GRID-CONNECTED RENEWABLE ENERGY: OVERVIEW
Grid-Connected Renewable Energy: Overview
• Global Resources and Costs
• Goals & Objectives
• Barriers
• Strategies for Successful RE Projects
• Best Practices
Grid-connected Renewable Energy Toolkit

This Toolkit is intended to help USAID mission staff and national decision makers understand and assess the relevance of policies and programs that have been used successfully in support of large, grid-connected renewable energy (RE) development. The design of a country’s energy policies and programs is determined by the decision makers in that country. A successful long-term energy strategy enables RE projects to be designed, financed, constructed, and operated consistent with that country’s goals and objectives.

This Toolkit is made up of six PowerPoint presentations that include notes and references. These PowerPoint slides may be used for oral presentations, or as a self-tutorial educational tool with the notes and references providing additional information for those interested in pursuing these topics in greater depth.

The six modules included in the Grid-connected Renewable Energy Toolkit are:

This Overview Module, which includes a synopsis of RE technologies and discussions of economic factors, barriers, and policy strategies necessary to overcome the barriers common to most large grid-connected renewables. Five technology modules provide greater detail on each technology, issues specific to that technology, and a summary of best practices for development of that technology.

The technology modules cover large grid-connected:

- Biomass
- Geothermal
- Hydroelectric
- Solar electric (both PV and CSP)
- Wind power

In addition, the toolkit includes two case studies that illuminate some of the policy and technology issues discussed in the modules. These include:

- A wind power case study
- A large, grid-connected solar PV case study

Acknowledgments – The principal author of the Overview Module and manager of this project was Dr. Jan Hamrin of HMW International Inc. Mathew Trask of Mathew Trask & Associates was deputy manager and author of the Biomass Module; Dr. Ron DiPippo was the author of the Geothermal Module; Carlos Yermoli of Hydroscience Consulting was the lead author of the Hydro Module; Dr. Jan Hamrin and Dr. Edward Kern of Irradiance were co-authors of the Solar Electric Module and Dr. Kern was author of the Solar PV Case Study; Dr. Joanna Lewis of George
Washington University was author of the Wind Module and Peter Banner of Support Services, Inc. was author of the Wind Case Study. Steven Ferrey produced the Finance section of the Overview Module. Bob Eller of Mathew Trask & Associates and Connie Merron of HMW International contributed critical editing, technical, and reference expertise for all of the modules. Throughout the process USAID staff in the Office of Infrastructure and Engineering, EGAT Bureau provided on-going support, editorial comments, and suggestions.

Disclaimer – The views and opinions expressed in this Toolkit are strictly those of the authors and do not necessarily reflect the views of the United States Agency for International Development, the United States Government, or IIE. All price and performance data contained in the modules and case studies are from publicly available sources and are intended to be used as general information and for relative comparisons of generating options. The data do not represent actual cost or performance data for any specific project and should be used only for general instructive purposes.

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RENEWABLE ENERGY RESOURCES

- Solar
- Geothermal
- Biomass
- Wind energy
- Hydroelectric
Renewable energy encompasses a variety of resources and technology applications involving different policy and infrastructure needs. The term “renewables” generally is applied to those energy resources and technologies whose common characteristic is that they are non-depletable or naturally replenishable.

Solar energy is broadly distributed throughout the globe. In many developing countries, solar energy often is thought of as applicable primarily for off-grid electrification in rural areas. However, new technology developments have resulted in large grid-connected solar facilities that may also include storage, making this resource increasingly attractive as part of a country’s overall energy resource mix. (See Solar Module)

Geothermal resources require extraction of heat and, in many cases, reinjection of fluids into subsurface areas. Drilling for geothermal resources involves many of the same discrete considerations as drilling for petroleum. Geothermal facilities tend to have very high capacity factors and deliver baseload power that makes them attractive to utilities, despite a somewhat higher initial installation cost than traditional fossil fuel-based forms of power generation. (See Geothermal Module)

Biomass is a broadly inclusive term encompassing wood and wood waste, agricultural waste and residue, energy crops, urban waste, and landfill gas resources. While some type of biomass fuel can be found in virtually every country, the availability and costs of biomass resources can be highly variable, and require careful management. Biomass facilities generate baseload power using direct combustion, anaerobic digestion, and other technologies. These facilities use feedstocks that range from solid liquid to gaseous fuels. Biomass applications utilizing waste products can help resolve waste disposal problems, a feature unique to this resource. (See Biomass Module)

Wind energy, like solar energy, draws on a resource generally thought of as being free for the taking. The principal resource issue with both wind and solar power is the use of large amounts of land. However, wind farms do allow for multiple land uses. In many places, wind is one of the lowest cost renewable resources on a kWh basis. But both solar and wind facilities have variable power output that requires different management strategies from other forms of power generation, and may result in higher costs for integration into the grid. (See Wind Module)

Hydroelectric (hydro) resources are the oldest and most widely used of the renewable resources. However, hydro development must contend with competing uses for water, including potable water supply, navigation, irrigation, fisheries, and cultural and recreational interests. The various approaches to handling these rights and the huge size of some hydro projects make this a very complex technology area. (See Hydroelectric Module)

Policymakers developing a national electricity system should focus on RE resources that are locally available, have established themselves commercially, are cost-effective in the long term, and fit the
needs and characteristics of the country’s electricity market. These resources should be included in an enabling legal and regulatory framework that governs and encourages private-sector investment in renewable resources and technologies.

Policymakers should be aware of the similarities as well as the variations among renewable resources:

- Are there sufficient commonalities among the local renewable energy resources that renewable energy development in the region may be handled as a generic issue?
- Or do the differences among the local renewable energy resources and their applications require that they be addressed on a technology-specific basis, with separate incentives, regulations, and laws?

Large, grid-connected RE facilities usually require a special framework of promotional strategies that are different from what is required to support small, distributed, and non-grid connected renewables. These policies and strategies are a focus of this Overview Module.
GLOBAL RE POTENTIAL AT <20¢/kWh

Source: REN 21 Gleneagles Report
Global Renewable Energy Potential

This graph depicts one scenario for the amount of undeveloped global renewable energy resources estimated to be economically feasible over the next 30 years for 20 cents/kWh or less (wholesale). Note that going from 20 cents/kWh to 10 cents/kWh does not reduce the amount of developable energy by much.

However, when the price drops from 10 cents/kWh down to 5 cents/kWh or lower, most of the solar PV, some solar CSP, and much of the onshore or offshore wind power resources become infeasible to develop. But the important fact to consider is that, according to this scenario, at the 10 cents/kWh threshold (which is in the cost range of new wholesale power) there are still sufficient renewable resources to meet most of the world’s electricity demand forecast until 2050.

Forecasts of renewable energy costs and development vary greatly depending upon the assumptions made by the forecaster; it is not uncommon to find estimates for deployment vary by a factor of five. What we do know is that the cost of development in any particular country depends upon a number of factors:

- The quality of the RE resource;
- The industry resources available to develop renewables in that region;
- The size and characteristics of the electricity market; and
- The enabling policy framework and political interest in supporting renewable development.

References

GLOBAL INVESTMENTS IN SUSTAINABLE ENERGY

- $148.4 billion in 2007
- More than 2.4 million associated jobs
- Current stimulus plans often include renewables

Global Investments in Sustainable Energy

**Level of Investment** – There has been increased global interest in sustainable energy over the past several years, with actual levels of investment growing at an exponential rate until the global economic slowdown (this includes investment in renewable energy, energy efficiency, and other low carbon technologies). New investment in sustainable energy reached record levels of $148.4 billion in 2007, 60% higher than in 2006. Wind power dominated new global investment in sustainable energy in 2007 with a 38% share – solar was second with a 26% share.

Solar investment took off in 2007 with $28.6 billion of new investment. Solar energy sector investment has grown at an average annual rate of 254% since 2004. Further details are available in the UNEP Report on Global Trends in Sustainable Energy Investment 2008, which includes energy efficiency and discusses only new renewable energy technologies (it does not include hydropower).

Emerging markets – particularly Brazil, China, and India – are capturing increasing shares of investment flows for new capacity, manufacturing, and R&D. Renewable energy industry jobs are estimated to exceed 2.4 million worldwide, with considerable room for expansion if investment levels stay high.

**Global Economic Downturn** – The current economic downturn is affecting all sectors of the economy, including the RE sector. Though overall investments in renewable energy continued to grow rapidly during the first three quarters of 2008, they began to fall during the fourth quarter. Though investment capital is scarce in most regions, some type of incentive measures for new renewables has been included in most of the stimulus plans of the world’s large economies, including the United States, China, Japan, and many European nations. The US stimulus package included $50 billion for renewable energy tax credits and grants over a 10-year period. China is rumored to be including a similar amount of renewable power development money in its stimulus package as well.

One of the hottest RE technology areas, photovoltaics (PV), has seen a unique set of economic impacts. The demand for photovoltaics dropped dramatically in 2009, just when PV manufacturing was increasing. This has resulted in excess supply, with the concomitant result of lowering the cost of PV in the marketplace. However, this situation is probably temporary, with the PV market expected to recover as global demand for solar power rebounds. As a result of the lower demand in 2009, China, a major manufacturer of PV cells, reportedly is looking at policies (e.g., rebates and feed-in tariffs) to stimulate the use of grid-connected PV within its domestic market, rather than relying exclusively on PV export sales.

**References**

- 10. USEA – Handbook on Best Practices RE India
- 75. IEA – Impact of Financial and Economic Crisis on Global Energy Investment
98. The State of Renewable Energies In Europe 2008
## Selected Indicators

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
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<th>2008 (estimated)</th>
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Source: REN 21 Global Status Report – 2007
Renewable Energy Development Indicators

This summary table looks at direct capital investments in RE, providing a snapshot of the global momentum in RE development in recent years. The chart is based on data available in 2007 and therefore does not reflect the impact of the 2008 global economic downturn, but it does show a pattern of significant growth in many RE sectors and indicators prior to that event. Recent data from the International Energy Agency suggest that capital investment in renewables in 2008 reached $81 billion, exceeding the $71 billion forecast shown in this table.

References

ESTIMATED COST OF NEW GENERATION

Source: FERC – 6.08
Slide 7

Estimated Cost of New Generation in the United States

This table compares the capital costs of eight common types of electric power generation, including three types of renewable resources. The bars represent the cost spread due to different sites and resource quality. This graph does not include fuel costs, decommissioning, or waste fuel disposal. The U.S. Federal Energy Regulatory Commission compiled these data in June 2008.

One change outside the cost bands indicated here is for nuclear power generation. The most recent nuclear plant proposal in the United States (Florida Power & Light’s Turkey Point expansion) is now estimated by that utility to cost in the range of $8,000-$10,000/kW. The high cost of nuclear power is due partly to the fact that there have been few new nuclear power plants constructed and brought into operation anywhere over the past 10 years, making actual cost data limited. As new plants are constructed, actual costs for nuclear will render true cost estimates more accurate.

These cost bands have been used for price comparisons in all the technology modules of this toolkit, but have been refined for specific RE technologies and applications. However, these price ranges do not reflect the prices for any actual project and should be used for general comparative purposes only.

References

- 37. DOE – Increasing Costs in Electric Markets
LEVELIZED ENERGY COST

**Note:** Assumes 2.5% annual escalation for production tax credit, O&M costs and fuel prices, 40% tax rate, financing with 60% debt at 7% interest rate and 40% equity at 12% cost.

(a) Includes capitalized interest costs during construction.
(b) High end incorporates 90% carbon capture and compression.
(c) Low end represents assumptions regarding GE 7FA. High end represents assumptions regarding GE LM6000PC.
(d) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression.
(e) Does not reflect potential economic impact of federal loan guarantees or other subsidies.
(f) Low end incorporates illustrative economic and efficiency benefits of combined heat and power (CHP) applications.
In contrast to the previous slide, which provided estimated capital costs of new power generation investments, this table provides estimates for levelized cost of energy (COE) of various generation technologies. The levelized cost of energy includes operation and maintenance costs, as well as financing costs, usually projected over 20 years. This table is based on estimated costs for the United States (the impact of subsidies/incentives is not included). It shows that when all costs are taken into consideration, many renewable energies are competitive with conventional forms of power generation. These costs may not exactly match some of the levelized costs identified in the Toolkit Technology Modules due to different capital and operating cost assumptions, but they do provide a reasonable comparison and show that several renewable technologies are already cost competitive with conventional generation technologies under some scenarios even before factoring in environmental and other externalities. (For more details on the assumptions used in calculating these numbers, see the Lazard reference below.)

Numerous companies and agencies have come up with COE estimates for renewable and conventional sources of energy. Based on the assumptions that feed the model (i.e., future fuel and technology prices, the impact of policy incentives, etc.), the COE can change dramatically. If one considers the fluctuations in global fuel prices, cost and availability of capital, and cost and availability of key components (such as wind turbines and PV panels) in just the past two years, it becomes obvious that accurately predicting prices over a 20-year period (or even longer) is extremely difficult. Many estimates, therefore, are revised almost as soon as they are announced. Nevertheless, such analysis can provide useful information on expected pricing trends and facilitate comparison of technology costs over the long-term. From a review of COE estimates over the past two decades the primary trends are that the COE for conventional sources are consistently trending up while the relative COE for renewable resources are consistently trending down.

References

- 360. Lazard – Levelized Cost of Energy Analysis
- 361. WB – ESMAP Technical and Economic Assessment of Generation Resources
• Global Resources and Costs
• Goals & Objectives
• Barriers
• Strategies for Successful RE Projects
• Best Practices
Slide 9

Goals & Objectives
COMMON RENEWABLE ENERGY GOALS & OBJECTIVES

• Resource diversity
• Economic development
• Energy independence
• Environmental benefits
• Electricity price stabilization
Slide 10

Common Renewable Energy Goals and Objectives

In order to develop a policy framework it is important to be clear about why renewables are important to a country’s energy outlook. Why should energy planners encourage renewable energy? It is helpful to think explicitly about a state/region/country’s energy goals and the role of RE in meeting those goals in order to design an enabling framework that will help a country meet its objectives.

Common Goals

Diversity of Generation Mix – Renewable energy technologies directly contribute to diversifying the country’s electricity supply mix. A traditional energy supply model that relies upon a few large central station generation facilities fueled by one or two resources increases reliability and price volatility risks, and may result in higher electricity service costs. A more diversified mix of resources, technology types, plant sizes, and fuels increases electricity reliability, reducing price volatility risks and the overall cost of power over the long term.

Economic Development – The development of RE facilities can bring additional economic benefits when compared with traditional power plants. The 2007 IEA renewable energy report indicates that the renewable energy sector’s value chains (e.g., feedstock preparation, primary energy supply, manufacturing, construction, installation) are significantly different in scale and scope from those of traditional forms of electric power generation. While fossil fuel and biomass power technologies have a labor-intensive feedstock chain, this does not apply for wind, solar, and hydro facilities. Solar PV has labor-intensive manufacturing and installation stages, while hydropower has a labor-intensive construction stage. Wind power has significant labor intensity in operation and maintenance.

Some countries have taken the lead in implementing RE technologies and have already achieved considerable levels of new employment in one or more RE technology areas. As renewable energy production has increased, the value added and the number of jobs created have become very significant factors. In 2007, Germany reported around 260,000 jobs in renewable energy and related industries. Other countries, provinces, and US states, as well as companies, report similar success stories. The REN21 Global Status Report estimates that 2.4 million people were employed in the RE industry in 2006. The multiple benefits of associating renewable energy market development with renewable energy business development, including manufacturing, increasingly is desired by many countries, and in particular by countries that are heavily dependent on energy imports.

Energy Independence – For many countries, this is an increasingly important electricity sector goal that is by definition tied to the development of renewable resources. Every country has some renewable resources that can be developed to provide an indigenous-based electricity supply. With indigenous RE development, the effects of external influences on a country’s energy policy decrease. Moreover, large-scale development of renewable energy could greatly decrease the need for foreign exchange if foreign imports of fossil fuels can be reduced.
Environmental and Climate Change Benefits – Reducing or eliminating the negative environmental impacts of power generation is a common electricity sector goal. While all electric generation technologies have potential negative environmental impacts, the environmental benefit of obtaining power from RE facilities is one of the key drivers behind renewable energy development in many countries. Renewable energy resources, by and large, tend to have few negative impacts on air and water quality, and produce less solid waste. Moreover, RE facilities produce far fewer greenhouse gas emissions than fossil fuel plants. Scientists (and economists) maintain that, over the long run, pollution prevention is generally less expensive than suffering environmental damage and later trying to mitigate adverse environmental impacts. In general, renewable energy projects tend to have impacts that are more location-bounded (e.g., land use and visual impacts) than the impacts of central station nuclear and fossil projects, which create environmental impacts that extend beyond the project location. In addition, the impacts of fossil fuel and nuclear plants may occur many years or decades after they have begun operating and affect, in aggregate, the general quality of air, water, and land in neighboring regions, as well as globally.

Electricity Price Stabilization – Renewable energy is best known for its environmental benefits. However, wide fossil fuel price fluctuations in recent years have drawn attention to renewables as price-stabilizing resources. Fossil fuels have had, and continue to experience, unpredictable and volatile price changes. Often there is little correlation between forecasted and actual prices, contributing to unwelcome uncertainties for energy planners and end users alike. In order to lock into long-term, fixed-price contracts for fossil fuels, a considerable premium must be added to the supply contract. Coal prices have been easier than petroleum prices to forecast, but under a possible climate change framework post-Copenhagen there may be major environmental and regulatory risks that reduce the accuracy of most fossil fuel price forecasts.

Renewable energy is sourced primarily from free fuels such as wind, sunshine, waterways, and earth heat sources. Utilities and electric service providers can tap into the price hedge value of renewables by basing their evaluation not on natural gas price forecasts, but on actual forward prices. Including significant quantities of renewable energy in the energy mix is likely to reduce cost fluctuations since running costs are negligible compared to initial capital costs. Therefore, future price risks should be included as factors when evaluating non-renewables. Price stabilization benefits mean RE options should be taken into account in any resource plan analysis or as criteria when developing a country’s energy supply portfolio.

Prioritizing National Goals

How national goals are prioritized will influence how a country’s enabling framework should be structured. For example:

- **Economic Development** as a top electricity sector goal would focus attention on building a strong domestic RE market, supporting local manufacturing, and encouraging partnerships with local developers and job training.
- A policy framework anchored in environmental benefits would have a strong energy efficiency component, include the costs of environmental pollution when calculating the cost effectiveness of different generating technologies, support measurement and verification of carbon reductions from RE projects, and include some type of participation in international climate change initiatives.
- A policy framework with a top goal of stabilizing electricity prices would include long-term...
fixed price RE contracts as a key element.

The implementation details of the policy framework will be tailored to the hierarchy of priorities. The next section discusses some of these implementation details.

References

- 25. CRS – Renewable Energy as a Hedge Against Fuel Price Fluctuations
- 68. NREL – Dollars from Sense: The Economic Benefits of Renewable Energy
- 226. Lewis – From Technology Transfer to Local Manufacturing: China’s Emergence in the Global Wind Power Industry

Further Reading

CONFLICTING GOALS & OBJECTIVES

• Electricity sector always has conflicting goals

• Managing those conflicts is the job of government

• Balancing long-term vs. short-term goals is the big challenge
Conflicting Goals & Objectives

The electricity sector in just about every country has always had conflicting goals – securing capacity vs. minimizing price impacts on consumers; maintaining system reliability vs. reducing maintenance costs. Adding renewable energy can raise many of these same conflicts, but can also bring significant benefits.

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

**Short-term Benefit** – Despite their long-term benefits, the majority of RE projects involve capital costs that must be paid up front, even before a plant starts operating. Concerns regarding the short-term electricity price impacts of adding new generating facilities (as opposed to the long-term cost impacts of maintaining the existing resource mix in the face of changing environmental and economic circumstances) are among the principal conflicts in electricity planning.

The next section of this presentation looks at these conflicts in greater depth.
Global Resources and Costs
Goals & Objectives
Barriers
Strategies for Successful RE Projects
Best Practices
Slide 12

Barriers
KEY BARRIERS

• No market
• Utility culture & framework
• Lack of expertise
• Limited role for private sector
• Capital costs vs. variable energy costs
• Transmission access & strength of grid
Key Barriers

**Political Barriers** – In any country, the electricity sector is one of the most capital-intensive sectors of the economy. It costs huge amounts of money to build, operate, and maintain an electricity system. Typically, energy resource industries with an established market share make large amounts of money. The market interests of traditional generation technologies represent a significant barrier to renewable resource development in many countries. Moreover, many decision makers have little experience with renewable energy or other innovative technologies, making it difficult for them to evaluate energy options comprehensively or objectively.

