Renewable Energy: A Hedge Against an Uncertain Energy Future

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ABSTRACT

Energy consumers, especially large industrial consumers, more and more are looking to reduce risk their businesses face from price and supply uncertainties in energy derived from fossil fuels. Energy efficiency provides a proven resource to reduce overall risk impacts from future energy prices. In addition, with incentives provided by federal and state governments, renewable energy is growing as an option to hedge against energy price spikes. Further, renewable energy alternatives can provide competitive, fixed energy rates over future decades.

However, company energy managers often have little experience with renewable energy. Researching technical options and economic issues can be time consuming. In some cases, "sexy" project concepts dominate discussions, with little thought devoted to their feasibility.

This paper provides a decision-making framework for plant energy managers to begin investigating the potential for renewable energy. It discusses both on-site and purchase options, and walk-through goals, such as energy security, price stability, public relations and green enhancement. Pertinent examples will be provided based on the authors' experience in performing feasibility studies and advising industrial, commercial, and public entities on options right for them, with a goal of reducing due diligence work required to explore options.

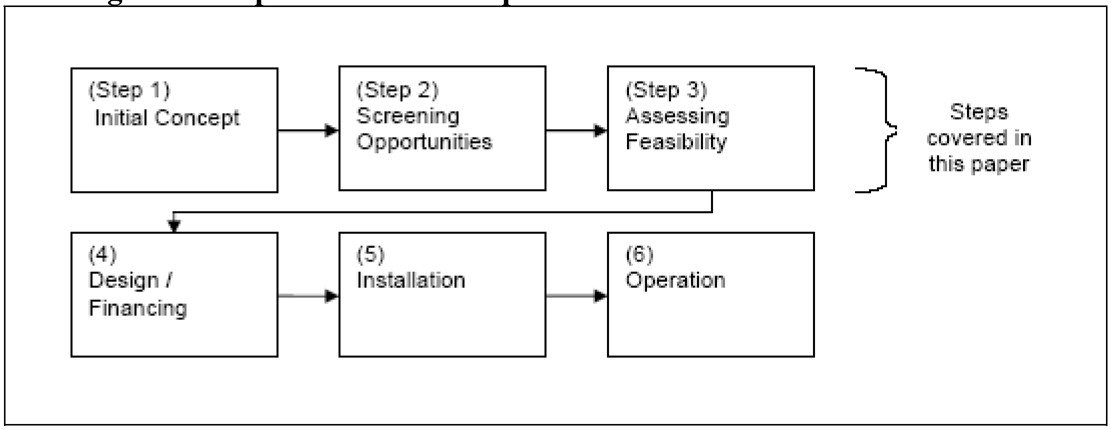
Introduction

The 2009 ACEEE Industrial Summer Study focuses on moving investment decisions to energy-efficient solutions. Hence, this paper examines investment in renewable energy projects, with an emphasis on the initial steps taken in launching a renewable energy project. This process can be affected by a series of factors, including a relative lack of experience with renewable energy, which can prevent the germination of new projects or, in some cases, lead to the development of poor projects that would not have otherwise passed a good feasibility assessment. These issues arise in steps one through three of the development process, shown in Figure 1. This paper includes several examples of how potentially good projects can become bogged down and poor projects, paradoxically, end up being pursued.

Though other barriers can arise in later steps, the authors' primary experience, working with organizations new to renewable energy projects, is that otherwise sound projects are often terminated in the early stages. Still, the renewable energy industry is thriving, and many well thought-out projects are in the queue. There is, however, a portion of the market that needs development support to successfully complete this process.

During *Step 1: Initial Concept* in Figure 1, potential benefits of renewable energy are identified. Frequent challenges to achieving this include gaining a clear understanding of how renewable energy projects can complement energy efficiency projects, and what incentives are available to defray project costs. At the start of the decision-making process, the question often must be asked: "Why should we invest in renewable energy when there are still cost-effective opportunities with energy efficiency?"

