms attract private-sector development and bridge the impediments to the development of renewables?

In assessing the impediments to attracting private-sector investment to the power sector, the energy strategist needs to be mindful of the dynamics which occur when a country shifts from using sovereign credits for new infrastructure facilities to using private debt and capital on a project-specific basis. Grid-connected generation projects are capital intensive, easily running into the tens of hundreds of millions of dollars to construct. Few developers can underwrite individual generation projects that cost hundreds of millions.

Private-sector developers, no matter how well capitalized, do not have the credit capacity to underwrite the debt on a portfolio of projects whose total capital cost can run into the billions of dollars. Accordingly, third-party debt is essential to most private-sector financing for electricity generation.

Remove legal barriers which may prevent the private sector from developing, owning, and operating power generating plants.

The project financing format shifts a lender’s credit analysis from the project sponsor to the project itself. To be deemed a creditworthy investment by potential lenders, a private-sector project must meet three basic criteria:

- revenue flows from the project must be deemed likely to meet pro forma expectations;
- interruptions to revenue flows must be deemed a manageable risk; and
- unanticipated external costs that may deplete available revenues must be deemed sufficiently remote.

Consequently, the energy strategist will need to identify those elements in a country's economic, legal and regulatory environment which may not be conducive to long-term investment in such projects.

- *Does the government exercise restraint in making adjustments in government policies of private investors?*
- *Does the legal environment contain explicit governmental authority for the types of public-private transactions contemplated?*

Enact renewable resource laws designed to promote private-sector development.

In this context, the policy strategist may identify the impediments to private-sector investment by inquiring whether, and to what extent, the legal rights and obligations of the domestic economic, legal and regulatory environment impede, enable, or encourage project financing. To bridge the impediments so identified, the policy strategist may construct an incentive package. To identify appropriate incentives, the energy strategist may profitably initiate a three-fold inquiry:

- Identify existing and potential incentives which may apply broadly to all private investors in any infrastructure project;
- identify incentives which may apply exclusively to private investors in renewable energy power generation; and
- identify incentives which may apply to unique situations of a specific renewable resource.

As a final measure, the strategist may consult with potential developers and financiers to evaluate incentives.

The needs of both the public and private sectors merit scrutiny. The more significant considerations include the following:

- ***Authority to generate electricity.*** Private-sector investors need the authority to engage in a given public activity (*e.g.,* electric generation) together with, independent of, or on behalf of, the government.
- ***Authority to select private parties.*** Public entities need the authority both to select the private party which will perform the "public" activity of providing generation as well as to enter into legally binding relationships designed to produce a firm, reliable stream of payments to support project financing.
- ***Exemption from taxes.*** In recognition of their environmental and other benefits, one can make a good case for substantially lowering taxes and duties for renewable energy technologies, while taxing conventional energy industries' supplies in accordance with standard principles of tax policy. Experts have also long argued in favor of imposing corporate and sales taxes on electricity on the grounds that it is a fairly price-inelastic product.
- ***Foreign loans and contracts**.* Foreign investors need the right to remit, at the prevailing exchange rate at the time of the remittance, such sums required for the payment of interest and principal on foreign loans and obligations arising from

contracts.

- ***Freedom from expropriation.*** Foreign investors need legal certainty that property represented by investments shall not be expropriated except in the interest of national welfare and upon prompt payment of just and adequate compensation.

- ***Judicial stability.*** Lending institutions sometimes require a judicial stability agreement to the effect that the tax regimes and the foreign exchange regimes valid at the granting of a concession will remain unchanged during the lifetime of the concession.

- ***Reduction or Elimination of Import Duties.*** Much of the equipment for renewable generation must be imported into host countries. High capital import duties and tariffs distort the market, artificially raising the price of renewable technologies, and discouraging their adoption. Temporary waivers may remove this impediment and allow renewable technologies to compete on an equitable basis. Such waivers may be justified either on the basis that renewables are a **"pioneer"** (or start-up) industry or on the basis that payment of such duties and tariffs by a generating company will ultimately be passed on either to the rural poor or to the government.

- ***Remittance of earnings.*** Foreign investors need the right to remit earnings from foreign investments in the currency in which the investments were made and at the prevailing exchange rate at the time of remittance.

- ***Repatriation of investments.*** Foreign investors need the right to repatriate the entire proceeds of the liquidation of their investments in the currency in which the investments were made and at the prevailing exchange rates at the time of repatriation.

- ***Requisition of investment prohibited.*** Foreign investors need legal certainty that property represented by investments shall not be requisitioned except in time of war or national emergency and only for the duration thereof. In the event of such requisition, provisions need to be made to ensure that just compensation shall be determined and paid either at the time of requisition or immediately after the cessation of the state of war or national emergency.

Determine under which circumstances to treat all indigenous resources equally, and under which circumstances to differentiate between resources which are part of a mature industry and those which are presently undeveloped.

What are the affects of subsidies on renewable energy development?

Policy strategists will need to consider whether, and to what extent, government intervention is appropriate.

In a short-term market electricity system that effectively precludes projects with long-term benefits, the government may have to build a bridge to achieve policy objectives favoring environmentally benign renewable energy projects that deliver such long-term benefits.

Renewable energy projects face serious obstacles in areas in which government policies and subsidies artificially lower the price of conventional generation fuels and focus on short-term economics. In making energy choices, some governments have opted for carbon-based systems such as oil or diesel units, using economic analyses that either fail to take into account the long-term benefits of renewables or to account for the impact of continuing government fuel subsidies when making these investments. Policy makers electing to encourage renewable energy systems as part of an energy mix will be more certain of attaining their objective if they strive for decisions based on a comprehensive and long-term comparison of the costs and benefits of all alternatives.

Develop a policy of strengthening the development of indigenous resources to attain energy self-sufficiency.

Some governments have sought to promote the provision of affordable modem energy services in rural areas by subsidizing particular forms of energy. Although well intentioned, such policies, if not designed appropriately, have often proved to be counterproductive for the following reasons:

- Such policies work against consumers making least-cost choices, and in doing so, can undermine investors’ efforts to provide alternate energy forms.

- Widespread recourse to unnecessary subsidies has frequently proved to be fiscally unsustainable. When coupled with price restrictions, subsidies eventually limit energy companies’ investment programs.

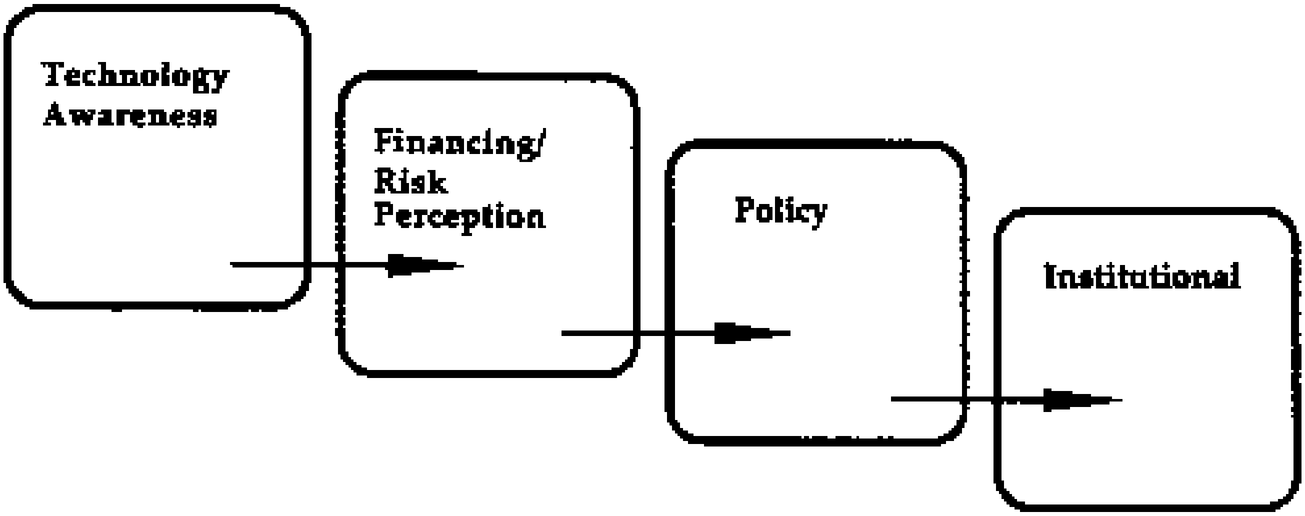
- Subsidies can discourage efficient energy use.

In some extreme cases, country legal regimes have simultaneously subsidized imported diesel fuel and imposed high import duties on renewable technology equipment. Such trade barriers result in making renewable energy systems uncompetitive with fossil-fueled generators. In these circumstances, energy planners are motivated to continue to purchase diesel generators regardless of whether they prove to be much more costly, unreliable, and environmentally damaging in the long run.

Countries electing to operate primarily through short-term or spot markets will need carefully to tailor policies if they wish to expand their base of renewable energy projects successfully.

In much of the world, perhaps the most fundamental consideration developing a strategy for new electricity generation is whether to finance new generation projects on a project basis or a sovereign-credit basis. Although traditional sovereign-lending activity has diminished in recent years, it is nevertheless incumbent on government policy makers to ask the critical question: Is government-financed generation infrastructure a better model than government-financed loans based on sovereign credit? The following chart illustrates barriers to alternative energy technologies.

Barriers to Alternative Energy Technologies



Barriers to Alternative Energy Technologies

- Technology Awareness
  - Lack of up-to-date info on the costs, benefits, applications of Renewable Energy
- Financing/Risk Perception
  - Perceived Risk
  - High Capital (Low Operations and Maintenance)
  - Non-Recourse Financing
  - High Relative Overhead Cost
  - Inflation Rates
  - Currency Convertability
  - Pre-Investment Funding
- Policy
  - Not a level playing field
  - Subsidies for traditional fuels
  - Tariff Barriers for Renewable Energy
- Institutional
  - Don’t have in-country organizations/networks in place to identify, develop and follow through on projects from concept to implementation to Operations and Maintenance.
- Requirements for Accelerating Utilization
  - User Understanding and Acceptance
  - Appropriate Financial and Legal Structures
  - Equitable Policy Environment
  - Better Resource Characterization

CHAPTER 4. GOVERNMENT’S ROLE IN THE ELECTRICITY SECTOR

Risk reduction is one of government’s most important roles in promoting private investment in the electricity sector. Reducing the number of potential unknowns is especially important where there is little or no experience with renewable technologies at the national or local level.

How can Government take a leadership role in risk reduction?

Government leadership in risk reduction can take many forms. Areas where it may be appropriate for the government to play a role include:

- national energy planning;
- resource evaluation;
- market evaluation;
- least-cost-planning;
- providing access to expertise;
- eliminating obstacles to equitable markets;
- project oversight and evaluation; and
- assistance in providing access to capital and financing.

One of the challenges in creating public-private partnerships is for governments to create an appropriate environment to attract private investment. When governments act in their sovereign role as guardians of the public welfare, they are essentially providers of public goods and services, which in turn may be delivered through public or private channels. When governments implement policy decisions and resolve political conflicts through the legislative and regulatory process, their role is objectively to carry out the will of the body politic.

The essence of public-private partnership is the arrangement for private capital to finance goods and services which traditionally have been provided by public entities.

Public-private infrastructure partnerships require government participation in both these roles. As purchasers of public goods and/or services, governments act in a quasi-commercial capacity. When policy strategists serve as legislators and regulators in matters concerning commercial enterprise, the challenge is to establish an environment in which government puts aside its commercial interests in favor of even-handed implementation of its political and policy objectives.

a. GOVERNMENT'S LEGISLATIVE ROLE

Legislation and regulation are two primary tools used for achieving public interest goals. A legal regime provides the underpinnings for commercial transactions to take place. Legislation can help to remove legal, economic and social barriers to investments in new technologies and investments in specific market sectors. It can provide a framework for the ownership and financing of infrastructure improvements and can provide incentives to encourage greater investment and use of goods with public interest benefits. Clear legal and regulatory guidelines contribute to a stable and predictable market within which the financial community - both domestic international - feels comfortable in investing.

What legislative features promote private-sector investment in the energy sector?

Statutory and legal standards which **dearly define and assign the authority and role of the government** and its various ministries, departments or agencies regarding the electricity sector will enhance the attractiveness of the electricity market for potential investors.

Ensuring transparency of government decision-making treatment of all developers maximizes competition. **"Transparency"** refers to procedures in which all factors and values are known ahead of time, allowing all the participants in a project to understand the criteria upon which discussions will be based. The potential participants in a project may include a combination of private-sector, public-sector and quasi-public-sector entities - such as private developers, a national or local government entity, non-governmental organizations ("NGO's") and private or quasi-public lenders.

The following eight-step process may be useful for legislative strategists establishing renewable energy policy:

Step 1. Articulate the hierarchy of broad national economic, infrastructure and energy *goals,* clearly differentiating between the desired ends and the means devised to reach those ends. Use this statement as a touchstone in evaluating, establishing and defending a national renewable energy policy.

Step 2. Determine *objectives* in the electricity sector.

Step 3. Establish the role of renewable resources in the energy mix. Identify the available or potential renewable resources. Determine whether such a supply and demand analysis supports a goal of attracting new capital investment into new renewable resource generating capacity. Define the term "Renewable Resources". Clarify that definition by setting forth the specific resources and defining each separate renewable resource. Incorporate technical, political and legal concepts.

Step 4. Articulate renewable energy *objectives.* Establish objectives for each renewable resource. Consult with each renewable energy industry. Identify the developer's needs, the legal rights the government must grant to fulfill that need, and the accompanying legal duties the government should impose.

Step 5. Identify existing and potential impediments.

Step 6. Identify the available *mechanisms to* remove the barriers to achieving renewable energy policy objectives. Identify incentives which may apply broadly to all private investors in any infrastructure project. Identify incentives which bridge hurdles to private-sector investment in renewable energy power generation and which may apply to unique situations of a specific renewable resource.

Step 7. Design a legal vehicle. Strive for expedited implementation of the policy objective, but ensure that government undertakings may be relied on without frequent ministerial, judicial, or arbitral interpretation.

Step 8. Design a regulatory vehicle. Implement the policy objectives established in the law.

Test proposed laws and regulations in the affected community before finalizing.

A useful strategy is to **test proposed laws** within the community which the law will govern before the law is finalized. This test may simply involve distributing a proposed piece of legislation to the affected community for comment, and it may involve executive-branch or legislative-branch hearings before a law is enacted. Under either approach, potential misunderstandings may be resolved. **Strive to overcome impediments at the outset of putting a legal regime into motion** before course correction becomes difficult if not impossible. In this process, the strategist may find three drafting issues critical:

- the guidelines for government decision making,
- the treatment of similarly situated parties, and
- the protection for investors.

Guidelines for government decision making.

Predictability in government decision-making is critical to investment. In every step in which the government must establish a statutory or regulatory process, the investment community will examine the standards that the government will apply in making decisions. Vague or nonexistent standards are viewed with skepticism by an investment community aware of the problems often inherent in laws allowing arbitrary and capricious government decision making. Furthermore, the lack of time-forcing decisions is also often an issue discouraging investment A bureaucracy without time limits creates time delays costly to the private sector.

Encouraging international private-sector investment.

Equal treatment of domestic and foreign parties is essential if foreign investors are to be encouraged. In some legal regimes, it is a valid objective to give statutory preference to nationals over foreign investors. In a resource development regime, in which foreign private-sector investment is a major objective, unequal treatment will have a chilling effect on the accomplishment of that objective.

Provide clear protections for investors and impartial enforcement for all parties.

Protection for investors.

The constitutional and legal investment climate is an essential component in investment allocation decisions. A foreign investor will seldom place its capital in countries unless, when, taken together, the body of laws in a country allow private investors to repatriate their profits and compete fairly with nationals.

National constitutions that respect and protect private property rights and enable laws that provide for private participation in the ownership and control of energy generation facilities are generally a prerequisite to outside investors and the international lending community. This generality does not mean that a country should necessarily have laws which allow for total ownership by the private sector. The investor is concerned primarily with exercising the right to make critical economic decisions free from governmental and political interference. Accordingly, a law that provides for majority (at least a 50.1 percent) ownership by the private sector will generally be acceptable to the international community. There are many additional ways to give the private sector the control it seeks while protecting the public interest in the facility. In the United Kingdom, for example, the government retains a “Golden Share” (which is a limited non-majority ownership interest) which allows it to veto certain fundamental changes.

What legislative features promote private-sector investment in the Renewable resource sector?

A renewable resources law serves three principal functions:

1. A law that focuses on renewable energy resource development allows a country to put together a systematic approach to the development and utilization of these resources. A focused and systematic approach has the best chance of achieving the policy objective of producing electricity from renewable resources.

2. A renewable resources law supports renewable resource investments. It helps establish the predictability necessary for investors to evaluate the risks of investment and to allow investment in a country's renewable resource sector.

3. Each of the renewables - hydro, geothermal, biomass, wind and solar - are unique resources. Rational exploitation of individual renewable resources requires resource-specific development laws.

For a country to be successful in bringing a policy goal to concrete reality, every implementing law, every implementing regulation, must make the achievement of that goal easy, practical and possible. Experience worldwide teaches that countries who try to develop renewable resources, relying only on a patchwork of unrelated laws, have generally not succeeded.

For example, geothermal energy may be defined as the “heat of the earth”. It is a unique resource and as such requires a particular set of development laws. There are significant differences between the extraction of minerals, water or hydrocarbon resources and the extraction of geothermal resources. Internationally, attempts to develop geothermal resources pursuant to mineral, water and hydrocarbon laws have proven difficult or impractical. Of equal importance - assuming that the objective of a country is to encourage the private sector to invest in its renewable resources - renewable resources laws establish economic predictability.

Investors and bankers need predictability in order to evaluate risk. They need to evaluate risk before they invest in or lend money to a project.

A private developer must secure two legal rights before financing a project:

- the exclusive right to explore and extract or use the relevant resource in an area that he can access; and
- the right to generate and sell electricity (and other products) from any resource developed.

Financial institutions insist that such rights be secured by law.

The only way that a hydro, geothermal, biomass, wind or solar private-sector power developer can make money - pay its debts and earn a profit - from developing a renewable resource, is to convert that resource to electricity.

Therefore, in order for an entrepreneur to finance a renewable energy project, it must first secure the legal right to enter the land, the right to explore for, extract, or use its renewable resource, and the right to convert that resource to electricity and sell electricity to a customer. Furthermore, these legal rights must be firmly in place before a developer can obtain financing.

A legal regime consists of laws, regulations (*and subordinate procedural documents*) *and contracts. The following discussions review the elements of those four elements of a legal regime.*

How does the legislator identify the requisite legal rights and duties?

It is essential that legal draftsmen understand the nature of the resource and the nature of the renewable resource development process. Form must follow function. To be effective, laws must be consistent with real world situations.

For each step of the renewable resource development process identify the developer's need, the corresponding legal right required to fulfill that need, and the accompanying legal duty imposed as a reciprocal responsibility.

The policy-maker should endeavor to identify the developer's need, the corresponding legal right required to fulfill that need, and the accompanying legal duty imposed as a reciprocal responsibility. For each step of the development process, a law that is designed to foster renewable resource development sets forth legal rights which address the needs of the developer. Each right has a concomitant or accompanying duty.

As previously discussed in Chapter 1b (Renewable Energy Overview: Cost-Effectiveness of Renewable Energy), one can identify three distinct stages in renewable energy development. From these three discrete development stages: ***"reconnaissance", "exploration"*** and ***"exploitation"*** flow three related areas of legal rights and duties.

Reconnaissance. Developers of geothermal, hydropower, biomass, wind and solar technologies in grid applications may need access to relatively large areas in which resources may exist. Reconnaissance activities have minimal impact on the environment of the land. It is in the mutual interest of the government, the owner of the surface rights, and the developer that a reconnaissance team is not seen as a trespasser. Therefore, some notice mechanism is useful.

Exploration. Exploration involves expenditure of money. The developer needs to be certain that, if it discovers a commercial-scale resource, it has the exclusive and unqualified right to develop that resource. The government, in turn, needs to ensure that a speculator does not claim a vast track of land, then sit on it without any intention to develop it - thus establishing a "use or lose" policy is prudent. Exploration activities often require building roads to haul heavy equipment. They may also require temporary surface rights to the land on which to set resource measuring equipment (such as wind anemometers or stream flow gages), excavation equipment or drilling rigs. Therefore, during the exploration phase, developers need rights of way and the use of a relatively small amount of surface land. The government, in turn, is concerned that compensation to the owner of the surface rights is equitable for both the developer and the surface land owner. With the absence of an easement or other surface right acquisition mechanism, some surface-right owners may attempt to extract an excessive fee from the developer. Furthermore, some private-sector developers may be less experienced than others. Therefore, it is in the interest of the public that the government impose duties - standards of safety - on the less competent developers and ensure environmental protection compliance on all parties.

Reconcile currently existing or projected laws to integrate renewable resource development policy objectives into a comprehensive and comprehensible whole.

Exploitation. Installation of a generating facility requires the use of a definite land area for a long time period - perhaps indefinitely. Rational resource use often requires the government to legislate safeguards. In the case of hydropower, the government may want to ensure that the volume of water flow in the river is not impacted to such a degree that other uses for the resource, such as agricultural irrigation are impeded. Likewise, in the case of geothermal development, the government may want to ensure that the fluids carrying the geothermal energy are not depleted but are re-injected. The government may also need to protect the geothermal field developer from competitors drilling into adjacent areas and "dipping their straws" into the resource it has developed - thereby reducing field pressure. All renewable resource developers in grid-connected areas need to be certain that the electricity from developed resources has the right to be carried over transmission lines, to supply the national grid, and to be distributed to customers.

What legal tools may be used to establish a renewable energy legal regime?

Develop a clear set of renewable resource laws.

A country may elect among a package of legislative and regulatory tools in the drafting of a renewable resource law: laws, presidential decrees, ministerial resolutions, regulations, or amendments to existing laws. Mechanisms must be balanced both for the political ease of execution and the legal security of a potential developer. The clarity, reliability, specificity and predictability of the legal and regulatory framework surrounding the electric sector in a country strongly influences the commitment of private investment to that sector. A legal framework is not the only factor necessary to attract private investment, but it is among the most important factors. Investors naturally seek to minimize their risk. Vague or contradictory laws and regulations may discourage investors from even the most attractive projects.

When determining whether to legislate, regulate or use alternative tools in crafting

renewable resource regime, consider both the legal security of a potential developer and the political ease of execution.

Select a legal vehicle that allows expedited implementation of the policy objective.

The policy strategist may consider a number of approaches designed to overcome these hurdles:

Ease of drafting and implementing, however, should not be at the sacrifice of a high degree of certainty that government undertakings may be relied on without frequent ministerial, judicial, or arbitrary interpretation. Resource laws are but one element in a legal regime governing the electricity sector. In most countries separate legislation establishes the electricity system, privatization, mechanisms, and fiscal policies (to cite three of many pieces of legislation which impact renewable resource development). Currently existing or projected laws will need to be reviewed, integrated and reconciled to ensure that renewable resource development policy objectives are integrated into a comprehensive and comprehensible whole.

Develop a clear mechanism for applying renewable resource laws.

It is useful to establish a single government entity with the responsibility and authority for all aspects of resource development and interagency coordination.

Provide procedures for dispute resolution between project proponents and State agencies.

Defining a clear and uncomplicated path for the renewable resource developer to follow is a key to expeditious, cost-effective project development. Ideally, the country will establish a single government entity with the responsibility and authority for all aspects of resource development. If that objective proves politically impossible in a given country, responsibility and authority for interagency coordination ought to be an achievable objective.

In many jurisdictions, the responsibility of agencies is overlapping, and the lines of authority and jurisdiction are confusing. For example, many countries distribute oversight functions for power projects among agencies, with no one ministry authorized to make final derisions relating to a specific project. In such an uncoordinated system, the ministry of finance, for example, may impose requirements on a project developer in terms of its relationship to a lender or in the form of reserve requirements for purposes of an unrelated law, which completely frustrates achievement of the objectives of a resource development law. This irrational interaction of laws in which the objectives of one law negate the objectives of another robs project development of the predictability necessary to attract capital. Furthermore, project development is often slowed or even stopped because of political fighting among state bureaucracies. Accordingly, laws and regulations which provide clear procedures for dispute resolution between project proponents and State agencies (and among State agencies themselves) will assure investors that projects will not be unreasonably delayed.

***Government resources may be invested in prefeasibility or feasibility investigations*.**

The extent of government involvement in pre-feasibility, feasibility, and development, determines the point at which the regulatory regime actually regulates private-sector activities. A fundamental question for the policy strategist is whether, and to what extent, government resources ought to be invested in pre-feasibility or feasibility investigations and, indeed, whether the government itself ought be an active participant in development. If a resource concession is to be offered, significant feasibility assessment must be completed prior to issuing a request for bids in order to have data sufficient to convince developers that sufficient potential exists to justify development in the proposed concession. In an open bid situation, the host country generally can be well-served by doing significant resource measurement and evaluation designed to provide baseline data for the developer who will often be required to do additional, more extensive feasibility investigations on its own. Government-funded exploration can be a positive factor from the private-sector perspective in the development of such resources as geothermal, in which exploratory drilling is not easily financeable and requires private-sector equity investment.

Government-funded exploration in such circumstances, may speed resource development. The government, of course, may seek reimbursement for these efforts. The amount of, and mechanisms for, such reimbursement is a policy issue to be considered.

Governments may require security to assure long term productivity.

Every country is concerned with the long-term viability of resource development. In those situations where the developer will build and operate the project only for a certain period of time and then transfer the project to a governmental authority (a process known as "BOT" - build-own-transfer), the country is justified in requiring security to assure long-term productivity.

Regulating for Diverse Rights

Rights to various resources on the same land may be licensed or let by concessions. This multiple-license situation is known as "juxtaposed diverse rights". To the extent that a resource concession may interfere with other surface or subsurface uses, the regulatory regime may make specific provisions for juxtaposed diverse rights. In some jurisdictions, the problem may require resolution in the organic law.

In the event that an application for renewable resource rights is presented for a resource area in which there are previously registered rights of a different legal origin and judicial nature (such as rights derived from legislation pertaining to hydrocarbons, or mining or electricity), the bearer of a renewable resource right should exercise its rights in a manner to avoid creating material damage to the holder of the other rights.

In the event that the holders of different renewable concessions of the same nature determine that these concessions, for example, may overlie the same interconnected geothermal resource, or may interfere with the same hydro resource, or may affect each others' wind source, it is essential that mechanisms be established to reconcile such competing interests as well as to ensure rational resource development

Consider requiring security to assure long-term productivity for BOT-type projects.

However, in situations in which the developer will build, own and operate and (perhaps) transfer the facility - processes known as "BOO" or "BOOT" - such security may not be needed or justified. Typical security devices include warranties, letters of credit, reserve accounts to secure operations and maintenance obligations and reserve accounts to secure capital improvement obligations. Penalties for failure to deliver on guaranteed energy performance may be an appropriate method of enhancing performance.

The question of whether and how much to charge for resource use is a key issue for the policy maker.