**Economic Barriers** – The primary economic barrier is the up-front capital cost of renewable power generation, coupled with the possible additional costs of grid integration and extension needed for much large-scale RE development. As noted earlier, this barrier reflects the classic problem of long-term vs. short-term benefits. In addition, government subsidies for fossil fuels pose an obstacle in many markets that make fossil generation appear to be less expensive than it actually is.

**Social Barriers** – The primary social barriers are the lack of knowledge and understanding about large grid-connected renewables and the belief that renewable generating technologies are small and not able to contribute significantly to a country’s electricity needs. Small, non-grid connected renewables have been used for years in many countries to provide rural electricity. As a result, much of the population may view renewables primarily in this light, instead of seeing the potential for grid-connected RE to meet larger-scale energy needs. There is also a persistent misperception that renewables are too expensive (even where they are not), coupled with the view that renewable energy is unreliable.

**Environmental Barriers** – Though as a group, renewable energy facilities generally have fewer negative environmental impacts than fossil or nuclear plants, they do have some negative impacts – as do all generating facilities. The negative environmental impacts of renewables should be compared to the negative environmental impacts of the other generating resources that are being considered at any given time. Further details on environmental perceptions and impacts are provided in each of the specific RE technology modules in this toolkit.

**Institutional Barriers** – Institutional barriers refer to the obstacles embedded in the institutional culture of the primary electric utility players and a country’s governmental/regulatory structure. Modular technologies like wind, solar PV, and certain forms of biomass traditionally have not carried the same cachet within the utility industry as large central-station facilities. Geothermal, concentrating solar power and large-scale hydro projects tend to be more appealing within the existing institutional culture in many countries, since these renewable energy technologies have characteristics that are more familiar both to utility engineers and government decision makers.

One way to deal with institutional barriers (and similar social barriers) is to bring energy managers, planners, and decision makers to visit large, grid-connected renewable facilities of various types so
they can get a sense of the scale of these projects and their potential contribution to the electricity sector.

Another institutional barrier is the lack of direct utility experience in the construction and operation of RE generating facilities. There often is a similar lack of familiarity with renewables within the banking and investment sectors. As a result, any campaign to introduce significant amounts of renewables into the electricity generation mix, almost by necessity, will involve participation by specialized private-sector developers. However, some countries have laws barring independent power producers from participating in electricity power production (with the exception of self-generation). This situation can lead to legal as well as institutional barriers that must be dismantled before renewables can become an integral part of a country’s energy mix.

**Technical Barriers** – The primary technical barrier to RE development in many countries is the existing electricity grid itself. Renewable resources such as wind and geothermal often are located outside major demand centers. Capitalizing on these resources typically requires transmission line upgrades or extensions to bring the power to where it is needed. In addition, the electricity grids in some countries are weak, unreliable, and poorly integrated with neighboring systems, which can make the addition of new generation problematic. Finally, some types of renewable power, such as wind and solar PV, are variable in their output and require special grid-integration measures. These technical issues may require specialized resource data analysis and training of grid managers to implement effectively the necessary grid-integration measures.

The effect of these barriers, any or all of which may be present in any given country, can be summarized as follows:

- Market purchase price for renewable power does not always reflect its benefits or the full cost of competing generation;
- Low operating costs and environmental benefits of renewables often are not appropriately compared in resource plans;
- Obstacles to private power development;
- Lack of access to transmission lines or inadequate transmission grid;
- Limited resources to invest in new transmission facilities;
- Lack of expertise in renewable energy development or operation; and
- Skeptical utility culture and lack of a renewable energy procurement framework.

**Photo credit:** HMW International, Inc.

**References**

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- 284. Electricity Generation and Environmental Externalities: Case Studies
• Global Resources and Costs
• Goals & Objectives
• Barriers
• **Strategies for Successful RE Projects**
  • Stakeholder Roles
  • Market Promotion Strategies
  • PPAs and Business Models
  • Transmission and Grid Integration
  • Financing and Risk Mitigation
• Best Practices
Strategies for Successful Renewable Energy Projects

- Stakeholder Roles
- Market Promotion Strategies
- PPAs and Business Models
- Transmission and Grid Integration
- Financing and Risk Mitigation
STRATEGIES TO OVERCOME BARRIERS

• Promote market development
• Support utility RE procurement
• Encourage private investment
• Provide long-term contracts
• Value RE attributes
• Facilitate access to electricity grid
• Train RE designers and operators
Strategies to Overcome Barriers

Why Are RE Policies Needed?

Quite simply, a framework that encourages renewable energy policies is the most effective means of overcoming the market barriers to renewable energy. In most countries, renewable energy markets develop only after the government has instituted RE promotion policies of some sort.

The privatization of utility systems worldwide has brought a degree of market discipline and economic reality to the electricity business. However, where privatization has resulted in a shift to reliance on a short-term market for wholesale power, an unwelcome side effect has been a negative impact on the development of new and innovative RE generation projects. In a short-term market, governments have to build a bridge to encourage the development of renewable energy projects that deliver long-term benefits.

Moreover, due to the capital intensity of the electricity sector, many countries do not have sufficient funds for new generation development, which puts renewable energy facilities at a distinct disadvantage, as the capital requirements for these projects typically are front loaded. This scarcity of resources combined with the lack of experience in building, operating, and maintaining renewable energy facilities on the part of many utilities makes it imperative that mechanisms be employed to attract private-sector investment and development. According to the US Energy Information Agency, only 9% of non-hydro renewable generation in the United States is owned by utilities, while 55% of fossil generation is utility owned. In many countries the percentage of utility-owned renewable generation is even lower.

In order to encourage the development of renewable energy, policies need to be in place that will:

- Promote market development;
- Support renewable energy procurement within the utility structure;
- Encourage participation and investment by the private sector;
- Provide long-term contracts;
- Fairly value RE characteristics and provide stable long-term contracts and pricing commensurate with those values;
- Provide open access to the transmission and distribution grids and support investments to strengthen the grid; and
- Provide knowledge and expertise in the design, operation, and maintenance of renewable generating facilities.

The next sections detail the roles, strategies, and models needed to develop a framework that enables the development of renewable energy.

**Photo credit:** HMW International, Inc.
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• Global Resources and Costs
• Goals & Objectives
• Barriers
• **Strategies for Successful RE Projects**
  • Stakeholder Roles
  • Market Promotion Strategies
  • PPAs and Business Models
  • Transmission and Grid Integration
  • Financing and Risk Mitigation
• Best Practices
Slide 16

Strategies for Successful Renewable Energy Projects: Stakeholder Roles
Governments lay the foundation for RE deployment via:

- Legislation
- Regulatory structure
- Administrative oversight of the energy sector
Government’s Role

Governments can play a key role in the development of renewable energy. Typically, three types of government bodies are involved, each of which has an impact on the policy environment for renewable energy:

**Legislative Body**
- Passes legislation that addresses public interest goals as interpreted by the legislative body

**Regulatory Bodies**
- Establish rules and regulations to implement the policies established through legislation
- Enforce the rules and regulations
- Direct resource planning and procurement policies
- Oversee voluntary programs

**Executive Offices/Ministries**
- Provide the administrative framework to support renewable energy development
- Create a political climate that encourages the use of renewables
- Lead by example by procuring renewable energy to serve the needs of government facilities

The following slides explore each of these areas in more detail.
Renewable energy laws should:

• Articulate goals
• Establish role of renewable resources
• Assign role and authority of government agencies
• Ensure transparency of processes
• Provide clear protection for investors
• Provide impartial enforcement for all parties
Legislative Role of Government

The legislature’s involvement typically revolves around drafting and passing renewable energy laws. Most energy policies are enacted through legislation passed by the national (or sub-national level) legislative body and then implemented by the appropriate government agencies. The effectiveness of the policies depends to a great deal on good communications between the legislative body and the agencies responsible for implementing the legislation. This communication helps to enable policy design that is practical, implementable, and enforceable. Not only is this communication necessary during the policy design process, but it is desirable to have some type of on-going reporting after the legislation has been implemented.

Seldom are policies designed perfectly the first time around. They often require fine tuning and adjustments based on the realities of the marketplace. Close coordination and communication by and with the implementing agencies can help legislators better understand the market situation and balance the information provided by special interests that may conflict with the public’s interests. Requesting that the implementing agency provide an implementation report, after a reasonable period, can provide the details needed to assess a policy’s effectiveness. In addition, it is imperative that new energy policies be given sufficient time to see if they will have a measurable impact on the market before making significant changes to the policy. The stability of the government’s policy framework is as important as the policies themselves.

Renewable Energy Laws Serves Four Principal Functions:

- Renewable energy laws allow a country to put together a systematic approach to the development and utilization of a country’s renewable resources.
- A renewable energy law supports renewable resource investments. It helps establish the predictability necessary for investors to evaluate the risks of investment, thereby enabling investment in a country’s renewable resource sector. A law has a more certain status than a collection of policies and is less likely to be changed with a change in government.
- A national renewable energy law can overcome the issue of inconsistent sub-national policies. Foreign investors, moreover, are more likely to invest in a more transparent and consistent regulatory environment. However, a national law should allow sub-national regimes to have goals and targets that go beyond the national ones if they so desire (e.g., sub-national targets can be higher than the national ones though the policies should be the same or compatible).
- Rational exploitation of individual renewable resources or particular resource applications may require resource-specific development laws.

In order to perform these functions, a renewable energy law usually contains the following elements:

Articulated Goals – Articulating goals and establishing the role of renewable resources in the country/state’s electricity supply mix are obvious legislative roles often informed by discussions with regulatory and state agency experts and articulated in the preamble to a renewable energy law.
**Assigned Roles and Authority** – A renewable energy law assigns authority to some agency for implementation and oversight of the law. If the law does not include such assignment, turf battles between agencies can ensue, hampering forward momentum on renewable energy development. Very often an agency will be asked to report back periodically to the legislative body so that the legislative body can determine whether the law is meeting its intended goals, or whether some type of fine tuning is required.

**Transparent Process** – It is important that the process for participation is laid out clearly so stakeholders know what is required to be eligible to participate and what the process for participation will entail. A renewable energy law may spell out participation eligibility in its definitions, or it may ask the implementing agency to define eligibility. The participatory process is more likely delegated by the legislative body. However, if the process details are delegated, the legislative language should direct the implementing agency to ensure there is a simple and transparent process for participants. It also is useful for the legislation to include a specific date by which time the guiding rules and regulations should be finished and the law becomes operational.

**Economic Predictability** – If one objective of the law is to encourage the private sector to invest in developing renewable resources, the renewable resources laws must establish economic predictability. Investors and bankers need predictability in order to evaluate risk before they invest in or lend money to a project. Protection for investors includes enforceable laws and contracts and consistent policies and programs over sufficient time, allowing investors to plan and complete their investments.

**Enforcement Measures** – Renewable energy legislation should include clearly stated provisions for any fines or alternative compliance fees needed to enforce the new law. The legislative body may leave it to the regulatory body to determine the level of these fines or fees, or it may specify them in the law itself. Nevertheless, the law needs to ensure the oversight body has sufficient authority to enforce even and impartial compliance by the appropriate affected parties.

**References**

- 136. AB1714: CA Solar Energy Legislation
- 151. Summary of the RE Act Philippines
- 152. Summary of China's Renewable Energy Law
- 170. Baker & McKenzie – Optimal Legal Frameworks for RE in India
GOVERNMENT’S ROLE – REGULATORY

- Policy implementation & enforcement
- Renewable energy market promotion
- Pricing of electricity
- Cost sharing
Government’s Regulatory Roles

In virtually every country in the world, electricity is considered a public good that is provided by a government-owned enterprise, quasi-governmental enterprise, or a government-regulated private enterprise. In countries where the electricity sector is separate from the governmental sector, there is often a regulatory body that oversees tariff setting, interconnection regulations, utility programs of all types, and policy enforcement, including the utility’s role in electricity markets. Where the electric utility is still part of the government this oversight role may be performed by the Ministry or Department of Energy.

In many countries the regulatory body is a financial regulator whose power to influence a utility’s actions comes from its authority to allow or disallow utility costs to be passed through to electricity consumers in the electricity tariffs. These regulators also oversee rulemaking proceedings that establish the rules that govern the implementation of energy policies and programs. Depending upon the breadth of its rulemaking authority, the regulatory agency can have a significant impact on renewable energy development. For example, in 1992 the Mexican Legislature passed the Public Electric Service Act (LSPEE), which allowed the participation of the private sector in self-supply generation. The implementing regulations written by the Mexican regulatory commission (Comisión Reguladora de Energía – CRE) permit both on-site self-supply generation as well as remote generation that utilizes wheeling services from the national utility (i.e., transmission of the power from where it is generated to where it is being used). These regulations effectively opened the door for private investment in renewable generation projects that had not previously been allowed. Now independently owned wind farms and other large, grid-connected renewable projects can operate in Mexico as long as they sell their output to participants in the generating project. (See Mexico Wind Case Study.)

Regulations and agency rulemaking are as important as the legislation itself in defining the opportunities for renewable energy development. The following points describe some of the many ways that regulatory processes can enable renewable energy development:

Implementation and Enforcement of Legislation

Implementation – Most energy legislation by necessity broadly frames government intentions toward the sector and relies on governmental agencies to write the rules and regulations that will result in proper implementation of the law. These implementation details are critical to the success of the policy/programs. The rules can be written in a way that makes participation easy or they can make participation complex, difficult, and expensive. These rules may interpret the legislative intent (as in the Mexican example) in a manner that provides more opportunities than were obvious from a strict reading of the law. Conversely, the rules may limit participation more than might be anticipated by reading the law alone. The implementation rules may be written and brought into effect within a few months or a year after the law is passed or they can be delayed for years, thereby thwarting the intent of the law.
Enforcement – Enforcement is an important element of any market-making legislation that requires specified activities (like paying feed-in tariffs to all eligible renewable generation projects or procuring a specified amount of renewable energy by a certain date). A governmental agency generally is assigned the role of enforcing such laws, including establishing the process for determining compliance and setting penalties for non-compliance. Properly designed penalties (e.g., penalties that cost more than the cost of compliance) can by their very existence result in compliance without the need to actually apply the penalties. Developing a process for determining compliance, including the collection of accurate data, is a critical first step in enforcement. Data collection is discussed in greater detail in slide #30.

Market Promotion

Regulatory agencies can also help create markets for renewable energy in the following ways:

- Through the rules they write that govern resource planning (e.g., directing how electric utilities should value renewable power)
- Through the rules governing electricity procurement (e.g., directing utilities to first acquire cost-effective energy efficiency and renewable power before acquiring other types of supply resources)
- Through their regulatory approval of power purchase agreements (PPAs) with independent energy producers (e.g., laying out the rules for energy and capacity payments as well as contract language for the conditions under which power purchases are made)
- Through regulations dealing with transmission upgrades and grid access rules; and
- Through regulations specifying how the costs of transmission and power acquired from independent producers will be allocated, along with other details.

Depending upon the breadth of its jurisdictional authority, a regulatory body may undertake any or all of these examples, independent of specific renewable energy legislation. Indeed, sometimes regulations are put into effect first before they are codified later by legislation. The advantage of legislation is that it generally provides greater certainty to the financial community than do regulations alone. Regulations can be more flexible but they can also be more unstable from the private sector perspective. Market certainty and stability are the cornerstones of good governmental policies.

Pricing and Cost Sharing – Identification of pricing and cost-sharing mechanisms for both transmission and power purchase agreements is a critical and often contentious part of the regulator's role.

Pricing is especially difficult because government and electric utility regulators always want to keep prices for electricity low, and must be concerned about how potential price increases will impact low-income households. When comparing the cost of old existing power generation projects to that of new renewable projects it is important to recognize that all new generation (including fossil-based generation) costs more to construct than existing power facilities cost when they were built. The proper comparison should be made by comparing the cost (including fuel) of other new generating resources also under consideration.

Cost sharing between local utilities and national grid customers is another issue. Obviously, the more broadly costs are spread over the electricity-consuming public, the lower the impact on
everyone. However, local electric companies often reject the proposal to spread the costs of new generation or new transmission across the entire population if they are not the ones planning on investing in new generation. Cost sharing can become quite a contentious political issue, depending upon a country’s electricity structure. Again, it is an issue of long-term vs. short-term costs and benefits.

References

- 10. USEA – Handbook on Best Practices RE India
- 25. CRS – Renewable Energy as a Hedge Against Fuel Price Fluctuations
- 81. Introduction to US Electricity Regulatory Structure
- 82. National Regulatory Research Institute
• Manage resource concessions

• Enable private sector participation

• Develop technology-specific strategies and programs

• Lead by example
Government’s Administrative Roles

The regulatory body may be a separate entity from the government body that deals with administration of programs and policies, or it may be a separate part of the same body. Generally the regulatory body oversees all electricity types while separate agencies or departments within an agency or ministry may focus primarily on sustainable energy issues – e.g., renewables and energy efficiency. This separate agency or ministry may oversee specific renewable energy programs and research and development activities, and provide advice to regulators based on analysis of the potential advantages and disadvantages of various courses of action. The energy agencies and ministries can also be important by providing supportive policies and programs that are discussed in greater detail in slide #37.

Government agencies developed specifically to serve renewable energy development and handle some of these administrative tasks can be particularly helpful, especially if the country is making a special effort to encourage renewable energy development and/or the existing energy agency or ministry is already spread too thin. For example, India has a Ministry of New and Renewable Energy (MNRE) and Sri Lanka has a Sustainable Energy Authority located within the Ministry of Power and Energy. A variation on this concept is the National Renewable Energy Laboratory (NREL) in the United States, which provides renewable energy research and support to the U.S. Department of Energy. However, having a separate agency is not useful if renewable energy tasks are spread across several agencies, resulting in duplication of efforts and agency competition.

Typical issues handled by a renewable energy agency or related government agency include:

Resource Concessions – A “concession” is a grant of special privileges by a government allowing a private party to exploit government land or resources. In many countries the government controls (via ownership of the land or through resource laws) the use of resources like hydro, wind, and geothermal. Where these resources are being developed on government-controlled land often there is a formal process for awarding “concessions,” or the resource rights associated with a particular geographic area. An effective resource concession process includes the following steps:

- Establish objective criteria upon which the selection of the resource concession award will be based;
- Establish an objective, qualified panel or committee to oversee competitive awards. It may be desirable to award temporary concessions that may later be converted to permanent concession to enable developers to evaluate project commercial feasibility;
- Minimize the number of secondary permissions required in concessionary grants;
- Require that certain milestones be met by a certain time in order for the party to retain its concession rights.

Enabling Private Sector Participation – Financial institutions insist that a private developer secure two legal rights before financing a project:
The exclusive right to explore and extract or use the relevant resource in an area that s/he can access; and
• The right to generate and sell electricity from any resource developed.

The rules governing these rights are generally written by governmental agencies in a manner that allows the outcome to be predictable. This means that both the process for obtaining these rights as well as the resource rights and power purchase agreement elements themselves should be clearly defined and known in advance by the interested parties.

**Technology-Specific Strategies** – A renewable energy promotion law may create a policy framework to enable renewable energy development, but may not specify how policy implementation details might differ when applied to different renewable technologies or technology applications. These details often are left to the implementing agencies. The most critical areas of difference are the application of policies to large grid-connected generators vs. generators that are located on-site behind the customer’s meter. The latter applications may include fairly large facilities, including biomass-fueled cogeneration and large corporate PV installations. A policy strategy needs different implementation details to encourage behind the meter renewable energy investments. (See slide #36 on Net Metering.)

Hydroelectric development may require quite different policies from other renewables because hydropower technologies are more mature and the obstacles to development are different from most other RE resources. Biomass resource development also has a number of sector-specific issues that may need to be addressed through specific programs and implementation details (since it has ongoing fuel costs and may be combusted, which creates a different environmental profile from the other renewables). The technology modules provide more detail on these issues.

**Lead by Example** – Governments typically use large quantities of electricity to operate public buildings and military facilities. Government agencies can lead by example by implementing energy efficiency procedures and procuring electricity from renewable energy resources. For example, the US government has had an Executive Order in place for the past 10 years that requires all US government agencies to use energy efficiency to the extent possible in their offices and buildings and to procure renewable energy to the extent practical. As a result, the US Air Force is one of the largest purchasers of renewable energy in the United States. Sub-national governments, including local municipalities, and universities can also lead by example by making their buildings more energy efficient and procuring renewable energy.