Figure 1: Steps Toward Development of On-site Renewable Generation



Step 2: Screening Opportunities presents a classic example of the decision-making process getting bogged by "death by committee." At any site, a number of renewable energy projects are conceivable, ranging from the reasonable to those that may sound "sexy" but are unlikely to be feasible. For example, the authors attended a meeting discussing possible projects for a municipality where the ideas included the plausible (solar photovoltaics and wind turbines) and the creative but ultimately economically unfeasible (such as developing a combined heat and power system to be powered by heat generated from decomposing leaf mulch). For organizations new to renewable energy, focusing on readily available and proven technologies can reduce the research needed to screen for plausible projects. More mature technologies also benefit from having third-party consultants and experts available to help with feasibly assessments and design. For new and novel technologies, the only support available may be from manufacturers selling the technologies.

For many projects (especially larger ones), experienced staff or outside consultants will be required to perform a thorough feasibility study (Step 3). However, simple steps can be taken by regular staff to perform a "rule-of-thumb" feasibility assessment for some renewable energy technologies. The results can save time and money by ruling out poor projects, while providing confidence that time and money invested in promising areas will be well spent. This paper's section *Feasibility: "Will This Really Work?"* provides more detail on "rules of thumb" that can be applied to assessing projects.

Steps 4 through 6 shown in Figure 1 typically require outside expertise from consultants, engineers and installers, or system integrators. If, however, an organization has never developed renewable energy projects, it can be daunting to even determine whether hiring outside help is necessarily cost-effective.

This paper addresses navigating the first three steps in this development process, based on the authors' experience in guiding public and private organizations through these steps. The authors have worked extensively with clean energy funding agencies, private entities, and municipalities and other government entities in developing a variety of renewable energy projects and programs. Many examples given in this paper are drawn from our work in the northeastern U.S., where favorable incentives and high electric rates have created a relatively favorable environment for renewable energy development.

Primarily, this paper focuses on on-site installation of renewable energy systems as a means to hedge against future growth and periodic shocks in electrical rates. Installing renewable energy provides a number of other benefits, which will be discussed, but the ability to fix a long-term electrical rate may be one of the most compelling of these, and more often is directly compatible with an organization's bottom line. Other opportunities, such as purchasing wholesale renewable energy or using a contract for differences, are reviewed as alternatives to on-site renewable energy development.

The Initial Concept and the Answer to: "Why Should We Consider Renewable Energy?"

Often, generating renewable energy on-site effectively is viewed as another energy-efficiency option. Potential projects are compared to energy-efficiency alternatives by their cost-effectiveness and the extent of due-diligence they require. Energy-efficiency opportunities, however, are widely available and typically have a high rate of financial return. Combined with many site managers not having worked with renewable energy, site managers may view renewable energy projects as options to be explored only after exhausting efficiency opportunities. As argued below, there are at least two reasons to explore renewable energy options while continuing to address energy efficiency: fixed, long-term energy rates; and incentives serving as equalizers.

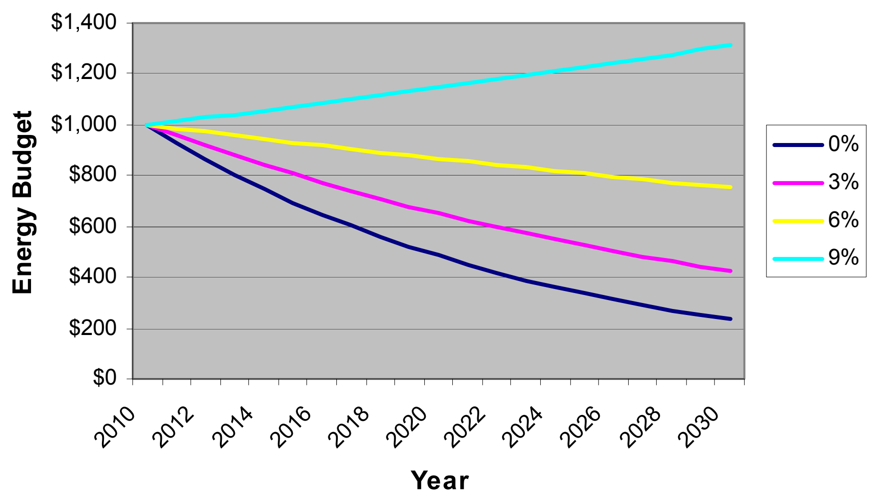
Benefits of Fixed, Long-Term Energy Rates

Renewable energy projects provide several unique benefits for a company's economic bottom line and public relations. Consider the simple energy cost equation: Energy Cost ($) = Energy (kWh) * Rate ($/kWh).

