

CHAPTER 1

An Overview of Renewable Power

The Walrus and the Carpenter were walking close at hand; They wept like anything to see Such quantities of sand: “If this were only cleared away,” They said, “it would be grand!”

“If seven maids with seven mops Swept it for half a year. Do you suppose,” the Walrus said, “That they could get it clear?”

“I doubt it,” said the Carpenter, And shed a bitter tear.

—from *Through the Looking Glass*, Lewis Carroll

Wind, solar, and geothermal renewable power technologies face a number of technological challenges. A typical wind power project has yearly availability only in the low 30 percent range and a typical solar photovoltaic project has an availability of approximately 16 percent. For further clarification, a 100-megawatt (mW) wind project could produce only 262,800 megawatt hours (mWh) in one year (e.g., $100 \text{ mW} \times 365 \text{ days/yr} \times 24 \text{ hours/day} \times 30 \text{ percent} = 262,800 \text{ mWh}$). Solar thermal projects have a higher availability but are more expensive, have regulatory permitting challenges, and are typically not located in liquid power trading markets.

Electricity, unlike other commodities, can't be stored, which leads to a large amount of volatility in electricity prices. It is important to remember that current battery technology is only capable of storing electricity for up to four hours. Switching the world's energy supply to renewable power is not like starting the next Google. It is not a case of placing five or six smart boys and girls in a room and asking them to think up the next clean energy technology. Older facilities are endowed with a scarcity value due to the difficulty of obtaining air permits for new fossil power plants. These are a

number of the issues that make it difficult for renewable power plants to be competitive with traditional fossil power plants.

The economic profile of a typical wind and solar power project is a small amount of earnings before interest, taxes, depreciation, and amortization (EBITDA), tax credits, and accelerated depreciation. Only EBITDA can be used to pay down debt, and overestimating kilowatt hours (kWh) produced or underestimating maintenance expense can lead to a debt default. Since there is currently no inexpensive, high-capacity battery technology, it is not possible to run the electric grid with wind and solar power on a 24/7 basis. For the next few years, the economics for these types of projects will work when constructed projects can be purchased on a distressed basis for cents on the dollar. An October 16, 2009, *Forbes* article stated that the U.S. Energy Information Administration estimates that a kilowatt hour of electricity from a photovoltaic (PV) solar plant entering service in 2016 will cost 40 cents/kWh in 2009 dollars. The article further stated that this is three to five times the projected cost of electricity generated from natural gas, coal, or uranium.¹

Other than battery technology, the only way to firm up the power produced from these facilities is to use gas turbine engines. One study under development will show that a gas turbine engine that provides backup to a wind power plant actually produced more carbon dioxide (CO₂) emissions than a coal-fired power plant. A gas turbine engine would also require a local supply of natural gas and pipeline transportation, which might not be available. Improvements in gas turbine engine design might also be required to meet both quick-start and a low-emission profile. There is also a shortage of electric transmission in locations where there is potential for wind power projects.

IT'S ALL ABOUT NATURAL GAS

A key challenge is that prices for renewable power in the United States are priced off of natural gas, which is currently at historic lows. Recent large unconventional natural gas finds throughout the United States should continue to support natural gas prices below \$7 per million British Thermal Units (MMBtu).

The Energy Information Administration estimates that the United States has approximately 1,770 trillion cubic feet (Tcf) of technically recoverable gas, including 238 Tcf of proven reserves. The Potential Gas Committee estimates total U.S. gas resources at 2,074 Tcf. It is estimated that technically recoverable unconventional gas including shale accounts for nearly two-thirds of American onshore gas resources. At the current production rates, "the current

¹ Duncan Greenberg, "Seeing the Light," *Forbes*, October 19, 2009.

recoverable resource estimate provides enough natural gas to supply the United States for the next 90 years.”² In 1996, it was estimated that the Barnett Shale contained only 3 Tcf of reserves. As a result of an upgrade in technology, it was estimated in 2006 that it now contains 39 Tcf. The natural gas was always there; it was just not possible to get to it with older technology. At the time of this writing, this new supply of natural gas has resulted in natural gas prices in the \$4/MMBtu price range. This is a large drop from \$13.57/MMBtu in the summer of 2008. The economics for natural gas storage projects still appear to work since there has been weekly and seasonal movement in price.