Certain national resources, such as geothermal and hydro, are held in trust for the benefit of the populace. To allow their development without receiving payment from the developer may prove a political impossibility in some jurisdictions yet it is the energy users in the populace who, in fact, are paying for the resource use, although indirectly. Moreover, the government will have expenses in establishing a resource regulatory regime. By establishing a payment requirement on the developer the government may be able to fund these regulatory costs - again at the price of imposing an indirect tax on the electricity user. The policy maker should be mindful, however, that any solution which imposes different costs on different classes of energy generators will change the competitive cost of delivered power.

What fiscal incentives to promote renewable resource development are available to the legislative drafter?

The following are some of the legislative mechanisms that can be promoted depending upon the structure of the electricity system and the goals and objectives within a country.

Impose a tax on sales of electricity generated from carbon-based fuels with resulting tax revenues dedicated to development of renewable resources.

Carbon-based tax.

One option may be to tax sales of electricity generated by polluting fossil fuels and use the revenue to pay a premium to generators utilizing non-polluting renewable energy sources. While this option may not provide the maximum amount of security desired by lenders, it will provide additional enhancement to the projected revenues received by a “merchant plant,” thereby improving the financeability of the project.

Collaborative financing approaches.

The government may also elect to step up efforts to assist private developers in securing financing or credit support from the multilateral development agencies. These agencies recognize the need to encourage the development of non-polluting and indigenous sources of electricity in emerging nations. With the participation of the large multilaterals, governments may be able to induce local lending institutions and capital markets to participate in financing. The more participants in a project, the more risks are shared. In market regimes which do not enable long-term power contracts, the lending community sees significant risk. If that risk can be shared among a greater number of parties, it enhances the likelihood of a project's being financed. One can envision a renewable energy, merchant plant project finance scheme in which venture capital provides 30 percent equity and 70 percent debt is shared among a consortium of local banks (thus significantly reducing local currency exchange issues) and more traditional lending sources. This approach could include guarantees by a partnership between the national government and one or more multilateral development agencies. Guarantees by the development agencies, which are, in fact, created to provide funding for risk situations others will not finance, will go a long way towards making such financing of merchant plants possible.

Increase the role of the government in convincing multilateral development agencies to play a more active role in the financing of renewable energy projects.

Credit mechanisms.

Other possibilities would include the creation of a "guarantee fund", sponsored by the national government and the multilaterals, which, although not project specific, would be available to lenders of failed projects which had qualified to be covered by the fund. Revolving funds consist of a dedicated pool of monies contributed by the government for the purpose of providing debt or equity capital for investment in renewable resources projects. As funds are invested and repaid (including a rate of return which approximates market conditions) the fund grows, thereby facilitating financing of more projects.

Create a national guarantee fund or revolving fund which is available as credit support to all qualified developers of renewable energy facilities.

Feebates or environmental dispatch.

"Feebates" are a revenue-neutral strategy (for the wholesale market) that places a pollution fee on electricity generated by more polluting technologies and gives rebates to electricity supplied by cleaner technologies. **"Environmental dispatch"** uses a pollution index to adjust the resource cost and dispatch power. The difference between the pollution index and the feebate is that the pollution index is not necessarily revenue neutral.

Both the feebate and environmental dispatch mechanisms can be instituted at either the state or national (federal) level and both are compatible with either a monopoly or market-based utility model. Both mechanisms affect all generation resources sold in the wholesale market, and internalize environmental costs in the short-term as well as the long-term market. The challenge in establishing either of these mechanisms is the difficulty of agreeing on a set of specific pollution indices (environmental externality values).

Provide fiscal incentives that will allow renewables to compete in an open-market system.

Fiscal incentives.

Fiscal incentives will always serve to attract private investors. They make renewable energy projects more financeable by reducing the capital costs and thereby providing greater comfort to the lenders that there will be sufficient revenues to pay the debt. Examples of fiscal incentives are: accelerated tax depreciation, removal or reduction of trade barriers on renewable energy equipment and investment-tax credits for capital costs.

Government purchase.

One of the strongest forms of influence is by example. If government entities such as schools, hospitals, government buildings and water districts, use electricity from renewable sources, this usage sets an important example for others. It also allows people to gain direct experience in working with various types of renewable energy facilities.

Require government agencies and institutions to purchase some or all of their power

from renewable resources.

Mandate that distribution companies have a minimum amount of their *load met by* ***renewable resources.***

Portfolio standard.

The government may mandate that all distribution companies have a certain amount of renewable energy capacity in their portfolio by requiring them to enter into long-term power purchase agreements with renewable energy project sponsors. These contracts could be for a term of years, renewable at the option of the distribution company. The distribution companies would be able to enjoy the economic benefits of a renewable project after its capital costs have been retired, a potentially valuable hedge in the event of an increase in the wholesale market price for electricity. New renewable energy facilities brought on line through a portfolio mandate may result in higher energy prices in the short-term, but the impact of the mandate will diminish, and the economics of these projects will “turn around” as the debt-service costs of these facilities are retired.

Appendix D ***contains a more detailed explanation of the renewables portfolio standard approach.***

b. GOVERNMENT'S REGULATORY ROLE

The private sector will not invest money into electricity generation (or any other aspect of the electricity sector) unless and until there is regulatory stability. Since regulators implement the law, regulatory actions become the framework within which electricity sector investments are made. The business community looks for a constant set of regulations and guidelines upon which investment decisions depend for their viability.

This section deals specifically with economic regulation and the regulation of natural resource use. Environmental regulation can also affect the electricity sector, but is outside the scope of this paper.

When is Government regulation necessary in a competitive environment?

Economic regulation.

The goal of regulation is the promulgation and preservation of the public interest

When a sector of government owns and operates the electricity industry, it is assumed that the public's interests will be expressed and protected through existing government processes. This assumption, however, is not always valid - as evidenced by the numerous examples in which the political process, particularly the influence of special interest groups, has subverted the public's interest in the policies that govern operation of the electric sector. When some or all of the electric industry functions are privatized or capitalized, or where competition is otherwise introduced into one or more of the electricity functions, the need for independent regulation emerges. In these situations, independent regulation is necessary because it is believed that the electricity sector is imbued with the public's interest - in other words, there are broad-based public services that are not likely to be realized through a private monopoly or a competitive market without governmental oversight and intervention. The goal of regulation is the promulgation and preservation of the public interest. The objectives of traditional regulation of the electric utility industry have been to:

- ensure reliable power at the lowest price;
- establish processes that result in sufficient revenues to attract additional investment in electricity infrastructure as required to ensure reliable power at a reasonable price; and
- design rate structures (*tariffs*) and incentives (*price signals*) to encourage the wide use of electricity.

Privatization and Capitalization.

One can bring new private-sector money in to dean up, re-power, and replace an existing government-owned electricity system base by restructuring the electric sector to allow the sale, in whole or part, of existing faculties to private-sector investors. Governments can either rely exclusively on the profit motive to ensure the desired upgrades, or they can couple the sale with the condition that revenue will in part be piled back into the requisite up-gradation. In either event, the sale of such facilities ends the existing government-monopoly structures. The terms applied to these types of enabling mechanisms are ***"privatization"*** and ***"capitalization".***

"Privatization" involves the transfer of state-owned utility assets to the private-sector. For example, the state may sell assets to private investors who then have 100% ownership. The private-sector investor's purchase price goes into the country's treasury to be used to plug the fiscal deficit or other state spending priorities. Privatization may or may not involve me structural unbundling of the vertically integrated utility and may or may not introduce competition into the utility system. Privatization alters the means of monitoring managerial behavior. Privatization of a monopoly industry also involves development of a regulatory structure to correct market imperfections and to prevent abuse of monopoly power.

"Capitalization" involves the government's contributing a given state asset to be matched by a capital contribution from an investor equivalent to the market value of the company. Under the capitalization scheme, generally a new corporation is formed which is jointly owned by the government and the private-sector "strategic investor". The private investor administers or manages the new corporation as its single largest stock holder. Under the capitalization scheme, the capital remains with the company and can be entirely channeled into new investment and production. This is a less commonly used mechanism than privatization.

What type of government organization administers regulations?

In many of the countries that are just introducing competitive markets into the electricity sector there is little regulatory experience. Experience indicates that in virtually every electricity sector that is attempting to move to a fully competitive market type, some independent system of regulation or oversight has been necessary to guide this new market to ensure competition actually develops. Frequently governments determine that separate regulatory agencies are best suited to implement regulation.

In theory, regulatory bodies are quasi-independent of the other branches of government, looking to legislatures for their broad scope of authority and funds, to the governor, minister or the people for appointment or election, and to the courts for support of appeals. In practice, such quasi-independent regulatory bodies, although susceptible to political pressure from a variety of sources, tend to be more independent and better informed about implementation issues than legislative bodies.

Regulatory commissions also serve as arbitrators who settle disputes that necessarily arise from time to time concerning contractual relationships among the key stakeholder groups.

This Manual does not attempt to discuss all the aspects of developing an effective independent regulatory regime. Rather, the guiding principles are highlighted and regulatory activities specifically related to the development of independent investments in the electricity sector (*and specifically renewable generating facilities*) *are noted.*

How does the economic regulator design a regulatory regime to promote renewables while protecting other public interest issues?

The policy strategist designs regulations to promote developmental investment in the renewable energy resources, while simultaneously establishing reasonable standards for the protection of the people and the environment of the country.

In developing regulation, the two primary tasks are:

- identifying the public's interest that is being fostered or protected; and
- identifying the mechanisms and tools that can accomplish this task with the least disruption to the market and the least-cost to the public.

In most cases the basic policy goals and directions are established through the legislative process then implemented through the regulatory process. Workable rules and regulations coupled with training of regulators and their staffs are critical components of an effective regulatory regime.

Experience indicates the primary economic regulatory areas specifically associated with the development of renewable resources include:

- calculation of the total value of renewable resources to the electricity system;
- analysis and comparison of various types of power within the resource planning process and how to account for the environmental benefits of renewable resources in the planning process;
- how to design technology-neutral requests for proposals for generation to be developed by independent power producers;
- how to develop standardized contracts for purchasing power from renewable resource facilities;
- how to provide fair and open transmission access for intermittent renewable resources; and

- how to assure quality performance (*i.e.,* good operation and maintenance service) for renewable facilities constructed for rural electrification programs.

How does the resource regulator design a regulatory regime to promote renewable resource development?

The regulatory structure conclusively establishes how a country's resource policy will be implemented in practice. Every experienced investor understands that the laws of a country are only first-level indications. Sometimes, for example, a development incentive which has been established as a matter of policy - in a law - has never been implemented as a matter of practice - in a regulation.

The following natural resource development policy strategies have proven sound in the drafting of new regulatory regimes in countries which are attempting to lay the groundwork for renewable resource development:

- Regulations while promoting resource development should also be designed to strike a balance between development and protection. Regulations must prevent waste and ensure the environmental integrity of the resources while they are being developed.

- Policy strategists can learn valuable information from countries that have already developed their resources; however, resource development regulations should be tailored to the environment of the country. What works in one country will not necessarily work in another.

- Adhere to the rule "don't over-regulate what you don't have". Regulations should not prematurely attempt to duplicate a regulatory system in place in a country which has extensive renewable resource development.

- Strike a balance between essential monitoring and over burdensome and costly reporting. Inspection and reporting requirements add to the costs of a project and thereby may dilute its economic viability. For the investor "time is money" and every moment spent in a reporting process represents an expenditure of time and money which results in additional project costs as well as delays.

- Both economic and natural resource regulations must be adaptable to tomorrow's technology. Regulations must be technically sound by today's standards, but today's technology must not be locked in.

Regulations must be technically sound by today's standards, but today's technology should not be locked in.

The following guidelines for developing renewable energy resource regulatory policy provide a reference for the policy strategist.

Guidelines for Developing Renewable Energy Resource Regulatory Policy

Step 1. Clarify the policy position of the Government. In drafting regulations, the threshold step for the policy strategist is to articulate the goal of the legislation which underlies all implementing action. Then, in order to ensure that the legislative goal is enabled, it is essential that the policy strategist articulates a conceptual objective for the regulations consistent with the legislative goal.

For example, the conceptual regulatory objective may be two-fold:

- to avoid micro-management of a resource which is not yet developed; and

- to promote a self-regulatory, private-sector environment with the minimum amount of direct government participation, while still ensuring operationally safe and environmentally sound conditions.

In other words (using a geothermal example), if it is dear that a safe and sound blowout prevention program is required, and if the conceptual objective is to minimize direct governmental participation, the regulations and norms may be directed to establishing compliance standards, penalties for non compliance, and bonding procedures for restitution in case of an incident rather than to establish on-scene, government oversight Other objectives produce different results.

Step 2. Determine the organizational structure within the responsible agency. The renewable resource regime may provide a single ministry with the authority to promulgate regulations and to grant authorizations and concessions. Within this context, it is essential to understand how the designated ministry allocates the promotional and the compliance regulatory functions between itself and its directorates; how the checks and balances - both formal and informal - have been instituted; and how the internal decision-making and appellate apparatuses function. Concomitantly, legislated interfaces among ministries need to be identified. In particular, fine-tuning the relationship between the ministry designated to oversee renewable resource development and other ministries is critical in the drafting of the regulations for the various renewable resources.

Step 3. Identify other laws with potential bearing on the renewable resource regulations. It is critical to ensure the integration of regulations into the country's legal regime. For purposes of standardization, subject matter to be addressed in regulations should be carefully reviewed to ascertain their coverage in other laws and regulations. The renewable energy resources law and the proposed regulations should be scrutinized and a check list made of issues that may be the subject of other laws or regulations. Pertinant laws or regulations can be cross-referenced or pertinant provisions can be inserted into the renewable resources regulations in parallel language.

For example, such issues as determination of rights of way, establishment of a record registry, and provision of environmental standards may be the subject of other laws or regulations.

Step 4. Establish a policy of regulatory content in relation to subordinate rules. In most countries, regulatory authorities enjoy broad discretion as to the content of regulations and norms. A threshold understanding of the desired allocation of content among laws, regulations and norms will prevent needless over-drafting of regulations.

Step 5. Draft regulations and subordinate rules as a single package. In many countries, a regulatory regime is a time-tiered system and a regulation must be in place before a subordinate rule is finalized. Nevertheless, for reasons of consistency and understanding of the regulatory concept, a total package should be drafted. Once drafted, they can be refined in context of regulatory changes, but without seeing and reading a preliminary detailed package spelling out how a regulatory provision is to operate, the ultimate effectiveness of a regulatory concept is difficult to envision.

Step 6. Incorporate a legal/technical translator on the regulatory team. A resources regulatory project designed to attract foreign investment typically includes the drafting of a definitive regulation and an accurate (not definitive) translation into other languages - English, Japanese, German, etc. Translations by a translator without a legal background consistently contain linguistically "accurate" but legally misleading translations - creating text which is misleading to readers.

Step 7. Encourage a team approach. The government of the policy strategist should be encouraged to incorporate persons from the private sector, from sister agencies, and from the legislative branch to participate in an advisory capacity on a regulatory drafting task force. There are potential risks with this approach - e.*g.,* perceived violations of the rule of separation of the executive and legislative branches, turf issues between sister agencies, etc. Nevertheless, the value of incorporating possible "opponents" early-on in the decision-making process outweighs the potential down-side.

Step 8. Solicit input from industry. In the case of a law designed to promote private-sector development of a resource, the advice of the potential developers whom the law is designed to attract and whom the regulations are designed to regulate is invaluable to the policy maker.

Step 9. Allocate sufficient time for the political process. Laws and regulations are not drafted in a vacuum. Political consensus and will to proceed is based on confidence, and confidence-building is a time-consuming exercise. Sufficient time must be built into the project

Step 10. Draw on but do not be a slave to, precedent The understanding of regulatory precedent ' from a variety of jurisdictions is essential; however, regulations in one jurisdiction can seldom be transposed directly into another.

For example, the governments of two countries may concur mat blowout prevention in a geothermal site is an essential regulatory task; nevertheless, the concept of one government (that its role as a protector of people requires a regulator to be on site for every well drilled) may be at odds with the concept of another government (mat the private-sector must be made responsible for self-regulation).

c. GOVERNMENT’S ROLE IN THE RESOURCE CONCESSION PROCESS

One of the more important regulatory elements is the resource concession process - that process which allows private sector involvement in most countries’ energy sectors.

What are resource concessions, and how are they granted through the regulatory process?

Viewed in its broadest context, a concession is any right or privilege which a private developer must secure from a government before engaging in a business activity. More technically, a ***“concession”*** is a grant of special privileges by a government allowing a private party to exploit government land or resources.

Most nations proceed on the principle that since the country’s natural resources belong to the nation as a whole, exploitation of the resources must be controlled by the government through a rational process of issuing concessions to qualified parties.

Governments consistently issue concessions to generate electricity, operate and maintain transmission or distribution systems or operate utility systems in discrete sectors of their country. In many countries governments grant concessions for the right to utilize a water resource or extract geothermal energy. Some countries may require several concessions to construct, own and operate a generation project. For example, one may need a concession to explore a geothermal resource, and then another concession to utilize the resource for the generation of electricity. In the context of rural electrification, concessions may be offered to private investors allowing them to develop vertically integrated, privately owned electricity systems for geographic areas defined in the concession.

Establish objective criteria upon which the selection of the resource concession award will be based.

In attracting private investment for renewable energy development, the structure of the concession is extremely important. For example, concessions may be structured so as to attract private investors, while at the same time the terms of the concession may be structured to assure that the entity holding the concession completes the proposed objectives (*e.g.,* timely completion of development).

The following sections describe regulatory principles which are important from both the private investor’s and the country’s perspective in any concession structure.

Regulations need to state objective criteria upon which the selection of the resource concession award will be based.

The private investor looks for assurances that the process for granting concessions is fair. From the private investor’s perspective this means that in the event of competition for a concession, the government will award the concession to the most qualified applicant, through a transparent and standardized process. What determines the most qualified applicant depends on the nature of the concession and government objectives in granting the concession.

In a competitive award process, an objective, qualified panel should apply the criteria.

A panel or committee comprised of people who are qualified to evaluate the proposals from technical, developmental, and financial perspectives - as well as to evaluate the proposal's responsiveness to the other objectives expressed in the concession offering - will give the investor greater confidence that its proposal will be fairly evaluated.

Establish objective, qualified panels or committees to oversee competitive awards.

Temporary resource concessions allow candidates for permanent concessions to evaluate project commercial feasibility.

Where concessions are granted for the development of energy projects and include the right to construct, own and operate an electricity generating project, the process typically provides for granting a temporary concession prior to granting a permanent concession. It is in the interest of all parties to allow developers the time and support to conduct thorough project feasibility studies. The purpose of the temporary concession is to give the selected developer sufficient time to undertake more extensive feasibility studies so the developer can assure itself and its investors that the proposed project makes sense in the final analysis. By linking a temporary resource concession with a pre-emptive right for the developer to obtain the permanent resource concession, the government may increase the developer's confidence that the money spent on expensive feasibility studies will not be spent in vain. Temporary concessions, although time limited, are exclusive. For a given project, no more than one temporary concession should be outstanding at any one time. The holder of the temporary concession needs to be assured that it will be entitled to a permanent resource concession for the site, so long as it complies with the terms of the temporary concession. These measures are necessary to ensure that the concessionaire has the proper motivation to expend the funds necessary for a feasibility analysis which is sufficient to satisfy a project lender.

Utilize temporary concessions linked to a permanent concession to allow candidates for permanent concessions to evaluate project commercial feasibility.

A concessionaire needs to know what its rights are and what it must do to maintain them throughout the period of the concession.

A concessionaire needs complete access to the project site and to all information in the possession of the government regarding the site, so that it can adequately evaluate the project. An investor will need confidence that if it obtains a permanent concession it will have the legal right to acquire, for fair market value, all land and other property (such as riparian rights) needed for attaining the objective of the concession. An investor will also look closely at the regulations to see if they provide for a quick and equitable way to resolve disputes between the land owners and the concessionaires regarding the determination of fair market values. For example, a dispute resolution process may be put into place which allows the concessionaire to proceed onto the property if it places a bond or other security instrument as collateral for the ultimate determination of value. Failure to provide for eminent domain rights leads to situations where an isolated local landowner can unreasonably delay project development. In the case where a law requires more than one concession to complete a project, the investor will want to know exactly what the process is for obtaining the subsequent necessary concession.

Minimize the number of secondary permissions required in concessionary grants.

Grants of concessions should minimize the number of secondary permissions required.

Concessions are often supplemented by secondary instruments (known variously as permits, licenses, warrants, etc.) empowering the guarantee to do some act, not forbidden by law, but not allowable without such authority. Many jurisdictions require the holders of concession rights to obtain secondary permits from various governmental agencies at the local, provincial and/or federal level. The project developer would like to be assured that, if its proposal conforms to the requirements of the concession offer, it will be able to obtain the necessary permits at all levels in a timely and cost effective manner. Investors prefer laws which empower a single agency with comprehensive authority over all matters, including permits that are needed to proceed with the proposed project. In many countries multiple agencies require multiple permits and the rules for the issuance of such permits are random - without reference to government objectives in the energy sector. Such situations have a chilling effect on investment. Non-exclusive reconnaissance permits can effectively attract developers to known resource areas. In unknown (or "wildcat") areas or in areas in which there is insufficient data, such permits can be even more effective in encouraging reconnaissance if developers are given an exclusive or preferential right to convert a reconnaissance permit to a non-competitive concession, or a right to match the highest bid if the concessions are awarded through competitive bidding.

In resource concessions, establish both the best use of the resource and standards for determining which concession applicant will meet those needs.

Governments are usually concerned that development make the best use of the available natural resources. In some instances, equipment efficiency is the paramount issue, as in the case of hydro and geothermal generation. In other instances, there is a specific task to be performed, such as pumping water or running certain equipment, and (so long as the task is accomplished at an acceptable price) efficiencies may be a less important factor. The best use of the resource may also involve multiple uses. Country objectives for hydroelectric development may include energy production, flood prevention, irrigation and recreation. Development of solar and wind projects may need to be consistent with the agricultural uses of the land on which they are located. It is incumbent upon the regulatory strategist to define in each concession what the government considers to be the best use of the resource and to develop standards for determining which concession applicant will best satisfy those defined uses.

A "use or lose" policy requires balancing several considerations.

While the concessionaire may be motivated by a date-specific commitment to provide electricity under a power sales agreement, the government may establish and monitor timelines. To assure that the concessionaire is working diligently towards construction of the project, the government may require that certain milestones be met by the concessionaire in order to retain its concession rights. This ***"use or lose"*** policy assures that developers will not "bank" projects to prevent other developers from competing for a limited resource or limited market place. By balancing a "use or lose" policy with government flexibility on excusing unintentional developer delays (*e.g.,* time consumed by the government, third parties or natural forces), realization of final project completion may be better assured. It is generally acceptable to the international lending community that the government require security in the form of bonds or letters of credit to assure that the concessionaire is motivated to perform in a timely fashion.

Although viewed from different perspectives, the private investor objectives of a resource concession be met. While the private investor's main concern is to obtain a reasonable rate of return on its investment, the country's concerns, while not necessarily in conflict with the private investor's, may be broader in scope.

d. GOVERNMENT'S ROLE IN THE MARKET

In countries in which vertically integrated utilities under state ownership or control predominate, long-term planning is relatively easy. Resource planning allows design of a capacity expansion program that includes renewables in the country's generation mix. The primary challenge under this model is designing a solicitation system that attracts private investors, fulfills the desired quota of renewables, obtains the utilities' expected output at competitive prices and yields projects that are creditworthy. A second critical element of any resource acquisition process is the power purchase agreement.

How are on-grid, renewable projects best solicited in a state-owned or monopolistic utility system?

Although there are almost as many different styles of bidding solicitations as there have been solicitations, most utilities are familiar with all-source bidding procedures: the utility issues a solicitation seeking bids from project sponsors for capacity and energy, with the bid going to the lowest cost supplier without regard to the project's fuel source. By this method, the utility seeks a specific amount of capacity and purchases the associated energy in accordance with a per-kilowatt-hour formula that normally allows the project sponsor to recover its fuel cost. Renewables are likely to be less successful in ***"all-source"*** bidding solicitations in which all technologies compete against each other. The emphasis on fixed cost in all-source solicitations favors the economies of scale of large, stand-alone fossil plants and creates difficulty in comparing resources with dissimilar attributes.

All-source bidding solicitations favor thermal projects because the costs associated with thermal projects can be readily determined and are normally not site specific. Thus, a private-sector bid to supply fossil-fired thermal generation can be prepared with comparatively little time and expense.

By contrast, renewable energy projects are normally very site-specific and can require many months of study before cost information can be developed to the point where a bid can be made.

The criteria established to determine the winning bid in most all-source bidding programs typically fail to take into account the long-term benefits offered by renewable projects and the different cost patterns experienced in conventional thermal versus renewable projects. Moreover, a tendency to take a fairly short-term view in weighing the relative costs and benefits of thermal versus renewable projects also impedes renewables.

In the case of most conventional thermal projects, per-kilowatt capital costs are low when compared to the typical renewable project. On the other hand, a renewable project may have a zero fuel cost and very low variable costs, while thermal projects have comparatively high and often unpredictable variable costs. Despite these differences, utility power solicitations for renewable energy projects often proceed using the thermal model and base comparative evaluations on an imperfect view of the long-term costs and benefits of the various technologies. Utilities tend to make their acquisition decisions on the basis of a project's capacity and energy costs in the first few years of a multi-year transaction, giving insufficient weight to the long-term implications of the arrangement. The design of a bidding program will influence the ability of particular technology types to compete successfully.

Solicitation and bidding models for renewable energy solicitation.

When a utility has determined what it believes to be a fair price to pay for renewable energy, it can then initiate the process of attracting private investors to develop the available resources. There are generally four solicitation models which have been used: the site-specific bid, the tariff-based solicitation, the site-specific tariff bid, which is a hybrid of the first two, and the negotiated solicitation.

Site-specific bid models. In this model, the utility has a specific site or sites and a specific energy source in mind, and asks potential developers to enter a bid for the rights to develop the site -- the lowest bid wins the right to develop the resource. Unfortunately, experience has shown that this approach is not effective in attracting private developers of renewable projects. The problem with this model is that the project developer's chances of winning such a highly competitive bid are so low, and the costs of a pre-feasibility study are so high, that a project developer is generally unwilling to undertake a prefeasability effort sufficient to develop a realistic bid. Prefeasability studies performed by the host country are rarely specific enough for the developer to undertake more than a sketchy plan for the project. Those developers willing to participate in this kind of a solicitation are compelled to make assumptions based on worst-case scenarios which result in a very high bid price. In fact, most developers have simply elected not to participate in site-specific bid solicitations. The few that do participate submit bids that are either not creditworthy or so high as to be unacceptable to the host country. This model has created many problems in the Philippines, which has been attempting to solicit firm bids for the development of several hydro sites.

