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more than enviro-friendly

renewable energy is also good for the bottom line

EARLIER THIS YEAR, THE Economic Club of Chicago organized a forum titled "Dealing with a Slow Burn: Government, Business and Global Warming." The speakers were Peter Goldmark from the Environmental Defense, a non-for-profit environmental advocacy group, and Paul Tebo from the DuPont Corporation. The speakers warned of the disastrous effects of global warming and its environmental and health consequences. However, two things stood out in the forum. First, the audience consisted of bankers, company executives, financial investors, and even some government officials and not the expected crowd of environmental or green activists. However, both groups share the same passion for the color *GREEN*!

The second item of interest was Tebo's statement that energy conservation and alternative energy technologies are "good for the business bottom line of cutting cost and generating profit." Mr. Tebo explained that during the last decade or so the company was able to cut emissions by more than half and reduce energy consumption while at the same time achieving significant production growth. This energy policy was part of DuPont's commitment to "sustainable growth," which includes ambitious renewable energy and resource targets for 2010. Tebo stressed that this progressive energy policy has delivered well for the company's bottom line.

It is not the purpose of this article to dive in the mix of the global warming debate but rather to point out how renewable energy resources can influence the outcome of this debate. There are three major groups in the global warming debate. First are the Passivists, who do not believe that there is a problem, and if there is one then nature or market forces will correct it. The second group is the Alarmists, who argue that the problem has reached dangerous levels already and that abrupt changes have to take place on the global level now through government mandates before it is too late to act. The third group is the Realists, who recognize the problem but believe that it should be solved through transitional steps to avoid dramatic economical and social consequences that accompany abrupt transitions. The Realists contend that it is too risky to maintain the status quo for carbon emissions and that there is a need for a transition to an emission-free sustainable energy system. The group envisions a decarbonization pathway through efficient utilization of existing fossil fuel resources tending to more reliance on fuels with lower carbon content (i.e., natural gas) and ultimately a complete shift toward renewable energy resources.

In this article, the trends in renewable energy resources will be examined. The review will help to determine whether (or not) renewable energy technologies are ready for mainstream power business and how they can help mitigate the increasing concern of global warming by providing emission-free, environmentally friendly sources of energy.

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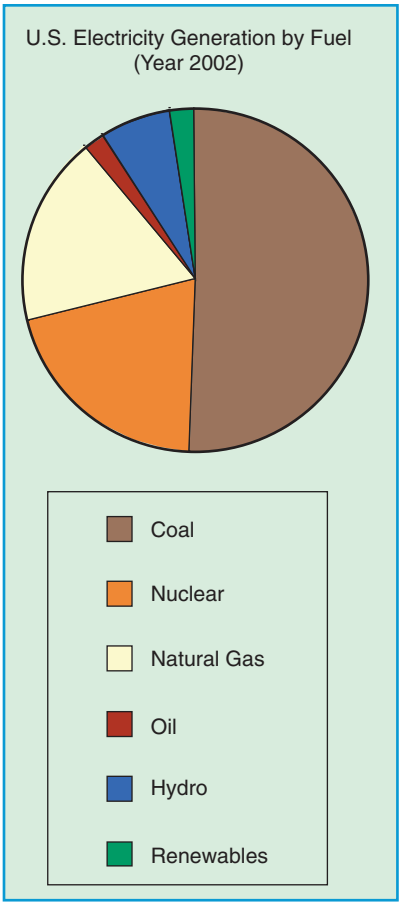

figure 1. U.S. electricity generation by fuel (year 2002).

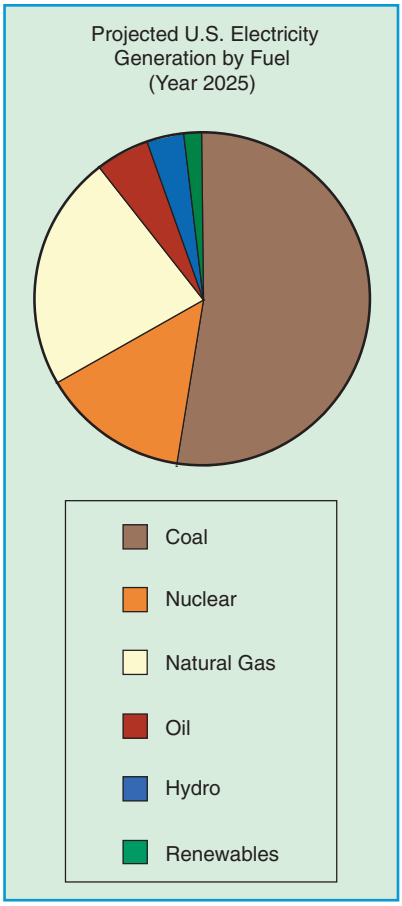

figure 2. Projected U.S. electricity generation by fuel (year 2025).