This unconventional natural gas supply situation has resulted in the return on equity for renewable power plants to be actually lower than the return from purchasing a secured loan in some existing natural gas-fired power producers. That an equity security in the bottom of the capital structure of a yet-to-be-constructed power plant could require a lower return than a first lien secured loan in an operating gas-fired power plant doesn’t make sense. This situation is similar to the real estate crisis, whereby real estate market mortgage loans written prior to 2007 were priced at levels that didn’t reflect their risk and ultimately defaulted. This situation means that in the short term it makes sense to bet against renewables as opposed to developing or investing in new projects. By comparison, renewable power producers in Europe are currently paid a very high fixed price for power under the national government’s feed-in tariff program. This situation is also unsustainable. A May 20, 2010, *Bloomberg* article entitled “Greek Crisis and Euro’s Drop Snare Clean-Energy Stocks” stated:

*. . . The aid to renewable energy, paid by consumers through their power bills, is being slashed by governments aiming to curb their own budget deficits and to cut energy costs for businesses and consumers. . . .*³

CONTROL OF CO₂ EMISSIONS IS NOT CURRENTLY POSSIBLE

Another challenge that renewable power faces is that there is currently no proven technology to remove CO₂ emissions from existing power plants. This is a critical fact that makes it difficult to switch from traditional fossil

² John D. Podesta and Timothy E. Wirth, *Natural Gas: A Bridge Fuel for the 21st Century* (Washington, DC: Center for American Progress, August 10, 2009).

³ Ben Sills and Mark Scott, “Greek Crisis and Euro’s Drop Snare Clean-Energy Stocks,” *Bloomberg*, May 20, 2010.

power plants to renewable power plants and has helped to make it difficult for a carbon cap and trade or tax to pass. Carbon emissions not only have to be removed from the stack of a power plant but also have to be sequestered or buried deep underground. This task requires a large amount of energy and a corresponding increase in production cost. The key pollutants that existing fossil power plants (e.g., coal and natural gas) emit include sulfur dioxide (SO₂), nitrogen oxide (NO_x) and particulates (in the case of coal power plants). With current technology, it is relatively easy to control these pollutants. In order to control SO₂, a scrubber is used; in the case of NO_x, selective catalytic reduction (SCR) is used; and for particulate, an electrostatic precipitator is used.

CO₂ scrubbers are currently being tested by the French technology company Alstom at the electric utility American Electric Power. The CO₂ cost resulting from the proposed congressional cap-and-trade program is based on mostly free or low-cost allowances. As a result, it will be cheaper to use allowances as opposed to purchasing an unproven, expensive emission control technology. There is a strong possibility that Congress will not pass CO₂ legislation, and this task will fall to the Environmental Protection Agency (EPA). The EPA will then use its New Source Performance Standard (NSPS) to determine the best available control technology (BACT) for CO₂. Since there is no “available” technology to control CO₂, the EPA would have a difficult time regulating CO₂. With pollutants such as oxides of nitrogen, a power plant can either buy allowances or install a proven control technology. This will not help the overall economics for renewable power projects.

The EPA will have a difficult time attempting to regulate CO₂ under its existing BACT program. In past BACT rulings, if a technology was not commercially available or too expensive for pollutants such as NO_x, a power plant would not be required to include this technology in its design. This is also true for operating power plants that fall under reasonably available control technology (RACT). Alstom has stated in a recent *Financial Times* article that their CO₂ control technology for coal-fired power plants will not be ready until 2015. It is quite possible that even this date is too optimistic, and a generator could claim that this technology is still not commercially available.⁴

Cogeneration as a CO₂ Control Technology

The existing BACT and RACT regulation will also not allow the EPA to force generators to change their fuel supply or their initial technology

⁴ Anna Fifield, “Uncertainty over Emission Targets Hinders Investment,” *Financial Times*, October 24, 2009.

selection in order to reduce CO₂ emission. As a result, a coal-fired power plant could not be required to cofire biomass. In new air permits, the generator proposes its fuel supply. If a generator wants to change its fuel supply, it has to modify its existing permit and conduct additional air modeling studies.

If CO₂ control technology were commercially available and cost, for example, \$100/ton per ton of CO₂ removed, the EPA could mandate that this was BACT/RACT. Generators could then make a cost argument unless the EPA ruled that CO₂ fell under lowest achievable emission reduction (LAER). Under LAER, generators can't argue that a particular technology is too expensive to install. Under both LAER and BACT/RACT, a technology still has to be commercially available. In order to accomplish this, the EPA would have to argue that each region of the United States is nonattainment or exceeds federal standards for CO₂ emissions. This would be difficult for the EPA to do since it has already ruled that CO₂ emissions are a global problem and not a regional one. To regulate CO₂ emissions, the fastest approach continues to be cap and trade or carbon tax regulation.