Tariff-based models

A variation on this model has fueled dramatic increases in the development of renewable energy projects in the United States. In this model the utility undertakes its least-cost planning and determines the rate, or tariff, it is willing to pay for renewable energy resources. It is critical that least-cost planning take into consideration all benefits and costs associated with various energy fuel sources. Predictably, the use of this model will establish rates which are different as between renewables and non-renewables as well as among the various types of renewables. Most importantly, the utility determines, on a reasoned basis, and after accounting for all benefits and costs, the value of its resources.

Once this price is established the utility offers to purchase a set amount of capacity for the various energy sources at the tariffed price. Assuming developers respond to the solicitation, they will submit applications to develop specific sites. The utility can then select the proposals which best meet the criteria established by the utility and award temporary concessions giving the developer the exclusive right to further investigate feasibility and commit to developing the resource. *See* section 4c (Government's Role in the Concession Process) of the *Manual* for a discussion of concession issues. If the response to the solicitation fails to meet expectations, the utility must determine if it is willing to offer a higher price for the resource and issue another solicitation. Or, the utility may conclude that the resource does not provide sufficient value in the current marketplace based on the originally established criteria and therefore abandon the particular resource until market conditions change.

Hybrid, site-specific tariff bid models.

Again the utility undertakes least-cost planning and determines the price it is willing to pay for a particular energy source. This price can then be included in a solicitation for site-specific renewable projects, with the understanding that the price included in the solicitation will be the ceiling price. Developers can then submit bids based on a percentage of the ceiling price. This method seeks to ensure that the utility will fulfill the goal included in the Comprehensive Plan regarding the expansion of the nation's base of renewable resources, while at the same time bringing competitive pressure to bear on project sponsors to constrain bids. However, this method presents similar problems associated with the first model: the feasibility studies supplied to investors may be based on unreliable or incomplete data, making it very difficult to develop firm bids. The effort could ultimately prove futile if no bids are received or may even need to be repeated if the received bids turn out to be impracticable.

Pre-qualification/negotiation models.

This model begins with a pre-qualification process whereby the utility establishes transparent criteria for qualification. These criteria should include not only technical ability and experience, but factors related to financial capability and the ability to obtain necessary financing for the construction of the project.

Once the participants in the process have been pre-qualified, the utility can then prioritize the successful qualifiers according to another set of criteria. That set of criteria should be based partly on the relative merits of the pre-qualification criteria as well as such criteria as the party's willingness to involve the utility and government in certain aspects of decision-making. the willingness of the party to provide incentives and equity participation to workers and employees and other matters that may be of particular importance to the government. Once the qualified parties are ranked, negotiations can begin with those at the top of the list according to a strict schedule requiring progress on such negotiations. Negotiations must be transparent and arbitrary rankings would need to be prohibited. This model has been used successfully in some counties, but has recently come into disfavor because of perceived or real favoritism in the process. A verifiable means of assuring transparency is critical to the success of this model.

A variation on this approach is to use the pre-qualification process to establish a bidder's list. The pre-qualified bidders then submit proposals addressing a discrete set of project attributes and requirements. Bids are evaluated on the basis of price and non-price factors and the bidder with the highest score wins the bid.

Certain energy projects are either too small to justify inclusion in a solicitation of utility-grade projects, or are able to deliver energy only on an intermittent basis, and special rules should be developed for these resources. Examples would include small wind machines or hydro projects having a capacity under 100 kilowatts, or larger facilities that serve sizable industrial loads. but which occasionally have limited amounts of excess power to sell into the grid. In these cases, the utility should develop and offer an energy-only purchase rate based on the utility's average energy cost.

Electricity, not the renewable resource, is the product of value.

What is the role of power purchase agreements in private-sector development of renewable resources?

The success of a country in attracting private capital is directly related to its sensitivity to the way in which private investors generate investment capital in the world markets. In particular, the renewable resource industry uses project financing for grid-connected systems.

"Project financing" is a mechanism whereby a developer borrows money and repays it from the revenues generated by the project.

The single most important key to project financing is a power purchase agreement. A ***"power purchase agreement"*** is the contract between the owner of a power-generating facility and its customers. In this agreement, the customer promises to pay a pre-negotiated rate for power and capacity over a period of years, assuming that the generation facility performs as promised.

The importance of the power purchase agreement to a developer may be more dearly understood by looking at these agreements from a developer's perspective. A geothermal energy investor, for example, has to spend money to explore for geothermal resources much the same way one does in prospecting for gold or oil - however, the geothermal prospector cannot export hot steam abroad. Similarly, the hydropower energy investor has to spend money to create a reservoir and the biomass, wind and solar developers have to invest in technology that converts a source of potential natural energy into electricity. Electricity. not the resource, is the product of value. Therefore bankers must be assured that someone in the producing country will buy electricity at a price that will generate sufficient revenues to repay borrowed monies - or that the electricity will be exported and bought by a customer in a neighboring country. For example, during the 1990's Mexico has been exporting approximately 500 megawatts of geothermal-generated electricity to Southern California.

Electricity, not the renewable resource, is the product of value.

Streamline and standardize the legal and regulatory procedures for power purchase agreements between the utility and private power producers to minimize costly delays and complications in contract negotiations.

A power purchase agreement is a means to an end. If the policy objective is to enable private-sector entrepreneurs to develop renewable energy, grid-connected facilities to sell power in a country, a power purchase agreement is the most effective mechanism presently in use to allow financing of private-sector generation facilities. Power purchase agreements are effective tools only in countries in which national legislation or practice allows entities other than the national utility to generate electricity.

What is the role of power purchase agreements in the renewable energy context?

Ideally, any purchaser of generating capacity and electricity which is soliciting power for addition to its grid - be that a utility. a distributor or other entity - will have prepared a well-thought-out standard power purchase agreement to be included as part of the solicitation. The preparation of standard power purchase agreements will not only speed the post-award contract negotiation process, but will also place bidders on notice regarding the terms and conditions of the contract. Since, from the developer's perspective, contract terms translate directly into costs and benefits, communicating the terms sought by the utility to prospective bidders permits the bidders to embody a complete assessment of the economics of the transaction in their bids. Without a firm understanding of these factors, bidders will be forced to rely on guesswork in formulating their bids, undermining the entire bidding process.

A power purchase agreement for renewables that has substantial monthly capacity payments can have fairly modest payments for delivered energy.

What policy issues need to be considered by the government in the context of power purchase agreements for renewables?

In general, the legal and regulatory procedures for power purchase agreements between the utility and private power producers need to be streamlined and standardized to minimize costly delays and complications in contract negotiations.

When preparing a standard power purchase agreement, utilities and other power purchasers should be aware that renewable facilities differ from conventional hydrocarbon-fueled projects in several ways. Failure to reflect these differences in the power contract will complicate, if not preclude. the renewable project's ability to attract financing. Fortunately, these differences can be accommodated without compromising the power purchaser's position.

Renewable projects tend to be far more capital-intensive than conventionally fired facilities. The typical renewable project will have a very high proportion of fixed cost - chiefly in the form of debt service - and a low proportion of costs that vary with the output of the plant. Given this cost structure, renewable projects seeking financing need to be able to demonstrate that the power contract will produce a very steady cash flow over the life of the financing. This demonstration of commercial viability can best be achieved by negotiating a power contract with some customer - be it a utility. a distributor or a commercial facility - that has substantial monthly capacity payments (payments per kilowatt of deliverable capacity). If the capacity payments are sufficient, then the payments for delivered energy (payments per kilowatt hour of delivered energy) can be fairly modest. This kind of payment structure presents a relatively low risk profile to investors, and the resulting lower debt service costs can be reflected in the prices paid by the utility under the power contract.

Pricing for power purchased from an independent power producer needs to reflect its value to the purchaser in terms of the power producer's ability to meet on-peak, off-peak, baseload and peaking capacity requirements. Given the higher value of electricity generated during peak demand, the cost difference between peak and off-peak electricity prices needs to be dearly defined. Alternative capacity payment and dispatching language can be developed and included for subsequent negotiation.

What are the major source-specific considerations in developing a power purchase agreement?

The source-specific considerations and suggestions below are relatively simplistic guidelines, and legal counsel should be sought before adopting them.

Geothermal Projects. Projects driven by geothermal energy are normally designed to run at a fixed output level around the clock. The power contract should include substantial capacity payments and very low energy payments, reflecting the typical cost structure of these projects. Capacity testing provisions can be based on the adequacy and regularity of deliveries during on-peak hours. Dispatching provisions should be limited to a requirement that the unit go to maximum output if required in the case of emergencies.

As a practical matter, dispatching provisions that allow the utility to reduce the unit's output below its normal operating level will result in a waste of the available geothermal energy and can engender additional operations and maintenance costs, and therefore should not be included.

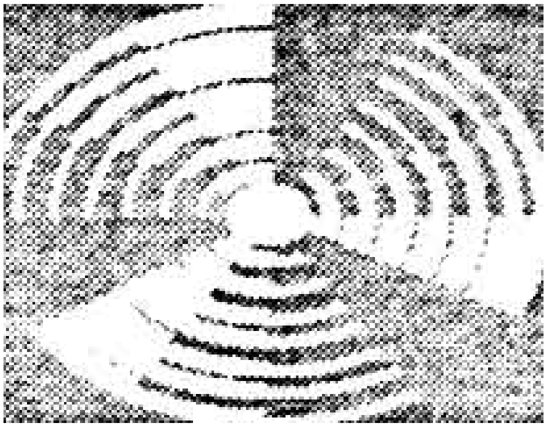
Hydroelectric Projects. Hydroelectric projects come in two varieties, peaking (or storage) projects, and run-of-the-river projects. In drafting power contracts this distinction must be kept in mind.

In the case of ***run-of-the-river*** projects, the operator of the project normally has very limited control over the output of the project: the project's deliveries vary with the water level in the river. In these cases, capacity payments can be tied to the results of regular capacity audits of the facility, or to actual on-peak deliveries. The power contract should not, however, contain dispatching provisions given the operator's limited control over the facility's output.

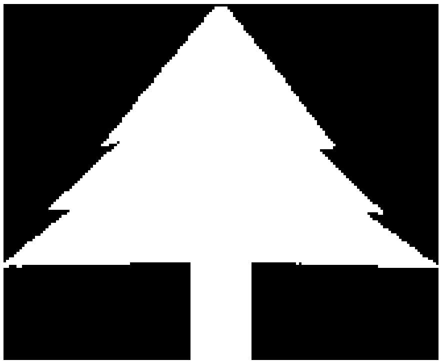
Power purchase agreement for the renewables should reflect the value to the purchaser in terms of the power producer's ability to meet on-peak, off-peak, baseload and peaking capacity requirements.

By contrast, ***peaking hydro*** facilities offer substantial capacity and dispatching benefits. A true peaking hydro unit will normally have a large reservoir behind its impoundment. Water flowing into the reservoir can be stored during low load periods such as weekends or evenings. At times of high demand, the water can be released through the unit's generators to support the increased load. Stored water can also be held behind the dam as an emergency reserve to provide immediate system support in the event of emergencies such as a sudden loss of generation elsewhere on the system. Contracts covering the output of peaking hydro units should include substantial capacity payments and relatively low energy payments. These units should be completely subject to utility dispatch.

Wind and Solar Projects. Deliveries from wind and solar projects depend entirely on the availability of wind or sun at the site, although in many cases generation patterns from these sources consistently conform to utility load - patterns. Accordingly, contract provisions should allow for capacity payments in the event that the project demonstrates consistent deliveries of energy during on-peak (high demand) periods. Dispatching provisions should not be included, since the operator has very limited control over the instantaneous output of the project.



***Biomass Projects**.* Many biomass projects are operated as cogenerators; they support production or manufacturing in a nearby industrial facility, such as a sugar or paper mill. In a typical application, the biomass unit will be both generating electricity (either for the grid, for the industrial host's electric load, or for both) and providing process steam to the host facility during all hours of the day and night. In this kind of operation, the typical biomass facility should be regarded in the same light as a geothermal plant: it should be expected to run in a base load pattern (around the dock) and should not be expected to respond to dispatching orders except in emergency situations, and then only if their design permits.



Power contracts for these facilities should include substantial monthly capacity payments tied to reasonable testing procedures. Biomass projects that are not operated in conjunction with an industrial host are often referred to as *"**stand-alone**"* projects. From the project developer's standpoint, these projects can be built and operated most economically in the base load approach followed by cogenerators.

Utilities requiring generating sources that have the capability to follow load fluctuations can negotiate with stand-alone biomass projects to obtain such capacity, but should expect to pay somewhat higher prices than for base load output, given the higher capital and operational costs encountered in building and operating these types of stand alone biomass projects.

Power purchase agreements are difficult to formulate in the abstract. Each country, each utility, each generating source is sufficiently unique in that, when coupled with the issue of renewable resource objectives, a model power purchase agreement, prepared in the abstract, without reference to concrete issues, can be an irrelevant document. With this very strong caveat, the agreement outline contained in Appendix C is designed to provide a very basic overview. The drafters of a country specific power purchase agreement are urged to seek expert technical, legal and financial counsel.

e. TECHNOLOGY SPECIFIC POLICY STRATEGIES

Depending upon the renewable resources that have been identified as factoring into the national energy mix, the policy strategist may determine that a resource-specific legal regime may need to be enacted and that resource-specific incentives may need to be put in place in order to encourage resource development - especially if a domestic industry is non-existent.

There are two principal resource issues with which the policy strategist will have to be familiar: the development of the resource (*e.g.,* the need for a geothermal resource extraction law), and the generation or **"dispatchability"** characteristics of the resource (*e.g.,* base load, intermittent load, distributed power, etc.). The legal issues regarding resource development are discussed below in this section. Dispatchability is especially worthy of note in the context of **"intermittent"** resources.

How are intermittent resources built into a generation mix?

Dispatchability is an area of significant interest for policy strategists concerned with the renewables. The term ***"dispatchability"*** refers to the degree of control that the utility will have over the output of the project. For example, in the case of a project that is fully dispatchable, the utility will have the right to change the output level of the unit from full output to zero output and back again whenever it chooses to do so.

For some types of units under certain types of power contracts, full dispatchability can be accommodated. For example, a hydroelectric unit that can go from full load to zero load without violating its environmental permits could agree to full dispatchability so long as its power contract or power purchase agreement had the kind of substantial capacity payments described in Chapter 4d (Government's Role in the Market). In the case of a run-of-the-river hydro project or a wind project, however, dispatchability will be greatly limited due to the fact that the unit is designed to run whenever the circumstances of its energy source permit it to do so. These resources are called ***"intermittent."*** Biomass units can be subject to similar conditions, especially when they are designed to support a thermal load in an adjoining industrial facility. In these conditions, project sponsors will not be able to obtain financing if the only thing they can obtain from the utility is a power contract requiring substantial dispatchability features and with payments solely for energy delivered.

Intermittent renewable energy is cost competitive with energy from fossil-fuel generating stations. It must be recognized, however, that the competitiveness of intermittent renewable fuels is realized over the life-cycle of a generating facility as the low cost of fuel and operations off-sets the front-end capital costs of a renewable facility.

The following list illustrates the types of incentives which may apply to unique situations of a specific renewable resource:

> ***Biomass.*** Create special biomass resource concession for energy use.
>
> ***Co-Financing of Exploration.*** Provide government-financed resource development or identification in whole or part by the government.
>
> ***Concessional Financing.*** Allow for pioneer renewable industries with soft loans, or provide soft loans only in remote areas.
>
> ***Geothermal Drilling.*** Provide depletion allowance for drilling investment (based on income not on capital investment) and expending of intangible drilling costs to offset exploratory risk factor.
>
> ***Geothermal Resources.*** Create a specific law dealing with the unique qualities of geothermal resources. Geothermal resources cannot successfully be managed under existing water, hydrocarbon or mining laws.
>
> ***Infant Industries.*** Focus on safety and environmental protection when drafting regulations and avoid micro-management particularly for infant renewable industries. In circumstances in which governmental action is prerequisite to industry action, delay on the part of the government should be construed as government approval.
>
> ***Mini/Micro/Small Hydro.*** Support the canal or cluster approach.
>
> ***Watershed.*** Initiate joint responsibility between the government and the proponent for the maintenance of watersheds. Especially in rural hydropower projects, water availability is influenced by a project's watershed.
>
> ***Windpower.*** Establish capacity definitions for intermittent resources.
>
> ***Windpower/Small Hydro.*** Establish exemption or streamlined procedures for environmental mitigation and forestry clearance.

When promoting infant renewable industries, focus regulations on safety and environmental protection and avoid micro-management.

One critical element in a potential lender's analysis of project economics is the pricing of goods or services to be provided by the project. Pricing of project outputs presents several complex issues. For example, in countries in which the electric utility is a monopoly, the purchasing power of electric utilities dictates that independent power producers will be ***"price-takers"*** not ***"price-makers."*** Thus, in order to ensure the firm, long-term revenue stream that is essential to obtaining financing, independent developers require a mechanism to ensure that electric utilities will pay an economically viable price for their energy.

In the United States, the financeability of electric energy generation projects was enhanced by legislation requiring electric utilities to purchase energy at a price equal to so-called ***"avoided cost".*** The advantage of such an approach is that it establishes a more-or-less objectively determinable level of prices for the project's output (*i.e.,* a fixed or determinable revenue stream).

On the other hand, much has been written about the various economic models used to calculate **"total costs,"** much of which supports the conclusion that the value of privately-generated energy is often in the eyes of the beholding economist. Laws may establish a sound framework for investment of private capital, if they take into account the fact that financial markets require certainty of revenues, and if they provide concrete guidance with respect to rates payable for project-financed infrastructure goods and services.

What legislative and regulatory tools are available for Government to take a pro-active role in creating an environment conducive to renewable resource project development?

The following list illustrates the types of tools that have been applied internationally to encourage entrepreneurs to develop new renewable generating sites that can provide an income stream for repayment of principal and interest as well as a - reasonable rate of return on investment. These strategies can be used to encourage greater use of renewable resources and can be implemented through legislative, regulatory or administrative actions depending upon the structure of the government and its relationship to utility activities.

Capital allowances/depreciation. The book value of assets may be depredated for tax purposes at liberal rates.

Clear guidelines. Clear and authoritative guideline information may consolidate and set forth the various laws and regulations for developers to use in developing a private, renewable energy power project.

Establishment of ombudsman. Designate a person or agency to be responsible for the promotion of renewable energy sources. Concomitant authority, responsibility and access to high level decision-makers is essential.

Income tax holiday. Renewable energy firms may be fully or partially exempt from income taxes for a sufficient number of years to allow either accelerated principal and interest payments or a reasonable rate of return on investment.

Investment credit. *A* percentage of every dollar invested in a renewable energy resource project development may offset future tax owed.

Labor. Renewable energy firms may employ foreign nationals without limitation. Employment of domestic labor may be encouraged by allowing an additional deduction from taxable income. A further deduction may be allowed for labor expenses of domestic workers in designated less-developed areas.

Loss carry-forwards. Renewable energy enterprises which suffer tax losses may carry forward such losses indefinitely to be offset against future taxable profits.

One-stop shopping. Governments may consolidate the oversight of all application and approval processes and the oversight of all rights and penalties consolidated in a single agency. This consolidation is called "one-stop shopping" or "single-window clearance". To the extent that such consolidation is impractical or impossible (*e.g.,* the functions of the customs agency will typically be separate) such single-source ministry may act as coordinator, ombudsman, or as chairman of an inner-ministry agency.

Performance undertakings. To the extent that a government-owned or controlled entity is the purchaser of electricity, lending institutions have consistently required a "performance undertaking," i.*e.,* the affirmation that the obligations of the entity involved carry the full faith and credit of the country and a guarantee to ensure that the entity will discharge such obligations at all times as they fall due.

Set-asides. The country may determine that an established percentage of its energy-mix shall be from the renewable resources within a specified time frame. Several incentive approaches may stimulate or mandate this objective:

- Distributors may be required to buy a specified percentage of their energy from renewable energy sources in order to maintain their concession. These distributors need to be protected from unreasonable power purchase rates.

- Distributors may be allowed, and encouraged, to own renewable resource generators.

- Distributors may be provided an additional tax exemption for the purchase of electricity from renewable energy generation sources (similar to the "tax credit" concept, above).

- Generators may be required to generate in accordance with a set energy portfolio mix (see ***Appendix D***)*.*

Simplification of customs procedures. Renewable energy firms may be entitled to simplified customs entry procedures.

Standardized power purchase agreements. The government may provide a standard power purchase agreement which is established as the mandatory structural and pricing contract for long-term agreements between distributors and renewable resource generators.

Tax and duty exemption on imported capital equipment. Renewable energy firms may be exempt from customs duties and national internal revenue tax payable for the importation of machinery and equipment and spare parts for a sufficient number of years to allow the establishment of full commercial operations.

Tax credit. For each kilowatt of hour of electricity purchased from a renewable generation facility per year the purchaser or distributor is allowed a percentage tax credit.

Tax credit on domestic capital equipment. Renewable energy firms may be entitled to a tax credit equivalent to a determined percentage of the value of the national internal revenue taxes and customs duties that would have been waived by purchasing the machinery, equipment and spare parts from domestic manufacturers instead of importing such machinery, equipment and spare parts.

Use or lose. Ensure that no speculator may claim and hold a resource for an indefinite period of time without developing it.

CHAPTER 5. UNIVERSAL ELECTRIFICATION POLICY

Nearly two billion people - more than one third of the planet's population - lack access to electricity according to estimates by the United Nations and World Bank. Broken down by regions these figures are even more dramatic - fully 90% of Africans have no access to electricity. With the Earth's population expected to double by the year 2042, the potential unserved population could rise above five billion. The numbers themselves are startling, but the overall social and environmental impacts could be disastrous.

We consume energy in all aspects of our lives: cooking, heating and cooling, pumping water, producing goods and illumination. When electricity is not available, biomass - firewood, crop residues and animal dung - is most often the fuel of necessity. These fuels are not energy efficient and the requisite high consumption for basic needs contribute to deforestation, soil depletion, and higher mortality rates from smoke and particulate inhalation. These problems will only worsen as the unserved population grows, unless there is an increased emphasis on providing electrification.

Electrification is a key to economic development and growth, a fact underscored by the international community's use of the rate of electrification as a primary measurement of a country's overall development. Electricity is the building block of a sustainable community. A government that supplies electricity for water pumps and simple production machinery, provides the means for creating enough local wealth to expand electricity coverage to homes, schools and employment centers. Improving the local standard of living and ability to earn a living provides a reason for citizens to remain in their villages and on their farms. Bolstering remote and rural economies, in turn, stems the migration to urban centers, reducing population pressures on cities and the urban problems that often accompany overcrowding - civil unrest - crime, pollution and health hazards.

Renewable technologies are suited in size and technical scope to off-grid applications.

National polices designed to provide electric service to an entire population, however, have encountered significant barriers. Ensuring an adequate supply of electricity to isolated populations - small villages and agricultural areas, with their relatively low population densities and distance from the main electricity grid - has proven to be a difficult challenge to the energy policy strategist.

Historically, energy strategists have elected two approaches to electrification of isolated areas: (i) to extend the existing grid, or (ii) to distribute diesel generators and subsidize the purchase and transportation of diesel fuel. Grid extensions tend to be very costly and, unless new generating sources are added to the system, extensions can cause a system-wide service degradation. The diesel approach has also proven unsatisfactory. Fuel and transportation subsidies must be continued indefinitely. Diesel units require constant maintenance and are difficult to run efficiently at remote sites. In addition, air, ground and water pollution problems are endemic to the fossil fuels that power diesel generators.

Renewable technologies, on the other hand, offer a real solution because they are suited in size and technical scope to off-grid applications. Renewables, by their very nature, operate using the pollution-free energy sources immediately available in the village and rural agriculture settings. When wind, solar, geothermal and mini-hydro resources are located near remote users, these resources can provide sustainable, long-term levels of electrification to isolated areas.

Electrification projects in remote and rural areas are by their very nature expensive and the populations they serve almost exclusively poor. The energy policy planner seeks to maximize service at a price that is affordable to the local population. From the perspective of the energy strategist, the words “affordable to the local population” express a concept fundamental to successful universal electrification.

From the perspective of the energy strategist, the words “affordable to the local population” express a concept fundamental to successful universal electrification.

Experience has shown that users will not use electricity efficiently and economically unless they pay for service. Payment imparts value. Even in areas in which incomes are low, there is some level at which electric service can be made affordable. Renewable technologies are ideally suited to such a challenge. They can be tailored to meet the needs and incomes of individuals, villages, cooperatives or isolated commercial sites.

The following sections deal with “lessons learned” from past programs that may assist in developing new universal electrification programs, describe the populations commonly served by universal electrification, and discuss emerging universal electrification programs and policies. An appreciation of the history, the target population and new development ideas can assist the energy strategist in defining the most effective types of electrification programs to meet different rural and remote population needs.

What historical “lessons learned” may governments apply in developing a universal electrification program?

During the latter half of the twentieth century - international finance and development organizations have actively supported rural electrification efforts; however, for decades their efforts focused on grid extensions - linking unserved populations to a national transmission and distribution network. Lending institutions have encouraged state-owned utility companies to expand their grids, whether or not such grid extensions were the most logical or cost-effective options. Least-cost planning models, an integral component of American and European energy planning, were not used in the decision-making processes that determined the design of the majority of early rural and remote electrification programs. ***"Least-cost planning"*** means an evaluation of all costs associated with each generation or energy option, and a comparison of those costs over a long-term basis (usually greater than ten years). The historical decision to encourage rural electrification through grid extensions has hampered the development of alternative, cost-efficient electrification options, including renewable technologies.

Evidence suggests that people are willing to spend a significant portion of their incomes on higher quality energy services that improve their quality of life.

In many circumstances grid extension is not an economical option, either because of distance from the grid or general low-load densities. In such circumstances, mini-grid systems have often been designed and constructed. These systems have been designed to re-create the grid model on a local scale. In the typical mini-grid system, power is distributed to consumers from a central source located in the community, usually a diesel or gasoline generator. Projects of this type frequently require government subsidization to off-set fuel and infrastructure costs These subsidies have led to inefficient energy use and reliance on non-indigenous fuel sources.

Consequently, many countries have been forced either to raise revenues to cover the costs of subsidies or to face limiting the growth and scope of rural electrification programs. Moreover, those countries which have opted for a diesel fuel electrification option, are confronted by the problems and limitations inherent to diesel generation:

- dependence on foreign fuel markets;
- increased local costs due to high costs of maintenance and repair;
- increased outages due to operations and maintenance problems;
- unreliable and unpredictable transportation of fuel;
- environmental degradation due to fuel emissions;
- retardation of the development of generation options (*i.e.,* renewables);
- retardation of the development of least-cost planning techniques and models; and
- health risks.

Renewable energy projects face serious obstacles in countries in which government policies and subsidies artificially lower the price of conventional generation sources and focus on short-term economics. In making energy choices some countries have opted for carbon-based systems such as oil or diesel units, using economic analyses that either fail to take into account the long-term benefits of renewables or the impact of continuing government fuel subsidies when making these investments. Policy makers electing to encourage renewable energy systems as part of an energy mix will be more certain of attaining their objectives if they ensure that decisions are based on a comprehensive and long-term comparison of the costs and benefits of all alternatives.