**References**

• 163. Gov of India – Ministry of New & Renewable Energy
• 164. Country Matrix Sri Lanka – Ministry of Sustainable Energy
• 262. US Executive Order 13123 – Greening the Government Through Efficient Energy Management
• 263. US Executive Order 13423 – Strengthening Federal Environmental, Energy, and Transportation Management
UTILITY ROLE

- Resource planning
- Procurement
- Integration into rates
- Operation of system
- Transmission access
- System stability
- Green pricing & other voluntary programs
- Technology-specific strategies
Electric Utility Role

The electric utility is a key player in every aspect of power development. With regard to renewables, the utility will be closely involved in the following activities:

**Resource Planning** – The utility, in its role as resource planner, often determines what types of generation will be built. The details of the planning process and the requirements set by legislators and the regulatory or oversight agency establish how much renewable energy development will take place. The regulatory process may also prescribe the actual process of how the resource planning will be conducted. In some cases the regulatory agency will review the resource planning results and suggest changes or revisions. However, the resource planning process has fallen by the wayside in some restructured electricity markets where the utility no longer builds or operates generating facilities. In that case, a government agency may step in to fill this gap.

**Procurement** – The primary question after “whether to acquire renewable power” is the question of “how to acquire the power.” Depending upon the renewable policy framework, there are a number of options for utility procurement of renewables: (1) the utility can build, own, and operate a renewable energy facility itself; (2) under a feed-in tariff, the utility buys all the renewable power that is offered for the feed-in price; (3) under a mandatory target, the utility can build its own facilities and/or purchase power from renewable facilities, either through a “first come, first served” process (i.e., buy eligible output as it is offered until it has reached the target) and/or use a tendering process for larger projects and offer contracts to the least-cost projects up to the point where it has met its target. The procurement mechanism should be matched to the market promotion policy that has been put into place.

**Integration into Rates** – The electric utility also is responsible for the integration of RE costs into electricity rates. The mechanism for doing this often is prescribed by legislation, or via regulations administered by a government agency.

**Transmission System Operation** – Another important utility role is the operation of the electricity system (including transmission) to ensure RE facilities have both transmission access and system stability. In states and countries where the electricity sector has been restructured, the transmission system may be managed by a separate transmission company or governmental entity rather than the electric utility. This separate entity may also do the planning, financing, and building new transmission lines, though the costs will most likely be passed through to rate payers in their electricity tariffs. (See slides #45-48 on transmission policies and related issues.)

**Green Pricing and Other Voluntary Programs** – Utilities may develop their own voluntary renewable energy programs. In this case, a utility may offer its customers the option of purchasing renewable energy (more than might otherwise be included in the utility’s regular resource mix) at a special rate. This rate typically is higher than the utility’s standard rate, which may reflect a generation mix of little or no renewables. However some utilities have offered a fixed electricity price over a multi-year period (e.g. five years) that shelters the renewable purchaser from fossil fuel price
fluctuations and may result in the renewable price being lower than regular electricity rates by the end of the fixed price period. These kinds of programs are known as “Green Pricing.” There are two common motivations for customers to find this voluntary offer desirable:

- If the renewable power is offered at a fixed rate, it can stabilize individual customer electricity costs. Many commercial/industrial customers find this to be a very attractive option because they tend to be more concerned about fluctuations in electricity price than in the absolute price itself; and
- Some companies may have directives from their parent company or agreements with their customers that require them to reduce the greenhouse gases associated with their operations. If the utility has a voluntary program that allows a customer to substitute renewable energy for fossil power, this is one way a company can meet those commitments.

**Technology-Specific Strategies** – Finally, the utility might implement technology-specific strategies. Net metering is one such strategy (see slide #36). Or a utility might build a solar project at a substation in order to improve transmission and distribution line efficiency. Alternatively, a utility might go out to bid for a baseload biomass project in a particular location that could improve system reliability.

**References**

- 25. CRS – Renewable Energy as a Hedge Against Fuel Price Fluctuations
- 165. IEA/DOE Website on RE Projects
PRIVATE SECTOR ROLE

Project development
• Financing
• Resource data
• Operation & maintenance
• Technology imports

Other activities
• Local manufacturing
• Technology transfer
• Technology-specific utility assistance
  – Resource exploration and measurement
  – Technology training
Private Sector Role

Often private sector companies may be the only entities with the knowledge, experience, and ability to build and operate large, grid-connected renewable energy facilities. As a result, in many countries the private sector plays a key role in renewable energy development. This role includes everything from collecting resource data, to financing projects, to importing equipment and establishing local component manufacturing facilities, engaging in technology transfer, and operating and maintaining renewable facilities, and other technology-specific services. (More specific discussion of these roles is included in the financing and business model sections of this presentation.)

Very often, private sector companies are the only ones who can take advantage of tax credits, accelerated depreciation allowances, or other policy incentives designed to reduce the effective cost of renewables and thereby stimulate the market. Experience by private companies with a history of successful design, construction, and operation of renewable energy projects can improve the efficiency of the projects and reduce both the project cost and the risk of project non-performance. Some types of renewable development require specialized skills (e.g., geothermal drilling, wind resource data collection, stream flow measurement, etc.) that a utility may not possess. So even if a utility is interested in constructing a renewable facility itself, private sector companies with special skills may still play active roles.

While there may be only a few government players in the energy business, and often only one electric utility per jurisdiction, there are increasing numbers of private sector renewable energy companies of all types that are competing for renewable energy business in countries around the world.
• Global Resources and Costs
• Goals & Objectives
• Barriers
• Strategies for Successful RE Projects
  • Stakeholder Roles
  • Market Promotion Strategies
  • PPAs and Business Models
  • Transmission and Grid Integration
  • Financing and Risk Mitigation
• Best Practices
Strategies for Successful Renewable Energy Projects: Market Promotion Strategies
# RE DEVELOPMENT POLICIES

<table>
<thead>
<tr>
<th>Innovative technologies</th>
<th>Emerging technologies</th>
<th>Mature technologies</th>
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<tbody>
<tr>
<td>e.g., Ocean wave &amp; tidal, some types of solar &amp; biomass</td>
<td>e.g., Solar, wind, geothermal, biomass</td>
<td>e.g., Hydroelectric</td>
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- Research & development
- Demonstration
- Interconnection requirements & transmission rules
- Public education
- Market & tax incentives
- Tech training
- Integrated energy planning
- Market creation – Feed-in or renewable targets (RPS), green pricing, and net metering
- Transmission access & construction
- Tax & other incentive programs
- Tariff & cost sharing
- Job training
- Integrated energy planning
- Appropriate tariffs
- Transmission & interconnection
- Public education
- On-going policy support
- Job training
RE Technology Development and Policy

This slide summarizes the suite of policies required to meet the diverse needs of different technologies during different phases of commercialization. No one policy can meet all goals on its own.

The combination of policies needed will be somewhat different depending upon a technology’s phase of commercialization. An individual technology will move from one phase to the next as the technology becomes commercially mature. The content and implementation details of these policies will differ for different applications and the unique country specific situation. Nevertheless, this table provides a reasonable framework for understanding the development and evolution of renewable energy policy depending upon the types of technologies that are being encouraged. The type of policy selected (e.g., whether a feed-in tariff or renewable target is chosen for market creation purposes) will be influenced somewhat by the market structure of the country. Restructured competitive electricity markets may require more tax and other incentives and market-based policies while traditional, vertically integrated utility markets may respond better to feed-in tariffs and integrated energy planning strategies. However, this is more a matter of emphasizing certain policies over others, rather than excluding some as appropriate only for certain market structures.

Experience worldwide has shown that a transparent, stable, and long-term policy framework is the biggest driver of renewable energy development. The next section of this presentation discusses the details of the individual policies.
• Feed-in tariffs (FIT)

• Mandatory targets:
  – Renewable Portfolio Standards (RPS)
  – Renewable Energy Standards (RES)

• Hybrid approaches
Technology Deployment Policies

The electricity sector typically needs a policy “push” to build the market for renewable electricity. The two most common RE technology promotion policies are a feed-in tariff (FIT) that guarantees the purchase of power at a specified price from renewable facilities that meet the tariff criteria, or a mandated target for the utility supply of renewable power – sometimes called a Renewable Portfolio Standard (RPS) or Renewable Energy Standard (RES). These two policies (or some variation of them) are the primary market-making policies used globally today to anchor a renewable policy framework, both in countries with a market-driven energy sector and in those with a traditional vertically integrated utility structure. Both RPS and RES policies are established through legislation that specifies the quota target and/or the feed-in tariff, or the analytical basis used to calculate the feed-in tariff. In both cases the costs are absorbed by the customer.

**Feed-in Tariff (FIT):** A feed-in tariff sets the price that will be paid for renewable energy, although the quantity of renewable energy that will be developed for that price is unknown. The feed-in tariff level is established by a government body (either the legislature or the regulatory agency). The actual price needs to be set at a level high enough to attract a significant amount of renewable energy development, but not so high that it results in windfall profits. A number of different methodologies are used for calculating the tariff. In the United States, initially the utility’s avoided cost or a fixed cost based on retail electricity rates was used. In Germany and Spain, the FIT payment is based on the levelized cost of renewable generation (often on a technology-specific basis, taking into consideration local resource conditions and O&M costs) plus a target rate of return. South Africa recently adopted a refined version of this approach.

The financial community appreciates the FIT policy because it allows them to do long-term planning, since they can calculate exactly how much revenue a RE project will receive. A FIT policy initially is the least complex market promotion policy to put into place and, if the tariff is set at an appropriate level, results in the greatest amount of renewable energy becoming operational in a short period of time. Depending upon the level of the feed-in tariff, it is also a policy that encourages innovation and may result in new renewable applications that might not otherwise have been contemplated. For innovative projects, because the tariff is known in advance and a pro-forma contract is available, a FIT policy significantly reduces financial and regulatory risks. (Innovative projects typically do not participate in auctions where the goal is to obtain power at the lowest price.) The feed-in tariff is established either by legislation or by the implementing regulatory body and may be regularly revised as technology costs change. The cost of resources acquired through a feed-in tariff is factored into customers’ electricity rates. The FIT can be rolled into the kWh base-rate or may appear as a surcharge on the electricity bill, depending upon regulatory preference. (The references below and on the next slide provide greater detail about FIT policy, tariff design and implementation.)

**Mandated Targets (RPS/RES)** – A renewable portfolio or energy standard sets the quantity of renewables that the utility will be required to have in its energy mix within a given timeframe, but the costs for which the energy will be acquired generally are unknown. The utility is typically the entity required to build or purchase these renewables under a mandated target policy. Politicians tend to like RPS policies because establishing renewable energy targets may demonstrate a commitment to
renewables without directly addressing the issue of cost. In order to limit the cost of meeting the target to consumers, government officials may establish a ceiling on the price a utility has to pay for renewables or create some type of alternative payment mechanism that can act as a cap on costs. An alternative payment mechanism allows the utility to pay a specified price per MWh into a renewable energy fund if the utility cannot procure renewable resources for that cost. This fund is then used to fund renewable development. Unfortunately, if not carefully designed (e.g., if they are too low) these price caps or alternative payment schemes can undermine the ability to actually meet the RE targets.

**Hybrid FIT/RPS Policy** – Several developing countries are designing hybrid FIT/RPS policies that combine some of the best elements of each approach. The Philippines has passed legislation and India is considering legislation that includes both a fixed price for electricity sourced from renewable energy, as well as mandatory targets for electricity suppliers using tradable renewable energy certificates (TRECs – see slide #59) as the mechanism for allowing utilities in regions with fewer developable renewables to acquire renewable energy credits from areas with more developable renewables. Sri Lanka has a new flat-fee tariff with three RE technology tiers that appears to borrow from both types of policies. China’s Renewable Energy Law also resulted in a hybrid of FIT and specific RE technology targets. To date in China, some of the technology-specific targets, such as the wind target, are expected to be achieved ahead of schedule and are being revised to a higher level. However, since all of these policies are relatively new, the details and results are still to be determined.

**Photo credit:** istockphoto.com

**References**

**Information on FIT Policies**

- 70. CA Feed-in Tariff Design and Policy Options
- 209. South Africa – Renewable Energy Feed-In Tariff Guidelines by the Energy Regulator of South Africa (NERSA)
- 227. Policy Action and Climate Toolkit
- 228. International Feed-in Cooperation
- 352. Best Practice Paper for the International Feed-In Cooperation

*(The next two reports are advocating for FITs.)*

- 71. WFC – Feed-in Tariffs -- Boosting Energy for our Future
- 72. EPIA – Supporting Solar Photovoltaic Electricity: An argument for Feed-in Tariffs

**Information on RE Targets**

- 230. NREL – Renewable Portfolio Standards in the States: Balancing Goals and
Implementation Strategies

**Renewable Energy Laws**

- 10. USEA – Handbook on Best Practices RE India
- 151. Summary of the RE Act Philippines
- 152. Summary of China's Renewable Energy Law
- 236. Promotion of Renewable Energy in Sri Lanka: Future Directions
COMPARISON OF FIT AND RPS POLICIES

FIT system benefits:
• Quicker market development
• Supports diverse group of resources
• Certainty of cost
• Flexible
• Low transaction cost
• Ease of financing
• Ease of entry

Mandate system benefits:
• Promotes least-cost resources
• Certainty of quantity – sets upper limits
• Perceived to be more market based
• Better integration into supply infrastructure
Comparison of Pricing-Based System (FIT) and Mandatory Quota System (RPS/RES)

In addition to its many benefits, there are some disadvantages to a FIT system. A pricing-based system (FIT) requires tariffs to be adjusted consistently over time to avoid consumers paying unnecessarily high prices for renewable power as project costs decline. Tariffs typically are reviewed every 3 to 5 years. Regulators indicate what the term of the tariff contract will be (generally 15 to 25 years) and a project receives the specified feed-in tariff that was in place at the time it signed its contract effective for the term stipulated by the FIT. Revisions to the tariff apply to new projects that sign contracts during the effective time period of the revision. The tariffs in both Germany and Spain are based on the estimated current costs of each technology. Though the feed-in tariffs may look high at the beginning when the quantity of power from a particular technology is relatively small, the prices are ratcheted down as the industry grows and the quantity of power increases. This results in an initial boost during the early stage of technology commercialization, but tariff prices level off later as each technology matures. (See references below for more detail on design and implementation of FITs.)

A pricing-based system may be more difficult for politicians to justify than a quota system because prices are always more difficult to justify than targets. Thus, the FIT is more vulnerable to repeal attempts by legislative bodies. In Germany, for example, legislation is introduced into the German congress almost every year to repeal the FIT, even though the tariff has been tremendously successful at encouraging renewable energy development. Spain has faced the same problem in the face of tremendous FIT policy success.

A quota system (RPS/RES) is quite popular with legislators since it gives a utility the opportunity to acquire least-cost renewable resources, sets an upper limit on the amount of renewables that need to be acquired, and is perceived to be "market based." However, a quota system requires a fairly high level of sophistication by regulatory staff to design and implement the policy effectively and can be difficult to adjust if situations change in the short term. For example, during an economic downturn, when financing is difficult to obtain, new project development may lag significantly behind the timeline that was legislatively established. RPS-type programs produce high risks and low rewards for equipment manufacturers and project developers, which slows innovation. There can be significant electricity price fluctuations in thin markets (those with few participants), creating market instability and gaming. Mandatory quota systems also tend to favor large, centralized generation plants and are not well suited for small investors. Mandatory quota systems tend to create cycles of stop-and-go development and high transaction costs.

In the long run (10-20 years), well-designed and well-implemented FIT and RPS policies are likely to yield the same results ultimately at about the same costs, though the distribution of those costs and results over time will be different. A FIT policy generally will yield more projects earlier in the process and the costs are likely to be higher in the early years of the policy than for an RPS-type policy. A FIT also may yield a more diversified resource mix than an RPS since it is an incentive for all types of generators that can produce at the FIT tariff, rather than being designed to contract with only the
lower-cost resources. But this is entirely dependent upon the tariff level and implementation details of
the two policies.

References

  Standards, Feed-in Tariffs, and Tendering Policies

Information on FIT Policies

- 209. South Africa – Renewable Energy Feed-In Tariff Guidelines by the Energy Regulator of
  South Africa (NERSA)
- 227. Policy Action and Climate Toolkit
- 228. International Feed-in Cooperation
- 352. Best Practice Paper for the International Feed-In Cooperation

Information on RE Targets

- 35. Database of State Incentives for Renewables & Efficiency
- 158. Worldwatch – National Policy Instruments
- 230. NREL – Renewable Portfolio Standards in the States: Balancing Goals and
  Implementation Strategies
GLOBAL POLICY LANDSCAPE

• 43 countries and 9 states/provinces have feed-in policies – more than half developed since 2002

• 52 states, provinces, and countries have enacted renewable portfolio standards (RPS) – half since 2003

• Many countries continue to actively supplement, revise, and clarify targets and promotion policies, including feed-in tariffs and rules

Source: REN 21 Global Status Report – 2008
Global Policy Landscape

From a global perspective, feed-in tariffs (FIT) have been the most popular market-making policy. And since they have been in place the longest, we have more data supporting their results. The most notable feed-in laws have been in Germany and Spain, but they have also been adopted by many other EU and eastern European countries, as well as Argentina, Algeria, Brazil, China, Ecuador, some Indian states, Indonesia, South Africa, Thailand, and Turkey. In the United States, several utilities in California, Florida, Oregon, Vermont, Washington, and Wisconsin also have implemented FIT policy variations.

RPS has been popular in the United States, where 34 states plus the District of Columbia have enacted these types of policies. In addition, Australia, China, Italy, Japan, Sweden, the United Kingdom, two Belgian states, six Indian states, and three Canadian provinces have adopted RPS policies. But since this is a newer policy approach than FIT, data on the results are in short supply.

Putting one of these policies into place is not the end of it. Both RPS targets and feed-in tariffs continue to evolve and change over time – RPS targets go up and FIT levels are reduced as costs, commercialization experience, and needs change. Feed-in tariffs have been refined to include different prices associated with specific technologies. As the technologies become more commercially viable and their costs are reduced, the price for the next batch of projects is reduced accordingly. Where new innovative technologies begin to emerge, a new tariff for that technology type may be added. The Public Utilities Regulatory Policies Act (PURPA) was a type of feed-in tariff that was adopted in the United States during the 1980s and 1990s. However, it fell out of favor and mandated targets (RPS) became more popular as states considered restructuring their electricity sectors. Many states have since adopted RPS policies, though not all chose to restructure their electric utilities. Today, many US states are considering moving to a more sophisticated feed-in tariff like those used in Europe, or developing a hybrid RPS/FIT policy, or adopting a feed-in policy specifically for smaller projects.

Mandatory targets (RPS-type policies) also must be adjusted over time. The most common adjustments are to increase the RE target level. As old targets are met, new targets are set. Adjustments in technology eligibility may also be seen in the future. In the United States, fixed tariffs are beginning to be being used for smaller projects to reduce their cost of participation in the RPS program. There also is a great deal of discussion and interest in combining mandated targets and fixed tariffs into a hybrid policy, though no definitive changes have emerged. The US Congress currently is considering passage of a national renewable portfolio standard that would act as a floor for state renewable programs, though state RPS targets could be higher than the national one.

Enforcement issues are vital to RPS policies, as are the data to support them. It is not possible to enforce a market policy like a mandatory renewable energy target unless regulatory bodies have credible, reliable, easily accessible data. The tracking systems mentioned in slide #30 under “Output Certification” are designed so that each responsible utility has a “retirement account” that measures the renewable energy purchases claimed by the utility. A report on this retirement account is then
sent directly to the regulatory agency responsible for enforcement of the policy. The utility report allows the enforcement agency to know immediately whether the utility is in compliance with the policy. Using electronic tracking systems also makes it easy to calculate any non-compliance penalties since all the data are in the one report.

