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STRATEGIC PLANNING IN ELECTRIC UTILITIES: USING RENEWABLE ENERGY TECHNOLOGIES AS RISK MANAGEMENT TOOLS

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ABSTRACT

This research investigates the potential of owning renewable energy technologies to mitigate risk faced by the electric utility industry. Explicit consideration is given to the renewable energy technology's attributes of fuel costs, environmental costs, modularity, lead time, location flexibility, availability, initial capital costs, and investment reversibility. The research concludes that renewable energy technologies, particularly the modular technologies such as photovoltaics and wind, have the potential to provide decision makers with physical risk-management investments.

INTRODUCTION

Regulatory and technical forces are causing electric utilities to move from a natural monopoly to a more competitive environment. Associated with this movement is an increasing concern about how to manage the risks associated with the electric supply business. There are several approaches to managing these risks. One approach is to purchase financial instruments such as options and futures contracts (Ref. 1). Another approach is to own physical assets that have low risk attributes or characteristics (Refs. 2, 3).

This research investigates the potential of mitigating risk by owning renewable energy technologies. It qualitatively discusses how the attributes of renewable energy technologies can help to manage risk from various ownership perspectives (see Ref. 4 for more quantitative results). Explicit consideration is given to the attributes of fuel costs, environmental costs, modularity, lead time, location flexibility, availability, initial capital costs, and investment reversibility. Ownership perspectives include investor-owned utilities (IOUs), municipal utilities, independent power producers (IPPs), and power consumers. The research concludes that renewable energy technologies, particularly the modular technologies such as photovoltaics and wind, have the potential to provide decision makers with physical risk-management investments.

RENEWABLE ENERGY ATTRIBUTES

Fuel Costs

One of the most often stated positive attributes of renewable technologies is that they have no fuel costs. As a result, there is no uncertainty associated with the future fuel costs to operate a renewable power plant. All ownership perspectives mentioned earlier can benefit from this attribute. Different ownership perspectives, however, will benefit to a different degree with those experiencing the most uncertainty realizing the greatest benefit. Currently, this includes IPPs and power consumers because fluctuations in fuel costs (or electricity prices) directly affect the profit of IPPs, the profit of commercial and industrial users of electricity, and the well being of residential consumers who use power for their residential needs. IOUs and municipal utilities that generate power realize less of a benefit from a reduction in fuel cost variability because they currently pass this uncertainty on to customers through fuel adjustment clauses. In a more competitive environment, however, it is unlikely that this practice will continue.

When comparing renewable to fossil-based plants, the absence of fuel cost uncertainty must be added as a benefit of the renewable plant or counted as a cost of the fossil-based plant. Cost analysis for fossil-based plants typically projects a stream of expected fuel costs, discounts the results, and considers the present value cost as part of the cost of the plant. This analytical approach, however, improperly converts the uncertain stream of future fuel costs into a stream of certain costs without accounting for the reduced uncertainty.

One way to account for this uncertainty is to determine the premium charged for a fixed price long-term fuel contract (e.g., a natural gas contract) over a series of spot-market based purchases (Ref. 5). Such a contract is analogous to a financial swap (i.e., a series of forward contracts). A second approach is based on utility theory and involves assessing the decision maker's utility function in order to determine his or her willingness to pay for "certainty" fuel instead of "risky" spot-market based fuel.

Environmental Costs

Another attraction of renewables is that they produce low or no environmental emissions. Quantifying the value of this benefit, however, is controversial. A good part of the debate stems from the fact that the various participants in the process may have vastly different valuations.

The perspective taken in this paper is that of the plant owner, including investors in IPPs, utilities, or power customers. Plant owners can incur two types of costs associated with emissions. First, there is the additional cost of building the plant to comply with current environmental standards. This cost, which is minimal when environmental standards are low, is usually included in evaluating all types of plants, both fossil-based and renewable.

Second, there is the cost associated with future environmental standards that have not yet been established. As Swezey and Wan point out, "prospective environmental cleanup costs of fossil-fuel-based plants are never considered up-front when generation investment decisions are made (Ref. 6)." These future costs have the potential to be quite high. Pacific Gas and Electric Company, for example, estimates that compliance with NOx emissions rules for its existing power plants could require capital expenditures of up to $355 million over the next ten years (Ref. 7). It is likely that these costs were not anticipated by Pacific Gas and Electric Company when the plants were initially constructed. Power plants that are considered to be very clean by today's standards (e.g., natural gas based generation) may fare very poorly in five years.