Programs that build on the knowledge and abilities of the local community tend to succeed.

Evidence from studies in rural areas suggest that people are willing to spend a significant portion of their incomes on higher quality energy services that improve their quality of life or enable them to become more productive. Restrictions imposed on electricity prices and subsidies that mask the real costs of power can have the negative effects of restricting people's choices and of limiting investments that extend services and provide alternative energy forms. Moreover, unnecessary subsidies are often fiscally unsustainable and may actually go to benefit higher-income households. Inappropriate subsidies can lead to excessive demands for electricity, fiscal stresses and inefficient energy use.

To date, all universal electrification programs have required some type of subsidy. The key is to devise policies and programs that are effective in providing the appropriate level of services to the desired population and that address market failures. The policy strategist designing universal electrification policies and programs is generally confronted with the challenge of high start-up costs and the risks and external costs inherent to providing electricity to rural and remote populations.

The lessons learned from past experiences offer the energy strategist valuable insight into what works and what does not. Programs that build on the knowledge and abilities of the local community and that take advantage of local institutions tend to succeed - particularly if these programs allow flexibility in the choice of generation; if they are built around wider development efforts (*e.g.,* road building, irrigation, education); and if they provide for continuous education - training and oversight.

What populations are served by universal electrification

Whom are we talking about? Every policy maker recognizes that proper nomenclature is an essential tool in analysis and communicating. If the goal is to bring electricity to populations currently not served by a grid, the policy analyst will identify the constituents of the target population in order to establish the best mechanism for reaching country objectives.

In general, the population which is not served by the grid are in isolated areas ***"isolated"*** in the sense of not being sufficiently near the grid to be connected. For analytical purposes, the remote or off-grid population - the potential recipients of ***"universal electrification",*** can be categorized in three subgroups:

- disbursed families,
- population centers, and
- production centers.

• ***"Disbursed families"*** refers to people sited too far either from other families or from other population centers being served by a grid, for it to be efficient to use shared generation. Since disbursed families most often work in agriculture, this population is often termed *"rural"* in the literature.

• ***"Population centers"*** refers to people sited in sufficiently close proximity to one another that common use of generation facilities is cost-effective. These populations tend to be concentrated in villages - generally organized farming communities of between ten and 500 households, however, larger population groups, towns or even cities, may be sited far from the grid and therefore "isolated". Moreover - such populations need not be agricultural. Large nomadic population dusters may be included in the off-grid sector. The literature usually uses the term *"remote"* to describe such population centers, but often, the term *"rural"* is also applied to villages.

• ***"Production centers"*** refers to commercial facilities sited in remote areas isolated from the grid. Such facilities may include mining, manufacturing or agri-business production units. Such centers can usually afford to build their own generation facilities, and may be able to supply electricity to the surrounding worker villages. The term ***“isolated production centers”*** will be used for the purposes of this *Manual.*

- ***“Universal electrification”*** is the term used to describe the goal of bringing electricity to all of these isolated populations in a given country.

- ***“Universal service”*** refers to providing some minimum level of electricity service to all customers regardless of their ability to pay.

Low-income households in developing countries typically use electricity mainly for lighting, television, radio, and ironing. With slightly higher incomes refrigerators and other appliances become affordable. The biggest sources of demand for electricity in rural areas and towns is usually for irrigation pumping, water supplies, crop processing, refrigeration, and motive power. These uses of electricity are both socially and economically valuable thereby justifying the economic investment in providing these services.

a. RENEWABLE TECHNOLOGIES & UNIVERSAL ELECTRIFICATION EFFORTS

The limitations of centralized (grid-connected) programs, coupled with the growing adoption of Least-cost planning models and a global trend towards privatizing state-owned enterprises, have focused attention of national energy strategists on the use of renewable technologies for universal electrification. In addition, the major advances in design, efficiency and production that have significantly lowered the cost of renewable generation have also captured the attention of the managers of isolated commercial production centers.

Renewable technologies require less maintenance than conventional generation sources, are far less harmful to the environment, and make use of plentiful and free indigeneous fuel sources.

Renewable technologies such as solar photovoltaics, wind (aeolic) power, small geothermal, small biomass and micro-hydro, are clean, efficient and highly adapted to the needs of dispersed populations. They can be installed as part of a mini-grid system or placed in individual homes or enterprises. In some locations, larger geothermal and hydro-power facilities can power isolated production centers at costs considerably more economical than the diesel alternative. Moreover, excess power from such facilities can be used in communities surrounding production centers that are self-generators.

Renewable technologies require less maintenance than conventional generation sources, are far less harmful to the environment, and make use of fuel sources that are indigenous, plentiful and free. See ***Appendix A*** for a more detailed description of renewable energy technologies applications in the isolated sectors.

Generation options for the national grid may include commercially available renewable

energy technologies such as geothermal, wind farms, hydropower, and biomass electricity, in addition to more conventional alternatives.

What are the primary models for offering universal electrification?

Grid Extensions. Grid extensions continue to be one of the most common means of universal electrification. Because of economies of scale, electricity from large, centralized power plants may be cheaper than that from small generating plants typically used in villages and farms. The problem is that, while the energy itself is inexpensive, considerable costs are usually incurred in transmitting and distributing this electricity to rural areas. To make possible the maximum use of inexpensive grid energy, the policy maker will have to focus on reducing the cost incurred in conveying electricity to the user.

Many analysts have concluded that one of the principal reasons for the high costs of distribution and grid extension is that these systems are usually designed and built by national utilities that tend to focus their activities on the electrification of urban areas. For the electrification of rural areas, national utilities have generally adopted urban standards in their expansion plans. Consequently, systems are oversized, some materials are inappropriate, and costs are further increased because of politics, lack of staff motivation, and bureaucratic delays. Clearly, cheap centralized power can benefit rural populations where it is available. Unfortunately, few utilities have the motivation or interest to incur the expense of expansion to remote areas.

Key variables to consider when assessing the **grid extension option** include distance and terrain for required line extension, population density of the community to be electrified, and the available capacity and reliability of existing generation sources. Grid extension is often the least-cost electrification option where load density is high (greater than five users per kilometer), consumption per user is high (more than 100 kWh per month), and where the extension distance is short (typically less than five kilometers).

Renewable energy minigrids.

Renewable energy mini-grids are a proven alternative to fossil-fueled mini-grids. Technical options include small hydro, biomass-powered generators, small geothermal, solar photovoltaics (PV), solar thermal, wind turbines, and hybrids consisting of more than one technology (with the possible inclusion of fossil-fuel-powered generation.) All small, community-wide electric systems - be they hybrid, micro-hydropower, photovoltaic, wind, or biomass - are dependent on a local distribution grid to transmit energy from the source to the consumer.

If rural or remote consumers are to have access to electricity at the lowest possible cost, policy strategists need to focus on reducing the cost of transmission and distribution from mini-grids.

Key variables to consider when assessing the **renewable mini-grid option** include the available resources, the population density for distribution of power, and service and load requirements, including productive uses.

Dispersed renewables energy options.

Dispersed renewables energy options using small-scale, renewable energy systems, including solar photovoltaics and wind turbines, are reliable and cost-competitive options for electrification of households in dispersed or isolated communities.

Key variables to consider when assessing the **dispersed renewable energy option** include the available resources, service and load requirements, and financing mechanisms which amortize the initial investment.

Diesel generation. Isolated diesel (or gasoline) generators are widely deployed in remote areas for rural electrification because of their relatively low initial costs and simple installation.

Key variables to consider when assessing the **diesel option** include:

- they often operate at well below full capacity, and thus do not achieve maximum efficiency;

- they are dependent on transporting fuel, and this dependence results in high cost and unreliable resource supplies;

- they require diligent maintenance, regular oversight, and are generally unreliable; and

- they generally have negative environmental impacts.

Replacement of diesel by renewable technologies may be an attractive alternative in some cases. However, it is not unusual for certain groups (such as indigenous people or a union group) to have been given diesel concession rights (storage, local sales, transportation to remote areas). In such cases, it may be prudent to develop a substitution strategy that will in some way compensate the diesel stakeholder for the economic loss resulting from a transfer to another technology based electric system or otherwise mitigate those losses.

Incumbent utility companies may view the provision of universal electricity service and rural electrification as a burden.

Awarding rural concessions for energy services

With the privatization and unbundling of the electricity industry in many countries, incumbent utility companies may view the provision of universal electricity service and rural electrification as a burden to be shed. But to others such services may provide a business opportunity. In some countries, federal or state governments have established electric service criteria and then request private sector companies (including affiliates of traditional utility providers) to bid to provide the services (*e.g.,* the state of Massachusetts in the United States). Such criteria may include one or more requirements, for example:

- to use renewably generated electricity (or other environmentally preferable technologies);

- to provide universal service (lifeline rates) for all citizens in the area; or

- to provide some types of electric appliances and/or services through either lease-purchase options or other types of beneficial credit plans.

Structural organization. Organizational structure issues may also be pertinent. Where the issue is rural electrification (such as in Argentina) a government subsidy may be offered as an incentive to attract various providers. Some countries have structured a system in which monopoly concessions are awarded based on the company bid that can offer the greatest amount of service at the lowest level of subsidy. Other countries have adopted a rural electrification structure which allows companies to compete to provide rural electric services on the basis that the government, in the early years, shall pay either a fixed subsidy or the difference between the company’s cost and some pre-determined customer rate.

What are the market barriers and ideas for overcoming these barriers when delivering universal service?

Serving low-income people in grid-connected areas

Use of “lifeline rates”, though not a new idea, can be particularly effective in bringing universal electric service to households easily connected to the grid. ***“Lifeline rates”*** are low tariffs for low levels of electricity consumption. They may not include a financial need test and may simply be offered to all residential customers to assure affordability of the minimum amount of electricity determined to be necessary for basic quality of life. This subsidized rate is paid for by a very small fee on all electricity purchased above the lifeline amounts. Lifeline rates can also be used in combination with rural electrification strategies where, for example, rates for the first 35kWh are designed to make service affordable for poor people who use small amounts of electricity primarily for lighting.

Community organizations, familiar with local needs, are often willing to assume responsibility for implementing policies and projects.

Alleviating high start-up costs and risks.

The problem of high start-up costs and risks is related to the perception of the lack of creditworthiness of low-income and rural consumers. Though this perception has not always proven to be true, both public and private financing institutions, acting on this perception, continue to finance as though remote and rural customers were not creditworthy, thereby raising the initial costs of rural electrification programs.

Fortunately, several innovative programs in credit delivery systems offer promising opportunities to ease the credit situation in rural markets. One such solution may be to establish a local member-supported bank to make small loans, such as the Grameen Bank in Bangladesh (a member supported bank mainly comprised of poor families and women). Another is to enlist companies that already lease basic equipment to consumers, communities, and local energy suppliers (*e.g.,* LPG distributors and small power companies). Laws that give incentives to local banks to provide credit may enable universal electrification projects. The existence of a local bank willing to extend credit is a positive signal to the larger. international lending community. The ability to use local currency, even for only a portion of the project costs, reduces currency exchange risk issues. Although not generally favored. the national government can provide guarantees (security) or counter guarantees to local governmental guarantees on locally raised debt. Partnerships with the multilateral development agencies may enable the creation of funds that could serve just this purpose. Electricity companies can also provide credit including spreading the cost of service and connection fees over several years making rural connections and service more financially feasible.

Calculating external and benefits.

The costs of most renewable technologies costs are declining rapidly; however, new projects in remote areas where equipment must be imported and/or transported over long-distances can make initial costs appear high even though long-term life-cycle costs may be quite low in comparison to fossil fuel alternatives. Given the economic potential and environmental advantages of these technologies, initial subsidies for rural electrification using renewables are fully consistent with good public policy and can be handled in a variety of ways, including the following:

- **Participatory approaches:** Cooperatives, nongovernmental organizations, and local community organizations can be very effective vehicles for providing electric services of all kinds. These organizations are familiar with and understand local needs and are often willing to assume responsibility for implementing policies and projects. The key is to identify the appropriate community social unit or subgroups with common interests and with whom external economic activities can be combined. In Bangladesh, for example, locally managed rural electric cooperative's records of billing, collection, losses and maintenance are significantly better than that of the main power utility in charge of urban distribution.

- **Decentralized power combined with other infrastructure needs:** Combining the development of decentralized power with other infrastructure or social needs (*e.g.,* water or telecommunications, health and education services), can often be very cost-effective, stimulate greater community support and leverage funds from a variety of sources. The major barrier to overcome is traditional compartmentalized thinking that says each of these things must be done by a separate entity.

- **Credit Financing:** Credit financing can greatly expand the number of households able to afford electricity services. In rural Bolivia, the companies operating the rural micro-grids decided to finance the connection charges allowing their customers to pay back the costs in small installments over five years. This scheme enabled the number of households able to purchase electricity service to more than double, reducing both connection and electricity service rates for everyone.

- **Lower service standards:** The costs of electrification can be significantly reduced by initially working with lower service standards, then, gradually increasing the level of these service standards over time as improved local economic development increases rural customers' ability to pay. Simplifying wiring codes and using load limiters (circuit breakers) for lower levels of consumption can reduce costs significantly. Using cheaper poles and involving local people in works and maintenance also will reduce service costs. Moreover, participation of the local community not only reduces costs, it enhances consumer satisfaction and helps to provide financially viable investments. Another approach is to focus on providing electricity services (*e.g.,* lighting, refrigeration, battery recharging) rather than kWh of electricity. Though these services may be more limited than what is available in urban areas, this demand-side approach is often better at meeting customer's needs and facilitating their ability to pay. The types and extent of services can be expanded as demand and resources increase.

- **Provide adequate training:** The frequent lack of adequate support for training, operation and maintenance can cause many financiers to see investments in non-traditional technologies like renewables as high risk. Rural electrification programs using renewables that include adequate support for training, operation and maintenance can result in greater access to capital and lower interest rates.

Participation of the local community not only reduces costs, it enhances consumer satisfaction and helps to provide financially viable investments.

To the extent that the expanded availability of electricity can be linked to local economic development, the greater the likelihood of success of the electrification efforts.

b. GOVERNMENT ROLES IN UNIVERSAL ELECTRIFICATION

Begin with establishing universal electrification as a national goal. A goal statement provides concrete direction to all levels of decision makers involved with universal electrification in a country. If such a goal statement is embodied in a comprehensive plan, the comprehensive plan provides focus and direction, sets priorities, offers support, and helps attract investment capital from both within and without the country. It also lays out the acceptable models for development and identifies the geographical areas where concessions could be established. A universal electrification goal is most useful if it is concrete and quantifiable (*i.e.,* establishing numeric goals for the percentage of households to be connected by a certain date).

If national policy goals do not identify universal electrification and if sector policy objectives do not identify the role that renewable technologies can play in meeting that goal, both public-sector and private-sector developers and investors will likely focus their attention on urban centers, where electricity markets are more secure, easier to reach, and more financially appealing. Even with national-level direction and encouragement, private-sector development will only take place when the financial rewards outpace the relative expenses and risks.

Provide a factual basis **so** ***national objectives may be determined.***

Once a country has established universal electrification as a national goal, strategic planners will focus on the data collection that will provide a factual basis - the foundation on which sector objectives may be established. A paramount element of the factual basis is market identification. For example, collection of demographic data is essential to identifying the location and extent of the markets.

How does the government determine how much electricity is needed in each target market and how the populations in those areas will use and pay for that electricity when it is delivered?

Determine needs and abilities of the rural and village communities.

The first question is how much electricity is needed in each target market and how the populations in those areas will use and pay for that electricity when it is delivered. Ideally, the policy planner will access basic market research regarding the desire and willingness of a community to electrify and the ability of the community or household to support, financially and technically, an electrification program now or in the future. Concomitantly, the policy strategist may identify isolated production centers whose self-generation resources may be extended to surrounding communities.

Look at the resources available for providing electricity to remote areas.

An inventory and evaluation of the country's indigenous resources involves identifying national resources from all sources and then evaluating the quality of the resource (*e.g.,* strength and average daily amount of sunlight, strength and frequency of wind, etc.). This evaluation includes an assessment of the applicability of any particular resource to the areas in need of electrification. For example, a solar resource in an uninhabited portion of the country will not be particularly useful in providing electricity to a rain forest area. Accordingly. assessment also includes logistical issues associated with site selection. installation and operation. It should be noted that replacement or augmentation of diesel generation (that may only have been operated for four-to-six hours per day) with renewable generation (that provides 24-hour electricity service) has implications that go far beyond mere electricity service. One can expect a qualitative shift in the types of tasks for which electricity is being used as well as doing more of the same types of tasks previously undertaken.

Integrate the renewable technologies into the energy mix.

Technologies such as solar, wind, biomass and small-scale hydropower and geothermal are often well suited for rural areas and may justify more systematic attention by policy makers than they have hitherto received. If a given renewable resource is available through a resource assessment survey. utilization of that resource may be included as an objective of the universal electrification plan.

The accuracy of the information used in the analyses of short-term costs determines the usefulness and equitability of cost comparisons.

How does the government identify project costs in context of universal electrification?

Regardless of the model used to implement rural electrification, the totality of the costs must be considered in the overall analysis.

Sustainable development is based on an accurate economic and environmental evaluation of the relevant alternative systems and generation sources: usually called ***"least-cost planning".*** Least-cost planning means an evaluation of all costs involved with each option and a comparison of those costs over a long-term basis (usually greater than ten years). An analysis which focuses only on short-term costs will not provide the decision makers with all the information needed to make a well informed decision and may inherently favor traditional generation sources. The accuracy of the information used in the analysis determines the usefulness and equitability of cost comparisons.

Least-cost planning is a complex and professionally exacting process. Generally, least-cost planning analyses will be completed by trained professionals employed or contracted by the *government. The following is a list of factors that should be considered in this process:*

- Resource evaluation of the development potential of renewable resources is fundamental to rational planning. Local or national governments typically initiate these resource evaluation studies - often with the assistance or financial support of multilateral or foreign development agencies. In the areas of hydro, biomass and geothermal, many countries already have well documented studies that can provide valuable information for the least-cost planning process. However, many countries have not archived resource evaluation studies of either solar or wind resources.

- The consumer base also requires consideration.

  What are the current and projected demographics of the area?

  What is the expected load in the area, and how will the load vary from hour to hour?

  What are the expressed needs of the community and how will it use its electricity?

  What are the projected demand growth scenarios? What is the user willingness/ability to pay?

- Detailed financial analyses will be required to demonstrate projected costs of installation. Installation and start-up costs are the most expensive components of both rural off-grid areas and in urban on-grid renewable energy project facilities. In order to compare the costs of alternatives, all components of the initial start-up costs must be included, from the building of the facility, to installation of equipment, to internal and external wiring of individual households for electrification.

- The cost of support services for operation, maintenance and repair are essential components of a least-cost comparison. The cost elements of support services include the cost of inventorying spare parts and of operating a regular maintenance programs as well as identification and quantification of on-going operational costs on a life-cycle basis. For example, least-cost planning may recognize that a diesel-fired plant lasts five to ten years and then needs replacement, whereas solar and wind facilities may last 20 years and a geothermal or mini-hydro facility might last well beyond its projected 50-year life.

- The costs of the administrative infrastructure are also a factor. Such costs include education and training at both the professional and consumer level, as well as support services for the technicians and managers.

- Also included are **"soft costs"** - transaction costs necessary to engage in any commercial transaction, such as professional fees for bankers, lawyers, engineers and developers.

- The cost of obtaining credit for rural electrification projects is among the most troublesome factors, since the associated credit costs are generally quite high.

Many countries already have well documented studies that can provide valuable information for the least-cost planning process.

Regardless of the model used, the totality of the costs must be considered in the overall analysis.

How may governments and utilities assess the cost of universal electrification?

The challenge for least-cost planners is to quantify the value of externalities and include them in an objective least-cost planning process.

Since objective quantification of “benefits” in a cost:benefit equation is extremely difficult, externalities are usually not considered in the least-cost planning process. However, policy and decision makers generally recognize that there is extrinsic value in these aspects known as “externalities” and that value needs to be considered in the overall evaluation of electrification development. Rural or remote electrification projects that otherwise might be minimally feasible, might be very feasible when externalities are factored into the evaluation.

The cost of getting fuel to remote locations is a major cost component in the decision to install diesel-fired mini-grids.

“Externalities” broadly refer to the benefits or costs generated as a by-product of an economic activity that do not accrue to the parties involved in the activity. In this specific context of an electrification project, the term refers to the collateral effects a project may have on the overall economic, social or environmental condition of a region or a country. These collateral effects relate primarily to health and social factors, such as the health care costs observed in regions where air and water quality are below average levels. The cost of mitigating adverse social impacts, such as urban migration, and the social benefits of electrification, such as providing rural populations with more control over their own lives, can also be considered to be collateral benefits derived from electrification projects in isolated areas.

“Grid-extension costs” generally have the following components, all of which must be considered in evaluating alternatives:

- capital and fuel costs of generation;
- capital costs of reinforcing the transmission and sub-transmission networks;
- extension of medium voltage transmission networks;
- establishment of a low voltage distribution network and household connections; and
- indirect costs, such as household wiring.

The cost of getting fuel to remote locations is a major cost component in the decision to install diesel-fired mini-grids.

“True fuel costs” are an essential factor in evaluating nonrenewable energy development in isolated areas. For example, the cost of getting fuel to remote locations is a major cost component in the decision to install diesel-fired mini-grids. This determination entails projections of world fuel prices, transportation costs, and transportation infrastructure improvements.

How does the government promote the commercial viability of projects in rural and remote sites?

Pursue high-value markets for market entry. High value markets result in a higher "ability to pay" for electricity and concomitant project sustainability.

In general, projects can be based on two motifs:

- a ***development agenda*** whereby electricity is more likely to be at least partly subsidized and services are available to poorer people; or
- an ***economic agenda*** in which market factors play a more prominent role in project development and electricity is purchased with few subsidies.

Ensure compatibility with government agenda. but rely on local support.

Both types of projects are important, but the differences should be noted because they affect overall project development, including how the projects are financed and paid for and the level of service available. Projects may be a mix of the two (development and economic agenda) alternatives, and electricity metering can be a useful tool in these projects. Projects based on an economic (cost recovery) agenda usually have an enhanced opportunity to be more sustainable because they result in a higher ability to pay and hence generate revenue streams over the life cycle of the project. Such revenue streams are important, and sometimes essential, to pay for operations and maintenance ("O&M") costs.

Development projects are often the result of the availability of short-term capital funds (*e.g.,* over a three-year period). Funding for O&M may not be available over the life cycle of the project, thereby creating a less sustainable project environment. In addition, projects in which electricity is made available at no charge are usually much less sustainable than projects where electricity services are paid for, even if not at a full cost recovery level.

Rely on local support. It is important for projects to be compatible with the country's agenda, but projects that rely exclusively on government support may eventually fail because of the changes inherent to government agendas and because, without local support, proper operation and maintenance is difficult. Government support should be used to promote projects, and government opposition should always be avoided.

Identify an organization for long-term management and oversight.

Long-term management and oversight.

Long-term management and oversight of a project may best be vested in organizations associated with the villages that would transcend political volatility, such as NGOs with long term commitments to villages.

c. PARTNERSHIPS IN UNIVERSAL ELECTRIFICATION

During the upcoming decades, the greatest challenge to the national energy policy strategists will be attracting private-sector investments into rural and remote electrification. These policy strategists will be striving to reach three distinct objectives which may be inherently conflicting:

- ***to electrify as many communities and households without electricity service as possible*** in response to government goals that support widespread rural social and economic development.

- ***to decrease government expenditures*** in the electricity sector in response to government goals for fiscal stability.

- ***to promote private-sector investment*** in the production of electricity in response to government goals to reduce state involvement in the economy and achieve long-term growth through increased productivity and competition.

In most countries, these three objectives cannot be reached simultaneously under conventional models and practices for off-grid electrification. New models for sustainable, financially viable, large-scale rural and remote electrification are needed if most of the unserved populations are to have affordable access to electricity. It seems clear that most countries intend for universal electrification to proceed with or without private-sector investment; nevertheless, if government funds are insufficient or non existent, private funds are the only available alternative.

The question for the policy strategist is how to enlist private-sector investment in universal electrification.

The challenge to the policy strategist is to forge a shared understanding of public- and private-sector perspectives and fit them skillfully together to form a whole, thereby enabling universal electrification.

The challenge is to make universal electrification projects both profitable and less risky - and as soon as possible. Government strategists have an immediate need to partner government and private-sector developers to develop new frameworks enabling joint ventures. These new ventures will invest in commercial operations that can become profitable in a reasonable time (three-to-six years) and that can yield sustainable long-term returns on investments while serving the large need and demand for basic electricity services in isolated areas.

To enable and promote partnerships with private-sector renewable energy developers, policy makers may develop a four-fold strategy:

- **Facilitate the transfer of expertise and capital.**

- **Promote initiatives that provide remote and rural electrification projects with commercial viability.**

- **Reduce risks to the potential investor.**

- **Formulate a universal electrification plan that allows the rational use of renewable resources.**

No private-sector investor will invest in a project until it appears profitable and no private-sector banker will lend money to a project which has unacceptable risks. Rural and remote electrification projects have the reputation of being both unprofitable and high risk.

No single measure can improve the present approach to rural electrification of off-grid communities to one that is commercially viable, environmentally sustainable, and meets both the needs of remote populations and their ability to pay. However, if a combination of measures, when taken together, can reduce operating costs and increase revenues to the level of commercial sustainability, private-sector participation in universal electrification will be a reality. Renewable energy is an integral part of this solution.

What economic measures are available to governments to encourage renewable integration into the energy mix?

Researchers have found that people in rural communities have a greater willingness to pay for electricity and a greater capacity for saving income than is commonly believed by some energy policy strategists.

The goal of universal electrification (and the objective of promoting private-sector investment in universal electrification) can be buttressed by establishing the long-term objectives: (i) of project self-sustainability, and (ii) of pricing based on the cost of service. Project development that does not emphasize long-term sustainability will be avoided by private-sector investors. To this end, project development strategies should take several preliminary steps, including:

- ***Verify willingness and ability of end-users to pay.*** Directly related to long-term sustainability is the willingness and ability of consumers to pay for service. Projects should be developed whereby users can contribute to the capital cost of the project. For extremely poor people, a significant component of the project costs may be covered by grants or other external sources of funds, but individuals and communities should be required to pay something, even if it is in the form of in-kind labor rather than money.

- ***Seek local investors.*** Local investors should be sought out and brought into projects. Profit will be a key motivator for private-sector participants.

- ***Organize a method of collecting money for* O&M.** An administrative procedure for collecting revenue for operations and maintenance needs to be in place.

- ***Require that pricing be based on the costs of service.*** Although the costs per household to provide electric service in a remote rural village may be more than in an large urban center, it does not follow that the village customer must pay more for his electricity.

Develop projects in which users can contribute to the capital cost of the project.

There are several financing options that have proven successful around the world.

- ***End-user credit****.* On a local level, financing household renewable energy systems through end-user credit mechanisms is useful for overcoming the “first-cost” barrier, and thereby reaching a broader spectrum of the rural market. Local revolving credit funds are often used to supply credit and provide a self-perpetuating financial mechanism for expanding system use.