Government policies and development trends will be presented to evaluate the state of the technology development and market share of renewable energy technologies.

Renewable Energy Is Growing, but ... ?

Currently nearly 98% of the electricity in the United States is generated from nonrenewable resources (52% coal, 20% nuclear, 16% natural gas, and 3% oil) and from hydropower (7%). The remaining 2% is generated from renewable resources (Figure 1). According to the U.S. Department of Energy (DOE) Energy Information Administration projections in Figure 2 (EIA, Annual Energy Outlook 2004, reference-case data), renewable resources will grow but their overall contribution to U.S. electricity supply will drop below its current 2% level to 1.7% in 2025. Moreover, excluding biomass grid-connected generators that use renewable fuels, wind, solar, and geothermal are expected to play a minor role in the U.S. electricity supply between 2001 and 2025 (less than 1% combined, mostly wind energy).

EIA anticipates significant capacity addition to electric generation capacity (nearly 356 GW between 2002–2025) to meet the growing demand for electricity and to replace old plants. Most of these additions for 2010 are already in development, while significant additions are anticipated beyond 2010. As shown in Figure 3, the majority of these projected additions are expected to come from combined-cycle natural gas plants due to their high efficiency (50% and above). Coal will continue to play a significant role with a minimal role for renewable resources. According to EIA, the choice of technology for projected capacity additions is based on the least expensive option available at rates that depend on the current stage of development for each technology. Therefore, EIA estimates assume that the current cost of renewable resources is hindering its potential to play a significant role in the U.S. electricity generation market.

In the following sections, a review of the current state of economics and development trends for the renewable energy industry (mainly wind and solar photovoltaic) will be presented. This review is intended to help evaluate whether a proposed national renewable energy portfolio (REP) is achievable and how it will impact the U.S. economy.

The State of Renewables in the United States

Wind Energy

The increased public awareness of the negative environmental and health consequences resulting from burning fossil fuels in conventional power plants has created much-needed momentum for renewable energy. In 2003 alone, 1,687 MW of wind energy capacity was added, which brought the U.S. cumulative installed wind energy capacity to 6,370 MW. Renewable energy advocates have touted that the increased capacity of wind energy farms in the past few years has led to demand reduction for natural gas and brought new jobs and tax revenues to cash-strapped states. The improved economics of wind energy have made it more competitive with conventional sources for both capital and generated electricity costs. These improvements were achieved through technological innovations (i.e. turbine size, efficiency, and improved electronics), favorable geographical siting, and by locating wind turbines in large wind farms. In contrasts with EIA projections, the American Wind Energy Association (AWEA) projects that with an 18% annual growth, wind energy will be able to provide 6% of the U.S. electricity demand by the year 2020. However, the wind

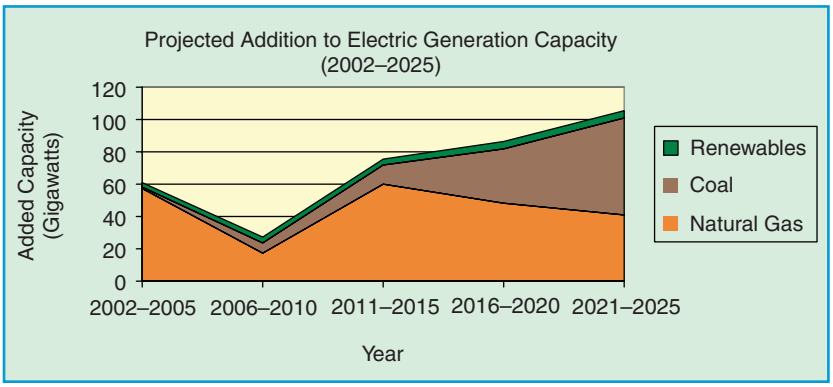

figure 3. Projected addition to electric generation capacity (2002–2025).

energy industry still relies on government subsidies in the form of the production tax credit (PTC), which has proven to be vital to the survival of the industry. Before the tax credit expired in December 2003, AWEA warned that:

> the wind industry's future beyond year's end will be strongly influenced by whether Congress extends the wind production tax credit (PTC).

The proposed FY 2005 U.S. DOE budget, which was released recently, included several energy-related tax incentives through year 2009 including the renewal of the PTC for electricity produced from renewable energy sources such as wind and biomass. If passed by Congress, these measures will have a positive impact on the development of the U.S. wind energy industry and should allow the industry to continue its current record annual growth through the year 2009.