Energy efficiency addresses the first part of the equation and reduces energy costs through controlling energy use. However, energy efficiency does not affect the rate. As prices for electricity rise, savings associated with improved energy efficiency also rise, making the cost-effectiveness of projects even more compelling. If, however, the electricity rate increases faster than the inflation rate, many energy-efficiency gains, in terms of reduced annual energy budgets, can be lost.

For example, Figure 2 (below) demonstrates the impact of rate increases on annual energy budgets for a hypothetical site that reduces electricity use by 7% through efficiency measures for each year starting in 2010 and continuing to 2030. Assuming annual kWh use will be reduced by about 50% after 10 years of steady energy-efficiency gains and 80% after 20 years, the blue line in Figure 2 represents a scenario in which the price of electricity remains stable and has a 0% gain over inflation. The steady progress in reducing site electricity use transfers directly into reduced annual energy budgets in terms of 2010 dollars. When electrical rates increase faster than inflation, the positive impacts of efficiency measures on energy budgets are reduced. At an average rate of 3% above inflation over the next 20 years (which is on par with the average increase seen during this decade [DOE/EIA 2008b]), the 2020 energy budget would be about 30% higher than if a stable electrical price had been secured. In 2030, the energy budget would be 80% higher.

Figure 2: Impact of Average Electric Rate Increase on Annual Energy Budgets for Site with Improving Energy Efficiency (Per $1,000 of Energy Budget)



A larger electric rate increase reduces the positive impact on future annual energy budgets gained through energy-efficiency measures. Fixing the rate of increase (e.g., to 0% above inflation) with renewable energy generation reduces future energy budgets and secures gains made through energy efficiency. (Energy Budget in 2010 Dollars. Assumed energy-efficiency gains of 7% per year, on average.)

Although energy-efficiency projects result in lower annual energy budgets, even greater savings are possible if long-term electrical rates can be fixed. As renewable energy potentially offers fixed rates over one to two decades, it can act to secure annual energy budget reductions made through energy-efficiency improvements.

The risk of increased prices can be mitigated to some extent through strategies such as load shifting (under a Time-of-Use rate schedule) or long-term supply contracts. Though self-generation can control prices, if generation is based on fossil fuels, prices are subject to variations in fossil fuel costs. Only a fuel-free option, such as renewable energy, can provide price certainty for periods of a decade or longer.

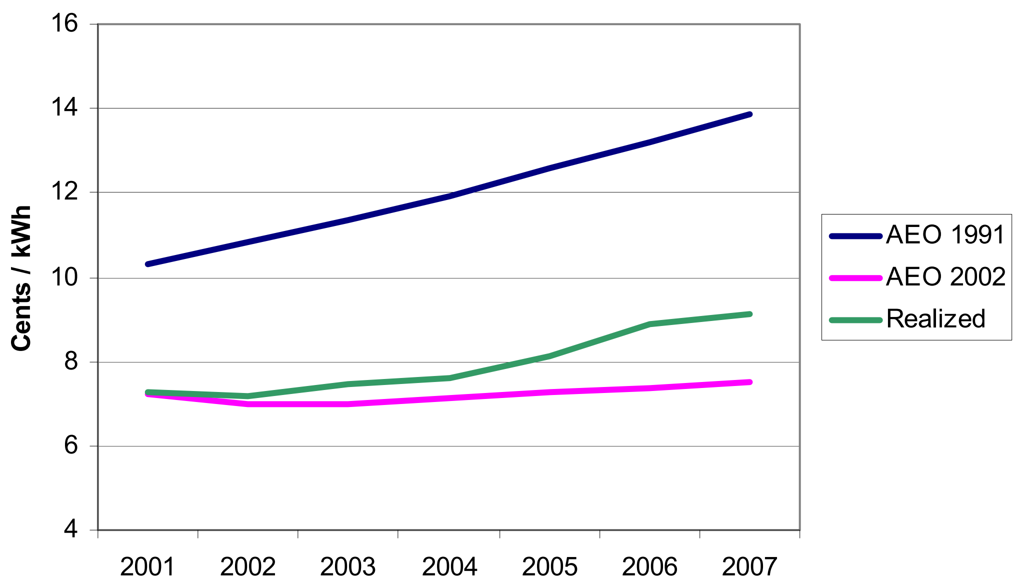
When considering whether to use renewable energy to reduce the impacts of possible future energy prices, it is natural to ask: "What are predicted future rates, and what are the uncertainties around them?" According to the latest U.S. Energy Information Agency (EIA) projections, electricity rates should increase at a modest 0.6% rate above inflation over the next 20 years (DOE/EIA 2009). However, one should approach these projections cautiously due to the inherent uncertainty in trying to predict energy prices so far into the future.