- ***Environmental incentives****.* One of the major benefits of renewable technologies is the positive effect they have on the environment, particularly in the area of air emissions. Restrictions and limitations on hydrocarbon emissions encourage the use of renewables. Environmental laws which contain emission ceilings and an emissions fine or that impose a tax on emission-producing fuels and facilities may be used to generate funds that can then be applied to lower the start-up costs for renewable-based projects.

- ***Leasing*** may prove a viable financing mechanism for supplying household renewable energy systems such as photovoltaics and small wind turbines.

- ***Subsidies*** may be established that require grid-connected tariffs to include a component defraying the start-up costs of off-grid projects. A typical approach followed in most industrial countries has been for the government to mandate a requirement (by law, regulation or contract) requiring that a utility expand services in rural areas and towns. Such expansion requirements typically allow utilities to recover their costs through an overall incease in average electricity tariffs. As the costs of service are higher in rural areas, such policies lead to some cross-subsidization from urban consumers. If such a measure is focused (*e.g.,* based on per family income and unavailable to those who can afford to pay), it will not undermine the financial position of the grid-connected generators and distribution companies. Theoretically, as incomes and demand grow, economies of scale will reduce the high costs of start up, resulting in the eventual elimination of the need for the subsidy. At the national level, financial support may come from public revenues, often with multi lateral development bank support (*i.e.,* World Bank, Inter-American Development Bank, etc.). Financial support may also come from user charges or surcharges on the use of fossil fuels. The latter has the advantage of making the programs less dependent on public financing.

Organize administrative procedures for collecting revenue for operations and maintenance needs.

- ***Tax incentives and investment grants*** may be appropriate, especially where education and training is required to enable local residents to operate and maintain isolated systems. NGOs are generally willing to participate in providing investment grant programs which promote the use of new and innovative technologies Also, tax incentives may be appropriate in cases where start up costs are high. Since start-up costs include the capital cost of the equipment, tax incentives related to capital investment in equipment used in remote and rural electrification projects (*e.g.,* accelerated depreciation, tax credits, tax holidays and production tax incentives) serve to lower the start-up costs and attract private equity and debt.

What partnership policy strategies may be designed to overcome the high initial costs of renewable energy?

The investment costs of rural electrification systems can be daunting when the task is to electrify an entire country. Access to long-term, low-interest capital is restricted normally to large, low risk generation projects, and is generally unavailable to universal electrification projects designated for remote and rural areas. However, with the advent of successful pilot projects and working installations in renewable energy rural electrification projects, the question of longer term financing is again being revisited by multilateral development banks (“MDBs”) as they weigh the risks against the obvious economic and environmental benefits these projects will yield. Depending on the scale of the initiative, financing can take the shape of large MDB projects ranging down in size to local leasing programs for household renewable energy systems.

The common thread running through all of the outlined approaches is the willingness of government, multilateral development agencies, NGO's, and the private-sector to work together to design mechanisms and opportunities for providing credit that responds to the needs and abilities of the local community.

National commercial and development banks have an important potential role to play as second-tier financial institutions.

To date, national commercial and development banks have been relatively minor players in the area of rural electrification. These institutions have typically perceived the risks of investment in this sector as being too high, and the rates of return as being too low, for their involvement. Policy strategists can overcome such perceptions through a variety of mechanisms, including pre-investment study support, loan guarantees, education and training efforts, the development of infrastructures, and the use of least-cost technologies.

Commentators from the World Bank have observed that the primary obstacle that discourages private-sector companies from providing supplies to rural areas is high start-up costs. Extending an electricity grid to remote villages can be very expensive, especially if only a few households are to be connected.

The problem here is not necessarily that people are unwilling to pay. Evidence suggests that people will spend a significant proportion of their incomes on better energy, which improves their quality of life or enables them to become more productive. In Bangladesh, for example, even the poorest people are connecting to the grid when the service is available.

Require that pricing equal the costs of service.

The problem is the perceived lack of creditworthiness of low income consumers in remote and rural areas, combined with the unavailability of long-term credit in nations with the greatest numbers of unserved populations. Rural customers who cannot get affordable credit can seldom pay the high startup costs of improving energy supplies. The government, through partnerships with NGOs, cooperatives, extension services, equipment manufacturers and multilateral development agencies, can address this problem in several ways:

- **Link government capital investments for other rural services** (*e.g.,* schools, hospitals, government buildings) with capitalization of electricity for the same region. In this strategy, a government subsidy is being offered to ensure stable electricity service for public benefit. The incremental cost of serving others in the immediate region may then be less onerous.

- **Bundle development of several rural infrastructure services** (*e.g.,* water, telecommunications and electricity) together to reduce transactions costs of financing, construction, training of local people to maintain the systems and general operations and maintenance costs.

- **Promote regional infrastructure programs.** Economies of sale may be achieved if neighboring countries can cooperate in developing multinational universal electrification efforts.

How may governments evaluate the issue of subsidies in the renewable context?

If project costs cannot be recuperated, subsidies and financial incentives may be required.

Countries may find that if costs associated with the least expensive universal electrification option can not be fully recuperated in the form of a tariff paid by consumers, then subsidies and financial incentives may be the only viable option. No country, so far, has succeeded in providing universal electricity service without some form of public support or cross-subsidies in the tariff structure.

There are two approaches to the commercial viability of universal electrification projects.

- First, **remote and rural electrification projects should permit full recovery** so that the private sector will be motivated to provide the services; and
- Second, **subsidies at the capital equipment level are justified as an investment in the social benefit of the community,** *i.e.,* government subsidies at the capital level constitute an investment in the people.

Target subsidies to remedy specific market failures and to stimulate new technologies.

These two approaches may be pursued in parallel. Compelling cases have been made throughout the world that it is a legitimate function of government to promote social and economic objectives through the use of subsidies and incentives in order to meet the goal of universal electrification. However, it is critical that if subsidies or incentives are provided that they be provided in a very focused and targeted way so as to address specific issues related to market failures and for the purpose of stimulating an economy. Limited subsidies or financial support can be justified for some programs in areas where education and training may be needed or where the costs and risks of start-up are high.

Design projects to recover their costs.

Recognizing that, in most isolated electric systems, some form of subsidy may be required initially to keep rates affordable and to promote development, it is especially important that each project be designed, over the long term, to recover its costs. Although the majority of the alternatives for encouraging rural electrification development are one form of subsidy or another, in the long-term subsidies are not healthy for a country and are not sustainable. Subsidies often represent a significant portion of a country’s gross national product, and work against least-cost-planning decision making. Subsidies also discourage efficient use of energy and generally go to higher income households. For example, in many countries where the price of kerosene is subsidized, the families who are relatively wealthy, who can afford to buy more kerosene get a disproportionate advantage. Subsidies are also traditionally provided to farms and commercial enterprises that could afford to pay the true costs.

In a number of countries, such subsidies have recently been greatly modified and in many cases eliminated altogether, as policy makers have determined that they have led to economic inefficiency. Instead of subsidies, countries have been experimenting with longer-term loans granted on a competitive basis to the rural and remote electrification projects. To date, such loans have demonstrated a high economic benefit per dollar invested.

Initially tariffs may not cover present costs but as demand and load increases, full costs will eventually be recovered.

The challenge to the policy strategist is to design a regime in which prices recover the present value of costs over the long term.

CHAPTER 6. PROGRAM IMPLEMENTATION

Institutional issues are at the center of sustainability, and sustainability is at the heart of private-sector interest. The English word **"sustainability"** has two connotations: in one sense it means "to support," and in another "to be on-going". As the term "sustainability" is used in the literature on rural electrification, both connotations are present. Typically, a government or another sponsor contributes start-up monies with the understanding that, once started, the program will be on-going, but with the need for the government or sponsor to provide some continuing, additional assistance.

From the perspective of a private-sector investor however, the concept of ***"sustainability"*** has a more demanding meaning. If a private-sector investor installs generating capacity, it is requisite for the customer community to pay for the electricity it consumes in an amount sufficient for repayment of capital costs as well as operations, maintenance and fuel expenses, plus a reasonable profit.

In an institutional sense, sustainability may be achieved through a series of steps:

- Educate customer communities on the merits of electrification and generation options.
- Select the most appropriate technology.
- Institute effective collection processes.
- Provide for adequate maintenance.
- Develop in-country technical capacity.

Education, technology selection, collection, maintenance and the development of in-country technical capacity are threads that are interwoven into the fabric of program implementation. The following sections discuss the institutional issues which affect sustainability from three different, but complementary, perspectives: program management, social factors and information programs as they relate to program implementation.

a. PROGRAM MANAGEMENT

Realization of predicted revenue streams requires active and effective collection processes. Historically, remote and rural electrification collection practices have proven inadequate. This one factor can lead more quickly than any other to the failure of rural electric utilities, whether they use conventional or renewable energy technologies.

Cost recovery through rate collection has been problematic for many rural electricity providers in isolated areas. Some rural areas have no tradition of monthly payment for services. Services are often paid at the instant the product or service is received. If electricity is being sold on a kWh basis, this can introduce a number of problems related to collection procedures. Costs of metering, billing, and collection are high, and, if not controlled vigorously, theft can become a significant problem. Losses, largely administrative and not technical, can run as high as 40% in some rural systems. Proper administrative, financial, and technical controls must be installed to ensure that collection is efficient and effective and that losses are minimized.

What policy strategies facilitate self-sufficient electrification in rural and remote areas?

Establish collection cycles in consultation with the local community.

Frequency of payment is best established in conjunction with community and local experts. Income in local communities is often tied to the land and harvests. Timely collection may be achieved in agricultural communities by simply reducing the number of payments to meet the availability of income. In some more successful projects a variable monthly fee tied to the harvest-cycle has aligned payment with income (*i.e.,* smaller payments during the time interval between harvests and larger payments when the harvest comes in). Such real world accommodations have helped consumers develop regular payment habits lessening the possibility of default.

The objective of the disconnect policy is to collect delinquent payments, not to punish consumers.

Establish procedures for nonpayment.

When consumers are unable to pay their bills, service may need to be disconnected. At such times, clear standards and procedures for disconnection are essential to minimize or prevent political interference. An individual’s status in the community can affect the collector’s willingness to penalize that individual for not meeting his financial obligation. Such practices undermine the integrity of the remote and rural electrification effort and shift the financial burden to consumers in good standing.

The objective of the disconnect policy is to collect delinquent payments, not to punish consumers. The swiftness and severity of the disconnection process should be determined by national and local leadership. Delay in initiating collection enforcement may be misinterpreted as a lack of seriousness of the payment requirement. Furthermore, delay allows past debt to build, and may result in debt accumulation to such a degree that repayment is impossible. Prudent management suggests that a disconnection process begin as soon as payment is more than one payment period past due (*i.e.,* if paying on a monthly basis, when one payment is more than 30 days past due). In most systems, the disconnect process does not mean turning off the delinquent consumer's electricity, but rather a staged process affording adequate notice. The process may begin with a warning which may include a late fee or interest charge. A second warning may result in disconnection and imposition of a surcharge for re-connection. A third warning, in the case of a distributed system, may result in removal of the generating source *e.g.,* a PV panel or wind turbine. In addition, most successful disconnect policies also outline procedures for handling consumers who are unable to pay because of temporary financial distress. An alternative to a disconnect process is the installation of pre-payment meters or availability of "life-line" amounts of power. *See* Chapter 5a (Renewable Technologies and Universal Electrification Efforts).

Establish a tariff structure geared to the social and economic realities of local area. Many local consumers have little experience with using credit or the obligation to pay a regular fee for service. Many project sponsors are unfamiliar with the income patterns of local villages or regions. While a kilowatt hour charge may be appropriate in a city, this pricing structure may be inappropriate for a rural or village setting. The policy strategist will need to give careful consideration to the most appropriate types of tariffs in any area that is a candidate for electrification. Service tariffs (a fixed amount for a particular application or load) and consumption tariffs (fees based on the number of kilowatt hours used), are the two prevailing mechanisms.

Give careful consideration to the most appropriate types of tariffs in any area that is a candidate for electrification.

In a distributed generation environment (in which a generating unit is placed in individual homes), charging consumers by type of use (*i.e.,* a set price for lighting, radio and televisions, sewing machines, etc.) may be preferable to charging a straight fee per kilowatt hour. This pricing structure removes the need to install and read meters and gives consumers a consistent and predictable figure for which they can budget. If it is desired to utilize a service fee, such a fee should be in the form of a single charge. Covering all the costs may prove less confusing both for the collection agent and the customer. Such a service fee may include the following costs:

- rental or loan fee, depending upon whether the consumer owns or leases the generation equipment, amortized over a minimum five-year period;
- administrative and technical support fees, including training, customer service, collections and disconnections;
- preventative maintenance and replacement fees for batteries, PV panels, parts, etc;
- profits or returns to developers; and
- taxes levied by the national or local government.

Accountability is essential to a sustainable universal electrification program.

"Accountability" means that the managers of a project who have the day-to-day, decision-making authority also have the responsibility to be answerable for their actions. Being "answerable" in this context means not merely in the sense of preparing statements concerning the assets, liabilities and operating results of the project, but also in the sense of being responsible for obtaining the objectives established for the project. The effectiveness of any accountability system depends on both the local managers and their reporting supervisors having a clear understanding of, and agreement on, the objectives established for a project. Commercial businesses have learned that objectives established at the operating level are more often achieved than objectives mandated from above. The same lesson is applicable in remote and rural electrification projects.

Communicating on-going results is essential to effective monitoring.

Regularized reporting forces the operating level to collect and assimilate results on an on-going basis and allows early course-correction by both operators and supervisors. Achieving such on-going communication may require overcoming numerous hurdles. Many local groups and villages have little experience with record keeping and little time or incentive to maintain extensive records. In many isolated areas, literacy deficiencies and lack of writing skills are a fact of life. Mail, telephone and telegraph may be slow or non-existent. An over-zealous bureaucracy can impose unrealistic and burdensome demands on the resources of a manager in a remote area. By limiting the number of reporting requirements, greater accuracy can be expected of the reports delivered. For example, if managers require only an original of a report, rather than duplicates or copies in even greater multiples, limited local resources will not be overtaxed. Effective monitoring is equally essential. Communicating is a two-way exercise. Furthermore, an unanswered or unacknowledged report is a lost opportunity to encourage success or provide guidance.

The challenge to the policy strategist is to identify the minimum information required to ensure accountability and to devise mechanisms for its accurate dissemination. Such minimum information requirements may include:

- general financial and operating information;
- account delinquency rates;
- system performance measures; and
- customer satisfaction measures.

How may governments establish sound local administration?

Knowing who has paid and who has not paid their bills is the primary function of a rural electricity record-keeping system. No organization can survive without an accurate picture of its finances, yet this is often the case in remote and rural electrification installations. Local communities often are not familiar with record keeping techniques. Since many have never been required to make regular payments of any type, they have no knowledge of what is required to track those payments. National, state or local governments usually must exercise primary responsibility to provide the training, infrastructure and oversight of the records management process. This process requires creating uniform procedures and forms and then mandating their use.

Sound practice suggests centralized record keeping, and institutionalizing the payment of bills by individuals.

Without centralization, payment information can be easily lost or neglected. If payments are made collectively (*i.e.,* by a neighborhood or village in a cooperative) it may be administratively unwieldy, if not impossible, to determine who within that village has actually paid. As a check to the collection process, it is good practice to provide consumers with receipts for their payments which they should be instructed to keep and, in case of disputes, use as proof of payment.

The challenge to the policy strategist is to identify the minimum information required to ensure accountability and to devise mechanisms for its accurate dissemination.

Maintenance plans may be created with the assistance of the vendor and product manufacturer and tailored to the specific circumstances and means of a project site.

Regular audits ensure adherence to policies and procedures.

Regular audits of the records ensure that the policies and procedures are being met. Without oversight, there is little incentive on the part of local communities to comply with records management requirements.

How may governments provide for adequate maintenance?

Although renewable technologies require less maintenance than conventional forms of electricity generation, they are not immune to equipment or parts failure. Ensuring reliable electricity supply is key to customer satisfaction and, ultimately, to the success of a rural electrification effort.

Preventative maintenance and tracking records minimize system failure.

A preventative maintenance and testing program is the best method for minimizing system failures and maintaining a reliable supply. Maintenance plans may be created with the assistance of the vendor and product manufacturer and tailored to the specific circumstances and means of a project site. Preventative maintenance programs will reduce the number of system failures, but they can not eliminate them entirely. A standardized record system for tracking maintenance and repair records is also an essential part of such a maintenance plan, thus a repair and replacement program will be required.

Maintenance plans begin with the consumer.

Consumers are closest to the individual units and can be trained to spot minor problems before they become too severe. Additionally, consumers can be instructed in basic maintenance of their systems - keeping them dean, lubricated, etc. As an incentive to follow a maintenance regime, consumers may be offered a small discount for their efforts. Such programs can significantly extend the life of installed systems and favorably impact both the financial and social bottom line.

Test prior to installation.

Test to identify equipment problems before installation. Testing programs can be as simple as a visual check for obvious unit defects or component-based testing with appropriate testing equipment.

Formal maintenance programs are essential to sustainable programs.

A formal maintenance program with supporting infrastructure is essential to a sustainable program. Such a formal maintenance program includes:

- a job request system for initiating and tracking service orders;
- access to system manuals, training programs, and testing and diagnostic equipment;

- ready access to spare parts and replacement equipment;
- access to maintenance and repair records; and
- a mechanism for evaluating the success and longevity of repairs.

b. SOCIAL FACTORS

Development of rural and remote electrification projects requires a major level of community involvement In the past, those projects with a high level of community involvement - consensus, support, and participation - have been the ones which have proven the most successful.

Community participation creates ownership, and ownership leads to success.

Even the best crafted energy plan and the best funded rural electrification project ultimately may be frustrated if the local community is not brought fully into the process. Urban programs or experiences can not be easily replicated in a remote and rural setting. The dynamics and reference points are just too different. Local community members are in the best position to assess their willingness to support electrification efforts and to choose the best options for generation once those options have been explained to them. Participation creates ownership, and ownership leads to success.

Local village structures and interpersonal relationships are complex and involved. Remote villages are microcosms of a country, and like a country, are made up of many groups and subgroups, often acting at odds with one another. But villages are more sensitive than large population centers to small disruptive elements. Policy planners seeking electrification for remote areas have found that by enlisting the involvement and support of groups and sub-groups within villages, they can better ensure that such electrification programs are perceived as equitable and are not resisted as favoring one group over another.

From the private-sector perspective, ***local ownership, a project champion,*** and ***affordability*** are key issues:

Focus on projects with a high level of community involvement.

- ***Requirement of local ownership****.* Local ownership is important for project sustainability; and provides a link between the project and the community. It increases the communication between the villagers and project developers and allows a project to be seen as more of a local response to local needs than a government-imposed, top-down development.

- ***Need for a project champion.*** Related to the local ownership issue is the identification of a project champion. A project champion is someone who lives in the village (such as the acknowledged leader of the community) and who actively supports the project. This person could also be the owner or the operator (or both) of the system. They would be available on a day-to-day basis for the interface (social and technical) that is required for village power projects.

- ***Need to match local needs while assuring affordability.*** Matching local needs to project development and design is important. For example, projects based on an economic agenda (*i.e.,* few grants or subsidies included in the financing) should ensure that services offered correspond to the local ability to pay.

Local ownership, a project champion and affordability builds a high level of community involvement. Community involvement entails consensus, support and participation - necessary elements found in the great majority of successful electrification programs.

On what basis may governments select areas for electrification?

Define the criteria for participation in an electrification program.

Frequently, a nation cannot electrify its rural areas all at once, so some method of selection and prioritization must be decided upon. Selection of villages or households for electrification can be a highly politicized process. Choosing who receives access to electricity and who does not confers a lot of power on the individual making that decision. Without a clearly defined plan and criteria for participation, electrification can become a tool of political patronage, leading to discontent and inefficient distribution of product. Criteria may properly reflect the ability to pay as well as the need and appropriateness of the area for installation or connection.

Depoliticize the selection process.

Enlist the involvement and support of groups and sub-groups within villages to ensure that electrification programs are perceived as equitable and are not resisted as favoring one group over another.

Selecting communities to receive electricity has often been a highly politicized process. With privatization of state-owned systems, central planning is becoming a thing of the past. Universal electrification, however, may be one area in which integrated resource planning remains a valid government tool. Otherwise, particularly if the State continues to be involved in co-financing projects, the decision errors of the past could be repeated in the future. To safeguard against these tendencies, either integrated resource planning or some alternative, pragmatic methods of planning seem prerequisite to a national universal electrification program. At a minimum, such planning should incorporate criteria such as the needs of communities, costs and benefits, productive uses and the environment.

Establish an objective review board.

The selection process requires more than merely establishing standards; it requires the establishment of an impartial review board to apply those standards. The most effective review boards are ones that represent a cross-section of the community, not just one faction or class. Diversity of representation however, should fit the cultural requirements of the local community and seek to support (not supplant) the local governing structure. The board should be provided with the necessary training and support to execute their responsibilities and should develop models for resolving disputes. In cases where the demand for access outweighs supply, a lottery system for qualified applicants may be an effective method for choosing recipients.

c. INFORMATION AND IMPLEMENTATION

Education and training make remote and rural electrification possible. Once the policy strategist formulates the objectives of such an educational and training program, the policy implementer will establish an educational and training plan that enables these objectives to be met.

In a universal electrification program, ***"education"*** implies imparting information sufficient to allow rational decision making, and ***"training"*** implies instructing the recipient how to perform a specific task. ***"Demand-side management"*** - the planning implementation and monitoring of utility activities designed to influence customer use of electricity in ways that will produce desired changes in a utility's load shape - is related to training but is a little different and includes the perception of the local communities about the project.

Electrification is an information and knowledge-driven process.

Electrification is an information and knowledge-driven process, from the establishment of policy to the day-to-day operation of generation equipment. Policy strategists at the national level will become familiar with the capabilities and operational requirements of different renewable technologies, comprehend the vagaries and nuances of national energy law and policy, and master basic financial analysis and administration techniques. This basic knowledge is equally important to local governments, local developers, and consumers.

Decision makers in countries with large populations without electricity may not have access to accurate information on the appropriateness of various generation options. Often they have no information either regarding user willingness and ability to pay or the local availability of renewable natural resources. In such an environment, policies and planning tend to be politically based rather than prioritized on an economic or financial rationale.

Communicate realistic expectations of electricity availability and project performance to users before project implementation. Education is a two-way communication.

At the national level, planners are often unaware of the potential for the utilization of the PV, wind, biomass, mini-hydro and geothermal technologies. They may also be unaware of the existence of these technologies as viable options to meet the basic electricity needs of isolated communities and to assist in reducing CO_2 emission. Such unawareness results in these technologies being left out of the energy planning process. Consequently, policy strategists need to act not only to promote awareness of the potential for utilizing such technologies, but to assist, wherever possible, with their integration in the sectoral-planning process.

Education is a two-way communication.

The project developer must become aware of the needs of the community and the community must learn about the project and take part in its development. It is important that realistic expectations of electricity availability and project performance are communicated to users before project implementation. For this knowledge to be properly communicated, training programs must be infused into every aspect of the process.

Once the decision to electrify is made, the training process begins.

Training is a key social issue. The policy planner responsible for ensuring that everyone associated with a project becomes familiar with their particular responsibilities and obligations will need to identify the whole spectrum of potential trainees and establish the objectives for each trainee group: **administrators, technicians,** and **consumers.**

- ***Administrators* (*system owners and operators*) *-*** Train to understand and apply the rules for selecting participant households, for collecting and recording payments, for dealing with delinquent accounts, and for communicating with consumers and regulators.

- ***Technicians* (*maintenance people*) *-*** Train to install and maintain the generation systems, to diagnose and repair problems and to respond to customer requests in a courteous and timely manner.

- ***Consumers -*** Train to use electricity efficiently and train to operate and perform the basic upkeep on their systems.

Infuse training programs into every aspect of the process.

Establish, test and recognize proficiency levels.

Regular skill and competency testing, especially of technicians, allows policy implementors both to evaluate the general effectiveness of training programs and to provide a reasonable degree of quality control. A certification program for technicians can be useful for ensuring a minimum degree of competency and improving work quality. Certification confers status on the individual and can improve productivity and encourage compliance.

A sound training program is both stable and dynamic.

Economies of scale as well as elementary management requirements usually dictate the standardization of educational and training programs for electrification. Standardization does not, however, mean that these programs are frozen or immutable. Since the training requirements will be on-going, training programs will evolve to reflect changing circumstances. Consequently, these on-going training programs should be flexible and adaptive to meet the changing needs and patterns of the community.

Educate local communities on the benefits of electrification.

In an education program designed to explain the practical applications of electricity (how it can be used efficiently) and the financial implications and obligations of each household, adult students learn not only about electricity but also about what it means to be a consumer.

Consider gender issues, cultural practices and local customs.

Sensitivity to gender issues, cultural practices and local customs ensure that educational and training efforts target the proper individuals. For example, in many countries, household tasks ripe for electrification (including illumination) may be the responsibility of women. In this instance, instruction targeted at male consumers may prove ineffective.

Educate local communities on the benefits of electrification and familiarize communities

with generation options.

Familiarize communities with generation options.

Few communities or individuals will opt for a technology about which they know little. An informed choice requires information. An education program which introduces local communities to the different generation technologies and promotes a unbiased discussion of the advantages and disadvantages of each technology: (*i.e.,* costs, reliability, maintenance, output, resource requirements) allows those local communities to make sound decisions. A community which is knowledgeable about generation options can participate in choosing the most appropriate technology for their location and situation.

Energy strategists should be alert to identify misconceptions that serve as a deterrent to facilitating the utilization of renewable energy systems. For example, planners in many developing countries still mention the high investment cost of PV compared to diesel generators, instead of comparing these two technologies on a life-cycle costing basis. In this example, were the planner to consider both life-cycle costing and undistorted (unsubsidized) conventional fuel prices, PV systems would compete on an equal economic footing with diesel generators in view of the minimal maintenance needed for upkeep; the lack of fuel requirements for electricity generation and the positive impacts created on the environment.

In an education program designed to explain the practical applications of electricity (*how it can be used efficiently*) *and the financial implications and obligations of each household, adult students learn not only about electricity but also about what it means to be a consumer.*

APPENDIXES

Appendix A. Description of Renewable Energy Technologies

The fact about...
Biomass Energy

Presented by US/ECRE in cooperation with the Bioenergy Industries Association U.S. Agency for International Development

Biomass - any organic material such as wood and woodwastes, agricultural residues, municipal waste, and animal waste-is the oldest source of energy known to mankind.

For thousands of years, people have burned wood to generate heat and to cook food. Until the mid-1800s, 90% of the energy consumed in the U.S. was generated by burning biomass. Today, biomass energy accounts for about 3.2% of total U.S. energy consumption, or some 2.9 quadrillion BTUs (quads) every year.