References

- 236. Promotion of Renewable Energy in Sri Lanka: Future Directions
# Developing Countries: Existing Renewables in 2006 and Targets

<table>
<thead>
<tr>
<th>Country</th>
<th>Existing share (2006)</th>
<th>Future target</th>
</tr>
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<tbody>
<tr>
<td>Argentina*</td>
<td>1.30%</td>
<td>8% by 2016</td>
</tr>
<tr>
<td>Brazil*</td>
<td>5%</td>
<td>—</td>
</tr>
<tr>
<td>China</td>
<td>17%</td>
<td>—</td>
</tr>
<tr>
<td>Egypt</td>
<td>15%</td>
<td>20% by 2020</td>
</tr>
<tr>
<td>India</td>
<td>4%</td>
<td>—</td>
</tr>
<tr>
<td>South Korea</td>
<td>—</td>
<td>6.1% by 2020</td>
</tr>
<tr>
<td>Malaysia</td>
<td>—</td>
<td>5% by 2005</td>
</tr>
<tr>
<td>Morocco</td>
<td>10%</td>
<td>20% by 2012</td>
</tr>
<tr>
<td>Nigeria</td>
<td>—</td>
<td>7% by 2025</td>
</tr>
<tr>
<td>Pakistan</td>
<td>—</td>
<td>10% by 2012</td>
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<tr>
<td>Thailand</td>
<td>7%</td>
<td>—</td>
</tr>
</tbody>
</table>

Source: REN 21 Global Status Report – 2007
Summary of Developing Countries’ Renewable Targets in 2006

This table gives some idea of existing and future renewable energy targets in developing countries as of 2006. Policy targets for renewable energy have been revised, clarified, added, or supplemented in a large number of countries since then. By early 2009, renewable energy policy targets existed in 73 countries or regions, a number that includes sub-national targets in the United States and Canada (which had no national targets at the time this report was written). In addition, the European Union enacted a 20% EU-wide renewable energy target. It is up to individual countries to agree upon and adopt their own targets. More developing countries are likely to adopt promotional policies and RE targets as pressure to reduce greenhouse gas emissions increases both in the developed and developing world.

References

TENDERING/COMPETITIVE BIDDING

• Overseen by government

• Primarily used for very large projects

• Has defined criteria for determining winning bids

• Includes a PPA at specified price for specified time
Competitive Bidding for Contracts – Competitive bidding (also known as a tendering policy) uses government-overseen competitive processes to meet a planning target and includes long-term power purchase agreements (PPAs) for the winning generators. Tendering policies are a variation of or supplement to renewable portfolio standards. The key difference between the two is that the price and the eligible projects are selected through a competitive bidding process, rather than on a first-come, first-served approach. Like feed-in laws, tendering policies guarantee that the output of a qualifying renewable energy facility will be purchased at a specified price for a specified period of time. The difference between these two policies is how the price is set, and which renewable energy generators can participate.

While the feed-in laws set a price and guarantee to purchase the renewable energy output from any eligible facility at that price, a tendering policy uses competitive bidding to select projects that offer the best price. These projects are then awarded PPAs for their output. Through the competitive bidding process, renewable developers submit proposals to build new renewable generation facilities and indicate the price they would accept for their output. The lowest-priced renewable energy projects (that meet other selection criteria as well) are then selected with a guarantee to purchase all the output from these projects. As with feed-in laws, a guaranteed PPA helps reduce investor risk and helps the project secure financing (see slide #40). Like the feed-in law, the amount of power acquired depends upon the price (i.e., the cheaper the bid prices, the more can be purchased). This strategy can also be combined with a mandatory quantity (RES target or RPS goal) and a ceiling on acceptable bid prices.

The U.K. Non-Fossil Fuel Obligation (NFFO – 1990-1999) is the most widely cited example of a tendering policy. The U.K. NFFO also used a public benefits fund (called the fossil fuel levy) as the funding mechanism to pay for the incremental cost of renewable energy generation above that of conventional power. More recently, China has used a bidding process called the Wind Concession program as the means for setting the price for wind and allocating large wind contracts.

Advantages of Bidding – The advantage to tendering/competitive bidding is that if the product being bid is simple and easily defined, the actual costs of the product are well known, and there are a significant number of competitive suppliers, then competitive bidding may be the most effective approach for procuring that product at a low price. Unfortunately, power projects do not tend to meet these criteria.

Disadvantages of Bidding – This procurement process immediately becomes more complex if the tenderer has multiple goals (such as acquiring new or innovative technologies, while keeping costs low in the short and long terms). It is difficult to achieve a portfolio of different renewable resources through a single competitive bidding process, in part because the different resources have different attributes. A simple least cost-based bid will usually result in the predominant acquisition of one resource type. Moreover, in a new resource area or region where renewables are just beginning to be developed, the actual kWh cost may not be known because it is so closely tied to the quality of
the resource as well as the experience of the developer. Few experienced development companies may be available to submit knowledgeable bids, resulting in inaccurate bids and failed projects. And finally, due to the uncertainty associated with building a market under a tendering policy, this strategy could limit local creation of development and manufacturing companies.

In summary, there are several risks involved with the bidding approach:

- Very simple bidding schemes based primarily on price often result in winning bidders that have underbid their costs and can end up defaulting on the project (as happened in some early bidding in China);
- The preparation of more complex competitive bid proposals can require a considerable amount of time and expense, both on the part of the bidder as well as on the part of the bid evaluators. Moreover, the more complex the bidding regime becomes the longer it takes to prepare the bid, and then determine the outcome. This can result in the bids not being awarded until nine months or a year after they were submitted. By that point, the economic situation and project circumstances may have changed significantly;
- Because of the uncertainty associated with getting a winning bid and the time and resources required, competitive bidding tends to be used for very large projects (>100 MW) and to limit the competition to large, well-funded companies. If there are only a few participants, there are more opportunities for collusion, with the possibility that a higher price will be paid for the energy than might otherwise be expected.

**Criteria for Determining Winning Bid** – Careful consideration must be taken when determining criteria for the winning bids. Where competitive bidding processes are being used e.g. China and Quebec, Canada), the scoring includes a number of elements and is weighted less on price and more on other factors (such as localization of equipment, developer experience, etc.); it is limited to one resource/technology (e.g., wind in a specific geographic area or geothermal development rights); and the process is streamlined to reduce time and preparation costs.

**Hybrid System** – The California RPS competitive bidding program has begun offering fixed-price contracts to smaller projects because the bidding process has become so expensive relative to the value of the project. State regulators are even considering a move away from competitive bidding and back to a fixed tariff or bilateral contract approach.

**Power Purchase Agreement (PPA)** – Ideally, any utility or other entity that is soliciting power for addition to its grid will have prepared a well thought-out standard PPA to be included as part of the solicitation. The preparation of a standard PPA 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 contract terms translate directly into costs and benefits for developers, communicating the terms sought by the utility to a prospective bidder permits the bidder to embody a complete assessment of the economics of the transaction in his/her bid. Without a firm understanding of those factors, bidders will be forced to rely on guesswork in formulating their bids, thereby undermining the bidding process. (For more information on Power Purchase Agreements see slide #41.)

**Competitive Bidding for Energy Supply** – Recently, both Brazil and Columbia instituted competitive bidding as a mechanism for obtaining firm capacity and energy for their electricity systems. Both countries managed to procure new resources but both are works in progress.
Intermittent energy sources like wind were able to participate in the Brazilian auction but were limited by the cost of the resource. Intermittent resources were more difficult to handle within the Colombian framework. It appears that both these bidding schemes were for wholesale power markets.

**Image credit:** istockphoto.com

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- 10. USEA – Handbook on Best Practices RE India
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- 67. Supporting Localization of Wind Technology Manufacturing through Large Utility Tenders in Quebec
- 154. Cramton – Electricity Market Design
- 155. Jaimemillan, Auctions for Renewables
Important for:

- Siting & design of facility
- Efficient plant operation
- Output certification
- Equipment assessment
- Enforcement data
Quality of Technology & Resource Data

Accurate data are required for all aspects of renewable energy development. These data are important to the siting and design of the power facility for efficient plant operation, for certification of a plant’s output, to assess the equipment needed for operation, and to evaluate the performance of renewable policies.

Data Collection

Resource studies and resource forecasting are important tools for enabling the development of renewable energy. Without these data, projects are more risky and investors are reluctant to provide capital. For example, a recent Baker & McKenzie study identified the paucity of reliable hydrological data for small streams in India as a major impediment for development of small hydropower projects and the under-performance of small hydro projects in comparison to their design generation expectations.

Resource Data

The performance of renewable generating facilities is dependent on the quality of the natural resource. Therefore, accurate resource data are a prerequisite for project development and efficient operation. While each of the renewable technologies has different resource data requirements, these data are critical. For many projects, compiling the data represents a significant up-front cost. To encourage renewable resource development and help reduce initial costs, many governments and non-governmental organizations have collected preliminary resource data through global satellite data assessment techniques combined with other data sources. Individual renewable energy resource maps are available for many regions of the globe. Providing maps with high quality resource data indicating where renewable resource projects should and should not be located provides an invaluable service. However, individual project developers must still supplement this general resource data with site-specific data collected over a sufficient period of time that it is credible. (See each of the accompanying technology modules for specific resource data requirements.)

Facility Output Data – In order to assess how well a policy is working it is important to know not only how many renewable energy facilities have been brought into operation, but also to measure the output from those facilities to ascertain how well they are functioning. Facility output data are particularly important for renewable energy target policies (e.g., RPS/RES) that are often based on energy rather than capacity targets.

In order for generators to collect revenue for the power produced there must be electric meters that measure the energy output. Often, government and the public do not have access to this output data. Output data absolutely are necessary to evaluate the effectiveness of feed-in tariffs and to assess compliance with mandated renewable energy targets. For the purpose of evaluating general policy
success only aggregate data are needed, not data on individual facilities. The electricity regulator can require that the utilities report this aggregate data to it on a regular basis.

**Output Certification** – Certification of output data is required to obtain CDM credits, TREC, or other types of environmental certificates, and also to prove compliance with RPS/RES targets. Both the United States and European Union have developed credible, efficient tracking systems that collect electronic output data directly from balancing authorities and transmission agencies (see slide #59), providing a critical tool for market policy implementation and evaluation. Development of these electronic software systems is relatively expensive, though once they are in place they are paid for through user fees. Since the development costs tend to be fixed, the larger the geographic area over which they are used, the lower the transaction fees will be. For example, in Europe one system covers all participating EU countries.

**Technology Standards** – How does a utility or a private sector company know whether the renewable generating equipment will do what the companies selling it say it will do? Most of these companies and technologies are relatively new and there may be many competing products on the market. Money could be wasted if the wrong equipment is purchased. While there is no substitute for experience, technology standards have been developed for most types of large generating equipment. Though not fail-safe, these standards offer some protection for the purchaser. The existence of RE standards means that individual countries do not need to establish their own standards and testing. Technology-specific trade associations, including the International Electrotechnical Commission (IEC) and ASTM International – Standards Worldwide are able to provide the most up-to-date information. Asking for advice from energy or utility planners in other countries may also yield useful information on technology choices.

When there is a tendering process for a new generation unit, international technology standards are often specified as a minimum threshold for bidding eligibility. Lenders may tie financing to technology standards to reduce the risk of the project not performing as specified. Even in a country trying to nurture a young renewable industry, requiring that equipment used in new generating facilities meet international standards will support the development of a credible and more robust renewable manufacturing sector. Some countries interested in encouraging domestic manufacturing (e.g., China) are establishing technology certification programs to encourage the manufacture of high quality equipment.

**References**

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- 78. Information on Tracking Renewable Energy Certificates in North America
- 106. Technical Standards for Interconnection to the Grid
- 130. Hunter-Fanney – International Standards for RE Sources
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FINANCIAL INCENTIVE POLICIES

Capital subsidies
Grants
Rebates

Tax credits
Tax rebates
Tax reductions
Accelerated depreciation allowance

Public investment
  • Low-interest loans
  • Loan guarantees
Purpose of Financial Incentive Policies

Financial incentive policies are designed to overcome the cost gap between the cost of renewable power and the price the government/utility is willing or able to pay for that power (i.e., incremental cost difference). This gap may exist for a number of reasons:

- Some renewable technologies simply cost more than conventional generation because they are just entering the market
- Some renewable technologies are cost effective in the long term but there is a cost gap with the short-term wholesale market
- Some renewable energy may be cost effective but the government/utility is not able to pay the cost of new generation regardless of its cost effectiveness
- Financial institutions in a country may be unfamiliar with renewable energy facilities and therefore charge a high risk premium to finance such facilities.

The policy options listed here represent three of the most common categories of financial incentives used to overcome these types of cost gaps.

- Capital subsidies, grants and rebates
- Public investment loans & financing
- Tax credits & tax rebates

The new Philippine Renewable Energy Act, for example, offers developers: (1) an income tax holiday; (2) preferential realty tax rate; and (3) exemption from import duties.

The next few slides discuss each of these types of incentive policies in greater detail.

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Public Benefit Funds

• Defined surcharge on electric rates

• Accumulated funds support public purposes (e.g., rebates for distributed RE generation, RE & EE projects, support for low income customers)
Capital Subsidies, Grants, and Rebates

Capital subsidies, grants, and rebates most often are limited to smaller renewable energy equipment (such as on-site, customer-side of the meter generation, including distributed photovoltaics). In developing countries they are seldom obtainable unless multi-national lending agencies or regional redevelopment banks are offering them. This is due to the volume of the capital that would be required to make a significant difference in renewable energy project finance.

One way to fund grants/rebates is through a Public Benefit Fund (PBF). Such funds can be used to make up the difference between the wholesale cost of renewables and the wholesale cost of traditional fossil-fueled generation plants. The difference is determined through a competitive bidding process, which will identify the extent to which the lowest cost RE bids are still above the kilowatt per hour cost of new fossil plants being planned or built in the region. Public benefit funds are used as the source of revenue for capital subsidies, grants, or rebates used to bridge the cost gap (as opposed to government general funds that must also be used for police and fire protection, health, and education purposes).

Funding These Policies

A public benefits fund (PBF) is a fund that is collected through a defined surcharge on electricity rates or electricity generators. A PBF for renewables is usually at a rate of less than one percent of the customer’s monthly electricity charge. Accumulated PBF monies are used to directly support public purposes in the electricity sector. For most states and countries that use PBFs, this mechanism is used to collect revenues in an equitable manner to continue funding important public benefits that might be lost in a restructured utility environment. However, a PBF is not exclusively a restructuring tool. A few places, such as Norway, Thailand, and Vermont in the United States, created PBFs without any pressure from restructuring.

While some might view a public benefits surcharge as a “tax” on electricity service, in reality, PBF activities are integral to the provision of electric service and therefore the surcharge should be seen as just another element of the cost of providing such services – like salaries, generation costs, and wires. For the purposes of this discussion, the focus is on the use of such funds in supporting RE and energy efficiency investments, though in many jurisdictions these funds also are used to support public interest electricity research and development, and to assist low-income electricity customers.

References

- 9. World Bank RE Toolkit
Low-interest Loans
• Common in early stages of RE development
• Capital may come from a Public Benefit Fund

Loan Guarantees
• Less expensive than low-interest loans
• Reduces or eliminates need for a risk premium
Public Investment: Loans and Loan Guarantees

Public investment loans and loan guarantees are used where the national or state government has sufficient resources to offer this type of incentive, or in situations when the incentive can come from multinational sources. Funds for this public investment may come from conventional banking, government funds, multi-lateral or regional development banks or public benefit funds. The following describes some of the common ways these public investments are used:

**Low-interest Loans** – The most common public investment-type incentive occurs when a national bank or government agency offers low-interest loans to finance renewable facilities. The capital for such loans (or the capital to cover the difference in interest rates) may come from conventional banking sources or the government treasury. Capital also can flow through the government from a multilateral or regional development bank, or come from a public benefit fund. Government-sponsored low interest loans are very effective where investment capital is scarce, and when local banks are unfamiliar with renewables and want to charge a high risk premium. This strategy is most common in a country’s early stages of renewable energy development, when investors are first exposed to renewable energy financing, or in the early stages of commercialization of a new technology. The state of California had a low-interest loan program for renewable energy projects in the early 1980s.

**Loan Guarantees** – A related mechanism that is less expensive but can also be very effective is the use of loan guarantees. As with low-interest loans, the goal is to reduce the cost of financing new renewable facilities. The loan guarantee reduces or eliminates the need for a risk premium since the government (or multilateral lending institution) takes on the risk of project performance. Since the project is guaranteed to perform as predicted, the risks associated with financing these projects are substantially reduced or eliminated.

**References**

- 9. World Bank RE Toolkit
TAX INCENTIVES

Tax Credits
- Investment tax credit
- Production tax credit
- Accelerated depreciation

Tax Reductions
- Import and VAT
- Property tax
Tax Credits & Tax Reductions

The evaluation of domestic taxes and their impact on renewable energy development is unique to each country and requires expert knowledge of the country’s tax structure. Most national renewable promotion frameworks include a section that focuses on appropriate tax adjustments to stimulate investments in renewables. An effective tool to encourage private sector investments in renewable energy is the use of tax credits and/or other types of tax reductions. The two primary types of tax credits are (1) investment tax credits and (2) production tax credits. During good financial times, tax credits can be a big incentive for prospective private investors. If the company taking the credit pays taxes at a 30% rate, then a 10% tax credit reduces the project costs by about 3%. (But of course the business has to be making enough money to have a tax obligation.) The following describes some of the more common tax incentive policies used to promote renewable energy.

Investment Tax Credits (ITC)

A number of countries, including Belgium, Canada, the Czech Republic, Ireland, Korea, Luxembourg, the Netherlands, Spain, and the United States, offer investment tax credits. The purpose of an investment tax credit (ITC) is to encourage investment in new technologies that may not be commercially viable, or to encourage seed money for new manufacturing facilities. Areas for which a firm may receive an ITC include direct purchases of equipment as well as lease purchases; investments in research and development; or investment in manufacturing facilities. An ITC usually is defined as a percentage returned on the amount invested (e.g., a 10% ITC). This type of incentive policy encourages large capital investments but does not necessarily incent efficient operation. Best practice would limit ITC policies to R&D, emerging technologies, and new manufacturing investments, and would also limit the period of time over which such a policy would be in place for a particular technology.

Accelerated Depreciation Allowances

Accelerated depreciation is similar to an investment tax credit in that it allows renewable energy developers to receive tax benefits sooner than they would otherwise receive them. However, as with investment tax credits, they provide no incentive to improve production. Thus, this type of incentive should be combined with others that encourage greater efficiency, such as production tax credits. Belgium, Canada, India, Luxembourg, Portugal and the United States all offer accelerated depreciation for renewable energy facilities.

Production Tax Credit (PTC)

The goal of the production tax credit is to encourage investments in commercially viable renewable energy facilities by helping fill the gap between the cost of such facilities and the price to be paid for the power they will produce. Production tax credits are generally set at a specific price per output (e.g., two cents/kWh). This type of incentive policy encourages developers to keep the capital cost of
the project as low as possible, while operating the project efficiently to achieve maximum power output. To be effective, production tax credits need to be stable. In other words, the credits must remain in effect long enough to allow potential users to plan their project, obtain financing, build the project, and become operational (since the tax benefits don’t apply until a project is actually producing). Offering a production tax credit that must be extended frequently by legislators (as has happened in the United States) has a boom and bust effect on the industry and is not the recommended approach. A better way of structuring tax credits is illustrated by the California Solar Initiative, which makes tax credits available to projects for a long enough period (10 years) to stimulate the market and then gradually steps down the level of the credit until it is phased out entirely. Canada, Finland, Sweden, and the United States offer production tax credits.

Tax credits require both a solid economy and companies that have sufficient tax liabilities to take advantage of tax credits. If the economy is not so strong and/or lacks companies with sufficient tax appetite to use the credits then another option is to allow for the credit to be refundable (e.g., actual cash paid back to the company) or allow the credit to be transferable to another company that has sufficient tax liability to use the credit. For example, utilities often do not pay taxes so a tax credit for investing in renewable energy would be of no use to them. However, if they could transfer that credit to another company (i.e., sell the tax benefit) they would earn capital that would reduce the effective cost of the renewables.

A transferable/refundable ITC and PTC was adopted by the US Congress in the 2009 stimulus package. The legislation allows companies to trade or sell the credits to companies with a significant tax obligation and provides developers the option of taking a direct grant if, as in the current economic downturn, there is no market appetite for tax credits.

**Tax Reductions**

There are several types of tax reductions that can incentivize RE investment. The most common areas for tax reductions are reductions in the levels of sales taxes, energy taxes, excise taxes, property taxes, import taxes, and value-added taxes (VAT). In all of these cases the purpose is to reduce the tax level that might otherwise be paid by renewable energy facilities to make them more competitive with the cost of conventional energy facilities. Not all of these taxes are applied to all renewable energy facilities in all countries. As a first step, officials must evaluate which taxes are applicable, how those taxes compare to taxes imposed on other generation technologies, and which taxes create the greatest cost burden on any given RE technology. They can then decide how to adjust them to achieve their desired goals.