> "Energy market projections are subject to much uncertainty. Many of the events that shape energy markets are random and cannot be anticipated. In addition, future developments in technologies, demographics, and resources cannot be foreseen with certainty." (DOE/EIA, 2008a)

For example, compare previous, long-term projections to realized electrical rates. Figure 3 shows DOE/EIA predictions made in 1991 (AEO 1991) and in 2002 (AEO 2002) for electrical rates for all customer classes from 2001 to 2007. Rates projected for 2007 in 1991 are 52% higher than those actually realized that year. Rates for the same period projected in 2002 are 20% lower than the 2007 realized rate. However, the average annual rate increase of 1% predicted in 2002 turned out to be quite low when compared to a realized annual average increase of 4%.

An alternative view of potential electrical rate increases can be seen in recent legislation passed in Massachusetts, which provides a default increase of 3% per year above inflation for life-cycle cost estimates (MA GCA).

Figure 3: EIA Annual Energy Outlook (AEO) Projections and Realized Nominal Electrical Rates



Source: (EIA/DOE 2008b)
Table 15. Average Electricity Prices, Projected vs. Actual (nominal cents per kilowatt-hour)

Incentives as the Equalizer

Due to falling costs and generous state and federal incentives, renewable energy can, in several regions of the U.S., be purchased at or near parity to grid rates on a $/kWh basis, providing a reasonable rate of return on an investment with relatively little risk. For example, 16 states and Washington D.C. have dedicated funds totaling $6.8 billion available to support development of renewable energy projects.[1]

[1] See: http://www.dsireusa.org/documents/SummaryMaps/PBF_Map.ppt#526,1. Public Benefits Funds for Renewables (Estimated Funding).

Without incentives, for example, the simple payback on a solar photovoltaic installation can be around 40 years.[2] However, in combination with federal tax incentives, state-level incentives can bring simple paybacks down to as low as four to five years (SEBANE 2009). A comprehensive list of state and federal incentives is maintained in the Database of State Incentives for Renewable Energy (DSIRE).[3] Not all sites will be able to take full advantage of the incentives offered.

Power Purchase Agreements (PPAs), discussed in more detail below, are an alternative to direct purchase of a renewable energy system, whereby the energy user purchases energy generated from an on-site renewable energy system owned and operated by a third party. By taking full advantage of state and federal incentives, a PPA provider can often offer renewable energy at rates competitive with power purchased from the grid.

Screening Opportunities: "What Do We Do Now?"

Stories about renewable energy technology developments continue to grow in the press. These stories range from proven technologies currently installed to those in research and development stages. For those new to renewable energy projects, the time-tested advice of "keep it simple" especially applies. Table 1 (below) compares four proven technologies that might apply to a site: solar photovoltaics (PV), wind turbines (Wind), landfill gas generators, and small hydro. Solar photovoltaic is the most broadly applicable of these technologies and generally faces fewer development hurdles than the other technologies. It is, however, typically the most expensive before consideration of federal and state incentives. Wind energy can be highly cost-effective and also generally applicable, but, due to variability in wind speeds, may not be feasible at many sites. Landfill gas and small hydro can be cost-effective opportunities for sites where these resources are available.