A conceptual framework that can be used to view this future cost is that the decision to build any polluting generation source includes the plant owner's decision to give a valuable option to the government. The option gives the government the right (but not the obligation) to change emissions standards or impose externality costs (i.e., environmental taxes) associated with environmental damages at any time and require that all generators meet the standards. The result of this is that there is a positive probability that the plant owner will incur costs in the future. The cost of this option must be accounted for when comparing fossil-based to renewable plants. Either fossil-based plant owners require compensation for the option that is given to the government or renewable plant owners need to be given a credit. The benefit of low or zero future environmental costs depends upon who owns the plant, since some owners are more likely to incur environmental costs. For example, utilities and IPPs are likely to experience more stringent regulation than power consumers that own plants.

This idea is similar to stock options that are given to company executives as part of their compensation; while there are no costs associated with the options when they are given, the cost will be incurred at some future time if the option is exercised, thus diluting the stock's value. This represents a cost to stockholders and a value to the executives to whom the compensation is given.

Lead Time

IOUs and municipal utilities are still considered to be regulated natural monopolies, which requires them to serve all customers regardless of whether or not it is profitable to do so. The interaction between demand uncertainty, plant lead time, and capacity additions is of concern to these utilities. The smaller the utility is in size, the greater the concern. For this reason, municipal utilities might be particularly concerned about demand uncertainty at the generation system level.

A typical approach to assessing the interaction between demand uncertainty, plant lead time, and capacity additions is to develop scenarios of high, medium, and low demand (Ref. 8) and to calculate the expected present value cost of meeting demand using plants with different lead times.

This approach, however, does not capture the dynamic nature of demand growth. Demand growth can change over time so that demand can grow or not grow at each point in time. For example, rather than always having high, medium, or low demand growth, actual demand may be high the first year, low the second year, and medium the third year. This leads to the situation where the number of scenarios equals the possible growth rate at each time period raised to the power of the number of time periods. For example, if demand growth rate can take on three levels at any time and there are ten time periods, there is a total of 3^{10} or almost 60,000 possible scenarios.

Taking the dynamic nature of demand growth into account rather than simply examining three scenarios results in a valuation that more accurately captures the effect of demand uncertainty. This will often result in an increase in the value of plants with short lead times over the value of plants with longer lead times.

Location Flexibility

IOUs and municipal utilities have historically satisfied customer demand by generating electricity centrally and distributing it through an extensive transmission and distribution network. As demand increases, the utility generates more electricity. The capacity of the generation, transmission, and distribution systems can become constrained once demand increases beyond a certain level. The traditional utility response to these constraints is to build new facilities.

Utilities, however, are beginning to consider alternative approaches to dealing with transmission and distribution capacity constraints, such as using photovoltaic and other distributed generation technologies or reducing demand through targeted demand side management programs (Ref. 9). These investments can reduce a utility's variable costs and defer capacity investments (Ref. 10).

A special case of the value of modularity and short lead time occurs within this distributed generation setting due to the location flexibility associated with the modular generation technologies such as photovoltaics. The analysis from the previous subsection can be applied to the transmission and distribution system in addition to the generation system in the case of distributed generation. That is, rather than determining the value of short lead time for the generation system, the value of short lead time is determined for the transmission and distribution system.

The value of short lead time when combined with location flexibility in a distributed generation setting is probably of greater value to IOUs than to municipal utilities. The reason for this is that municipal utility systems tend to be highly concentrated in urban areas (and thus are highly interconnected) while IOUs have systems that are more spread out.

Availability

Plant modularity affects plant availability in several ways. First, from a revenue perspective, modular plants begin producing power (and thus revenue for utilities and IPPs or cost-savings for power consumers) earlier than non-modular plants. Modular plants begin producing power earlier than non-modular plants because each segment of a modular plant can come on line as it is completed.

Second, from an operational perspective, modular plants have less variance in their equipment availability than non-modular plants when equipment failures in the modular plant are independently distributed. A non-modular plant can be considered to be either operating or not operating. Modular plants, by contrast, can have partial availability. For example, a modular plant with two identical segments has three possible levels of availability: the plant is 100 percent available if both segments are functional; it is 50 percent available if either the first or the second segment is functional; and it is unavailable if both segments are non-functional.