In 1994, biofuels generated 2.7 quads of energy in the U.S. That’s roughly the same amount of energy generated by U.S. nuclear power plants and 45% of total U.S. renewable energy consumption that year. The U.S. Energy Information Administration (EIA) reports that U.S. consumption of biomass has grown more than 10% since 1990, and projects that biomass will generate 3.4 quads by the year 2010, an increase of over 20% from 1995.

Wood burning accounts for the majority of bioenergy use in the U.S., with over 700 facilities currently using wood or woodwaste to generate electricity. Two-thirds of this wood is consumed by. industrial facilities - primarily pulp, paper, and sawmills and wood products manufacturers - to produce electric power and process heat or steam for their industrial operations.

A number of independent power producers generate biomass-fueled electric power and sell it to electric utilities under long-term power purchase agreements. These facilities range in size from 5 MW to over 50 MW and bum a variety of biomass resources, including woodwaste, rice hulls, nut shells, orchard prunings, and sugarcane bagasse. The remainder of U.S. bioenergy comes from agricultural residues, landfill gas, municipal waste, livestock waste, and ethanol, and is used for a variety of residential, commercial, industrial, and transportation applications.

U.S. utilities, municipalities, and economic planners have become increasingly interested in using bioenergy to meet economic, environmental, and social goals. These groups see a number of benefits related to the use of bioenergy:

- **Bioenergy systems address local and global environmental concerns.** When used to offset fossil fuel use, bioenergy systems can significantly reduce or eliminate sulfur dioxide emissions (which cause acid rain) and a variety of other harmful emissions, including nitrogen oxides and particulates. Moreover, since growing biomass absorbs an amount of carbon roughly equal to that emitted when it is combusted, bioenergy systems produce energy with no net emissions of carbon dioxide, the chief greenhouse gas. The U.S. is negotiating international agreements to limit greenhouse gas emissions, and bioenergy is expected to play a prominent role in helping the U.S. comply with these treaties.

- **Biomaas offers short-and long-term economic advantages.** The use of locally produced fuels directly reduces the need to import oil or coal from other regions or countries. Development of local infrastructure for fuel supply generates local employment in the cultivation, harvesting, and processing of biomass fuels. In 1992, the use of biomass resources to produce electricity generated more than **$1.8** billion in corporate and personal income and more than 66,000 jobs throughout the U.S. economy.

- **Biofuels can be burned with the same type of equipment used for conventional power generation.** Unlike other renewable energy sources, bioenergy can be generated using combustion technology similar to that used in existing fossil fuel-fired power plants. In fact, biomass can be used as a supplemental fuel in existing power plants in a process called co-firing.

- **Crop production can help revitalize many rural area** According to the Electric Power Research Institute (the research arm of the U.S. electric utility industry), the U.S. could support 50,000 MW of biomass power generating capacity by dedicating currently available cropland for fuel production. This capacity could create a $12 billion annual market for agricultural producers.

- **Biomaas generates profitable co-products and ancillary benefits.** In addition to useful energy, bioenergy systems can create lucrative by-products such as animal feed, pulp, and industrial chemicals.

In developing countries, biomass is still the dominant energy source, accounting for roughly 35% of energy consumption overall, and contributing up to 70% of total energy consumption in some countries. This energy, used primarily in the form of fuelwood for cooking, is produced and consumed in a very inefficient manner. In some areas, fuelwood gathering is contributing to deforestation and other environmental problems. However, many efforts are underway throughout the developing world to promote more efficient production and use of biomass energy. India, for example, is implementing new policies and fiscal incentives to encourage its sugar sector to produce electric power for the grid using sugar cane bagasse and cane trash.

Through the use of snstainable timber harvesting practices, full use of all harvested wood, agricultural by-products, and everyday waste products, countries can reduce their dependence on fossil fuels while boosting their local economies, increasing employment, and protecting the environment As utilities, consumers, and policymakers become better educated about its benefits, bioenergy will become an increasingly important part of the modern energy economy.

BIOMASS TECHNOLOGY: HOW DOES IT WORK?

Bioenergy is generated from biofuels - organic materials such as trees, grass, agricultural residues, animal wastes, aquatic plants, and municipal waste. These fuels store energy captured from the sun during photosynthesis.

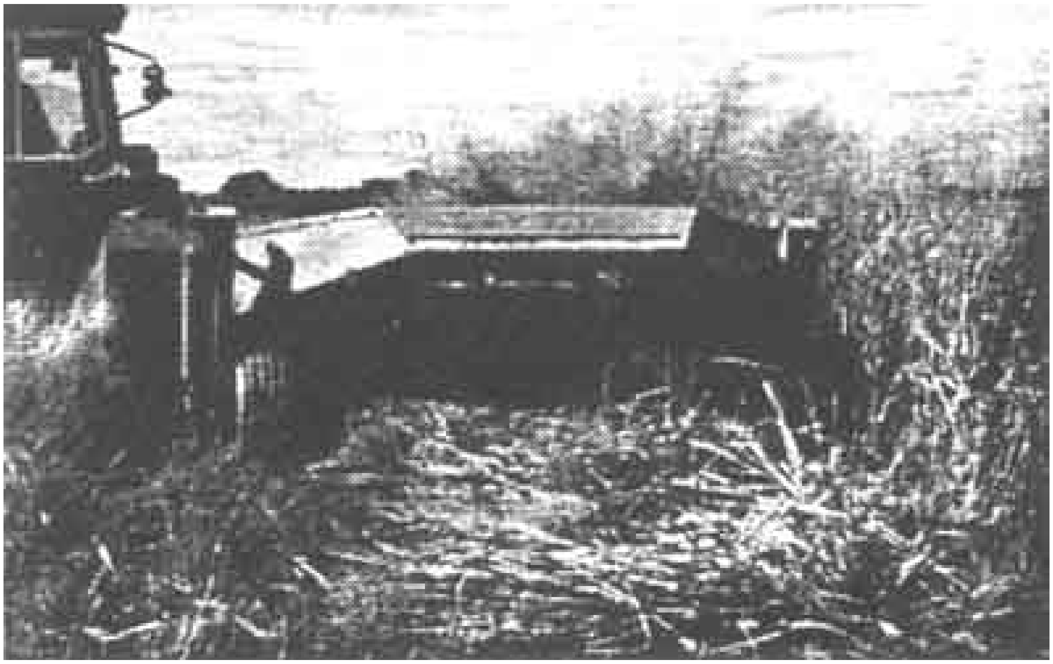
Bioenergy technology extracts the energy stored in biofuels through direct combustion or by converting the fuel into charcoal, liquid, or gas. There are four basic methods for converting biofuels into energy:

- **Direct Combustion:** Biofuels can be burned to produce steam for generating electricity, heating homes, or supporting industrial processes. This is the simplest and most commonly used method of biomass conversion.
- **Anaerobic Digestion:** This biochemical process uses bacteria to accelerate natural decay and converts biomass into methane. Methane gas can be burned like natural gas for residential cooking and heating, industrial heat and steam, and/or electricity generation.
- **Gasification:** Through direct combustion biofuels are heated, usually in the absence of oxygen, and reduced to gaseous compounds. The resulting fuel is treated and can be burned to produce heat or steam, injected into engines to produce mechanical or electrical power, used as transportation fuels, or converted into synthetic fuels.
- **Fermentation:** By using yeast to decompose carbohydrates (such as starches in grain, sugar cane juice, or molasses), biomass can be converted into ethanol and used as a transportation fuel Each year, U.S. ethanol production offsets approximately 60 million barrels of imported oil and positively impacts the U.S. trade balance by $2 billion.

Each of these bioenergy conversion methods is in use today. However, bioenergy will never reach its full potential until its benefits are properly understood and accounted for by policymakers.

Bioenergy has a particularly strong role to play in mitigating environmental concerns such as waste disposal, acid rain, and global climate change. In addition, bioenergy systems can stimulate economic development and job creation.

The cost-competitiveness of bioenergy systems is dependent upon several factors, most of them site-specific. For example, since biofuels have a relatively low energy content per ton, bioenergy facilities must be sited close to their fuel source in order to minimize transportation costs. A bioenergy project generally requires a long-term fuel contract to ensure adequate fuel supplies at stable prices. The economics of bioenergy are most advantageous when the project operator receives a “tipping fee” to dispose of biomass that would otherwise end up in a landfill



BIOFUEL: WHAT QUALIFIES?

Most biomass fuel is gathered in the form of waste or residue from forests, cities, towns, agricultural interests, and industry. Fuel also can come from fast-growing plants that are harvested specifically for energy production. Ideally, energy crops can grow on a marginal amount of land, thrive without fertilizers or extensive maintenance, and protect the soil from erosion.

Biomass Wastes -

- By-products from manufacturing processes (wood shavings or pulp waste)
- Agricultural and food processing wastes (fruit pits, rice hulls, corn cobs)
- Sewage and solid waste

Biomass Residues -

- Forest residue (diseased timber, forest thinnings, poor quality timber that cannot be sold)
- Agricultural residue (sugar cane bagasse, corn stalks, straw from rice, wheat, or other grains)

BIOMASS CASE STUDY

Dow Coming Corporation, Midland. Michigan, USA

Rising energy costs led Dow Corning Corp. to build a biomass-fueled 28-MW steam and electric cogeneration facility at its Midland, Mich, manufacturing plant Using wood harvested from nearby aspen forests, wood wastes from local industry, and commercial woodwastes from area businesses, Dow produces steam (formerly produced by a fuel oil generator) and electric power to meet its industrial energy needs.

The facility generates an average of $9 million in annual fuel savings and has kept thousands of tons of wood waste from Michigan landfills.

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Center for Renewable Energy & Sustainable Technology (CREST)
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World Wide Web: http://solstice.crest.org.renewable/usecre

The facts about...
Energy Efficiency

Presented by US/ECRE in cooperation with the U.S. Agency for International Development and the National Association of Energy Service Companies

When people begin exploring energy efficiency measures as means of reducing their energy costs, many start with a “turn-down-the-thermostat” approach reminiscent of the 1970s. Today, however, the energy services industry provides a full range of high-technology approaches for reducing energy consumption and improving end-use efficiencies without sacrificing comfort or productivity.

These new technologies - ranging from high-efficiency lighting equipment to energy efficient motors and energy management systems - are helping consumers rework the way they use energy. Energy efficiency investments in residential buildings, commercial enterprises, manufacturing, and industrial facilities can provide tremendous savings to consumers and a strong boost to the economy as a whole. For example, lower operating costs resulting from energy efficiency improvements in government buildings convert into huge savings for American taxpayers. In addition, reduced energy costs in the private sector translate into increased profits for individual companies as well as greater overall economic health.

Figure I.

According to the National Association of Energy Service Companies (NAESCO), investments in the U.S. residential and commercial sectors alone could save the equivalent of 80,000 MW of electric generating capacity while creating 345,000 new jobs and reducing carbon emissions by 72 metric tons *every year.*

In order to achieve this level of success, the energy service industry goes beyond simple conservation. By using technologies and project designs that require less fuel, the industry helps its customers actually improve indoor comfort levels and (in the industrial and manufacturing sectors) increase production. This brings savings for everyone because reduced energy consumption, energy costs, and increased production capacities translate into a more efficient economy. In the hypothetical scenario outline below (see Figure 1), energy efficiency investments enable U.S. consumers to increase their annual consumption of non-electricity goods and services by $45 billion.

Long active in the U.S. domestic market, energy service providers are expanding their project horizons internationally. The companies that develop energy efficiency projects are seeking to provide international customers with the same benefits that U.S. consumers receive from innovative projects.

Facility owners, utility officials, and government decision makers in a number of countries are expressing a growing interest in American energy efficiency products and services. Opportunities are increasingly abundant for American equipment manufacturers and investors working in the international marketplace. This is good news for the U.S. economy, where the 82 billion invested annually in installed projects around the world creates about $700 million in direct employment benefits each year.

WHAT IS AN ENERGY SERVICE COMPANY?

An energy service company (ESCO) is involved in the development, installation, and financing of comprehensive, “performance-based’ energy efficiency projects. ESCOs maintain project equipment, monitor and verify a project’s energy savings, and assume the risk that a project will save the amount of energy promised.

Energy efficiency projects are considered “performance-based” because the ESCO’s compensation is generally based on the amount of energy actually saved. Projects generally seek to achieve energy savings from the widest possible combination of cost-effective measures in a facility. These characteristics set ESCOs apart from other market providers who do not offer comprehensive project designs using multiple technologies.

While ESCOs may pursue various market strategies, all are characterized by their comprehensive project development capabilities and their assumption of performance risk for each project they develops

CORE TECHNOLOGIES -

The core of a typical energy efficiency project is built by employing a combination of some or all of the following technologies:

- high-efficiency lighting (fluorescent and incandescent);
- high-efficiency heating and air conditioning;
- efficient motors;
- variable-speed drives; and
- centralized energy management systems.

In some cases, these technologies exhaust the possibilities for energy savings at a given facility. Many times, however, they form a foundation from which additional savings can be achieved through more innovative measures, such as the addition of cogeneration or renewable energy systems.

ENERGY EFFICIENCY CASE STUDIES

For *most projects, a* ***baseline energy audit*** *is conducted to gain a general understanding of a facility's energy consumption. The initial audit can help determine the potential scope of an energy efficiency project and provides the building blocks from which an ESCO can perform a more detailed and* ***comprehensive investment-grade energy audit*** *Results from the comprehensive audit are used as the basis for project financing and energy savings projections built into the contract* ***Ancillary services*** *are of ten provided within a project contract, such as removal and disposal of hazardous materials from a customer's facility. In addition, projects are centered on* ***educating customers*** *about their energy consumption patterns and building an* ***energy efficiency partnership*** *between the customer and the ESCO. Finally, ESCO contracts include a* ***maintenance component*** *to ensure that new high-efficiency equipment achieves optimal performance over its lifetime.*

Libby-Owens-Ford Glass Manufacturing Plant
Laurinburg, North Carolina
PROJECT DEVELOPER: Honeywell

At Libby-Owens-Ford's (LOF) plant in North Carolina, Honeywell Home & Building Control has developed a comprehensive energy efficiency system which is saving $1.5 million annually in energy and operating costs. Honeywell conducted a major modernization project at the 23-year-old plant, including environmental controls, lighting, and production-line improvements. For example:

- Variable-speed drive retrofits on fan systems provide the largest single energy savings ($250,000 each year).

- High-pressure sodium lamps and electronic ballast retrofits save $160,000 annually.

- Programmable controllers adjust critical temperatures in the manufacturing process.

- A digital facility management system monitors conditions, flags equipment problems, and administers energy management programs.

Equipment upgrades and process improvements add more than $1 million annually to the energy cost savings earned by the project After five years, LOF will retain 100% of the cost savings.

Hyatt Regency Hotel
Buffalo, New York
PROJECT DEVELOPER: Power System Solutions

In the early 1990s, the Hyatt Regency Hotel in Bufalo received an energy audit from its utility, Niagara Mohawk Power Corp., which identified a number of opportunities for saving energy. Based on this initial audit. Power System Solutions (PSS) conducted an investment-grade audit which revealed that the hotel could save at least 1.4 million kilowatt-hours and $ 100,861 in energy expenditures each year by making specific equipment changes and installing an energy management system. The hotel agreed to install:

- variable-speed drives on its ventilation fans, water pumps, and cooling tower;
- a run-around-loop heat recovery system;
- a direct digital energy management system which enables the hotel's engineers to match energy use to the use of the building's facilities; and
- complete high-efficiency lighting.

PSS guaranteed annual energy savings of $100,000. Since the project's completion in Spring 1994, the hotel has saved roughly $160,000 every year. The project has provided positive cash flow from day one, and after four years, the hotel will retain 100% of its savings.

For more information, contact any of the following organizations:

Center for Renewable Energy & Sustainable Technology (CREST)
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Export Council for Energy Efficiency
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National Association of Energy Service Companies
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The facts about...
Geothermal Energy

Presented by US/ECRE in cooperation with the U.S. Agency for International Development and the Geothermal Energy Association

Geothermal resources serve a substantial portion of the world's energy demand, and use of this renew able energy technology is growing.

More than 6,700 MW of geothermal electricity generating capacity is installed in 20 countries in virtually every region of the world. In addition, the world has more than 11,300 thermal megawatts operating in direct-heat geothermal applications. In the United States alone, the geothermal industry provides 2,750 MW of electricity generating capacity and 700 MW of thermal capacity. The world's geothermal capacity saves the equivalent of 150 million barrels of oil each year.

Despite this success, geothermal energy could provide significantly more electricity if its full potential is tapped. Many view geothermal energy as a key resource for meeting growing power demand in developing countries. Clean, efficient resources and energy efficiency measures are essential to satisfying explosive demand in these markets. The Geothermal Energy Association estimates that over the next 30 years, as much as 80,000 MW of electricity generating capacity could be constructed in developing countries. This amount of power could bring significant quality of life benefits to citizens in places like Mexico, Central America, the Caribbean, South America, and the Pacific Rim.

GEOTHERMAL ENERGY - THE BENEFITS

- **Minimal Environmental Impact:** Geothermal plants generate far fewer and more easily controlled environmental impacts compared with conventional technologies. Air emissions are virtually zero; water used in geothermal plants is returned to reservoirs at a depth well below gronndwater levels; and geothermal plants re quire a very small amount of land.

- **High Reliability:** Existing geothermal systems have proven to be highly reliable. They are available for power generation 95% of the time with excellent efficiency and production values.

- **Modularity:** Geothermal plants can be built over time to serve demand as it grows. A 10-MW geothermal power plant can be built in as little as six months. Clusters of plants totalling 250 MW or more can be built in two years.

- **Indigenous resource:** By tapping its geothermal resources, a community or nation can avoid costly energy imports. Also, plants generate local jobs and economic development As part of a diverse resource base, geothermal can help insulate against fuel price increases and provide greater energy security for consumers.

GEOTHERMAL ENERGY TECHNOLOGY-HARVESTING THE EARTH'S NATURAL HEAT

In order to generate electricity, geothermal developers drill deep into the Earth to tap naturally occurring hot water or steam. Water temperatures found thousands of meters beneath the Earth's crust can reach 400° Centigrade. Heat is brought to the surface and harnessed to power electricity-generating turbines.

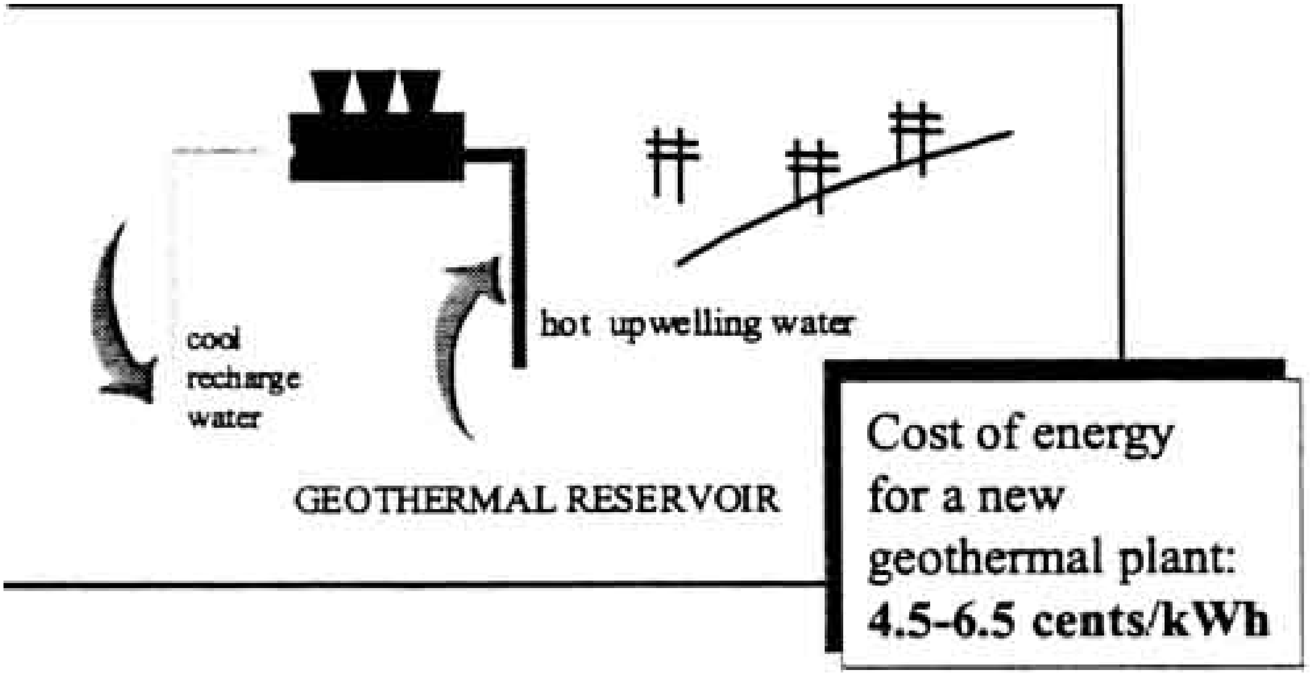
Three geothermal regimes exist within the Earth's crust hydrothermal, hot dry rock, and earth energy. Hydrothermal energy and earth energy provide economically competitive power for today's consumers. Geopressured, hot dry rock, and magma energy all require additional technology improvements in order to be cost-competitive.

- **Hydrothermal energy, geopressured energy, and magma energy** result when heat is concentrated in specific regions of the Earth's crust The most obvious indicators of this type of energy are volcanos, geysers, and hot springs. In many places, however, significant geothermal resources exist in locations where such indicators are not present on the Earth's surface.

- **Hot dry rock energy** is found eight to 16 kilometers (five to 10 miles) everywhere beneath the Earth's crust Hot dry rock energy is difficult and expensive to extract since the rocks are either too dry or impermeable to transmit water in useful amounts.

- **Earth energy** is used in geothermal heat pumps throughout the United States. This thermal energy is found just beneath the surface and is the normal temperature of shallow ground. Without enhancement, earth energy can be tapped by heat pumps to help alleviate electricity demand.

For generating electricity, hot water (ranging in temperature from 177° to about 370° C, or 350° to greater than 700° Farenheit) or steam is pumped from an underground reservoir to the surface. The steam is transferred to a turbine which turns an electricity generator. The remaining geothermal fluid is pumped back to peripheral parts of the reservoir to help maintain its pressure.



Low-temperature resources (lower than 177° C or 350° F) can be harvested through binary power plant technology. A binary plant taps geothermal fluid to heat a “working” fluid that vaporizes at low temperatures. The working fluid vapor is fed to a turbine and is re-condensed and then re-heated repeatedly in a closed-loop cycle.

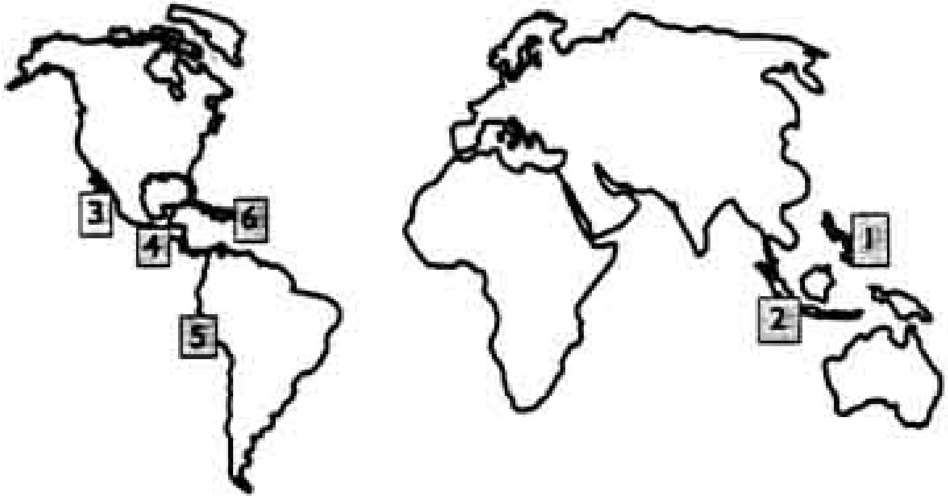
In direct-heat applications, geothermal water is usually fed into a heat exchanger which transfers heat to the household. The geothermal water cycles through the heat exchanger and then returns to the reservoir. Direct-heat applications can be used for home heating, greenhouse heating, vegetable drying, and other uses.

Geothermal heat pumps use yet another process. A heat exchange fluid runs through a closed-loop system, absorbing heat from the earth and transferring it to the home.

KEY GEOTHERMAL RESOURCE AREAS

A large number of high-temperature geothermal systems are found along the edge of the Pacific Ocean. This region is home to hundreds of active volcanos and stretches from the Aleutian Islands of Alaska east to the Philippines and Indonesia and south to the Andes Mountains in South America. Because of widespread volcanic and earthquake activity, this part of the world has been called the “Ring of Fire.”

Geothermal projects are operating and being built throughout the Ring of lire, but the U.S. geo-thermal industry is concentrating its efforts on six specific areas (see map below).



1. The Philippines The Philippines ranks second in the world in installed geothermal-based electricity generating capacity. Geothermal fields throughout the Philippines are large, but most development is focused on the islands of Luzon and Leyte. The first Philippine geothermal plant began operating in 1979. The country now hosts 1,051 MW in geothermal electricity generating capacity, and plans for 927 MW of additional capacity are in the pipeline. In addition to electricity generation, geothermal energy is used in the Philippines for fish processing, salt production, and coconut and fruit drying.

2. Indonesia: Another world leader in geothermal energy development, Indonesia first began harvesting the earth’s energy in the 1920s. The country has 114.5 MW of operating geothermal-based electricity generating capacity and is planning to develop more than 1,300 MW in additional capacity by the year 2000. These new installations will bring power to the central grid as well as to isolated villages. Indonesians also use natural steam and hot water for cooking and bathing.

3. Mexico: Approximately 756 MW of geothermal electricity generating capacity is operating in Mexico. The country also has 1,400 hot springs, and direct-use applications are used for industrial laundries, refrigeration, district heating, greenhouse heating, concrete block production, and timber drying.

4. Central America: Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Puerto Rico have tremendous geothermal potential, but most of it is undeveloped. El Salvador is most advanced, with 105 MW of capacity operating, followed by Costa Rica with 60 MW, Nicaragua with 35 MW, and Guatemala with 24 MW.

5. Andes Volcanic Belt Several high-temperature geothermal systems exist in sparsely populated areas of Venezuela, Colombia, Equador, Peru, Bolivia, Chile, and Argentina. However, because of low population density, energy demand is low and most of these fields remain undeveloped. A 670 MW power plant is operating in Argentina and hot waters throughout South America are used for bathing and district heating.

6. The Caribbean: Several Caribbean islands are exploring and developing their geothermal potential: Guadeloupe, Dominica, Monserrat, and St Lucia.

For more information, contact any of the following organizations:

Center for Renewable Energy & Sustainable Technology (CREST)
1200 18th Street N.W.
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(202) 383-2550
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The facts about...
Hydropower

Presented by US/ECRE in cooperation with the U.S. Agency for International Development and the U.S. Hydropower Council for International Development.