An alternative option site owners should consider is a PPA, which allows an installation owned by a third party (as opposed to the site owner) to offer rates competitive with power off the grid. In a PPA, the site owner works with a financing and installation firm that will install and maintain an on-site renewable energy system, charging the site owner a previously negotiated fee for delivered electricity. The PPA offers benefits such as simplified logistics and known electric prices to the site owner; the site owner, however, may be constrained as to technologies or installation types available.

[2] At a site with a 15 cent/kWh delivered electric rate, installing a PV system that costs $8,000 per kW and produces 1,200 kWh per year per kW would return a simple payback of 44 years without incentives. This payback period is well beyond the typical warranty period of PV panels.

[3] The database can be accessed at: http://www.dsireusa.org/

Table 1: Comparison of Four Renewable Energy Technologies

	Resource Availability	Cost Per Watt Installed	Capacity Factor*	Developmental Hurdles
PV	Widely available	Relatively high compared to some other technologies ($5–$10)	10%–20%	Typically no environmental permits or zoning variances needed. Generally the easiest technology to install, and projects can be completed within one year.
Wind	Resource varies substantially, but widely available across the U.S.	Equivalent to PV for systems under 100 kW; MW scale systems at $3 per Watt or less.	Up to 40% for good locations. Poor locations can be 10% or less.	Can be high in areas that require changes to ordinances for regulating height. Significant public involvement and aesthetic concerns (NIMBYism)[4]can be significant hurdles.
Landfill Gas	Limited	Low: $2 per Watt.	High: greater than 50%	Environmental permits can be required, but NIMBYism typically not a concern.
Small Hydro	Limited	Varies: large and simple projects can be as low as $1 per Watt; smaller and more complicated projects can be up to $5 per Watt.	Varies: 25%–100%	Can be substantial if environmental permitting required.

*Capacity factor is the ratio of the actual output of a generator over a period of time to its output had it operated at full nameplate capacity over the entire period.

Feasibility: "Will This Really Work?"

Before investing in outside consultants performing a thorough feasibility study, site owners can take some basic steps to make sure potential projects in which they are investing will be cost-effective and feasible. Using basic rules of thumb site owners can rule out poor projects and focus further efforts on reasonable projects with narrowed, minimizing upfront costs.

Solar photovoltaic rules of thumb—a feasibility study may be warranted if a site has:

- Significant roof or other open areas (10 to 15 Watts per square foot provides a good rule of thumb for estimating potential system size).
- A newer roof, which can more likely bear the additional weight and wind load of a solar PV system. Furthermore, an older roof may be replaced sooner, requiring all solar PV arrays be removed and reinstalled.
- Open areas far from (or above) obstructions in the south, east, and west.

A simple online tool such as PVWatts can be used to estimate potential energy output of the PV system.[5] Rebates and incentives can also be looked up online, allowing a fairly easy calculation of the system's simple payback.[6]

[4] NIMBYism refers to "Not In My Back Yard."
[5] PVWatts is available at http://www.pvwatts.org/

Commercial wind rules of thumb—a feasibility study may be warranted if a site has:

- Existing zoning regulations that address wind turbines or allow expedited height variances to local zoning.
- A 50m wind speed of 6 m/s or greater, according to free online wind maps (such as 3Tier Firstlook[7]) or maps available from the DOE Wind Powering America program.[8]
- Long distances between the proposed site and scenic vistas or residential areas. Proposed wind projects within 1,000 ft of residences or other places of frequent use can lead to significant permitting difficulties. This should be considered on a case-by-case basis, and projects that seem economically marginal may not warrant the necessary effort (and expense) of protracted permitting processes.

Feasibility Studies: Working With Consultants

A pre-development study is recommended for commercial renewable energy projects. The project's size will dictate the effort level devoted to project feasibility. If starting completely from scratch, site owners may wish to conduct a renewable energy potential study. This study can vary widely in scope, but it typically includes a review of available renewable resources, pro forma economic analysis, and an overview of several possible renewable energy technologies. Once this is completed, further study can be done on the best options for going forward with project development.

Solar photovoltaic. Commercial solar photovoltaics projects can be developed after completing a basic feasibility study. This study should focus on: available open space (e.g., roof space); structural integrity of existing building and roof members; available space and conditions for inverters, meters, and other balance of system components; and verifying the availability of a consistent solar resource. Other factors to be considered include local permitting and interconnection requirements.