Solar Energy

The U.S. photovoltaic (PV) industry has shown 20–30% annual growth rates in the past few years. Most of the PV production in the United States was shipped to supply growing demand in Europe and Japan. In year 2002, only 40 MW of the 120 MW produced by U.S. PV companies was installed locally while the rest was shipped overseas. New PV applications in the United States involved various market sectors (i.e. off-grid, centralized, and distributed grid-connected). The U.S. cumulative installed PV capacity just surpassed 200 MW in 2002, which is a very small portion (~0.02%) of the cumulative U.S. power capacity. The U.S. cumulative installed PV capacity is still small even when compared to other renewable energy resources such as wind energy (which has near 6,370 MW cumulative installed capacity). However, many in the renewable energy industry expect the U.S. PV industry to continue with record annual growth and to be able to provide gigawatt levels of capacity additions to the U.S. power capacity by 2020. By then, 15 GW cumulative installed PV capacity is projected.

Most of the growth in the U.S. PV installed capacity in the past few years was driven by significant subsidies through grants and other tax credits for renewable energy set-asides by some utilities and through state mandates. Such subsidies, which account for the majority (>70% in many states) of the real PV installed cost, have encouraged large-scale installations in local governments and municipalities. The purpose of these programs and initiatives is to provide a market to increase the PV production volume in order to bring the cost down. However, since 1992 the cost of PV modules has not dropped significantly. For example, according to some studies, estimated single and multicrystalline silicon module prices (FOB factory) dropped by nearly 25% between 1992 to 2002. In addition, even with the significant cost and performance improvements of balance-of-system equipment (i.e., inverters, charge controllers and electronics), the installed grid-connected PV cost is still above $10,000/kWp for systems of 10 kW size and above. Therefore, contrast to coal and gas, which cost hundreds of dollars per kW, and wind, which costs around $1,000/kW, PV capital cost is still out of reach for the mainstream power market. The PV industry has to overcome this barrier before it can play a significant role in the U.S. power industry. In addition, until the PV cost is more competitive, the PV industry should focus on important niche market opportunities such as building integrated photovoltaic (BIPV) architecture and remote applications.

Biomass

According to U.S. DOE, electricity generation from biomass accounts for the largest source of nonhydroelectric renewable generation. U.S. DOE forecasts that biomass including combined heat and power systems and biomass cofiring in coal-fired power plants (i.e., switch grass) will continue its dominant role of electricity generation and electric capacity addition among renewable sources through 2025. Electricity generation from biomass is mainly from landfill gas and is mostly driven by the need for waste management and for compliance with environmental regulations. However, biomass cofiring in coal-fired plants is still questionable and may prove inefficient in the long run.

Bringing Renewables to Mainstream U.S. Power Industry

For many years, renewable energy advocates have relentlessly argued that renewable energy has tremendous environmental benefits and can provide a solution to the global warming problem. In addition to and with the ongoing security concerns in the United States and the troubles in the Middle East, it is becoming clear that the United States needs a comprehensive energy policy that is based on self-reliance

with a significant role for renewable resources to ensure national energy security. However, in spite of their environmental appeal and security role, it is clear that both arguments (environment and energy security) were not enough to spur drastic changes in the forecast for renewable energy's role in future energy policies in the United States. As discussed in the previous section, the cost of renewable energy resources is still high compared with conventional energy systems. The cost of renewable energy technologies has to come down significantly before they can play any significant role in the future of the U.S. power industry.

The majority of the recent capacity additions to the power industry were natural gas power plants due to its high efficiency and cost competitiveness. However, as has been demonstrated in the past few years, the heavy reliance on natural gas for electricity generation without a concurrent expansion in its infrastructure has inflated its cost significantly. As a mean of offsetting the expected increase of natural gas prices and avoiding the risk of price volatility due to its rapid increase in usage, the U.S. DOE proposed among other measures the increase of electricity generation from coal-fired plants. The falling prices of coal and the abundance of the coal supply in the United States have strengthened this case. However, until the environmental issues that are associated with burning coal and the handling of CO_2 emissions are resolved, coal will remain a nonsustainable source of electricity.

An alternative approach would be to continue the use of a least-cost strategy to improve energy efficiency and minimize pollution without relying on exhaustible primary energy sources; in the other words, follow the decarbonization pathway. The recent expansion of natural gas power plants is consistent with this pathway and should continue depending on natural gas pricing and availability. Coal will still play a major role in fueling existing and under-development coal-fired plants. Ultimately, clean coal technologies can be utilized to generate low-carbon content fuels and eventually to generate hydrogen to fuel a sustainable U.S. economy.