For example, one must consider whether other types of generating technologies receive tax benefits that give them a particular advantage (for example, some may be exempt from some taxes on their fuel, or receive some special types of depreciation, or tax deferral benefits). If this is the case, a parallel reduction for renewable projects might be an appropriate and politically easier way to achieve balance than revoking tax benefits accorded to other types of generation. To give another example, because renewable energy projects tend to have high investment costs as well as high costs for improvements to facilities, they may be subject to higher property taxes than thermal power plants since such taxes often are based on the installed cost of the facility. Depending upon a country’s goals for technology transfer and local manufacturing, import duties and value-added taxes might also need to be adjusted to facilitate renewable activities.
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Concern about climate change is driving a reconsideration of electricity resource planning methods.
Utility Regulation: Resource Planning & Climate Change

In many jurisdictions, resource planning is overseen by utility regulators who are responsible for making sure there are sufficient resources to meet electricity demands. In a traditional vertically integrated utility structure, the electric utility is responsible for resource planning, guided by regulatory policies. Where the electricity sector has been restructured into separate generation, transmission, and distribution units, resource planning may be undertaken by a governmental ministry/agency responsible for planning and development. Similarly, where a country or sub-national entity has adopted a FIT policy, resource planning may be the responsibility of a government agency. Now that more and more countries are concerned about the impacts of global climate change, concerns about reducing greenhouse gas emissions have begun to be integrated into the electricity resource planning process. New policies and processes have evolved to facilitate comparisons between demand reduction programs and generation acquisition, and between renewable resources and resources that emit significant greenhouse gases.

Integrated Resource Planning (IRP) – In the 1980s, a new type of resource planning was introduced into the electric utility sector by US electric utility regulators. Termed “Integrated Resource Planning,” this approach included not only comparisons between different supply-side options (like renewables, nuclear, coal, natural gas), but also compared demand-side options like energy efficiency. Though the title has changed, this type of integrated planning approach has become more common. The market barrier this policy/process addresses is the lack of a fair and systematic assessment of all the resource options needed to ensure the electric consumer receives both long-term and short-term benefits from the resources selected for procurement. One purpose of the IRP approach is to require and encourage utilities to consider all resources, demand-as well as supply-side, and to select those with the lowest total costs. A related purpose is to expand the offerings of the energy services market and open the generation market to new technologies and providers.

Resource Planning and Climate Change – Two recent policy developments in US resource planning, both driven by concerns about climate change, have emerged to address the need to incorporate reductions in greenhouse emissions into the planning process. California utility regulators first introduced these policies and they are being replicated in other western US states. The first planning policy is called the “loading order” and directs utilities to: (1) undertake all cost-effective energy efficiency; (2) acquire the least-cost renewable power available to them; and 3) only if additional capacity is still required, procure it from the cleanest fossil-fueled facilities.

The second policy establishes a cap on the level of carbon emissions that can come from fossil plants from which California utilities are obtaining energy. In California, the utility can only recover the costs of projects and/or purchases that meet the loading order and the emissions cap criteria. Otherwise those costs will be disallowed and not incorporated into the utility tariff.

Photo credit: Time Magazine

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49. CA Energy Action Plan 2003
51. 2008 CA Energy Action Plan Update
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53. SB1368: GHG Emission Standards for CA
NET METERING

- A policy for on-site resources
- May be applied to commercial/industrial
- Most commonly used for PV but can apply to other RE technologies as well
- Benefits utility & customers
Net Metering

Net metering is a policy designed to overcome barriers to grid-connected distributed generation – a generation facility that is paid for by the utility customer and is located “behind the meter” (BTM) on the customer’s property. Net metering is a policy that is usually created by a legislative body with the details designed by the regulatory body.

The market barrier this policy addresses is that an on-site generation system may produce more power at some times of the day or certain months of the year than the customer can use. At other times, the customer may consume more power than s/he is generating at that particular moment. Net metering allows the utility customer-generator to average electricity production and consumption over a specified period of time (commonly 12 months) so they do not have to pay the utility for the power they have generated themselves. In essence, net metering allows the customer to run the meter backwards and bank excess power with the utility until s/he needs it (typically up to 12 months) in order to balance the generation/consumption timing problem. The utility benefits from this policy, as it can use the excess power to serve other customers.

Net metering is most commonly applied to solar PV systems that often produce maximum power during peak hours and peak months of the year in excess of the owner’s immediate needs. The owner may then use that excess (the banked power) during nighttime and non-peak months. Thus, net metering can benefit both the customer and the utility and is an important tool for attracting private investment in on-site generation. In areas where there is a shortage of generation, a net metering program can be used to encourage customers to install BTM generation in excess of their immediate needs to help bridge the gap in power supply. To accomplish this, utility regulators must establish a tariff that will be paid to the customer for the excess power.

Although net metering is most common in the United States, some European countries like Italy, Denmark, Germany, and Malta apply net metering or similar measures. In addition, the new Philippines Renewable Energy Act and Sri Lanka’s renewable energy policies both include provisions for net metering, though the implementation details are not yet available. To the extent that customers are investing in BTM renewables (to improve reliability or to reduce their greenhouse gas footprint) and where there are frequent shortages of power, especially during times of low hydro resources, a net metering policy with a reasonable buy-back tariff can be used to encourage the design of larger than necessary systems in order to provide excess power to the grid.

Net metering may also be applied to on-site wind and biomass facilities, depending upon the resources available in a country and the government’s desire to encourage private investment in different kinds of on-site power generation.

References

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134. Challenges for Small & Behind the Meter Generation
138. SB1: CA Net Metering Bill
139. WAPA – Treatment of Behind the Meter Generation
162. IREC – Model Net Metering Rules
285. ETNNA – What is a REC?
SUPPORTIVE POLICIES AND PROGRAMS

- Research, development & demonstration
- Public awareness & information
- Capacity building
- Technical training
- Resource maps
- Land-use planning reform
Supportive Policies

Government agencies also engage in a number of important supportive policies and programs that can spur development of RE resources. These include:

**Research Development and Demonstration (RD&D)** is the most common supportive policy. Most large economies have renewable energy RD&D programs of some type. RD&D is the first step on the road to the development of new technologies and the refinement of existing ones, but is insufficient in and of itself to lead to large-scale deployment. As noted in slide #24, a number of other steps are required to move the commercialization process along.

**Public awareness and the dissemination of information** about renewable energy is important at any stage in the commercialization process. Public awareness and accurate information serve as the basis upon which to build support for renewable energy policy. In fact, in the United States, public support for renewables over the last few years has helped to overcome legislative and utility opposition to more aggressive renewable energy policies.

**Capacity building** refers to assistance to help people or institutions to develop a certain competence, or for general upgrading of performance ability. In the energy context, capacity building may be applied to improving the knowledge base of regulators and decision-makers so they are better able to design policies and programs suited to the needs of their state or country. This toolkit is an example of a capacity-building tool for USAID mission staff and country decision makers. Today, capacity building also is being used by governments to transform community and industry approaches to social and environmental problems.

**Technical training** is different from capacity building in that it is more focused on teaching specific technical skills rather than a general upgrading of performance ability. Technical training is a key implementation tool for renewable energy development in order to have a trained workforce that can build, operate and maintain renewable energy facilities.

**Resource mapping** is necessary in order to assess the quality and quantity of the renewable energy resources available for development within a country. Data collection and data quality are discussed further in slide #30.

**Land-use planning and reform** sometimes is required to allow renewable energy development. For example, excellent renewable resources may be available on government-owned land but renewable energy development may not be specifically identified as an acceptable use. Land use information is most useful if it indicates both where project development is encouraged and where it is discouraged. There is no point spending time and resources on the development of a project in a sensitive area where such development will not be approved.

**Streamlined approval process** for renewable energy projects, particularly where different
approvals are required from both central and sub-national governments and for different sizes and types of projects, can be very useful. Streamlining the approval process is extremely important for technologies that have a long lead time and may require multiple permits before securing funding, such as geothermal.

**Intellectual property laws** in many countries provide a good foundation for protection of intellectual property if they are properly enforced. Otherwise, lack of such laws or their enforcement can result in a barrier to technology transfer and investment in cutting-edge renewable energy technology.

**References**

• Global Resources and Costs
• Goals & Objectives
• Barriers
• Strategies for Successful RE Projects
  • Stakeholder Roles
  • Market Promotion Strategies
  • PPAs and Business Models
  • Transmission and Grid Integration
  • Financing and Risk Mitigation
• Best Practices
Slide 38

Strategies for Successful Renewable Energy Projects: PPAs and Business Models
Utility Ownership

- BOT, turnkey

Utility may purchase RE from IPPs via:

- BOO plants
- Excess power sales from distributed generation
- Aggregation
- Competitive wholesale markets
Contracting Agreements

There are three main types of contracting arrangements that can be made between a private sector renewable energy company and a utility:

- The utility can hire a company to construct a RE project on its behalf. When the facility is completed, it is turned over to the utility, which then operates the facility itself – e.g., contracting with an outside firm to build a turnkey or build-own-transfer (BOT) project for the utility. This is a very standard project sales agreement that puts the risk of project completion and initial performance on the contractor. In this case the private-sector company is simply a contractor to the utility.

- The utility can enter into a build-own-operate (BOO) contract arrangement that is the most common arrangement under an RPS-type policy. The utility can buy a project’s output from an existing project, or contract with a development company to purchase the output once the project is built and operational. A Power Purchase Agreement (PPA) is the standard contract form for this type of business arrangement and forms the basis for most project financing. In this case, the private-sector company is the owner of the project and enters into a PPA to sell the power to the utility.

- The utility can implement contracts for excess power from behind the meter generators (see discussion of net metering), where the customer on whose property the generation is located banks excess electricity and may sell or give excess power beyond its own needs back to the utility at the end of the banking period. If the on-site facility is sized to produce significant amounts of power in excess of a customer’s load, then any sale of excess back to the utility is generally done through a separate PPA rather than through the net metering agreement.

Aggregation – There are a few specialized aggregation arrangements that can be made between private-sector plant owners and a utility. Small projects can be aggregated by a private company or the participants themselves. The definition of a “small project” can be defined either by market rules or, in their absence, by the participants. Aggregation has been suggested for residential PV projects, but could also be used for a group of commercial PV projects, wind turbines spread around agricultural land, a group of cogeneration projects, or any subset of power generators that have a common owner, technology, or are smaller-sized capacity compared to conventional central station plants.

One example of plant aggregation is a company that has a number of geographically separate facilities, each with its own on-site generation. The intent is to make contracting with the utility easier for both the individual facility owners and the utility itself, since aggregation enables the use of only one PPA, rather than many separate contracts. A developer or equipment supplier could act as the agent for the project owners, or one of the owners could act as the agent. Aggregation of this type could be viewed as an informal cooperative. Some cities in the United States (including Boulder, Colorado) have begun to aggregate together all public facilities generating renewable energy, and then negotiate a PPA with the utility for the sale of power from those facilities. In addition to selling power, this approach can be used to aggregate and sell greenhouse gas reduction credits (e.g., CDM credits, TRECs, or other greenhouse gas credits that may be created in the future) produced
from multiple smaller renewable projects.

**Wholesale Markets** – Financing, particularly for renewable energy projects, typically cannot be secured without a long-term power purchase agreement. However, on occasion a project with a specific limit on the power output purchased in their PPA may, due to resource fluctuations or repowering, produce excess energy and sell that excess into the spot market. Or, a renewable energy project’s contract may have expired and the project can sell power to the wholesale market until a new contract is negotiated. In rare situations, a renewable project will be constructed as a “merchant plant” (e.g., constructed without a power purchase agreement) and able to sell into the spot market in lieu of a PPA. This last situation is most likely where there are severe energy shortages that have driven spot market prices to high levels for example, during the 2001 energy crisis in California).

Renewable energy sold in competitive wholesale markets does not involve a typical power purchase agreement. Instead, energy is sold in the spot market on an hourly, daily, or weekly basis. The market rules guide eligibility for participation, while the amount of power being sold and the price paid can vary widely over time, and is determined by the market itself. Usually the spot market is used to regulate variations in demand, provide a market for excess power supplies, and provide special transmission services (e.g., voltage support, spinning reserves, etc.) See slides #42-47 on transmission-related issues. However, one of the causes of the collapse of the California energy market in 2000/01 was too much reliance on the short-term spot market with insufficient long-term contracts.

**References**

- 9. World Bank RE Toolkit
- 10. USEA – Handbook on Best Practices RE India
- 94. WB – California Power Crisis: Lessons learned
- 227. Policy Action and Climate Toolkit
- 250. Policy Instrument design to Reduce Financing Costs in Renewable Energy Technology Projects
The Power Purchase Agreement (PPA) specifies terms and conditions of payment

- Critical component for IPP financing
- Typical term: 15-25 years
- Sets prices for energy and capacity payments
- Can be used in either RPS or FIT regimes
- Pro forma PPA lays out standard terms and conditions in a competitive tendering process
Power Purchase Agreements (PPA)

The PPA is the building block upon which a private sector project obtains financing. The PPA defines the price that will be paid for capacity and energy and the circumstances under which those payments are made. For feed-in tariffs (FIT), the price is specified by the policy rules and regulations so a traditional PPA is not required. However, more countries are opting for a standard PPA in addition to the FIT. How much detail already is stipulated in the FIT itself determines what might need to be included in a PPA. If the FIT outlines only price and a contract term, then the PPA would stipulate the technical terms and payment schedule. For investors, a PPA with a FIT has a higher value than a FIT alone. The lack of a PPA under the initial German FIT hindered the influx of foreign investors until the PPA was added. The typical term of the PPA for renewable energy projects is 10 to 30 years.

PPA Terms & Conditions – Even where a price is specified through policy or some other means, the PPA is a critical element that contains the terms and conditions of payment. Those terms and conditions affect the total amount of revenue a project can be expected to receive for the sale of its power over the term of the contract. For this reason, even under a feed-in tariff or a tendering process, it is important to have the standard contract terms and conditions known in advance through provision of a pro forma PPA. If a bidder wins a competitive process and then has to negotiate a PPA, the winning bid price is likely to increase based upon unanticipated requirements or contract constraints. This undermines the validity of the tendering process itself, since losing bids might actually have proposed prices lower than the ultimate price negotiated with the winning bidder. The term for long-term power purchase agreements is typically no shorter than 10 years and may be as long as 25-30 years.

Pricing – The PPA spells out both the price to be paid and under what conditions. With regard to FIT policies, many countries do not distinguish time-differentiated prices and simply pay a flat tariff. However, as a larger share of power is supplied by renewable energy, there is a greater need for incentives for generation to track demand more closely. There is some movement in countries with FIT policies to give renewable generators the option to market their power independently on the power market (where they can benefit from the time-differentiated prices) with the guaranteed FIT price acting as a floor.

Energy Price – This term refers to the price paid for the energy delivered by the project. It is usually denominated in the relevant unit of currency per kilowatt-hour (e.g., ¢/kWh) or megawatt-hour (i.e., $/MWh). Sometimes the energy price is different for different periods of time. Some common examples are pricing based on peak hours, off-peak hours, working days, weekends, dry season months, wet season months, etc. These time-differentiated prices are generically called Time-of-Delivery pricing. Where there is a feed-in tariff, the energy price is dictated by the rules and regulations governing that tariff.

Capacity Price – The capacity price is also sometimes called the demand price. This is the price paid for the maximum capacity (i.e., instantaneous power output) delivered by the project during a
specific interval of time, usually one month. Capacity price often is denominated in dollars per kilowatt-month. Some contracts differentiate between firm capacity prices and as available or non-firm capacity prices.

**Firm Capacity** – Firm capacity is capacity that can be relied upon when called by the system operator. Firm capacity contracts have requirements specifying operation and the time required to bring the generation on-line. The generator either meets these requirements, or doesn’t receive the capacity payment. Hydro-electric, biomass, and geothermal facilities as well as concentrating solar projects (CSP) with storage may qualify for firm capacity contracts.

**Non-firm Capacity** – Conversely, non-firm capacity is generation that can be relied upon only when it is available, like wind and solar. Contracts for as-available or non-firm capacity specify how the generation operates, and include requirements for notifying the system operator of the availability of the generation. Since non-firm capacity is less valuable to a utility than firm capacity, it typically is paid at a lower rate and is earned on an output basis (generally in ¢/kWh).

**Monomic Price** – The monomic price (also called a one-part tariff) refers to one price that includes compensation for both energy and capacity delivery but remains denominated in units of energy such as $/MWh. When the average price of a given market or contract is quoted it most often refers to a monomic price that results from dividing all payments (energy and capacity) by all the energy deliveries. (See also the Economics section of the Hydroelectric Module.)

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- 221. Yarano and Brusven – Basics of a Power Purchase Agreement: Sample Power Purchase Agreement (PPA)
- 228. International Feed-in Cooperation
- 244. Bonneville Wind PPA
Utility Ownership – Turnkey Project

**STEP 1: Non-Utility Project Development**

- **Project sponsor**
- **Lender**
- **Project development company**
  - **Equity**
  - **Construction cost**
- **EPC contractor**
  - **Construction loan**
  - **Development/acquisition fee**
  - **Plant value**

**Utility/Utility Consortiums**
- **Equity**
- **Corporate equity or state funds**
- **Long-term debt**
- **Bond market, banks or government loans**

**STEP 2: Utility Purchase of Project**

Source: Black & Veatch
The Impact of Different Business Models

Financial incentive policies are designed to overcome the gap between the cost of renewable power and the price the government/utility is willing or able to pay for that power. This gap may exist for a number of reasons: (1) Many renewable technologies simply cost more in up-front capital expenditures for the generation equipment than conventional generation because of their newness and level of commercialization in the marketplace; (2) some renewable technologies are cost-effective in the long-term but not during the first 5-10 years because of the high capital cost of the technology; (3) some renewable energy may be cost effective at market rates, but the government/utility, as the sole wholesale purchaser of RE power in the country’s electric sector, is unable to pay the market rate of new generation, regardless of its cost-effectiveness; and (4) financial institutions in a country may be unfamiliar with renewable energy facilities and therefore demand a high risk premium to finance such facilities, due to difficulty evaluating project risk. Regardless of the reason for the cost gap, different business models can facilitate or retard RE development depending upon the type of policy incentive measures available and the ability of different stakeholders to shift risk and cover capital costs with incentives as a way of reducing project cost.

Two Models of RE Project Development – This and the following slide, using illustrations from Black & Veatch, discuss the differences in the utility ownership model and the private ownership model (independent power producer – IPP).

This first slide illustrates a utility ownership case in which a private project developer develops, sites, and constructs the power plant. When the plant is completed and operational, the developer sells it to a utility, which subsequently owns and operates the facility. The second option, on the next slide, is a private ownership model, in which the plant is developed, sited, constructed, and operated by a private independent entity that finances project construction with a combination of equity and debt from a commercial bank, development bank, or the issuance of a taxable bond. This diagram indicates the flow of money among the various participants when the utility owns the project but has contracted with a private sector company to actually do the project development.

Utility Ownership – Turnkey Project (For concentrating solar and geothermal projects, the engineering, procurement and construction (EPC) companies are often also the project developers.)

Phase I: Project Development

In the Project Development phase, the developer can realize any investment tax credits, which ultimately will reduce the net acquisition cost for the utility when it purchases the project. In this model, the objective of the development company is to mobilize capital through the period of construction, and then sell the completed “turnkey” project to the utility for ownership during operation. The development company assumes all project development risk, which it mitigates using various contracts, guarantees, and risk allocation mechanisms.

Phase II: Project Ownership and Operation
In phase II, the completed RE generation facility is transferred to the utility for ownership and operation. At the point of transfer, the utility refines the project with a long-term loan, or with its own equity, when it takes possession. The utility may be eligible for other incentives depending upon tax law and renewable incentive policies in the host country. As a large company with a routine and predictable cash flow from the sale of electric power, a utility may be able to obtain long-term financing on the most favorable terms, or to finance its capital debt obligations with government funding. Because of the high capital cost of RE projects, incentives and programs designed to reduce debt financing interest rates can reduce RE project costs significantly. Tax incentives offered in many countries can also improve the cost competitiveness of renewable energy projects. However, unless the credits are transferable or refundable, the effectiveness of tax incentives can be limited when the entity does not have net income against which to offset the tax incentive.

References

- 97. Black & Veatch – New Mexico Concentrating Solar Plant Feasibility Study
Private Ownership – IPP Model

Contractor → Government → Rules, regulations & incentives → Operator

Construction cost → Operating cost → Cash distributions & tax incentives → Equity

Debt service → Construction & Term loans → Output

Output purchaser → Revenue → Output

Lender → Credit enhancement or guarantee → Source: Black & Veatch
Private RE Independent Power Producer (IPP) Development

This diagram indicates the flow of revenues that might be expected for a typical IPP plant. The exact amounts depend upon the type of plant and the governmental rules and incentives for which the plant might be eligible. In a developing country, the IPP model involves the project development company taking on many risks. For this reason, it is critical to have a predictable and stable renewable energy policy framework so the developer can assess the potential risks and rewards accurately before deciding whether to move forward with the project.