In the short term, combined heat and power (CHP) or cogeneration power projects will provide a bridge to reducing CO₂ emissions. CHP power plants are located at the site of an industrial steam or process heat user or at a district heating/cooling system and provide the ability to work one fuel twice. A CHP power plant would allow an industrial factory to run its existing boilers on standby since it would produce both steam and power. CHP typically allows an industrial factory to produce power at a lower cost than it can buy from the grid and to produce heat at a lower cost than from its existing boilers. According to the EPA, a typical CHP power plant can have an overall cycle efficiency of 75 percent, while conventional generation has only a 49 percent overall efficiency.

CHP can also be a source of electric power in a congested area where it might not otherwise be possible to site a traditional power plant. Depending on the size of the CHP plant and the amount of steam sold, this can result in a drop in not only CO₂ emission but also NO_x, SO₂, CO, and other criteria air pollutants. A typical CHP power plant employs efficient gas turbine engine technology, which is lower in emission output than the local power plants. The states of New York and New Jersey have realized how CHP can cut air emissions and provide power in critical and/or transmission-constrained locations. As a result, they have been providing financial incentives for the development of CHP power plants. One New Jersey regulator recently stated that CHP projects should be supported since solar power is only 16 percent available and is very expensive.

REALITY OF DEMAND-SIDE MANAGEMENT

Utilities are currently implementing a number of smart grid and energy efficiency or demand-side management programs. These programs include encouraging industrial consumers to shift load to off-peak times and installing smart meters, which provide real-time power pricing and communication with the central office of an electric utility. Programs of this type could help reduce the need to build new power plants and/or reduce the operation of existing power plants. Peaking power plants would be most affected by an increase of demand-side management. Peaking power plants are the highest emitters of air pollution, so this would result in a subsequent reduction in CO₂ and other air pollutants.

The concern is that future demand-side management reduction could be overestimated since industrial customers might not reduce their load when it affects their own customer's requirements. An example would be a hotel not turning down the air conditioning on a hot day when power supplies are tight so as not to upset its guests. Some residents might not be able to live in an apartment building that turns its common-area lighting off when not in use due to religious customs. Since most residential customers pay an average price for power and are not currently exposed to real-time electricity pricing, their bills under a real-time pricing program could actually increase in the future. Consumers would not be willing to have their high-energy-consuming televisions turned off during their favorite program in order to reduce load. Certain industrial customers have a number of different options to shift load to off-peak times. Residential customers can run the dishwasher and do the laundry only in the evening.

Apartment buildings have converted clothes dryers from electric to natural gas. This helps to increase natural gas load during a low-gas-consumption period in the summer and to reduce electric power load during a high-consumption period in the summer. Natural gas dryers have a higher initial cost and are more efficient than electric dryers. This initial cost can be offset by a grant to the apartment building by the local natural gas and electric utility, which both benefit. However, this will not result in a material amount of reduction in load. This situation has made it difficult for smart metering and energy efficiency programs to be approved by public service commissions. Due to legacy liability issues with existing power meters, there is a large cost to switch to smart meters. In most cases, regulated utilities would bear this cost and be required to raise rates to accomplish this.

Unlike large coal, nuclear, and natural gas power projects, wind and solar power projects will not create a large amount of "green collar" jobs. Photovoltaic solar projects that are under development are typically only in the 1- to 2-mW size range and have a very small permanent staff. This

staffing issue is also true for wind turbine power plants. Even the requirement to weatherize and relamp existing buildings will not create a large number of permanent full-time jobs.

SUMMARY

Renewable power plants compete in a world of operating fossil power plants and currently inexpensive natural gas. Despite many governments financial grants, subsidies, and tax incentives, a large number of alternative energy companies have failed over the past 30 years. In the short term, investment opportunities with renewable power will be with financial and operation restructurings of troubled or bankrupt power plants. Longer term, competitively priced battery storage will have to be developed, along with a very high price for CO₂ emissions, in order to support the growth of renewable power. In any event, power investors will want to continue to monitor investing in renewable power in order to avoid the mistake that the old AT&T made by continuing to focus on long distance fixed-line telephone business and ignoring the mobile telephone market.

Chapter 2 describes how to accomplish this task.