The greater the number of segments in the modular plant (i.e., the more modular the plant is) the lower the variance. This means that there is a greater reliability associated with the availability of modular plants than with non-modular plants. Renewable energy technologies such as wind and photovoltaic plants are composed of a large number of identical parts.

Initial Capital Costs

Projects with short lead times tend to have greater certainty associated with their installed cost due to fewer cost overruns and less lost revenue due to plant delays. This is of interest to any party that is responsible for plant construction, although it is most significant for IPPs since utilities and power consumers frequently install generation facilities through a contracting procedure, thus shifting the construction risk away from themselves to the contractor.

In addition, a modular plant ties up fewer capital resources during the construction of the total plant. The project developer only needs enough working capital to finance one segment at a time. Once the first segment is completed, it can be fully financed, and the proceeds used to finance the next segment. This benefit is of particular interest to companies with limited financial resources, such as IPPs.

This benefit is similar to the benefit realized by a developer that chooses to build single-family dwellings rather than an apartment building. The full financial resources are tied up in the apartment building before it is sold while the single family dwellings can be sold as they are completed, thus requiring less working capital.

Moreover, continued construction of a modular plant is often contingent on the success of the previous phase so that there is the opportunity to stop the project without incurring a total loss after each segment is completed. This is because the completed increments of the project are used to produce revenue whether or not the project is fully completed. The same is not true for non-modular projects. While there is always the opportunity to halt construction, doing this on a non-modular project results in a loss of all capital sunk to date, less the partially completed project's salvage value. While modularity thus provides value to utilities who want to control demand uncertainty, it is also of value to investors who are funding an IPP and are unsatisfied with the project's progress.

For these reasons, utilities are investing in small plants, such as gas turbines. Even smaller investments may further increase the risk-mitigation value.

Investment Reversibility

Investment reversibility is the degree to which an investment is reversible once it is completed. This is of interest to plant owners because they need to know if a plant can be salvaged and what its value is in an alternative application. Modular plants are likely to have a higher salvage value than non-modular plants because it is more feasible to move modular plants to areas of higher value or even for use in other applications. The degree of reversibility is a function of the difficulty and cost in moving the technology to another location and the feasibility of using it in different applications.

To illustrate this concept, suppose that a utility is accepting bids for a 50 MW battery facility. Two IPPs submit bids with identical prices proposing two technologies with identical efficiencies, lifetimes, and maintenance requirements. The only difference is that one plant is a single, 50 MW battery while the other plant is 50,000 automobile batteries (rated at 12 volts and 83.3 amp).

Now suppose that in the future, due to technological breakthroughs in Superconductor Magnetic Energy Storage or other storage technologies the battery plant may become obsolete. The automobile battery plant could be salvaged for use in cars, while the 50 MW battery would have few other uses and may have to be sold as scrap. This makes the modular plant superior to the non-modular plant because the plant has a higher salvage value under an assumption of technological progress.

This value is not merely hypothetical. Consider, for example, the 6 MW Carrisa Plains photovoltaic plant facility in California, whose original owner, Arco Solar, sold the plant for strategic reasons to another company. This company dismantled the plant and resold the modules at a retail price of $4,000 to $5,000 per kilowatt at a time when new modules were selling for $6,500 to $7,000 per kilowatt (Ref. 11). That is, the investment was reversible, partially due to the modularity of the plant.

CONCLUSIONS AND FUTURE DIRECTIONS

Regulatory and technical forces are causing electric utilities to move from a natural monopoly to a more competitive environment. Associated with this movement is an increasing concern about how to manage the risks associated with the electric supply business. This paper discussed the risk-mitigation potential of renewable energy technologies from several ownership perspectives. Specific attention was given to the attributes of fuel costs, environmental costs, modularity, lead time, location flexibility, availability, initial capital costs, and investment reversibility.

The conclusion of this research is that renewable energy technologies, particularly the modular technologies such as wind and photovoltaics, have attributes that may be attractive to a variety of decision makers depending upon the uncertainties that are of greatest concern to them.

The next step of this research is to develop a set of representative case studies to numerically quantify the economic risk-mitigation value of the various attributes described in this paper. Analytical approaches to be used in the analysis include risk-adjusted discount rates within a dynamic discounted cash flow framework, option valuation, decision analysis, and future/forward contract comparisons. The analytical approaches will be selected based on the available information and how well they demonstrate the value of the various attributes of the renewable energy technology given the specific requirements of the decision maker making the investment decision.

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