Advantages of the IPP approach may include:

- More potential developers and/or resources with which to develop RE projects;
- Private-sector ownership may be more politically feasible than public sector investment; and
- Infrastructure (including transmission lines, substations, and roads) can be developed to serve multiple plants.

Disadvantages to the IPP approach include:

- Many RE IPP development companies have weak balance sheets;
- An IPP requires an alliance between multiple players – developer; engineering, procurement, and construction (EPC) contractor; and lenders and equity investors – and this alliance may be difficult to build and maintain;
- An acceptable and financeable power purchase agreement (PPA) needs to be negotiated with the electric utility or power off-take purchaser, which can be difficult and time-consuming; and
- A PPA acquisition price, reflecting profit and risk premiums to the developer, must be rolled into the acquisition cost of the power. Many countries have set this acquisition price at the purchasing utility’s avoided cost, so that all stakeholders are indifferent to the rate impact. However, avoided cost is often well below a project’s actual cost, thereby reducing or eliminating the ability of the IPP to include actual risk and profit premiums.

IPP Project Step I: Project Development

In this approach, a private sector developer who funds the development cost would develop the project. The project would be financed with a combination of equity and debt. Debt could be sourced from a commercial bank, from issuance of a taxable bond, from issuance of a tax-exempt bond, or with a loan from a development bank. The equity would be raised from private sector investors who have a use for tax credits and for the accelerated depreciation that might be available from the project. This figure shows the interrelationships between the key entities and the various cash flows.

Step II: Private Ownership and Operation
As opposed to the prior model, it is the power product of the RE that is sold to the utility on a wholesale basis, rather than the sale of the completed project itself. This leaves operating risk with the private entity, from which the utility is contractually bound to purchase output under a PPA. In this ownership approach, equity would be sourced as in the private ownership development options, but the debt portion of the financial structure would be a combination of debt provided by private sector and public sector sources, such as a state pension fund or trust fund. The private sector debt could be interest-only for the first 15 years to improve the debt coverage ratios. A combination of debt from these sources would lengthen the maturity of the debt and might improve the cash flow at the front-end of the project. The diagram shows the key entities and cash flows.

Advantages of public-private financing include:

- Innovative debt financing structures may be utilized to bring down capital costs;
- A novel solution to the debt portion of the capital structure could be used;
- The debt amortization schedules could be stretched; and
- Stronger incentives would be provided to equity investors by minimizing debt impact.

Disadvantages include the following:

- The private/public combination of debt is not widely used, so public entities may be reluctant to partner with an IPP;
- There is a long-term risk on the public sector lender;
- Terms need to be negotiated with private lenders, adding additional time required for negotiations and increasing project cost; and
- A longer-term PPA is needed, which may be difficult to obtain.

**References**

- 97. Black & Veatch – New Mexico Concentrating Solar Plant Feasibility Study
SITE & RESOURCE CONTROL

- Private land
  - Resource rights agreement
  - Access road rights

- Public land
  - Most common for hydro and geothermal

- Public/private partnerships
One of the first issues to be considered by a developer is where the RE facility will be located. Though it may not have the same level of financial impact as the PPA, the location has important implications for many of the project’s overall costs. No new facility can be built until clear agreement has been reached on who owns the land rights, and how permissions and compensation are to be structured. Because they have different needs and impacts, each RE technology will have different land rights concerns.

**Private Land** – Wind, solar, and biomass resources often are developed on private land. The right to use the wind, solar, or biomass resource on that land typically resides with the land owner. Therefore, the rights to use a site and its resources must be obtained in an agreement with the land owner. Wind and solar projects may pay to lease the land, plus a royalty based on a percentage of their annual energy revenue. A wind developer may sign an agreement that allows the land owner to continue using the land for agricultural purposes, resulting in dual land uses. Where land is being aggregated from several individual land owners to use for a single facility, best practice dictates a standard agreement and set of terms and conditions be offered to all similarly situated land owners. Agreements with land owners can be very sensitive if one land owner finds out that an adjacent owner negotiated a higher royalty or lease payment. Since project development will also include the need for access roads for large equipment involved in the project construction, it is important that the size and extent of such access roads be clearly spelled out in the agreement with the land owner.

**Public Land** – Any of the renewable technologies may be constructed on public land, although this is most common for geothermal and large hydroelectric facilities. Moreover, the government usually controls the concessions for geothermal and hydro rights even if private land is involved. This means that prospective developers must secure water rights and resource concessions (the right to develop various resources under or on the land) from the government in addition to acquiring the use of the land itself. Resource concessions often are bid out to the highest bidder and for public lands will usually include both the land and the resource use rights.

**Public/Private Partnerships** – Public/private partnerships commonly are used for biomass facilities at landfill sites or other types of waste disposal locations where the waste is used as fuel for power generation that may either be used on site or sold to the local utility. However, there may also be public/private partnerships with other public entities that may not provide the fuel resource but want to use renewable power for a public purpose. For example, public/private partnerships may be beneficial for public water agencies in order to provide electricity for pumping large quantities of water, or to provide power needed to treat or desalinate water. In these cases the public agency provides the project site and may provide some or all of the fuel resource needed for power generation, in addition to some or all of the financing.

**References**

- 169. NRECA – Guide to Public/Private Partnerships
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• Global Resources and Costs
• Goals & Objectives
• Barriers
• Strategies for Successful RE Projects
  • Stakeholder Roles
  • Market Promotion Strategies
  • PPAs and Business Models
  • Transmission and Grid Integration
  • Financing and Risk Mitigation
• Best Practices
Strategies for Successful Renewable Energy Projects: Transmission and Grid Integration
TRANSMISSION ISSUES

- Sufficiency
- Rules for access
- Cost allocation
- Grid integration
Transmission Issues

Transmission is a key area for renewable energy implementation. A guarantee of transmission access for RE electricity production is absolutely imperative. These guarantees are guided by grid access rules and processes. In addition, the manner by which transmission planning and expansion are handled, as well as how the costs are allocated, can make or break the effectiveness of renewable energy promotional policies. And, finally, it is very important for the development of variable technologies like solar and wind to have a well-designed integration plan. The next few slides discuss these elements in greater detail.
TRANSMISSION BARRIERS

• Weak grids (small or not interconnected grids)

• Lack of transmission planning to accommodate new resources and resource rich areas

• Inappropriate rules for transmission access
  – Transmission interconnection
  – Ancillary services
  – Plant scheduling
Transmission Barriers

Transmission is a universal problem for renewable energy in almost every country. Transmission systems, which carry bulk power from a fleet of generating plants to substations near load centers, generally are referred to as the backbone of the electricity system. Renewable resources are often located in quite different regions from load centers or existing fossil generation facilities. For this reason there is almost always a need for new transmission lines to connect these areas of renewable rich resources to the rest of the grid. In addition to new transmission, existing transmission lines may need to be reinforced in order to carry the increased power coming from these new renewable resource areas.

Many developing countries suffer from weak grids characterized by frequent brownouts and blackouts, usually caused by overloading, poor interconnection, and lack of coordinated operations. In the Philippines, for example, a small grid in Mindanao provided power from a barge-mounted 50 MW diesel-fueled power plant to a nearby cement plant and, further downstream, a village where most of the cement plant workers live, as well as some limited distribution to large corporate farms in the surrounding region for irrigation pumping. Nearly every time a cement pump was started at the plant, the village and the farms went black for 10-60 minutes. This practice continued for more than a year before the operator of the cement plant was convinced to coordinate the startup with the barge power plant operator over the phone. These kinds of problems can also occur when a renewable generator is connected to the end of a transmission line on a weak grid unless reinforcement of the grid is undertaken. Interconnecting any new large transmission facility onto a weak grid structure is going to be more difficult and possibly more expensive than interconnecting with a strong, well integrated grid.

The need for new or reinforced transmission raises the issues of cost and cost allocation. Moreover, the rules and codes for grid interconnection in many systems may not be designed in a manner that is friendly to modular technologies or medium-sized renewables. These issues are discussed below.

Transmission System Planning increasingly is viewed as one of the most important areas of energy system planning, especially for RE development. Some areas regulate transmission and generation separately, and have separate agencies (such as an independent system operator) that operate the system. The grid may remain the property of the utility but be operated by the independent operator, or the transmission system may be owned by a private company, or a governmental or quasi-governmental entity. Transmission planning can become quite complex when several entities are involved – or it can result in none of the parties taking responsibility for planning. Spain is credited as the first country to form a comprehensive regional transmission system planning process by forming a Regional Transmission Organization (RTO) with its interconnecting neighbors, Portugal, France, and Morocco.

A primary planning objective is to ensure the transmission system is of sufficient size to accommodate electric demand (load), and that the generation (supply) needed to meet that load is available. The transmission planning process varies widely around the world. Until fairly recently,
however, planners generally have neglected to consider in a comprehensive manner the transmission needed to accommodate new renewable resources supported by renewable market policies.

**Transmission Access Rules & Grid Codes** – The rules for transmission access and grid codes are very important and can either hinder or help renewable energy deployment. These rules and codes are intended to maintain a reliable grid system, but may be written in a manner that either does not allow certain types of renewables to be interconnected or makes it too expensive for renewables to interconnect. Grid access rules and codes in the past have often been written by the utilities. However, with the addition of projects owned and operated by independent power producers, and with increased interest in renewable resources, many transmission rules and codes are being revised to facilitate participation by private sector companies and modular types of generation. These revised rules may be developed or reviewed by a governmental agency or regulator.

**Rules for Transmission Interconnection** – Every transmission grid has rules for interconnection and access to support grid management and assure reliability of the system. As with the transmission system itself, most of these rules were created when large central station plants were the only generators connected to the grid. As a result, many grid access rules require specific pieces of equipment (e.g., Automated Generation Control – AGC) rather than the generator performance that is desired (e.g., the ability of the facility to be taken off line when requested).

For modular (e.g., wind, PV) and intermediate-sized renewable generators (e.g., 10 to 50 MW), these equipment requirements may be inappropriate and/or unreasonably expensive. Moreover, the renewable generator may be able to meet the performance desired in another way. Therefore, if non-hydro renewable resources are desired, transmission interconnection rules should be reviewed and modified using performance standards rather than equipment standards to make sure the interconnection rules do not act as a barrier to renewable grid access while still maintaining the appropriate levels of system reliability.

**Ancillary Services** – In addition to interconnection rules, there are a number of ancillary transmission services that are necessary in order to operate a transmission grid efficiently and reliably. Ancillary services are the corrective actions needed to integrate electricity from generation sources into a larger, real-time electricity supply.

The grid operator purchases ancillary services to balance the imperfectly predicted, constantly changing load demand with the electricity supply from generators that do not perfectly match their prescribed output. All loads and generators, both conventional and renewable, require ancillary services at some time. **Regulation** and **load following (supplemental energy)** are the two key ancillary services required to perform this function. Other ancillary services include such things as spinning reserve and VAR support (VARs are reactive power). Regulation is the use of online generating units that are equipped with automatic generation control (AGC) and that can change output quickly (MW/minute) to track the moment-to-moment fluctuations in customer loads and to correct for the unintended fluctuations in generation. In so doing, regulation helps to maintain interconnection frequency, manage differences between actual and scheduled power flows between control areas, and match generation to load within the control area. Load following is the use of online generation equipment to track the intra- and inter-hour changes in customer loads.
In the past, when all generation came from traditional central station plants, all generators were required to provide ancillary services if they wanted to be interconnected with the system. However, it is not necessary for every generator to be able to provide these grid services. Modern grid managers contract for these services with individual generation facilities that indicate they have the appropriate capability. An equitable tariff is then paid for each service provided, thus encouraging facilities with the appropriate capabilities to come forward. This provides greater flexibility for both generators and grid operators.

**Plant Scheduling** – Grid operators need to be able to schedule generation so they know when generators will be available and whether they have sufficient generation to meet load. This scheduling is often done on an hour-ahead, day-ahead, and/or week-ahead basis. Variable renewable energy facilities without storage may not be able to accurately predict their power output a week ahead or even a day ahead of production. However, as more experience is gained with these technologies in specific geographic locations, the accuracy of these new resource predictions is improving. Nonetheless, variable renewables will often be scheduled as “must take” power, meaning the grid will take the power whenever it is offered. Where there is a FIT policy, participating renewables are “must take” resources – this is the core of the FIT policy. Baseload renewables like biomass, most geothermal, and large hydro, as well as solar thermal electricity with storage, can accurately schedule their power deliveries and thus be paid more than for non-schedulable power. It is important for the development of renewables like wind and solar PV that they not be penalized or fined for their inability to meet a specific schedule.

**References**

- 28. Achieving a 33% RE Target
- 79. IREC – Freeing the Grid – 2007 Edition
- 171. State of CA – Interconnection Guidebook
- 172. State of Texas Electric Interconnection
- 173. FERC – Standard Interconnection Agreements for Large Generators
- 174. FERC – Standard Interconnection Agreements for Wind Generators
- 175. CA ISO – Ancillary Services Information
- 352. Best Practice Paper for the International Feed-In Cooperation
Key issues:

- **Cost and cost allocation**
  - Many strategies exist
  - Costs can be paid by consumers, developers or both
  - Most efficient to plan for an entire region/corridor

- **Integration of variable resources**
  - Cooperation among regional utilities eases integration
  - Reward market surplus flexibility
  - Increase low-cost flexibility
  - Develop & apply new flexibility technologies
Extending the Grid

Paying for new or updated transmission networks can pose a significant obstacle to RE developers and transmission system operators. A reasonable assessment of the new transmission requirements is needed along with an equitable distribution of the costs where some of the upgrade costs are necessary due to a weak existing grid. To the extent that additional transmission capacity is needed regardless of what type of new generation is added to the system, those costs should be incorporated into the general electricity rates and not attributed to the cost of the renewable plant.

One approach now being used to plan and fund grid extension in the western United States is to identify renewable-rich resource areas and to construct “trunk lines” to the grid out of those areas to accommodate projects as they are developed. The consumers (through their electricity rates) pay for the construction of the trunk line and the individual project developer pays for the line extensions to his/her project. This is a particularly relevant strategy where there is an excellent resource area that may ultimately support a number of individual projects that will be constructed over time. It would be unfair and unrealistic to charge the first project the entire cost for all the transmission that will ultimately be needed. Since it often takes longer to construct a new transmission line that to construct a new renewable energy facility, this approach allows transmission construction to commence in advance of the projects. Moreover, it is to the public’s benefit to develop the resource so this shared approach helps both consumers and project developers.

A variety of approaches have been used to pay for grid extensions and each country approaches it differently. In many places (China, Denmark, and Texas) the utility pays for transmission upgrades and the developer only pays to the nearest point of interconnection. In a second model – illustrated by Germany, Mexico, and Brazil – the developers pay for the full cost of transmission upgrades unless such upgrades are determined to be necessary for system reliability needs separate from the needs of the renewable developer.

Model #1 – Electricity customers pay for transmission upgrades (examples):

**China** – The project developer is responsible for costs to the nearest interconnection point. Transmission line extension and expansion costs are included in the final energy costs for the whole system. Generally the utility or transmission company will provide the initial capital required for transmission expansion costs. If approved by the regulators, those investments are included in the electricity tariffs. In China, these transmission costs are spread over all the customers using that electricity grid.

**Denmark** – The project developer is responsible for costs to the nearest interconnection point and any other reinforcements are paid by customers through transmission rates.

**US/Texas** – The Texas region has moved from pure reliability and capacity addition interconnection...
criteria to competitive renewable energy zones. Zones with high potential are identified by nomination and adjudicated by the regulatory commission. The transmission needs are planned for each zone. Transmission costs are borne by all electricity customers and are included in the electricity tariffs.

**Model #2 – Renewable developers pay for transmission upgrades (examples):**

**Mexico – Transmission open season for remote wind trunk interconnections**

- The national utility/transmission operator identifies transmission infrastructure needs based on private-sector interest (identified through self-supply and PPA commercial schemes)
- A transmission plan is presented by the utility to each wind power developer to identify the developer’s interest in reserving firm transmission capacity
- A final plan is prepared, and an “open season” is held during which developers make commitments to reserve firm transmission capacity. Guarantees are provided to the utility based on the transmission reservation.
- Utility starts construction of new transmission lines
- This mechanism pools costs among wind power developers within a transmission corridor (similar to Texas system, but costs are not added to retail tariffs, except those incurred by the utility as necessary for system reliability)

**Brazil – Jointly organized market for renewable energy and transmission services**

- For variable energy resources special auctions are held to supply energy
- The product is firm energy computed according to a specific methodology
- The energy auction takes place over a reference transmission network with known transmission fees
- Once the results of the energy auction are known, the transmission plan is revised
- If the reference transmission plan changes and rates are higher (due to less generation), the difference is paid by all customers

The idea is to remove the transmission uncertainty for renewable energy. This mechanism pools transmission costs among developers, who then share these costs (costs are not incorporated into retail rates, except the part of transmission needs required for reliability purposes).

**Integration of Variable Generators** – Wind, run-of-river hydro, and solar PV, in particular, are variable in their production output (i.e., they are not available at all hours of every day but may vary by time, day and season of the year). This means there are some specific technical and economic issues associated with their integration into the transmission grid. These are not insurmountable problems but they may be unfamiliar to many grid operators, and these people will require training and information in order to design proper responses.

Electricity load is extremely variable so managing variability is not new to the electricity system. However, managing the ebbs and flows of power into a system can add to the difficulty of maintaining system stability. The grid operator must manage its generators to compensate for the real-time variations between actual generation and actual load in the electric system. In most cases
integration of variable generation is less a technical issue (the technology to accomplish this exists and new technology is rapidly entering the market) than it is an economic issue. As described under the discussion of Ancillary Services, regulation and load following can be provided but there is a cost for this service. Moreover, the quality and quantity of the ancillary services required to balance variability depends upon the type and quantity of variable resources in the supply mix, and the match between the aggregate output of those resources and demand requirements.

Experience indicates that under most circumstances, electricity grids (unless they are very small or very weak) can integrate 15% variability in supply with little impact on system stability and little cost (e.g., <$2/MWh) to the system. In fact, a number of electricity grids (Denmark and Germany, for example) have 20 percent or more of their power coming from variable generation sources like wind without any negative impacts on system reliability. That said, there is a cost associated with providing these services. The integration cost of variable renewables in the California electricity grid when they supply less than 10% of the generating capacity was calculated by the California Energy Commission at <$2.00/MWh and $5.00/MWh once variable supply reached 15%.

Steps that can be taken to increase integration capability and lower integration costs include:

- Developing more cooperation between regional utilities (e.g., agree to more power exchanges to balance supply/demand)
- Developing markets that reward utilities for market surplus flexibility (e.g., flexibility for buying, selling, and exchanging excess power among utilities in the marketplace);
- Making more low-cost flexibility available (such as real-time reserve and load-following services); and
- Developing and applying new flexibility technologies.

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174. FERC – Standard Interconnection Agreements for Wind Generators
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245. Presentation by Kevin Barnes on wind investments in Mexico
246. IEA – Innovative Electricity Markets to Incorporate Variable Production
264. Madrigal – Integrating – RE Transmission System
• Baseload power generation
  – Hydro
  – Geothermal
  – Biomass

Variable power generation
  – Solar (PV)
  – Wind

• May be peaking or dispatchable
  – CSP
Renewable Resource Load Profiles

In large systems, some generators operate as baseload, running at or near maximum power levels 24 hours a day, 7 days of the week, for months at a time, shutting down only for maintenance. Nuclear, geothermal, and most biomass plants generally are designed for baseload operations. Other plants operate as load-followers, starting at lower power operations in the morning and gradually increasing power levels as power demand increases during the day, and then lowering again in the evening. Still others operate as peak power generators, starting up quickly to handle sudden increases in demand. The load profiles of the major renewable generation technologies follow:

- **Hydro** – Baseload power, with good control and hour/day-ahead predictability but fair to low annual predictability
- **Geothermal and Biomass** – Baseload power with some control and good predictability
- **Solar** – Variable but predictable, may have an excellent match with system loads, particularly when combined with storage
- **Wind** – Variable with good annual and seasonal predictability, but low hour/day-ahead predictability (though hourly predictability has improved significantly in the last couple of years)

**Hydroelectric** plants with water impoundments can operate in any mode, and the way they are operated differs from country to country. Hydro plants in Norway and Canada operate in all three modes, as hydro provides nearly 100 percent of power demands in many areas of those countries. Hydro plants in the United States and other regions dependent upon snow-pack often operate as peakers, but during spring runoff must be operated as baseload plants.