The last two decades have seen significant growth in hydropower development throughout the world. While large projects were built in the 1970s to provide utility-scale, grid-connected power and flood management, smaller scale hydropower projects are now helping to address one of the developing world's most pressing problems: the need to bring electricity to remote, rural areas.

Few developing countries are able to satisfy the rapid energy demand growth that is fueled by their exploding populations. Power is desperately needed in these countries to satisfy a full range of needs, from electrifying village schools and health facilities to grinding grain and pumping clean water. Electricity sector restructuring in many of these countries, along with the ability for private development of hydropower projects, can bring electricity to these growing communities.

Less than 10 percent of the world's technically usable hydropower potential is being used today. However, small-scale hydropower plants are proving to be very cost-effective for strengthening grid-connected systems and for rural electrification. These plants provide a number of benefits to the communities that they serve. For example -

- Thousands of existing facilities sited around the world have proven their reliability and effectiveness.
- With sufficient water resource, these facilities can provide a 24-hour energy source.
- They have no fuel costs and cause minimal environmental impact.
- Operation and maintenance requirements are minimal and can be performed by local staff.
- Properly maintained facilities can perform well for 50-100 years.

Existing hydropower projects invest in local resources and provide energy for local activities (like grain grinding, milling, and drying) and electricity for lighting, communications, and small industries. In addition, hydropower plants are used to fuel water purification efforts and agricultural processes.

U.S. industry has been a critical player in the design, development, mitigation of environmental impacts, financing, installation, and operation of hydropower facilities around the world. The industry is continuing its leadership position by bringing competitively priced, state-of-the-art technology to the global market New hydropower facilities cost between $800 and 81,200 per kilowatt installed.

From the mountains of Nepal to the islands of Malaysia to the forests of Central and South America, American-manufactured hydropower equipment and expertise are helping bring improved quality of life to the world's developing economies.

HYDROPOWER TECHNOLOGY: HARNESSING THE POWER OF RUNNING WATER

Hydropower systems capture the energy in falling water. This energy is converted into reliable electricity to efficiently and cost-effectively meet market demand.

Hydropower plants are configured in one of two ways. "Run of river" operations use the natural flow of a river by diverting it into canals that lead into a power plant. In the second configuration, water is stored in a reservoir and sent to the power house as needed.

In general, hydropower systems include the following basic components:

- **Power House,** which contains turbines, generators, excitation, control systems, and hydraulic systems used to convert water energy into electric power.

- **Scroll case**, a pipe that supplies water to the turbine.

- **Forebay,** which funnels water from the canals or reservoir into the scroll case. Usually, a grate or trash rack cover prevents debris (trees, branches, rocks, etc.) from entering the turbine.

- **Wicket gates or guide vanes** meter water into the turbine from the scroll case.

- **Water supply system canals** made of either earth or concrete provide direct flow into the plant's forebay, and **penstocks** (pressurized pipes) direct water from the reservoir to the scroll case.

- **Tailrace,** a draft tube by which the water exits the power house and passes through a concrete or rock-lined outlet structure.

Three basic types of turbines are used to generate hydropower:

- **Francis turbine:** a fixed-blade turbine;

- **Kaplan turbine:** a variable-pitch blade turbine similar to a propeller; and

- **Impulse turbine:** a fixed-blade turbine with blades shaped like buckets or half circles. Water is metered to the turbines through one to six "needle valves" instead of through wicket gates. The needle valves send jets of water into the turbine buckets to turn the turbine.

EFFORTS TO PROMOTE HYDROPOWER DEVELOPMENT

Obstacles challenge hydropower development in many countries around the world. However, there are many efforts underway to minimize these barriers and encourage the use of hydropower to electrify rural and developed areas. These efforts are being made by government, industry, and other organizations. They range from programs offering tax incentives for renewable energy development to policies that welcome private investment in power generation projects. A few examples are listed below.

Standardization of Equipment-

By standardizing equipment design and manufacture processes, many governments in nations with developing economies are reducing the costs associated with hydropower development Standardized equipment and standardized project designs can be used to build a hydropower plant that serves specific end-user needs. For example, if a plant is to be build in a remote area with no major roadways, equipment can be made more modular than that used in an urban, developed area.

International Strategic Partnerships-

Partnerships between local companies and foreign hydropower firms can facilitate more cost-effective and efficient project development By tapping the experience and lending power of U.S. firms and combining it with their unique knowledge of local terrain and customs, local businesses can successfully utilize indigenous hydro resources. The Don Pedro project in Costa Rica is an excellent example of such a partnership (see box, right).

Renewable Energy Incentives-

Some countries offer “renewables obligation” pro grams to encourage the development of small hydropower, wind energy, and other clean energy sources. These programs provide set-asides for least-cost renewable energy sources and guarantee the prices that renewable energy developers will receive for selling clean power to electric utilities.

Poverty Alleviation/Rural Electrification Programs-

Rural electrification efforts in many developing countries are bringing small renewable energy systems to remote, off-grid areas of the world. When sufficient water resources are present, hydropower is often the least-cost option for these rural communities.

P.H. Don Pedro S.A.
Costa Rica

Size: 14 MW, high-head hydroelectric plant
Project construction cost: $25.6 million
Power sates: 15-year power purchase agreement

The Don Pedro project was built through an international partnership between Instituto Costarricense de Electricidad (ICE) and Jose Cartellone Construcciones Civiles, S.A., and is operated by Ogden Power Corp. The project provides power to ICE under a 15-year renewable energy power purchase agreement and is financed wife $20.6 million in debt through GE Capital Corp. and $5 million in equity provided by Energia Global and Energy Investors Funds.

For more information, contact any of the following organizations:

Center for Renewable Energy & Sustainable Technology (CREST)
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National Renewable Energy Laboratory
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World Wide Web: www.nrel.gov

U.S. Hydropower Council for International Development
122 C Street, N.W.
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Washington, D.C. 20001
(202) 383-2550

U.S. Export Council for Renewable Energy
122 C Street, N.W.
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(202) 383-2550
World Wide Web: http://solstice.crest.org/renewable/usecre/

The facts about...
Photovolatics Technology

Presented by US/ECRE in cooperation with the U.S. Agency for International Development and Solar Energy Industries Association.

Photovoltaics (PV) technology, which concerts sunlight directly into electricity, provides power for a full range of household and business functions. Around the world, PV systems are used in refrigeration, lighting, telecommunications, and agricultural applications, as well as in centralized-grid electricity production.

PV systems are operating in every region of the world. Because of its versatility, PV technology is in demand, and worldwide PV markets will continue to grow as costs continue to decline. Whether on a very small scale (such as in a telephone callbox) or in larger scale applications (such as in homes and commercial buildings), PV can provide clean energy from an abundant and free fuel source - the sun.

At the household level (or smaller) PV systems can either replace or supplement utility-generated electricity. In stand-alone PV electric systems, the power generated is stored in a battery and used as needed. In grid-connected systems, power from the utility grid can serve as a back-up source on cloudy days or when electricity use is unusually high.

The following are some examples of existing PV operations and the functions that they support:

- **Communications** - In thousands of locations, PV systems are providing electricity for remote telecommunications functions. Such installations range in size from a few watts to several hundred kilowatts of capacity. They electrify microwave repeater stations, remote control systems, radio communications, telephones, emergency call boxes, and other remote equipment

- **Lighting** - More than 6,000 PV-powered lighting systems are currently operating in the U.S. These systems power lighting for billboards, highway signs, rural buildings, parking lots, and vacation cabins. Many PV-powered lamps include timers or, “photo cells,” that sense darkness and activate the bulb when it is needed.

- **Refrigeration** - In many parts of the developing world, solar technologies like PV are the sole source of electricity for refrigeration. PV systems make it possible to refrigerate medical supplies and food items in remote areas, bringing improved quality of life to remote communities.

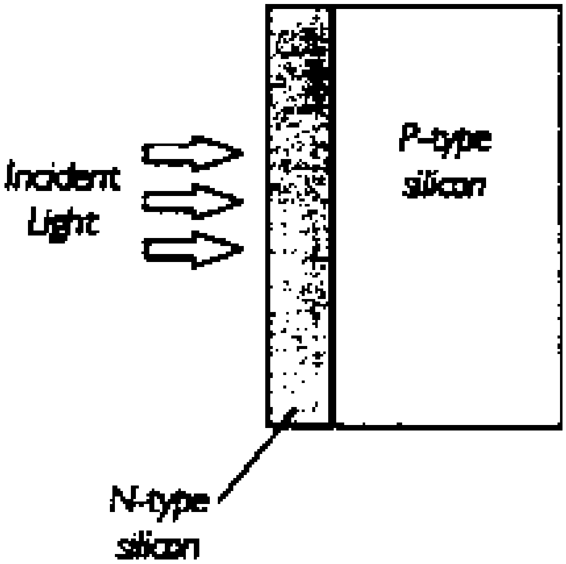
- **Water Pumping** - PV systems are used in almost every climate to power irrigation, livestock watering, drinking water pumps, and industrial water pumping operations. Like refrigeration systems, these installations bring significant quality of life and health benefits to the communities that they serve.

Nearly 90 MW of PV capacity was shipped in 1996, and that number is expected grow to 150 MW by the year 2000. U.S. industry is a leader in this dynamic market, bringing cost-competitive ($5/watt to $6/watt at the factory), high-end technology to individuals and communities around the globe.

HOW DOES PHOTOVOLTAICS TECHNOLOGY WORK?

Photovoltaics technology converts sunlight into electricity by using semiconductor material.

Single PV Cell



Many PV cells are made of pure silicon, an excellent semiconductor and abundant material When sunlight shines on a pure crystal of silicon, electrons are set loose from the atoms that comprise the material The freed electrons move about the crystal somewhat randomly until each finds an atom with which it can bond. Energy is produced when an electron returns to an atom that has been missing an electron. Silicon used in PV cells is chemically treated to facilitate this process and is usually about 1/50th of an inch thick.

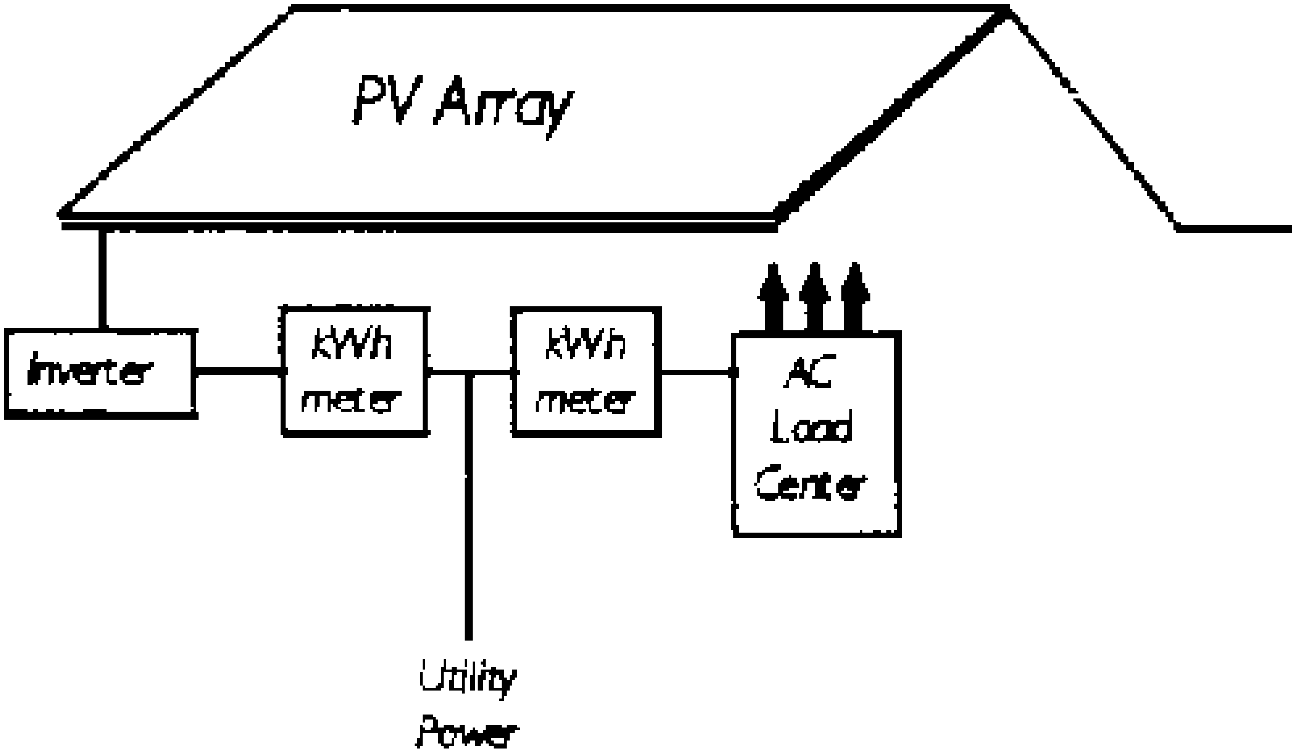
Each four-inch-wide silicon solar cell can generate about one watt of electricity when exposed to sunlight on a clear day. To increase the amount of power produced, several cells are typically packaged together in a “module” that is encased in a transparent cover with a water-tight seal Modules are often wired together in “arrays” to provide enough electricity to perform virtually any task.

Single and polycrystalline silicon, thin-film amorphous silicon, and several advanced materials can be used to make PV cells. Today’s conventional cells can convert between 5% and 17% of the sun’s light into useful energy. Experimental cells have proven to be twice as efficient in laboratory tests, a development that bodes well for the industry.

Materials improvement, technology advancements, and economies of scale all have contributed to improved efficiency and cost-competitiveness for PV technology. When PV cell manufacturing began in the early 1960s, the cost was about $1,000 for every watt of power installed - about 100 times the costs associated with conventional power sources. By 1970 (after growth in the space industry helped bring costs down a bit), the cost of installing PV systems had dropped to roughly $100 per watt Today, PV systems can cost as little as $7 for every watt installed.

These dramatic cost reductions, along with many non-price benefits, make PV a very competitive renewable energy technology.

Simple PV System (utility intertie)



This system would be used in a grid-connected home, with excess power sold to the local utility. The inverter converts DC power from the PV array into low-distortion AC power, which can be transmitted to the utility grid. Excess power is delivered through a kilowatt-hour meter to the utility grid. A second meter measures power consumed by the household.

PHOTOVOLTAICS APPLICATIONS - CLEAN ENERGY CASE STUDY

The Bohoc School Haiti

In an effort to combat a recent power shortage, the Bohoc School in Haiti has begun a simple photovoltaic program.

The school and its surrounding facilities required more power than its existing diesel generator could provide. In addition, the school was spending $6,000 each month for diesel fuel and generator maintenance and could not afford to add to those expenses.

After examining a variety of options, the Bohoc School decided to use PV to serve its classrooms, water pumping operations, auto shop, and other electricity needs. For the cost of one year's worth of diesel fuel, a new PV system was installed. The system generates enough power for the school's lighting and refrigeration functions, ceiling fans, and appliances.

By savings in fuel expenses alone, the school's PV system will pay for itself in about four years.

Benefits of Using PV Systems

- **Free Fuel:** Once equipment is purchased and installed, the bulk of PV costs are complete. Fuel costs are zero for the lifetime of the project, so PV systems will be more economical in many cases even though up-front capital costs are relatively high.

- **Simple Maintenance:** Because of the simplicity of PV systems, maintenance and repair costs are very low.

- **High Reliability**. PV systems are very durable and can work effectively for years. With no moving parts, PV is a reliable energy source in all types of climates and weather conditions.

- **Environmentally Benign:** PV systems are silent and do not emit environmentally damaging substances into the air or water.

- **Modularity:** Panels can be installed as needed and upgraded as the demand for power grows. Furthermore, additions can be made while the original system continues to operate.

For more information, contact any of the following organizations:

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National Renewable Energy Laboratory
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Golden, Colorado 80401
(303) 275-3000
World Wide Web: www.nrel.gov

Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-0753
(505) 844-4383
World Wide Web: www.sandia.gov

Solar Energy Industries Association
122 C Street, N.W.
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Washington, D.C. 20001
(202) 383-2600
World Wide Web: www.seia.org

U.S. Export Council for Renewable Energy
122 C Street, N.W.
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(202) 383-2550
World Wide Web: http://solistice.crest.org/renewables/usecre/

The facts about
Solar Thermal Energy

Presented by US.ECRE in cooperation with the U.S. Agency for International Development and the Solar Energy Industries Association

The solar thermal industry can trace its roots to the late 1800s, when Americans first used the technology to heat water for home use. Since then, the technology has evolved dramatically. In the 1990s, solar thermal technology is used to serve a fall range of energy needs in the industrial, commercial, utility, and residential sectors.

Solar thermal systems are used in homes, hospitals, and industrial plants around the world. More than one million residences and 250,000 commercial buildings in the United States alone employ solar thermal technology for water or space heating. In Tokyo, Japan, 1.5 million buildings use solar hot water heaters. In Israel, 30 percent of buildings and all homes must use solar water heating technology. Also, in many developing countries, solar energy is the only source of power readily available for heating water.

Solar thermal facilities can operate effectively in virtually any climate, from hot deserts to the earth’s coldest regions. The one million residential solar water heaters operating in the U.S. save between 220,000 gigawatt-hours (GWh) and 280,000 GWh each year. From medical facilities in Zimbabwe to swimming pool heaters in Miami to hot water heating in Japan, solar thermal technology is bringing clean energy, energy conservation, and improved quality of life to people around the world.

In addition to direct-use applications, solar thermal technology can be used to generate elec tricity. Today’s solar thermal power plants produce about 0.005 Quads (480 million kWh) of energy each year - that’s enough energy to power more than 45,000 American homes.* At their current production rate, solar thermal power plants displace 325,000 tons of carbon dioxide emissions every year.

> *The average American home consumes approximately 10,000 kWh of electricity each year.

Global markets for this technology are growing at a remarkable pace, and the U.S. solar thermal industry is stepping up to the challenge of satisfying increased demand with state-of-the-art technology. Improved technology, materials, and manufacturing processes will contribute to continued cost reductions and steady market growth for the forseeable future.

SOLAR THERMAL ENERGY: A WEALTH OF BENEFITS FOR UTILITIES

Solar thermal provides a number of advantages for utilities

- electricity and hot water can be marketed simultaneonsly;
- utilities can match power production to daytime demand peaks;
- plants have minimal environmental impact and
- plants can be built in as little as 18 months and scaled to demand.

In almost any climate, solar collectors can harvest the sun’s energy to provide reliable, low-cost power for small or large-scale direct-use applications (hot water for homes and industries) as well as or larger electricity generation facilities. There are significant differences between small- and large-scale solar thermal systems. The two are described below.

Solar Thermal Systems

Solar thermal systems can use flat plate collectors to capture the sun's energy and transfer it either *directly* or *indirectly* household, water or heating systems. Each collector contains an absorbing surface (called an absorber plate) and an insulating container (generally a metal box) that supports a transparent glazing material (usually glass). Heat from the sun is trapped by the collectors and absorbed by the plate. The heat is transfered to a heat-transfer media, which can be either liquid or gaseous, for immediate use or storage.

Direct solar systems transfer the sun's heat to water, which flows through the faucet to the end user. *Indirect* systems transfer heat to an intermediary heat-transfer fluid such as anti-freeze, a refrigerant, or treated water. The heat transfer fluid passes heat on to the household water through a heat exchanger (such as a coil wrapped around the water storage tank).

In typical installations, collectors are mounted on the roof of a building and oriented to achieve maximum exposure to the sun. One or two collectors are used in a typical household system. During cloudy weather or periods of excessive hot water use, backup heating can be used. These systems can save homeowners up to 3,000 kWh annually.

Solar Thermal Power Plants

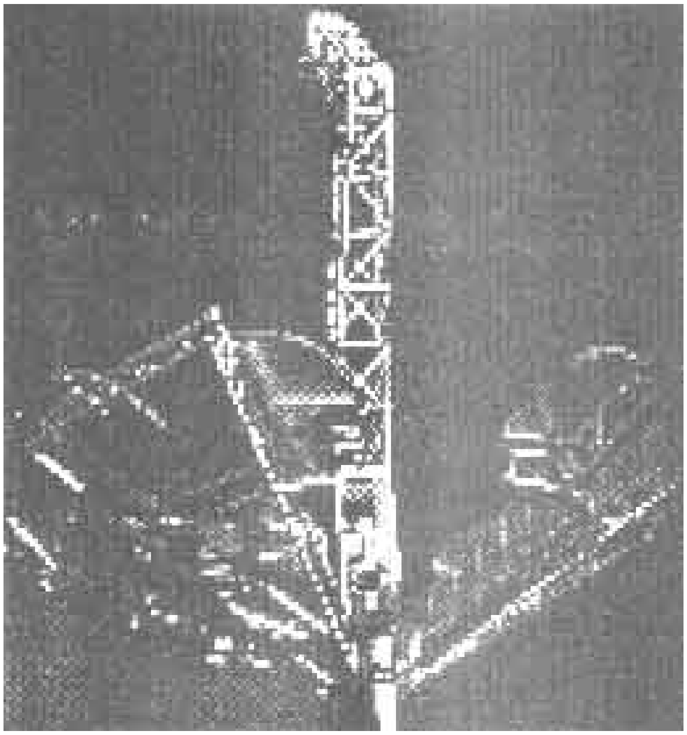
Utility power plants employ concentrating devices to focus sunlight and intensify the heat that is collected. By doing this, these facilities achieve extremely high temperatures and generate steam which powers electricity generators.

Three types of concentrating devices are used:

- **Central Receivers -** Mirrors focus sunlight on a single collector mounted on a central tower. The mirrors are heliostats, that is, they track the sun while remaining focused on the central receiver.

- **Trough Systems -** Long, curved mirrors focus sunlight on tubes filled with circulating heat transfer liquid. The liquid can reach temperatures as high as 400°C (750°F).

- Dish Systems - A parabolic dish reflector focuses solar radiation on a receiver mounted at the focal point of a dish. Fluid circulating through the receiver transfers heat to the power generator.



SOLAR THERMAL ENERGY APPLICATIONS

Solar thermal technology can provide energy for a variety of purposes:

Residential Hot Water - Water heating can account for up to 40 percent of an American household’s energy consumption. Solar thermal technology can help offset 60 to 80 percent of this demand. With a back-up heating element, all of a home’s hot water needs can he satisfied with a solar energy system. Over its lifetime, a solar system will pay for itself; and, in sunbelt states, solar systems can generate a 10 to 20 percent rate of return on the initial investment

Swimming Pool Heating - Solar thermal technology can raise pool temperatures by 4° to 6° Centigrade and can extend the swimming season in many locations by three to four months. An average pool heating system would have eight to 10 collectors, an electronic controller, and a pump.

Commercial/Industrial - Current solar thermal technologies can deliver water temperatures between 40° and 93° Centigrade. These systems match well with conventional energy systems and provide pro-heated water for industrial needs or fully-heated water for commercial use. They are most commonly used in the laundry, food service and processing, metal plating, and textile industries.

Utility-Scale Electricity Generation - Nearly 400 MW of solar thermal electric generating capacity is operating in the U.S. These power plants provide reliable power for thousands of American homes and businesses.

CASE STUDY: SOLAR HOT WATER HEATING

Kook Jae Office Building
Seoul, South Korea

More than 85 percent of daily hot water use at the 24-story Kook Jae office building is provided by solar thermal technology.

A 9,400 square foot solar water heating system was designed by Korean Steel Products using collectors manufactured by American Energy Technologies for U.S. Solar Corp. and was installed in 1984 Since then, the system has been so efficient that it even satisfies 10 percent to 20 percent of the building's annual space heating needs in addition to food service, gymnasium, spa, and other hot water requirements.

CASE STUDY: PARABOLIC TROUGH TECHNOLOGY

Solar Electric Generating Systems Southern California

Solar thermal parabolic trough systems have been working in tandem with natural gas in a Southern California steam cycle power plant since the late 1980s The commercial-grade solar thermal system is installed in nine units with 30 MW to 80 MW of capacity each for a total capacity of 354 MW.

The systems operate at peak efficiencies of up to 25 percent Until mid-1996, they have provided six terawatt-hours of electricity to California's power grid, resulting in sales of $800 million.

For more information, contact any of the following organizations:

Center for Renewable Energy & Sustainable Technology (CREST)
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National Renewable Energy Laboratory
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World Wide Web: www.nrel.gov

Sandia National Laboratories
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(505) 844-4383
World Wide Web: www.sandia.gov

Solar Energy Industries Association
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(202) 383-2600
World Wide Web: www.seia.org

U.S. Export Council for Renewable Energy
122 C Street, N.W.
Fifth Floor
Washington, D.C. 20001-2109
(202) 383-2550
World Wide Web: http://solstice.crest.org/renewables/usecre/

The facts about...
Wind Energy Technology

Presented by US.ECRE in cooperation with the U.S. Agency for International Development & the American Wind Energy Association

Between 1994 and 1996, nearly 3,200 MW were added to the world's total installed wind energy capacity, making wind power the world's fastest growing energy source.[1] Installed worldwide wind power capacity has tripled, outpacing growth in conventional fuels like oil, coal, and even natural gas over the same time period.

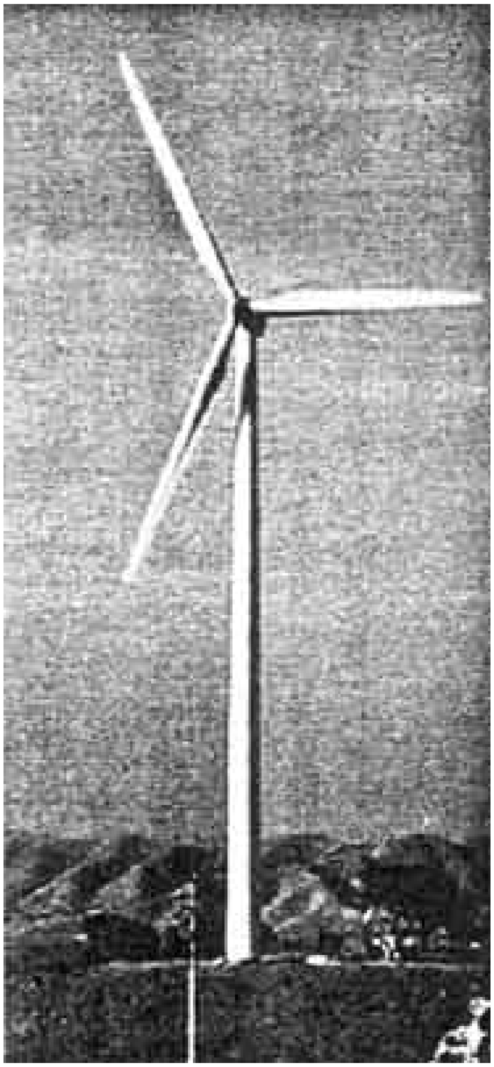
[1] WorldWatch Institute ***Vital Signs***, 1995

The last two years were record-setters for the international wind energy industry, which racked up $1.5 billion in sales during 1995 and 1996. In 1996, 1,271 MW of new wind energy capacity were installed, bringing the world's total capacity to 6,259 MW and total investment in wind power projects to more than $6.5 billion.