- Typical Timeline: 1–3 months
- Typical Cost: $5,000–$15,000

Wind. Commercial wind projects typically undergo several stages of project review and study prior to construction. A full feasibility study for a commercial wind project may include the following steps (also see Figure 4, below):

- Fatal Flaws Assessment: This assessment identifies potential roadblocks to a successful wind project. While not as detailed as a full feasibility study, a fatal flaws assessment will pinpoint "deal breakers," such as insufficient wind resources, inadequate open space, or onerous permitting requirements. If none of these factors are identified, a project may be cleared for further study and, eventually, development.
    - Typical Timeline: 1–3 months
    - Typical Cost: $5,000–$15,000

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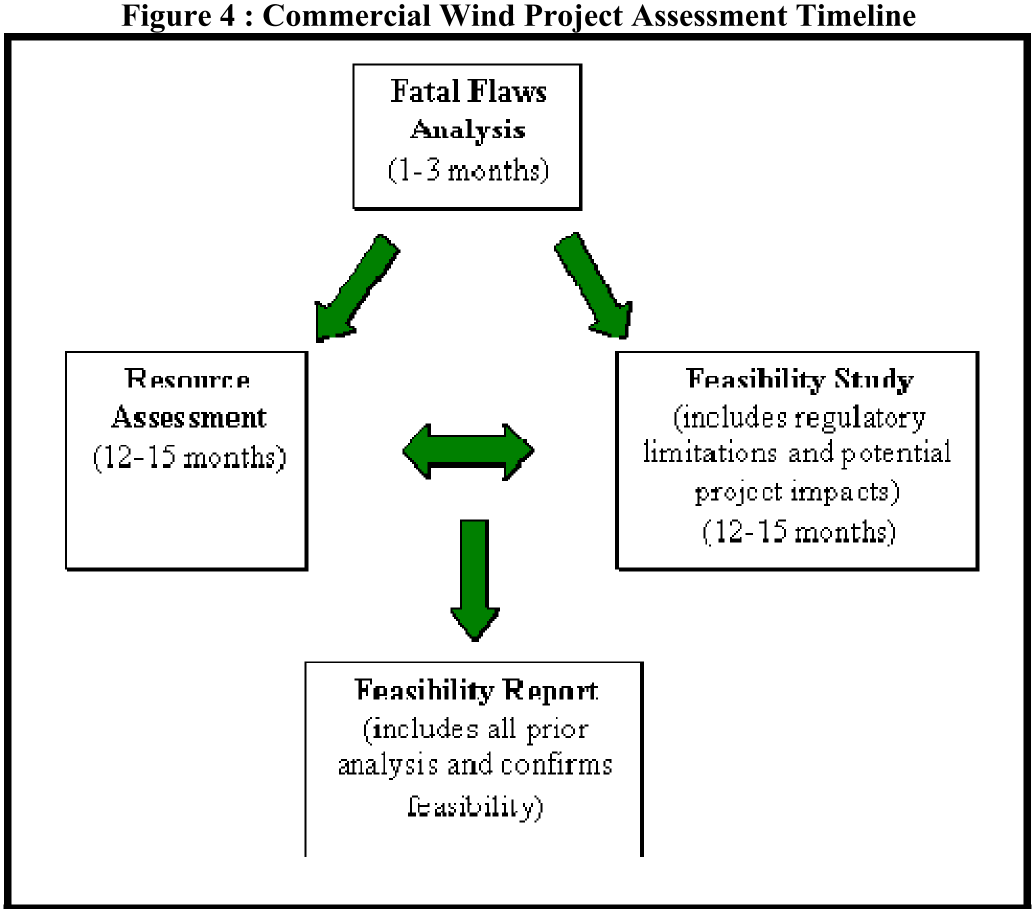
[6] As noted, a comprehensive list of available federal, state and local incentives is available at http://www.dsireusa.org/.
[7] Firstlook is available at http://firstlook.3tiergroup.com/
[8] See http://www.windpoweringamerica.gov/