**Run-of-river Hydro, Solar PV, and Wind** – Wind, run-of-river hydro, and solar PV power plants can operate only when the resource is available, and cannot alter their operations at will to meet sudden changes in load. Therefore, they are not dispatchable.

**Concentrating Solar Power (CSP)** – Concentrating solar power with storage is a dispatchable resource that can be operated as a peaking or baseload facility.

**Geothermal and Biomass** – Both of these types of plants also have some ability to follow load, but the metallurgy of their turbines generally cannot handle the stress of large load swings during the day. Therefore, with the exception of hydropower with impoundments and concentrating solar power with storage, renewable generation may not be considered “helpful” from the dispatcher’s point of view.

The types of resources and their load following capabilities, the load profiles being served, and the strength of the grid (including the size and number of interconnections with neighboring grids) will all influence the cost of integrating variable renewables into the grid and the design of an optimal...
System Momentum – Another transmission factor is the phenomenon of “system momentum,” which is a function of the mass and rotational speed of all the generators connected to the grid. The greater the system momentum, the greater the ability of the system to ride through a system transient, such as when a very large load is started or a generating unit suddenly trips off-line. Compared to conventional steam and water turbines, and concentrating solar with storage, wind and PV make considerably smaller contributions to system momentum.

A number of studies (particularly by the California Energy Commission and the National Renewable Energy Laboratory and several European countries) have been undertaken to identify mechanisms for improving the integration of variable renewables like wind and solar into the transmission grid, while reducing the costs of integration. These studies can be found in the reference library for this toolkit.

References

- 176. Aust – Capacity of Victorian Elect Trans Network to Integrate Wind Power
- 177. Denmark – Windpower Integration
- 178. Egypt – Wind Integration
Diversity
- Many solar and wind plants
- Geographically dispersed
- Different weather patterns

Aggregation
- Easier to forecast wind and solar energy production for 1000’s of MWs than for 5 MWs

Load following
- Changes in solar and wind output small compared to changes in load
Advantages of Large Control Areas for Grid Integration

There are a number of advantages to having large control areas (i.e., transmission systems) when adding renewable power. The bigger the control area, the larger the percentage of intermittent resources that can be used, as ebbs and flows caused by changes in the weather in one area, such as a wind resource area or solar plant, are cancelled by the opposite effect in another region. The greater the geographic diversity of wind and solar generation, the greater their collective ability to act as an aggregated firm resource, usually some relatively small and yet significant portion (5 to 15 percent) of total installed capacity. Larger systems also tend to incorporate more sophisticated control equipment that is better able to detect and compensate for instability.

The smaller the transmission system is, the more inherently unstable it is likely to be. This is due to the fact that as systems get larger, it is more likely that an increase in load in one area will be compensated by a like decrease in another part of the system. Smaller systems do not enjoy this benefit, and often suffer significant “transient events” when large loads are started or stopped. As a result, a smaller proportion of variable generation such as wind can be added to a small island system (without compensating for potential instability) than could be added to a transmission grid that was fully integrated with adjacent systems.
FIRMING RE WITH HYDRO OR NATURAL GAS

Wind and solar

- Highly predictable on an annual or seasonal basis but variable on an hourly or daily basis

Hydro

- Highly predictable on an hourly or daily basis but variable on an annual basis
Firming Variable RE with Hydro or Natural Gas

Integrating Variable Resources – The impact of integrating large quantities of variable power like wind into a system can be offset by the makeup of the remainder of the system. In general, power systems containing large quantities of hydro and gas-fired generation are capable of accommodating large quantities of variable output generation without incurring onerous integration costs. However, to achieve such benefits, the hydro and gas resources must have a degree of operational flexibility. Thanks to its diverse geography and favorable energy policies, the state of California emerged as a laboratory, of sorts, for learning how to integrate significant amounts of variable RE generation in its state-wide electricity mix. California is served by a vast hydroelectric resource, including several pumped hydro storage plants.

Much of the hydro resource is driven by a “water first” operating philosophy, where dam operation is governed by water needs as opposed to optimal electric power dispatch. Hydro operations are highly seasonal, and also are constrained by other water needs, such as irrigation and recreation, as well as by environmental concerns, such as minimum watering requirements for downstream fisheries, etc. However, much of California’s hydro resource does have a high degree of operational flexibility and has been used during some periods to balance out the gaps in variable wind and solar power production. (See Hydro module for more specific information on hydroelectricity.)

Pumped Hydro Storage – Pumped hydropower energy storage increasingly is being developed in some areas because it offers one of the very few methods to store energy production for later use. Water is pumped to a higher reservoir and is released to a lower reservoir when it is needed most, and when the price is more attractive. Many pumped-storage projects consist of reservoirs specifically constructed for that purpose; others utilize existing lakes and reservoirs at different elevations, connected by a penstock between the two. Wind power is especially suitable for combining with pumped hydro storage as it is often at its peak at night, when loads are low. If power generated from a wind farm can be used to pump water into storage, the water can be released to generate electricity whenever it is needed. In this way, the overall transmission system capacity can be reduced as energy is released more continuously. This combination of technologies may also be used to advantage where the existing power grid is very weak.

Moderating Variable Generation with Natural Gas – Gas turbine power systems can be designed with a very wide range of operational flexibility, including fast start-up and shut-down periods, rapid ramp rates, and good part-load efficiency. Flexible, intermediate or peaking duty gas turbine power systems, sited close to load centers, would be an excellent complement to large wind and solar deployments. Or, the natural gas facility can be located next to a renewable facility, or even integrated with a solar thermal plant. (See the Solar Electric Technologies module.)

The “Firming and Shaping” Option – Where energy policies allow, hydro or natural gas generating facilities located near wind power plants can partner with these wind projects and, for a fee, “shape” the wind power production to provide firm energy. This is a particularly attractive option if the wind power is being exported from one grid area to another that has fewer resources available.
for integration purposes, since the power is firm when it enters the new control area (and therefore is easier to integrate). This “firming and shaping service” has been offered by the Bonneville Power Administration (BPA) to wind projects in the northwestern United States that sell power to California. BPA takes in wind energy, delivers it when it is available, and provides hydroelectric backup when it is not, thereby providing firm energy. BPA charges the project owner $0.45 cents/MWh for the firming and shaping service.

References

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- 167. Wolcott – Report on the Big Creek Project
- 179. CEC – Source for Intermittent Integration Costs & Challenges
- 180. Energy Almanac
Global Resources and Costs
Goals & Objectives
Barriers
Strategies for Successful RE Projects
  - Stakeholder Roles
  - Market Promotion Strategies
  - PPAs and Business Models
  - Transmission and Grid Integration
  - Financing and Risk Mitigation
Best Practices
Strategies for Successful Renewable Energy Projects: Financing and Risk Mitigation
Issues to consider:

- Sources and costs of financing
- Revenue streams of various renewable technologies
- Risk & risk mitigation options
Financing RE Projects

Regardless of the policies or programs put into place, if renewable generation projects cannot be financed nothing will happen. The power sector is already the most capital intensive of all industrial sectors by a significant margin. This means that a very large amount of the cost of the sector is invested in power production equipment. With renewable power technologies, the issue is even more significant: Many renewable energy projects have capital costs that can be double the cost of conventional fossil-fired technologies (though they have no fuel costs). Financing can be difficult for renewables to obtain, due to their high capital expenditures (and relatively long construction periods for those projects involving significant civil works construction phases). Renewable energy financing depends upon having a stable and long-term predictable revenue stream legally guaranteed for the power production prior to construction of the facility. This revenue stream, in turn, is tied to a stable regulatory environment, good resource data, and knowledgeable developers and operators.

Providers of equity or debt financing are unlikely to finance a project located where the government or regulatory environments are unstable or unpredictable, and/or where the policies instituted by the government are not being enforced. Policy stability and enforcement are important factors in successfully obtaining financing for a power generation project in any country. Contract provisions can partially shift or hedge these risks, but are only as effective as the ability to enforce contractual arrangements. In fact, good policy design can reduce the cost of renewable energy by 10% to 30%.

Sources of Financing

Potential sources of financing include:

- Private sector financing provided by the project developer
- Public financing from special renewable energy funds (which have been increasing in number)
- Multilateral lending and grant institutions (like the World Bank and donor funds)
- Regional development banks (like the Asian Development Bank and its counterparts in various regions of the world)
- Export-import banks in countries whose vendors supply the capital equipment for the project
- Local or international banks
- Individual investors

Most projects are funded using some combination of these sources. Financing can be provided as equity or as debt. Debt must be repaid as per the terms of the lending contract and indentures; equity shares are repaid based upon the net returns and profits of the project. Both funding mechanisms are subject to certain risks.

Debt financing initially can involve securing a construction loan, which, in some cases, can be converted into a long-term loan after construction and performance testing is completed on the renewable project. The construction loan is used to repay the cost of the capital equipment, the
project engineering and construction, and the commissioning of the completed project. The long-term loan is necessary because the project cannot earn revenue until it is completed and generating salable power output. Therefore, the long-term loan is repaid gradually from the long-term multi-year revenues earned from project operation and output sale.

Financing Different Renewables

Financing is specific to each project, and renewable technologies can differ in their financing requirements. The revenue stream of a variable renewable energy generator may be more difficult for a lender to evaluate to determine whether project revenues provide a sufficient coverage ratio (net revenues/project debt repayment obligations) to provide a sufficient margin of security for the lender. However, as lenders gain more experience with these projects, evaluation becomes more accurate and risk premiums can be lowered.

When compared to conventional generation, all renewable projects have higher capital and construction costs. Yet they typically also have much lower operating costs, because they do not have to procure fuel. Therefore, the construction phase of the financing is critically important because it is where most of the cost of the project is expended, and it moves most of the expenditures forward in time to the initial phase of project development. Guarantees of proper construction and operation are essential components of a construction contract. The significant difference among RE projects stems from the different revenue profiles of the different technologies, with significant difference between variable renewable technologies and baseload, or non-intermittent, renewable technologies (such as hydroelectric applications, many biomass technologies, geothermal, and concentrating solar power).

Risk & Risk Mitigation

Risk must be mitigated anytime independent third parties to the project, including banks and governments, are involved in financing a power project. Mitigating risk can lower the ultimate cost of interest on debt financing, and extend the amount and length of time that the debt capital is offered to the borrower. One typical methodology of risk mitigation is to assign each risk to the party most able to control its cost effectively. This minimizes the risks in the most cost-effective manner, and reduces the residual risk of the project by diversifying the obligations to control risk among a larger group of involved stakeholders. For example, the equipment performance risk is generally assumed by the equipment manufacturing company through equipment performance covenants in the equipment contract and warranties. The equipment manufacturer is in the best position to control the quality and performance of the equipment it produces, assuming the equipment is installed competently and within the manufacturer’s recommended specifications.

The construction company typically assumes the risk of proper construction and installation of equipment consistent with the architectural design, and equipment specifications. Past experience working on similar projects and with similar equipment can be important. The construction contract may contain performance milestones and guarantees of performance, and may require the construction company to post a performance bond or insurance as part of its contractual performance obligation. Such a bond gives the project owner a guarantee that the work will be done on time and in the manner consistent with the specifications for the project; if it is not, the bonding company is liable for the added cost of performance above the specified price, and can bring legal
action against the construction company for any failures. This arrangement mitigates risk among multiple sources with different resources, while giving the owner and the lender the guarantee of project completion at the agreed contractual cost.

Before extending either construction or long-term financing, a debt financer will perform due diligence on the financial, engineering, and legal aspects of the loan. Often, using outside experts in each of these areas. The financial institution will compare the project data with comparative data from the same type of project located in the region, or geographically proximate areas, to evaluate the revenue, expenses, legal obligations, and key contracts, as well as the debt coverage expected from a renewable energy project. The financer also will evaluate the record of each of the stakeholders involved as well as their technical and legal consultants. Ultimately, it is the legal documents that set forth these relationships and responsibilities. The parties are obligated only to the extent set forth in the legal contracts and guarantees. As part of this financial evaluation, the stability of the renewable project incentives and regulatory stability in the host country, as well as the ability to enforce various project contracts, are essential elements.

References

- 9. World Bank RE Toolkit
- 169. NRECA – Guide to Public/Private Partnerships
- 250. Policy Instrument design to Reduce Financing Costs in Renewable Energy Technology Projects

Further Reading

The power purchase agreement (PPA) is the key in determining revenue flow for the project. For a detailed comparison of successful and unsuccessful RE PPAs in several developing countries, see assessment for the World Bank, at http://go.worldbank.org/QXEK531XJ0
Public sector financing:
- Grants
- Tax incentives
- Loans (debt)
- Credit enhancements; loan guarantees

Private sector financing:
- Equity
- Debt for:
  - Working capital
  - Equipment acquisition
  - Project construction
  - Long-term finance
  - Credit enhancements; loan guarantees
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Financing Options

Public Sector Financing – Financing available from the public sector includes:

Grants

Grants may be used either for general RE development of an independent power project (IPP), or to buy down some of the higher up-front capital costs of a RE technology. Sources of grants can include government, private foundations, or donors. The advantage of grants is that they do not need to be repaid, but grants only can be utilized for the purposes set forth in the grant documents.

Tax Incentives

Tax incentives can include tax credits or accelerated depreciation of equipment. Typically, these are only useful to offset other taxes that would be owed by the project owner. In the early years of a project, revenue may not be sufficient to create a tax liability. Allowing RE investors to transfer the tax benefits to other entities with larger tax appetites or to convert the benefits into cash significantly increases their financial flexibility.

Loan Guarantees

A loan guarantee provided by a third party mitigates risk by providing a secondary, conditional source of repayment if the borrower is unable to pay. Loan guarantees are important for purposes of influencing the underlying loan interest rate, terms of payback, and loan term, as well as enhancing the loan.

Equity

Equity represents IPP owner investment of capital or sweat-equity in the RE IPP project. The cost of equity capital is greater than the cost of debt capital for a project developer, as the interest costs of borrowing are business expenses of the project that are deducted when determining net annual income subject to income taxation. A higher debt-to-equity ratio increases the return to equity of the investment because of the “leverage” of using borrowed money, the interest for which is a deductible business expense that offsets other income for income taxation. Therefore, IPP project economics are better if less equity and more debt is utilized to finance a RE project. Equity funds are available from project owners, governments, specialized infrastructure funds, and multilateral financial institutions.

Debt

Debt is money that is borrowed for specific purposes and must be repaid to the lender over a period
of time, according to a specific schedule laid out in the loan’s legal documents. Debt financing can be made available by foreign commercial banks, local commercial banks, export credit agencies, insurance companies, public debt issues and multilateral financing institutions. Debt typically can constitute up to 80% of the assessed value of the equipment/property, depending on the risks perceived by the lender. Debt may not be available to less secure companies without strong balance sheets.

References

- For a discussion of equity and debt financing, see
- 362. UNEP, SEFI – Public Finance Mechanisms to Catalyze Sustainable Energy Sector Growth

Further Reading

For a discussion of grants in India made by IREDA, see Steven Ferrey (with Dr. Anil Cabral, World Bank), Renewable Power in Developing Countries, Pennwell Publishers, 2006, chapter 6.
**DEBT FINANCING OPTIONS**

**Option 1:**
**Full-recourse financing**
- The entire resources and balance sheet of the borrower are at risk for repayment of debt obligations
- The risk of repayment rests entirely with the borrower, unless enhancements are added to the credit facility

**Option 2:**
**Non-recourse project debt**
- Limits security to project equipment assets, and revenue stream
- The borrower/ultimate owners of the project are not otherwise liable
- All risks must be mitigated or shifted among stakeholders
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Debt Financing Options

**Full Recourse Debt Financing** is the most secure option for the lender. It makes the overall creditworthiness of the borrower, as an entity beyond the power project, the recourse eligible to secure repayment of the loan. The lender has recourse to the entire assets of the borrower, not just the specific IPP project and its revenue flow. The transaction costs to establish this debt are less than for non-recourse financing, as the borrower’s credit asset base is larger and lender due diligence is more straightforward. The entire balance sheet of the owner, not just the project entity, is evaluated. Typical interest rates for loans would usually apply for full-recourse financing, instead of the higher rates associated with non-recourse debt.

**Limited or Non-recourse Project Debt Financing** legally isolates the non-project assets and net cash flow of the owner of the RE IPP from the debt obligation associated with the power generation project. This option provides more protection to the project owner than full recourse financing. Recourse of the lender, and the liability of the borrower, are limited to the assets legally owned by the IPP project company, which are only the RE project itself and its contracts. Project companies on a regular basis will repatriate net profits to the ultimate IPP company owners, who legally are separate and isolated from the IPP project companies. Once repatriated to the ultimate owner, these assets are no longer liable for, or reachable by lenders or other creditors of the IPP. Their recourse is limited to assets of real property (land), personal property (equipment) and monetary assets (bank accounts, accounts payable, and long-term power sale contracts) and receivables of the project company.

Most contracts and insurance policies are assigned to the lender as part of the loan security in a non-recourse financing structure. This means that if not repaid on the terms agreed, the lender can seize and take possession of the contractual rights that support the specific project, and with this seizure could hire another operator to continue operation of the project. While this leaves the power generation assets at risk, conventional lenders typically do not want to foreclose their debt to assume control over an operating power generation company. Typical lenders, such as commercial banks, do not have the skilled personnel on staff necessary to operate a power project. If they did assume control, they would usually hire operators, and often must attempt to liquidate this asset by selling the IPP quickly to a new buyer. If the project lender also is the vendor of the project equipment, repossessing their own equipment may have more value to them than to a conventional lender with little or no expertise in power generation.

The primary security for this type of non-recourse loan typically is the power purchase agreement (PPA), which must be properly drafted and creditworthy or guaranteed, to secure the project non-recourse loan. This contractual asset provides the long-term revenue stream for the project. It is important that this asset be assignable to new owners, including lenders in circumstances where lenders could assume control of the project to mitigate the risk that they are not repaid on schedule. In typical debt structures, debt can constitute up to 80% of total project financing. Transaction costs and due diligence are higher for this non-recourse loan than for conventional full-recourse debt. Various risk guarantee mechanisms can be important elements of facilitating non-recourse loans to RE projects in developing countries. Guarantees, bonds, or warranties can provide additional credit.
Further Reading

Mitigate RE project risk though:

- Financial instruments
- Contractual provisions in legal documents (especially PPA)
- Insurance
- Credit enhancements
- Loan guarantees for project debt
- Escrow and control of funds
- Minimized transaction costs
Risk Allocation and Sharing

Risk is the potential for unexpected events to occur to a renewable energy project that diminish the expected cash flow and profitability of that project. The following financial instruments are used to mitigate renewable energy project risk:

**Risk Premium** – A risk premium is a higher payment for borrowed funds, reflecting the difference between the expected rate of return on a RE investment and the risk-free return over the same period of time. Risk can be project specific and can vary with technology and the contracts that support the project. With RE projects, because of reduced lender and investor experience, there is more uncertainty and perceived risk. Risk allocation formulas share risk among the various parties and stakeholders.

**Loan Guarantees** – Loan guarantees can apply to different aspects of an IPP, including construction, operation, and purchase agreements for power off-take. Loan guarantees add a new party to guarantee repayment of borrowed funds.

**Vendor Financing** – The manufacturer/vendor of the power generation equipment often can be a lender for the project. Export-import banks in many of the countries that produce power production equipment also can provide credit support for project financing, where equipment from that country is used in the project. Either form of this financing can have advantages for all parties. Vendor financing promotes the sale of the equipment manufactured by the vendor itself. For the IPP power developer, this financing approach consolidates the equipment acquisition contract, with the debt financing the equipment acquisition. The vendor thus assumes an extra risk, in that if the equipment does not meet warranty specifications and perform as promised and expected, then there will be less power sale revenue earned by the project and less ability to repay the debt used to finance equipment procurement. Therefore, the vendors, through the loan agreement, assume the added risk of effective operation for their own equipment in a particular application.

Such a vendor loan functions like deferred payment for the equipment. It also shifts the effort of securing capital to the vendor. The vendor can borrow from a conventional lender the money that is ultimately loaned to the IPP developer. The equipment manufacturer typically enjoys several advantages in borrowing funds. The vendor may be a larger corporation than many IPP developers and enjoy better access to capital on favorable, longer terms. The vendor typically is a corporation, while the IPP developer may be organized as a partnership or limited liability corporation with few assets. The vendor can more easily operate the IPP project or reuse/resell the equipment in the event of a default in loan repayment than can a conventional lender who knows little about a power generation facility or the equipment employed.