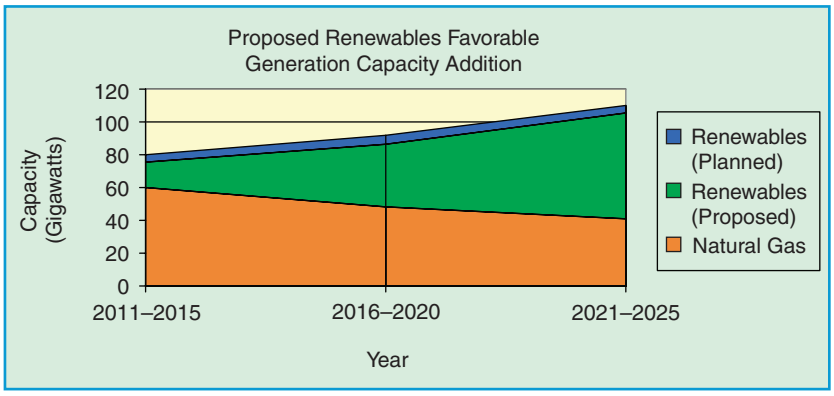

figure 4. Proposed renewables for favorable generation capacity addition.

Long-term growth of renewable energy sources should be market driven by providing an alternative clean energy source for consumers and through aggressive technical and market development.

It will take major initiatives and change from the current "business-as-usual" attitude of electric utilities and government policies for renewable energy sources to realize their potential as a major player in the U.S. electricity supply with 10–50% contribution in the coming 10–50 years. Several proposals and studies have emphasized the need for a government mandate for a national renewable electricity standard (RES) or national renewable energy portfolio (REP). These proposals argue that such renewable standards could stimulate growth of the renewable energy industry and lead to significant environmental and economical benefits while at the same time improve the U.S. energy security and lessen dependence on foreign energy sources. Recent studies by EIA concluded that a 10% RES by 2020 will have no impact on electricity prices and could save energy consumers billions of dollars by reducing demands for fossil fuels and creating new competitors for the conventional power industry. This optimism does not even embrace other positives such as the environmental benefits of fossil fuel avoidance. On the other hand, many in the power industry argue that within the next 50 years renewable energy will not be cost competitive and with its current state of development cannot meet the expected growth in electricity demand for a robust U.S. economy.

In Figure 4 a renewable energy favorable scenario for electric generation capacity addition in the United States is presented for illustration. The U.S. DOE projections for the period 2010–2025 (see Figure 3) were revised by replacing the estimated 105 GW additions of new coal-fired capacity with renewable resources additions. Of course, the proposed scenario can be realized only if the U.S. government and power industry agree to move boldly toward renewable resources from year 2010 and beyond. Such a move can be achieved only through immediate rapid increase in renewable

energy technology development and funding from both public and private sectors. A transition to renewable resources will offset the negative impact of the price volatility of natural gas due to the escalated demand to fuel gas-powered plants, which peaked in the past few years and is projected to continue its strong expansions. In addition, peak production for renewable resources, such as PV, coincides with peak load demand (i.e., peak shaving), which can reduce the need for additional investment in new power plants and transmission lines.

Concluding Remarks

The U.S. power industry can no longer rely only on cost and availability in planning the future of electricity generation. Global warming and environmental concerns of increased carbon and other emissions are becoming increasingly apparent. In addition, with the current security concerns there is a need for a national energy policy that is free from reliance on imported energy sources. Renewable resources are environmentally benign, generated locally, and can play a significant role in fueling a thriving U.S. economy with sustainable energy sources that take into account both the social and economic well being of citizens. However, the burden is still on the renewable energy industry to continue to demonstrate that it can grow at a rapid pace that will allow it to meet the increasing demand for electricity in a cost-effective way. It would be a grave mistake on the renewable industry's part to continue to rely on government subsidies. Long-term growth of renewable energy sources should be market-driven by providing an alternative clean energy source for consumers and through aggressive technical and market development, which will result in more revenue and job creation in the United States. Adopting innovative marketing to tap into green and emission trading markets could further stimulate growth.

For Further Reading

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Biography

Said Al-Hallaj is a research associate professor at the Chemical and Environmental Engineering Department and coordinator for renewable energy programs at the Illinois Institute of Technologies in Chicago, Illinois. Prof. Al-Hallaj earned his B.Sc. and M.Sc. in chemical engineering from Jordan University of Science and Technology in 1994 and a Ph.D in chemical engineering from IIT in 1999. Prof. Al-Hallaj has published over 20 papers in the area of energy storage and conversion with emphasis on renewable energy, batteries, and fuel cells for stationary and transportation applications.