- Resource Assessment: While the solar resource remains relatively constant from place to place, and can be estimated with a high degree of accuracy using only simple, online estimating tools, wind resources are extremely variable. Impacts of local topography and other site conditions can greatly impact the available wind resource and, thus, the economics of any potential wind project. Given the importance of and uncertainty in the wind resource at a given site, most commercial wind projects rely on 9 to 12 months of measured wind resource data to estimate system performance and project economics. These data are typically collected by erecting a 40 to 70 meter tower equipped with wind speed sensors and analyzing the data.
  - Typical Timeline: 12–15 months (concurrent with feasibility study)
  - Typical Cost: $50,000–$80,000

- Feasibility Study: Concurrent with the resource monitoring phase, a feasibility study should be conducted to build upon initial findings in the fatal flaws assessment. A full feasibility study should include an analysis of potential project impacts (e.g., noise, aesthetics, and shadow flicker), a detailed economic analysis, interconnection requirements, and barriers to local, state, and federal permitting.
  - Typical Timeline: 12–15 months (concurrent with resource monitoring)
  - Typical Cost: $50,000–$100,000

Figure 4 : Commercial Wind Project Assessment Timeline



Alternatives to On-Site Generation

Opportunities to purchase renewable energy directly through the grid or to hedge against fuel price instability are growing, and offer an alternative to on-site generation. Sites with larger loads may be able to "contract for differences," which effectively insures against electric rate volatility, while sites in some areas of the country may be able to purchase renewable energy directly through their utility or through a wholesale supplier.

Contracts for Differences

Following the development of new, innovative markets, the stability of renewable energy can be procured without actually purchasing the power. In a "contract for differences," an energy user and a renewable energy producer agree on a "strike price" and a duration or term for this agreement. The strike price guarantees the energy producer receives a minimum price for energy provided, and sets a maximum price for the energy user, mitigating the impact of price fluctuations for both parties. This type of arrangement is convenient for both the energy producer and user: the producer sells energy into spot markets to obtain the best prices, and the user continues to buy power from their usual supplier. After a predetermined period, the producer's energy sales are assessed. If the price received by the energy producer exceeds the strike price the energy user is compensated for the higher energy rates they experience. If the price received by the producer is less than the strike price, the energy user pays the producer the difference. Thus, the contract helps maintain stable prices for both the producer and user. In addition to stabilizing the energy user's energy budget, another benefit can be the inclusion of carbon offsets or renewable energy credits.

In a widely referenced example of a contract for differences, Southern New Hampshire University locked in rates for 15 years based on 15 million kWh per year of electricity at a price of 7.6 cents/kWh. It also effectively became a carbon-neutral campus (Stone 2007). One company offers to help establish an *Eco Power Edge* agreement,[9] targeted at large users with over $500,000 in annual energy costs.

Direct Purchase of Renewable Energy

Currently, a few utilities offer an option to choose renewable energy for their supplies. For example, Austin Energy offers green energy products as a hedge against rate volatility for electricity derived from natural gas generators. Customers have saved on their electricity bills relative to the standard rate, which is subject to the fuel cost volatility. (WRI #9).

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[9] See: The Eco Power Hedge Web site for more information: http://www.ecopowerhedge.com/index.cfm

[DOE/EIA, 2008b] Energy Information Agency, U.S. Department of Energy. *Annual Energy Outlook Retrospective Review: Evaluation of Projections in Past Editions (1982-2008).* DOE/EIA-0640(2008). See http://www.eia.doe.gov/oiaf/analysispaper/retrospective/excel/table15.xls

[DOE/EIA, 2009] Energy Information Agency. U.S. Department of Energy. *Annual Energy Outlook 2009 Early Release*, DOE/EIA-0383(2009). http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2009).pdf (See Table A1.*Total Energy Supply and Disposition Summary*).

[MA GCA] *Massachusetts Green Communities Act 2008*. Section 2, 39D, (4)(b). "To calculate life-cycle costs, a state agency shall use a discount rate equal to the rate that the commonwealth's tax-exempt long-term bonds are yielding at the time of said calculation and shall assume that the cost of fossil fuels and electricity will increase at the rate of 3 percent per year above the estimated rate of inflation or at a rate determined by the department of energy resources."

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