**Third-Party Guarantees** – Multilateral development banks and national development agencies may use concessional funds to provide partial or total guarantees. A subordinated recovery guarantee is like a partial guarantee. Some development banks, such as the International Finance Corporation (IFC) of the World Bank or the Asian Development Bank, can directly guarantee funds.
Other entities such as USAID's Development Credit Authority can work with commercial banks to provide loan guarantees for project debt.

**Senior Debt Guarantees** – Senior debt guarantees can be used to make local lenders more likely to realize that risks have been shifted, should it become difficult to repay the debt due to some of the risks set forth in the earlier slides. These guarantees may be provided by multilateral bank concessional funds. The IFC provides senior debt guarantees for grid-connected wind, small hydro, and biomass renewable energy projects. This can help prompt the commercial lender to extend the term of the loan that it would otherwise make, given the partial guarantee. Extending the loan term reduces the monthly payments of loan principal, as well as lowers the effective risk and interest rate the loan bears. This more favorable financing package, by lowering debt expenses, ultimately lowers the net cost at which the IPP can produce power.

**Subordinated Debt** – Commercial lenders, multilateral development banks, or national development banks can provide subordinated debt. If there is a shortage of project funds, this debt is not repaid until after senior debt and operating costs are first paid. Therefore, it carries greater risk if the borrower is short of revenue. In some cases, the subordinated debt principal may be repaid on a deferred basis after the senior debt is repaid. This allows the senior debt to be repaid in a shorter period of time, which makes senior debt lending more attractive and less risky to the prospective lender because it gets exclusive access to project revenues for repayment for a period of time.
## BORROWER FINANCING RISKS WITH IPP PROJECTS

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Borrower Financing Risks with Private (IPP) Ownership Projects

The following section examines common borrower risks and various measures that can be taken to mitigate those risks.

**Commercial Risk**

Commercial risk includes construction risks, technology risks, and operational risks, as set forth on the next slide. Construction risk can be mitigated through a project construction contract that assigns construction risk, under a turnkey contract, to the energy project contractor. These contracts include warranties on operating performance and efficiency, equipment availability, generation characteristics, and environmental impacts from operation. Technology and operational risk include the availability of the renewable resource (wind, solar, hydro, biomass inputs, etc.) and delays in construction or permitting. If a third-party operator is employed, risk is mitigated by operating contractor provisions that set risk mitigation and performance guarantees.

Commercial risk also can be mitigated by contractual provisions in the PPA, procurement contracts, and operating contracts. These agreements and contracts can transfer risk to other parties, or assume risk through insurance products or third-party guarantees. Insurance can cover technical equipment risk, delay in equipment delivery and installation, physical damage or casualty to the RE facility, equipment failure during operation or interruption of the business revenue-generating operations. It is not possible to obtain private sector insurance regarding permitting delay or changes to law or regulation. These legal risks of discretion and operation of government agencies are not things that can be mitigated by most commercial risk mitigation mechanisms. Rather, they can be allocated among the parties who produce and purchase power, as an element of the PPA.

**Sovereign Risk**

Sovereign risk is the risk of confiscation, nationalization, or other control by the government of IPP assets. This includes the host government or national utility’s failure to fulfill a promise to purchase power from the project. For non-recourse project finance, the power generation asset is the only “hard” asset needed to secure the loan. This asset is bolted to the ground and not easily moved. Nationalization effectively confiscates this asset, which is the security for the loan. Unless this sovereign risk is mitigated, a private lender will be hesitant to finance RE investments.

Political risk insurance or contingent contract provisions mitigate these risks. In addition, provisions can be included to have disputes judged under international law, or require that disputes are adjudicated in a neutral external country subject to dispute resolution provisions that are acceptable to the project lenders.
Regulatory Risk

Regulatory risk is the risk to the power producer that a change in law or regulation will alter the legal structure, or framework, within which the generation project operates, and thus its basic economics and viability. Such changes could involve the price, quantity, or time of the generation; transmission access; timeliness of RE power purchases; rates of taxes, levies, or surcharges on RE purchases; or changes to the rules for sale of power output. Regulatory risk can also include the failure to adhere to tariff provisions.

Regulatory changes occur at the discretion of the government, and can negatively or positively change the legal environment in which the project operates. These risks are mitigated either by provisions of the PPA that control contingencies created by change in law or taxes, or by political risk guarantees in the credit support for the project. These risks are often allocated to the enforcement of the contract for power sale between the power seller and the buyer.

Currency Risk

Currency risk results from a lack of developed local capital markets, and may result in financing a project with international capital that must be repaid in a currency different than the local currency. Therefore, project power sale revenues can be paid in local currency, whereas project debt must be repaid in the international currency that was borrowed or obtained to finance the project. Since exchange rates between different currencies fluctuate, the value of the project’s (capital and/or operating/fuel) inputs and power (sale/revenue) outputs are dependent on the potential differences in the exchange rate. A power project has a long life and is depreciated for tax purposes slowly over decades – therefore, over an extended period of time, currency risk is significant. Currency risk also is the risk that one cannot convert sufficient local currency to the currency necessary to repay the debt or equity holders if they are not in-country, or the risk of changes in value of relative currencies over time, thus changing the value of the revenue stream to the borrower. A country may also restrict the exodus of its currency beyond national borders. This is relevant to the repatriation of profits, and payments to both project debt and equity interests.

There is no uniform method to mitigate currency risk. These risks can be mitigated by indexation of some payments to an international currency, such as the U.S. dollar or the Euro, indexing payments in real (as opposed to nominal) currency value, or by the host country government guaranteeing currency conversion of the necessary amount of currency required to be repatriated elsewhere. Currency hedging contracts using future derivative mechanisms, if available in a country, are a way of mitigating currency risk.

Overall Risk Mitigation

Certain forms of guarantees, hedging and insurance may abate these risks perceived by private lenders to support IPP investments. These include partial credit guarantees, partial risk guarantees, and insurance.

- **Partial Credit Guarantees** – These cover all risks for a specified period of time during the debt financing. These guarantees can extend the length of a private loan and improve loan terms.
- **Partial Risk Guarantees** – These cover the risk of default of payment for power received or other nonperformance of contract obligations by the purchaser, or failure of a government agency. This provides an insurance backstop on a certain political or financial event.

- **Policy-based Guarantees** – These support structural policies and reforms undertaken by government to allow more access to credit markets. These guarantees can be controversial as they affect sovereign country decisions. This type of guarantee may allow an international financing bank to guarantee a local loan to a RE power project.

- **Hedging Products** – Hedging products include interest rate swaps, caps and collars, currency swaps, and commodity swaps. Interest rate swaps allow borrowers to exchange fixed with floating rate debt. Caps and collars bound the range over which variable interest rates can change as part of a debt obligation. Currency swaps allow borrowers to exchange cash flow from one currency to another, which can help repatriate earnings or revenue to owners or creditors of the borrower in a currency other than that of the country in which the project is located. Since the financial crisis of 2008-2009, various hedging products are being reevaluated.

As a mitigation technique, risk insurance by third-party financial resources can lower the ultimate cost of capital for a borrower by reducing the financial and legal impacts of various risk events over the life of a power project. The insurance industry does not have extensive experience in assessing the risks of insurance for many renewable energy applications. Insurance products for renewable power include conventional commercial and casualty risk insurance for power generation projects, political risk insurance, and credit derivatives. Options for renewable power generation could also include weather insurance and derivatives such as insurance for unexpected variations in wind, hydro flow, or solar radiation.

**References**


**Further Reading**

For more on the various sources of risk guarantees and credit guarantees from international organizations, see Steven Ferrey & Dr. Anil Cabraal, *Renewable Power in Developing Countries*, Pennwell Publishers, 2006, at pages 215-230.
PROJECT CONSTRUCTION RISKS

- Design & construction risks
- Technology & operation risks
- Operator risks

Mitigation techniques:
- Fixed price performance contract or contract penalties
- Completion guarantees
- Performance guarantees/penalties
- Liquidated damages for non-completion or non-performance
- Warranties provided by equipment manufacturers regarding performance
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Project Construction Risks

Regardless of the technology, the following risks must be mitigated:

**Design and Construction Risk**

Design and construction risks occur after the loan is made but before the power project begins to generate revenues. Risks also arise during project start-up and can be mitigated by performance guarantees or performance bonds. In the case of renewable energy projects, performance guarantees and performance bonds could be used to mitigate the potential that the technology does not perform properly.

**Technology and Operational Risk**

Technology and operational risks include availability of the renewable resource (wind, solar, hydro, biomass inputs, etc.) and delays in construction or permitting. Resource availability risks have very limited mitigation except through provisions in the contract with the company that provided the resource data used to model the project’s potential. Certain weather-related insurance can mitigate extreme negative variations in expected operation. Delays in construction can be mitigated through completion guarantees based on the project’s estimated construction schedule.

**Operator Risk**

If a third-party operator is employed, operating contract conditions that set performance standards and guarantees for the operator, staffing requirements, and incentive payments and penalties based on operating availability and performance mitigates risk. Operational risk can be mitigated by contractual risk-allocation agreements, escrow accounts, standby letters of credit, or government guarantees.

**Guarantees**

If a fixed price option is used, the owner/developer agrees to a not-to-exceed price. If the final price were higher than the agreed price, the contractor would be required to make up the difference from contingency accounts. To satisfy completion and performance guarantees, the energy project contractor must complete the project within a specific timeframe (e.g., a specified number of months) and, upon substantial completion, the plant (after a startup period) would be required to operate (perform) according to specified performance goals (e.g., 95% of nameplate capacity for a 14-day period). Failure to meet these guarantees would result in schedule and/or performance liquidated damages. Typically, total liquidated damages are capped at a specific not-to-exceed amount.

To mitigate financial risk, the developer and the financial institutions must engage experienced RE
project, finance, and tax attorneys. The deal is legally set by the various project contracts that control the acquisition of land rights; procurement of equipment; construction of the facility; supply of materials; operation; and power sale. Equity investors need to be fully knowledgeable about the debt instruments to which they obligate themselves and project revenues. Interest rates should be fixed or, should that not be possible, hedged to absorb the risk of changes in debt costs over time. Finally, technical, environmental, and legal due diligence must be performed to ensure that the financing is compatible with the energy developer’s contract and other project agreements.

References

- 97. Black & Veatch – New Mexico Concentrating Solar Plant Feasibility Study

Further Reading

 Tradable carbon offset credits

- Approved RE projects
- Must be “Additional”
- Verified to achieve reductions
- Earn CDM Certified Emission Reductions (CERs) in developing countries
Additional Innovative Credit Enhancements

The UN Framework Convention on Climate Change (UNFCCC), to which the United States is a signatory, resulted from the 1992 global climate change meeting held in Rio de Janeiro, Brazil. The 1997 Kyoto Protocol provided the first steps for reaching greenhouse gas reduction goals by the Annex 1 (developed) nations. As part of the Kyoto Protocol, a Clean Development Mechanism (CDM) was created to facilitate greenhouse gas reductions in non-Annex 1 (developing) countries, who could then sell their certified emission reductions (CERs) to buyers in Annex 1 countries. Though these protocols continue only through 2012 (when a new agreement is planned to replace the Kyoto Protocol), in the interim CDM credits still provide a potential supplemental revenue source for new renewable energy projects in non-Annex 1 countries. After 2012, there will only be a market for the further purchase of CERs if: 1) countries decide to allow their emitting facilities to purchase CERs to help them meet their commitments under domestic GHG reduction programs; or 2) the CDM continues beyond 2012.

Looking at the projects in the CDM pipeline (not all of which have been approved), as well as those projects that have already received credits, 37% of the CDM CERs issued by 2012 will be from renewable energy projects. China, India, Brazil, and Mexico have received the most CDM credits to date. China is the most active creator of credits with 55% of all CERs for CDM projects in the pipeline. Eighty-one percent of all proposed CERs are coming from the Asia-Pacific region, followed by Latin America with 14%. With regard to the leading individual countries, China has proposed 54% of the CERs, India 15%, and Brazil 6%. The CDM pipeline includes all CDM projects to date, including those that have been proposed but not yet approved, or “registered.”

Carbon Credits as RE Financing

Under the Regional Greenhouse Gas Initiative (RGGI -- carbon regulation in the United States in 10 Eastern states that began in January 2009) under certain conditions, European Union Emission Trading System and CDM renewable energy projects can create CERs that can be used as offsets in the RGGI regulation in the United States. These CERs can be created in approximately 140 developing countries in the world, if the project is “additional” to business-as-usual. Many areas in developing countries are served by carbon-based fossil fuels, so renewable projects there should qualify to create additional credits. The reason that earning credits on a kWh basis is considered a risk is because the credits are dependent upon the production output of the facility rather than upon the capital investment in the facility.

The CER certification process typically takes the CDM Executive Board of the UNFCCC more than a year, and there is considerable uncertainty as to the eventual certification of any particular CER. The steps include registration, verification, and certification of the CER. This makes the sequencing of the project’s financing and inclusion of certified emission reductions in the financial calculations awkward because it is not certain the project will yield saleable carbon credits.

These certificates are usable within the US RGGI scheme if allowance trading prices increase above...
certain specified thresholds. To date, in the few months since RGGI began in 2009, the trading price has not exceeded this threshold, so CERs are not yet usable in the United States. California’s proposed carbon regulation, beginning in 2012, also may recognize these CERs as eligible offset credits for California compliance, as might the pending US federal legislation. These actions would increase the market for CERs and possibly increase their value.

References

- 168. EPA – Clean Energy Guide to Action
- 229. UNEP Risoe CDM/JI Pipeline Analysis and Database
- 239. Regional Greenhouse Gas Initiative
- 305. Lewis – The Evolving Role of Carbon Finance in Promoting Renewable Energy Development in China
Production of renewable energy → Renewable energy certificates → Commodity electricity

TRECs can be sold or traded to markets with RE targets, to voluntary renewable markets, or (when eligible) converted to carbon certificates.
Tradable Renewable Energy Certificates (REC or TREC)

CERs are not the only way to trade renewable energy benefits. A Tradable Renewable Energy Certificate (TREC or REC) represents the non-energy characteristics of renewable power generation – the environmental, social, and economic attributes associated with generating one megawatt hour of energy from a renewable energy facility (this captures such things as zero net air emissions, low or no greenhouse gas emissions, economic development benefits, etc). TREC are denominated in units of one MWh and each is issued with a unique serial number. TREC are used primarily in the United States and Europe.

Like a carbon certificate, a TREC can be traded, sold, or banked. Though similar to a TREC, a carbon certificate is limited to representing the carbon emissions that were offset by the generation of the MWh of renewable energy (or whatever project activity produces the carbon savings). A carbon certificate is denominated in tonnes of carbon with each certificate equal to the avoidance of one tonne of carbon equivalent.

The rules governing the definition and use of carbon certificates come from state, national, and international carbon reduction programs as well as carbon credit certification programs. Renewable energy projects can be issued carbon certificates or they can convert their TREC into the appropriate number of carbon certificates. However, according to most program rules, a MWh of renewable energy can either be represented by a carbon certificate or a TREC at any particular time, but not by both at the same time. So, for instance, if a project’s TREC are converted to carbon certificates, the TREC no longer exist. Both carbon certificates and TREC must be retired when they are used (e.g., a claim is made).

How Are TREC’s Useful?

For Accounting: In their simplest application, TREC are used as an accounting mechanism to prove compliance with renewable mandates (RPS programs), green-pricing programs, or other types of renewable policies, programs, or claims. Each TREC has a unique serial number that allows it to be put into electronic accounts (like electronic banking) and transferred or sold until it is retired. Different programs and policies have specific rules stipulating under what circumstances a TREC must be retired. Though these rules vary by program, the general concept is that a TREC is retired from circulation when someone makes a claim about its use. For example, it is used to prove compliance with a RE target, or the owner claims that as a result of obtaining TREC it has offset the negative environmental attributes associated with conventional electricity generation. In this way, TREC’s are a valuable tool for the implementation of various types of renewable energy policies and programs.

To make the market more fluid: TREC’s are more than just an accounting tool. Energy is used instantaneously but TREC’s can be sold, traded, or banked over a period of time, thus adding fluidity to the renewable energy market. Trading TREC’s allows the purchasers to avoid the cost and difficulty of transmitting energy from one place to another. Depending upon a program’s specific
rules, TREC\textregistered s allow the owner to pair renewable attributes (particularly the environmental attributes) with regular electricity to drive green power. (Of course, when these TREC\textregistered s are stripped from the original energy produced, that power can no longer claim to be renewable or have zero emissions, since that attribute now belongs to the entity that acquired the TREC.) TREC\textregistered s also allow the generator to recover any difference between the price paid for the power and the actual cost of producing that power from someone other than the electric utility where the project is geographically located.

A TREC system can be the cheapest way to achieve a specified renewable energy target. A TREC scheme, where a market for certificates can operate separately from the electricity market, can accommodate both grid-connected and stand-alone power stations, and can operate across separate electricity grids. Under a TREC scheme, companies/individuals can capitalize on geographic areas with good renewable energy sources and supportive policies across the country even if they themselves are located in a resource-poor area.

TREC\textregistered s are sold in the voluntary renewable energy market in North America and are defined and governed by certification programs like the Green-e Program. There is a robust market for renewable energy certificates in the United States, where both commercial and residential customers buy them to reduce their carbon footprints and to demonstrate their support for renewable energy and a clean environment.

**Tracking Systems:** An electronic tracking system is necessary in order to implement a credible and robust TREC\textregistered s trading system. The tracking systems that exist in the United States and Europe are independent non-profit entities (often established with governmental support) that are linked electronically to the balancing authorities or transmission operators, allowing them to receive accurate third-party data on exactly how much power is being produced by each generator. The tracking system issues one TREC (with its unique serial number) for each MWh that the facility produces. That TREC is deposited in the electronic account of the generator and can then be transferred to other accounts at the instruction of the generator. The tracking system (like banking systems) does not get involved in the business transactions, but are simply responsible for issuing and accounting for the TREC\textregistered s as they change owners and then retiring them when the TREC has been spent.

**References**

- 76. Green-e – Website on certification of renewable energy certificates
- 77. Information on European Renewable Energy Certificate Tracking
- 78. Information on Tracking Renewable Energy Certificates in North America
- 170. Baker & McKenzie – Optimal Legal Frameworks for RE in India
Global Resources and Costs
Goals & Objectives
Barriers
Strategies for Successful RE Projects
Best Practices
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Best Practices
SAMPLE RE PROJECT DEVELOPMENT FLOW

- Resource assessment
- Work with community
- Secure land rights
- Siting and project feasibility considerations
- Transmission needs assessment
- Secure market off-taker agreement
- Secure construction financing
- Determine equipment suppliers
- Finalize O&M agreements
- Finalize economic assessment
- Project construction
- Performance testing
- Convert to long-term financing
- Commence commercial operation
This slide illustrates a sample renewable energy project development flow. Each of the individual technology modules in this Toolkit also provides technology-specific project development flows and timelines. The time required for the development process differs with each of the technologies, and also reflects the overall geopolitical situation within which the project is being constructed.
SUMMARY OF BEST PRACTICES

- Develop stable policy environment & framework
  - Market-making policies
  - Tax reforms & incentives
  - Transmission planning and access policies
  - Pricing & cost-sharing policies
  - Long-term PPA provisions
  - Enforcement provisions

- Identify responsible agencies
- Develop supporting policies & regulations
- Monitor & report on progress toward goals
- Fine-tune policies prospectively while maintaining framework stability
Summary of Best Practices

While each RE project will reflect the unique geopolitical and financial situation of the specific area or country, there are a number of best practices that can serve as an overall project guide. This summary of best practices concentrates on designing a policy framework for enabling large grid-connected renewable energy development. The policy framework should be stable and allow utility or private sector developers to plan, finance, construct, operate, and maintain renewable facilities within known policy and pricing parameters.

**Develop a Stable Policy Environment and Framework** – A renewable energy policy framework should have a designated governmental agency responsible for RE design and implementation, enforcement of RE policies, and implementation of programs and regulations. This agency, in conjunction with other government agencies, also should develop supporting policies (including research & development, public outreach, and job training) as well as monitor and report regularly on the progress and efficacy of these policies and regulations.

And, finally, though the policy framework needs to be stable and predictable, nonetheless it will require regular adjustments and changes as technologies and the marketplace itself changes. These changes may involve fine-tuning regulations so they work more efficiently, as well as evolving toward different market models as technologies mature or new technologies emerge. The important factor is that the policy framework should be stable and predictable, with changes always being prospective and announced sufficiently in advance of their implementation to allow market participants the time needed to adjust their businesses accordingly. Contracts for specific projects, once signed (including prices, terms and conditions), should not be changed over the term of the contract, except as specified in the contract itself.