Worldwide markets for wind energy technology are expected to continue this dynamic growth trend. The U.S. Department of Energy estimates that the world's winds could supply up to 580 trillion kWh of electricity each year. (The U.S. consumes about 2.8 trillion kWh annually.) In addition, wind power plants are being built today with 30-year levelized costs between 4 cents and 5 cents per kilowatt-hour (kWh), a price that is competitive with most conventional energy sources. Incentives can reduce prices even more. As prices continue to drop, wind power will serve an increasing portion of the world's energy demand.

Wind power can be used to serve a full range of energy needs, from grid-connected, utility-scale power plants, to small village power systems, to re mote water-pumping operations. Turbine sizes vary accordingly, from small wind turbines with a few watts of generating capacity to huge machines with power ratings of 1 MW or more.

Wind turbines can be installed singly for individual home or commercial use. They also can be built in small clusters of three or four to serve several homes or farms, or in even larger groups to provide power for the utility grid. Grid-connected wind power systems in the U.S. currently generate more than 3 billion kWh annually. That's enough electricity to meet the annual residential electricity needs of nearly one million Americans.



Wind is an indigenous, renewable, and free energy source that generates no pollution and has few environmental impacts. Wind technology is being recognized around the world as an excellent means of serving growing energy supply needs.

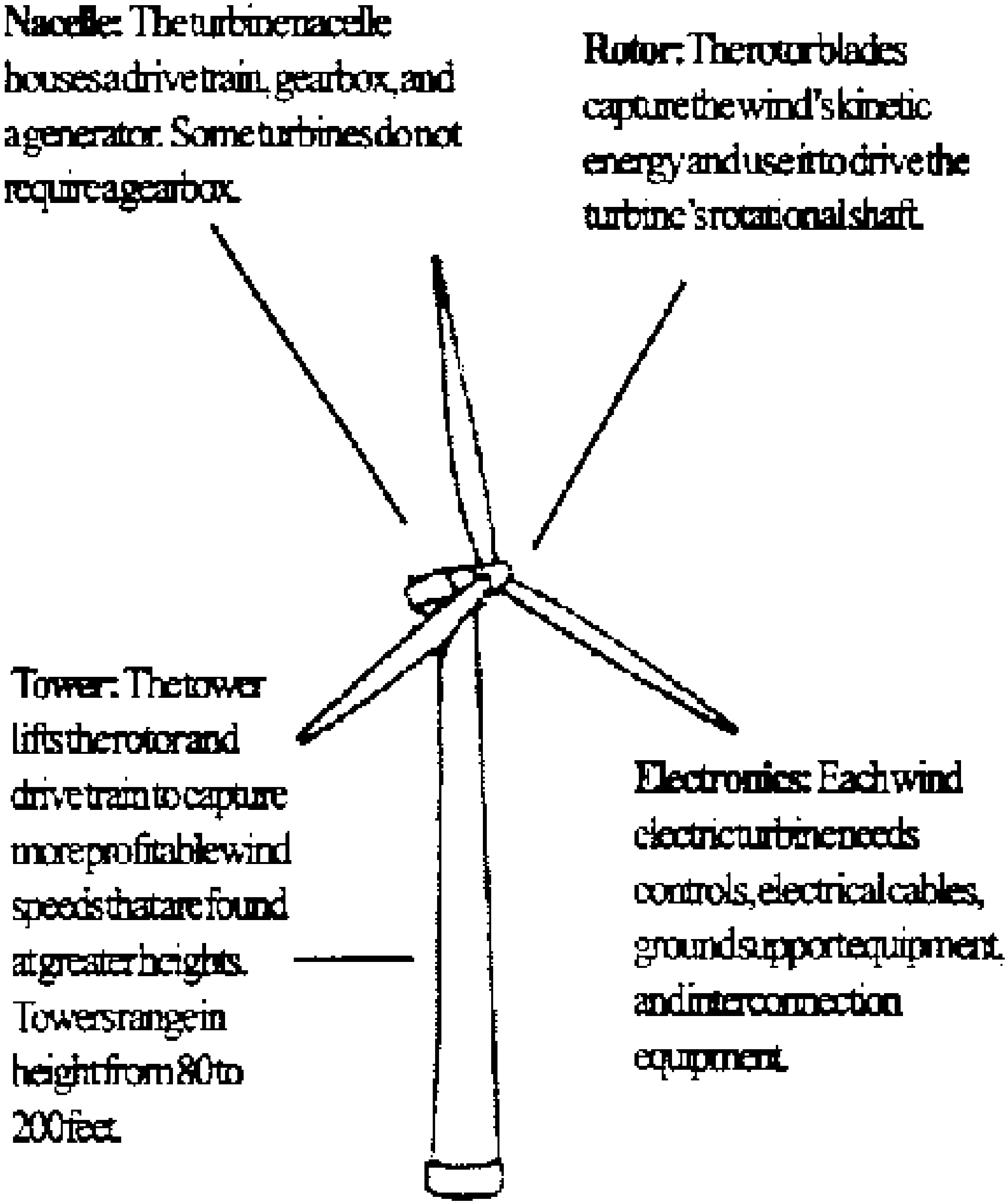
Worldwide markets for wind power are expected to reach a cumulative value of $23 billion by 2005.

HOW DOES WIND TECHNOLOGY WORK?

A wind turbine generator converts the wind’s kinetic energy into electricity or mechanical energy that can be harnessed for productive use. The mechanical energy generated by a wind turbine can be used for water pumping, irrigation, or water heating in rural or remote locations. Wind electric turbines provide electricity for direct residential or business use or for use by utilities.

Each turbine uses a rotor with one or more blades to turn a power shaft which either activates a mechanical pumping system or an electric generator. When the wind passes the rotor, aerodynamic lift is created causing the rotor to spin. Turbine components are described in the diagram below.

Commercial wind turbines are found in two basic configurations: horizontal axis (with propeller-like blades) and vertical axis (with curved blades that resemble egg-beaters). Most of the world's operating wind turbines are horizontal axis machines.



Nacelle: The turbine nacelle houses a drive train, gearbox, and a generator. Some turbines do not require a gearbox.

Rotor: The rotor blades capture the wind's kinetic energy and use it to drive the turbine's rotational shaft.

Tower: The tower lifts the rotor and drive train to capture more profitable wind speeds that are found at greater heights. Towers range in height from 80 to 200 feet.

Electronics: Each wind electric turbine needs controls, electrical cables, ground support equipment, and interconnection equipment.

Turbines vary in size depending on the type of service they provide. A rural water pumping operation would likely use a small machine with a few kilowatts of generating capacity. A 10-kW turbine located in a moderate wind regime can generate an average of 30 kWh of power each day. Remote villages might use a group of small turbines supplemented with power from a back-up energy source. Most larger-scale systems, such as those serving groups of homes or farms and electric utilities, utilize 250-kW or larger wind turbines.

- **Grid-connected power plants** generate electricity for the local electric utility. Utilities can own their own wind plants or can purchase wholesale wind power to sell at retail rates to their customers. Large-scale (at least 50-MW) wind plants are very cost-competitive with conventional electricity generating technologies.

- **Dispersed, grid-connected systems** can be used to generate power for homes, businesses, and farms. During low-wind periods, back-up power is purchased from the local utility. When the wind system generates surplus electricity, power is fed back into the utility grid.

- **Off-grid, stand-alone** systems provide cost-effective energy for consumers that are not connected to the utility grid. Such facilities include rural residences, water pumping, and telecommunications operations. Batteries can be used to store electricity and diesel generators can be used for back-up power. Wind hybrid systems, which use any combination of wind, photo voltaics, batteries, and diesel, are a cost-effective way of providing reliable power to remote areas.

WIND ENERGY COSTS & BENEFITS: WHAT TO CONSIDER

Wind Resource

The amount of energy in the wind is proportional to the cube of the wind speed. Although wind speed varies over time, it does follow general daily and seasonal patterns which are predictable and which can be tracked through scientific assessment.

Thorough assessment of a site's wind resource is crucial to determining whether a wind power system will provide cost-effective and reliable energy. In general, small turbine systems require annual average wind speeds of at least 9 mph (4 meters per second). Utility-scale wind power plants require wind speeds of at least 13 mph (6 meters per second). Wind resource assessment specialists recommend at least 12 months of consistent observation and recorded wind measurement for large-scale projects. However, three months is often sufficient for small systems.

Technology

Wind energy technology has come a long way. Due in large part to improvements in turbine reliability, durability, and technology innovations, costs associated with wind energy production in the 1990s are 80 percent less than the cost of generating wind power in the early 1980s.

Turbine reliability and productivity have improved substantially since the first wind plants were installed in California 15 years ago State-of-the-art equipment operates with 98 percent availability. In addition, turbine capacity factors (the number that reflects a turbine's productivity) have tripled since the early 1980s Today's machines perform with capacity factors that exceed 30 percent

Financing

Financing is another critical factor when determining the costs of wind systems and other renewable energy projects.

For example, two Lawrence Berkeley Laboratory researchers found that ownership of a typical

50-MW wind plant has a significant impact on plant financing and cost of energy. If such a plant is financed by a wind developer and owned by private investors, it could deliver power for just under 5 cents/kWh. However, if the plant is owned and financed by an investor-owned utility company, its power would cost only 3.5 cents/kWh.

Tax & Loan Incentives

Government efforts to help develop a stable, long-term market for renewable energy technologies like wind power can help bring down costs even further. Through direct, low-cost government loans and loan guarantee programs, interest rate buy-downs, tax incentives, and other mechanisms, governments can foster the growth of renewable energy industries.

For example, in the U.S., a federal wind energy production tax credit has been adopted to encourage wind energy development This incentive awards a 15 cent tax credit for every kilowatt-hour of wind energy produced and sold to a utility. The credit was enacted in an effort to level the playing field for wind power in a tax system that has traditionally favored the use of conventional electricity generating technologies.

Government incentives such as this can promote investment and begin to reduce financing costs for wind and other renewable technologies.

For more information, contact any of the following organizations:

American Wind Energy Association
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National Renewable Energy Laboratory
1617 Cole Boulevard
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National Wind Technology Center
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World Wide Web: http//www.nwtc.gov

U.S. Export Council for Renewable Energy
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Appendix B. List of Contacts and Resources

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Appendix C. Example Basic Power Purchase Agreement

1. OVERVIEW

1.1 BASIC AGREEMENT. The basic document is a single contract between a Company and a Utility where the Company contracts to design, build and operate for [“w” hours a day, “x” days a year for “y” years, a facility producing “z” megawatts] [firm] [as delivered] power.

COMMENT

- *The foregoing applies only to base-load generators.*

1.2 MAJOR DEFINITIONS. The following summarizes the key definitions:

“Agreement” means this Renewable Resources Power Purchase Agreement.

“Annual Period” means any one of a succession of consecutive 12-month periods.

“Buyers System” or **“System”** means the Buyer’s electrical system serving [country], including Buyer’s Electrical Interconnection Facilities, beginning at the Point(s) of Delivery.

“Date of Initial Commercial Service” means the day the Seller designates as the initial date of production of electricity by Seller at its Facility.

“Electrical Interconnection Facilities” means those facilities required for the receipt or delivery of Electricity or any Point(s) of Delivery required to connect Buyer’s System to the Facility in order to effectuate the purposes of this Agreement.

“Electricity" means the total amount of electricity producible by the Facility and available for sale.

“Force Majeure” a force such as (i) acts of God; (ii) war, insurrection, riot, civil disorder or disturbance; (iii) impact of national emergency; (iv) defaults of subcontractors and suppliers; (v) change of law; and (vi) strikes.

“Renewable Resources License” means the [Resources] License granted the____ day of 19___, by the [Minister] to Seller.

“Joint Venture Agreement” means the agreement entered between and among __________________.

“KWh” means kilowatts of electricity per hour.
“KW” means kilowatts of electricity.

"Points of Delivery" means any points where the Seller (s) Electrical Interconnection Facilities connect to the Buyer's Electrical Interconnection Facilities.

"Seller" means the joint venture entity producing electrical power.

COMMENT

- *These definitions are illustrative only.*

2. TERM. Thirty years (plus two extensions of five years each).

COMMENT

- *The terms of sale to the grid must be incorporated into the contract. To the extent that it is contemplated that the facility be transferred back to government or utility ownership, a build, own, operate, transfer* (*or "BOOT" arrangement*) *formula may be devised whereby, after the debt is paid and the company receives an agreed return on investment, the facility may be transferred for an agreed sum. If the government or utility wants to expedite transfer, it will offer incentives to allow high retention of gross income* (*perhaps forfeiting royalty and thereby vesting itself with an increasing share of the corporate ownership*)*, and be prepared to buy out the company early. If the government or utility wishes to minimize cash outlay, a long term contract can usually allow transfer for a token sum of money.*

3. SALE OF ELECTRICITY

3.1 Seller shall sell and Buyer shall buy all Electricity to be produced by Seller's facility.

3.2 MONTHLY ELECTRONIC CHARGE. Buyer shall pay Seller, in [designated hard currency], a monthly electricity charge equal to (i) the capacity charge, calculated on a kW basis, plus (ii) the product of the energy price for the applicable calendar year, and the monthly quantity of Electricity on a kWh basis.

COMMENT

- *This approach is illustrative. There are a number of formula which have proven effective. The economics of the project and the goals of the parties should dictate a result which can be expressed by formula.*

- *The kW basis and the energy price for the calendar year are at the heart of the agreement and therefore the subject of negotiations and formula set forth in separate appendixes.*

All parties must agree upon an electricity pricing formula which guarantees prices to the Seller. This formula should account for various factors such as system reliability, production costs to the private sector producer, avoided costs to the Buyer for oil, coal, natural gas, etc., and generation capability. If reliable power is supplied by the Seller, the full avoided costs (*energy plus capacity costs*) *are part of the criteria for selling the electricity transfer price which is also moderated by system reliability and capacity. From an economic perspective, avoided costs should reflect incremental or long run marginal costs of electricity production. These are the costs to the Seller for installing and operating the least-cost option.*

- *Depending upon whether baseload or intermittent-type resources are involved the parties will need to address the issue of capacity payments for "as delivered" capacity versus a c/kWh price that includes capacity.*

- *Hard currency payment is essential. Financial institutions will not loan the private sector project funds without hard currency repayment.*

Furthermore, since infrastructure projects such as power production facilities do not generate hard currency, financial institutions may require government guarantees. In some of the developing countries, the government guarantees only the power-purchase payments; it does not necessarily guarantee the wan. Should a government opt for this approach, it would only guarantee that payments will be made for the electricity it receives, not for the debt of a facility whether it succeeds or not.

4. DUTIES OF THE PARTIES

4.1 SELLER. Seller shall obtain all material government approvals. Seller shall own, operate and maintain all Electrical Interconnection Facilities necessary for the delivery of electricity from its Facility to the Points of Delivery. Seller shall endeavor to provide uninterrupted delivery of Electricity to Buyer's System.

4.2 BUYER. Buyer shall own, operate and maintain all Electrical Interconnection facilities necessary for the receipt of electricity from Points of Delivery to its System. Buyer shall purchase Electricity.

5. MEASUREMENT, METERING AND OPERATING SCHEDULE

5.1 UNITS OF MEASUREMENT. For the purposes of this Agreement Electricity shall be measured in kW and kWh.

5.2 MEASUREMENT EQUIPMENT. Seller and Buying shall each maintain electrical measuring, equipment. Seller's meters shall be used for quantity measurements. Testing, corrections of measuring equipment and maintenance shall be as mutually agreed.

5.3 OPERATING SCHEDULE. Seller and Buyer shall keep each other informed as to the operating schedule and condition of their respective facilities and equipment.

COMMENT

- *Measurement provisions, with the requisite checks and balances must be carefully honed. Confidence of Seller and Buyer in the measurements must be scrupulously maintained if the Agreement is to be effective during the operating years. This issue, if not set forth with specificity at the outset of the relationship, may prove to be a major cause of friction in the relationship.*

6. BILLINGS AND RECORDS

6.1 MONTHLY BILL TO BUYER. Seller shall bill Buyer for the amount of Electricity actually delivered by Seller during the preceding month.

6.2 PAYMENT. Buyer shall pay Seller in [designated currency] for all amounts billed pursuant to Article 6.1 within thirty (30) days of the receipt of Seller's Statement.

6.3 RECORDS. Both Seller and Buyer shall maintain such records as mutually agreed upon which shall be available for inspection by either Party upon reasonable notice.

COMMENT

- *Certainty of payment underlies project financing. Interest penalties for late payment are normally part of these provisions.*

7. TAXES. Seller shall be solely responsible for any income taxes relating to the Facility. Buyer shall be solely responsible for any sales, use, property, income or other taxes relating to the Buyer's System, as well as any taxes imposed on the sale to the Buyer of Electricity produced by the Facility.

8. REPRESENTATIONS AND WARRANTIES

8.1 REPRESENTATIONS AND WARRANTIES OF BUYER. Buyer hereby represents and warrants to Seller as follows:

A. Buyer is a corporation duly organized and existing in good standing under the laws of [country] and is duly qualified to do business with [country].

B. Buyer possesses all requisite power, authority, including regulatory authorities and financial capability, to enter into and perform this Agreement and to carry out the transactions contemplated hereunder.

8.2 REPRESENTATIONS AND WARRANTIES OF SELLER. Seller hereby represents and warrants to Buyer as follows:

A. Seller is a joint venture duly organized and existing under the laws of and is duly qualified to do business in [country].

B. Seller possesses all requisite power and authority to enter into and perform this Agreement and carry out the transactions contemplated hereunder.

COMMENT

- *In most international transactions, particularly where there is a direct foreign investment of the type contemplated here, an initial decision to be made concerns the type and nationality of the entity which will actually engage in the activity.*

Factors which are usually considered in making such selections include foreign and domestic taxation, methods of financing the operation, credit risks and concerns, trade incentives, risks concerning injury to person and property, local licensing and permitting public relations, etc.

Whether there is a requirement under law that the Licenses be a domestic corporation is a question which needs to be examined.

9. INDEMNIFICATION. Each Party agrees to protect, indemnify and hold harmless the other Party and its directors, officers, shareholders, employees, agents and representatives against any and all loss on account of injury to persons, or for damage to property arising out of that Party's operation of facilities, except if such injury or harm is caused by the negligence of the other Party.

10. INSURANCE. The Buyer and the Seller shall each obtain and maintain in force comprehensive general liability insurance in agreed amounts.

11. ARBITRATION. Arbitration shall be under the Convention for the Settlement of Investment Disputes between States and Nationals of Other States.

COMMENT

- *Most private-sector investors consider it of particular importance in contracts with government entities to specify clearly what jurisdiction's laws will be applied in the interpretation and enforcement of the contract, to specify where disputes will be resolved and how disputes will be resolved* (*arbitration is the generally preferred method*)*. Each party to the Agreement will normally want the laws of its own domicile to apply and for the dispute to be settled by a tribunal located in its domicile.*

- *In electing an arbitral tribunal, special care should be taken to ensure that the government has officially recognized that forum. The following list sets forth the major arbitral tribunals.*

    a. ICSID. The Convention on the Settlement of Investment Disputes between States and Nationals of other States ("ICSID") establishes the International Center for Investment Disputes. This convention has the unique advantage of providing that each contracting state shall recognize and enforce an ICSID award as though it were a final judgement of the country's courts. ICSID is limited to disputes arising between a state party to the convention and a national of another state and must arise from an investment dispute. [Country] is a member of ICSID, and contemplates the use of ICSID in the Model License.

    b. The New York Convention. The 1958 United Nations Convention on the Recognition an Enforcement of Foreign Arbitral Awards (the "New York Convention"), ratified by approximately 70 countries, provides that an international award rendered in a country party to the Convention may be enforced in another convention country.

    c. UNCITRAL. This model set of rules was unanimously approved by the U.N. They are of particular interest because arbitrations administered by the London Court of Arbitration and The American Arbitration Association can be carried out using these rules.

    d. ICC The International Chamber of Commerce rules have the advantage of being internationally recognized (unlike those of the American Arbitration Association).

    e. AAA. The American Arbitration Association rules are perhaps more effective than others, provided that the contracting parties are citizens of countries which have ratified the New York Convention, as its procedures generally involve less delay and expense.

12. BREACH OF CONTRACT. This provision sets forth the events which it has deemed to create a breach of contract and the remedies for such breach.

COMMENT

- *Liabilities such as penalties for default on contracts are important to the utility vis-á-vis future expansion plans.*

- *Of overriding importance are the breach of contracts envisioned under the domestic regulatory scheme. Since a breach results in forfeiture of rights, the government will have enormous leverage over the joint venture seller.*

13. MISCELLANEOUS. These provisions address notice, service successors and assigns, third party beneficiaries, confidentiality governing law, language, currency, effective date, amendments and other such significant issues.

Appendix D. Renewables Portfolio Standard

One mechanism for using competitive markets to attain an appropriate reliance on renewable resources in the fuel mix used to generate electricity is called the “Renewables Portfolio Standard" (RPS). Electric industry restructuring is aimed at inducing more efficient electric service- Energy policy strategists are seeking competitively-neutral, market-based strategies to ensure that the objectives of integrated resource planning are not lost. The RPS approach bridges the shift to competitive markets.

The RPS approach applies a resource diversity standard to all retail electric service suppliers. It relies on flexible, market implementation of this standard to obtain compliance at least cost. Specifically, all retail suppliers are required to possess a minimum percentage of renewable energy resources within their overall resource portfolio. A government or a grid system determines the percentage after considering its environmental and resource diversity goals and the availability and cost of renewable resources. Suppliers could meet the standard by owning renewable energy projects, purchasing renewable energy on the wholesale market, or purchasing renewable generation “credits.”

A. General Description

As a condition of doing business in a country (or a governmental subdivision) every retail power supplier (vertically-integrated utility, distribution-only utility, direct access supplier, or power aggregator), and any self-generator, are required to:

a. Demonstrate that a minimum percentage of its total kilowatt-hour (kWh) sales (or, in the case of a self-generator, its output) were generated from a defined set of renewable resources; or

b. Own certificates for an equivalent amount of kWh generation from such resources.

The retail power supplier could satisfy this requirement by owning and generating power from a renewables facility, purchasing renewable generation produced by a facility owned by another party, or by purchasing an equivalent amount of renewable resource “credits”. The percentage would be determined by the host government.

A system of tradeable credits would be designed to facilitate cost-effective implementation of the obligation to procure renewables. Every renewable kWh produced would constitute a “credit” which could be sold. For example, a retail power supplier that owns a renewable power facility or has contract rights to production from such a facility that is producing in excess of what the supplier needs to meet its RPS obligation could sell the excess generation as “credits.” The purchaser of the credits would have the right to count those credits toward its renewables obligation.

B. Application to a Power Pool

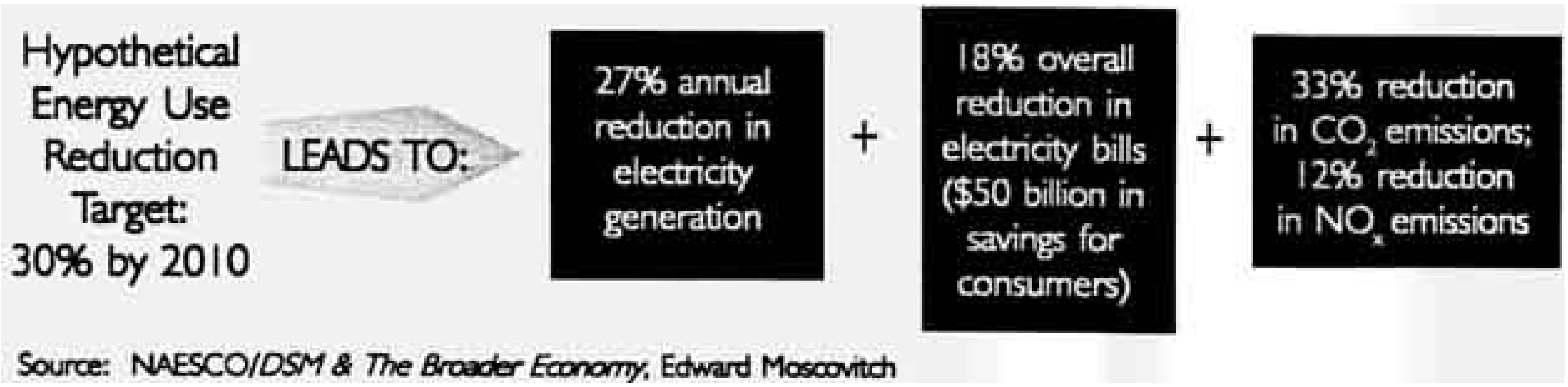
There are a number of ways in which voluntary power pools could be used to facilitate compliance with the RPS.

(1) Crediting for renewables which are dispatched under normal economic dispatch: Participants in a voluntary, single, or multi-jurisdiction power pool may agree to distinguish renewable resources from other sales into the pool so that the purchase of this power by a retail power supplier will count towards compliance with the standard. Under this approach, renewable generation not otherwise obligated to any retail supplier for purposes of complying with the RPS and that is successfully bid into the pool or is economically dispatched would generate credits that would temporarily be held by the pool manager. Periodic reports would indicate the fraction of total sales into the pool (through bid or economic dispatch) that were generated from renewable sources. The pool manager would then assign each buyer from the pool a pro-rata share of credits commensurate to the total generation purchased from the pool.

This system would be intended as a supplement to overall compliance with the standard, not as the primary means of compliance, since there would be no mechanism for assuring that sufficient renewable generation would be sold into the pool. However, the periodic reports would be issued as frequently as necessary to provide pool purchasers with enough information to gauge how much additional generation or credits they would need to acquire to fully comply with the standard.

(2) Dispatch priority for renewables: As a means of meeting their RPS obligation, some or all retail sellers participating in a pool could agree to establish a dispatch priority for renewables within the regular pool. Under this arrangement, these retail sellers would enter into an agreement with the pool manager to dispatch sufficient renewable sources in the pool to meet a designated target over the course of a year. Conversely, each retail supplier would commit to purchasing a specified amount of renewables from the pool on an annual basis such that, combined with the supplier’s own bilateral agreements and generation resources, the supplier would meet its total requirement. Each participating retail supplier would pay its share of the incremental costs associated with changing the dispatch priority to fulfill its renewables commitment.

(3) Separate renewables pool: A group of retail sellers could establish a separate renewables pool to facilitate them in meeting their RPS obligation at least cost. The retail sellers would develop a bidding procedure for renewables. The resources would be economically dispatched consistent with demand bids placed by purchasers from the pool (demand bids would include the maximum price purchasers are willing to pay). Each participating retail seller would be issued credits by the pool manager for the amount of generation purchased from the renewables pool. These credits would count toward the retail seller's renewables obligation.



Hypothetical Energy Use Reduction Target: 30% by 2010

LEADS TO:

27% annual reduction in electricity generation

+

18% overall reduction in electricity bills ($50 billion in savings for consumers)

+

33% reduction in CO_2 emissions; 12% reduction in NO_x emissions

Source: NAESCO/*DSM & The Broader Economy*, Edward Moscovitch