B L A C K & V E A T C H

International Renewables Review

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A Closer Look at Renewable Energy Capacity Factors

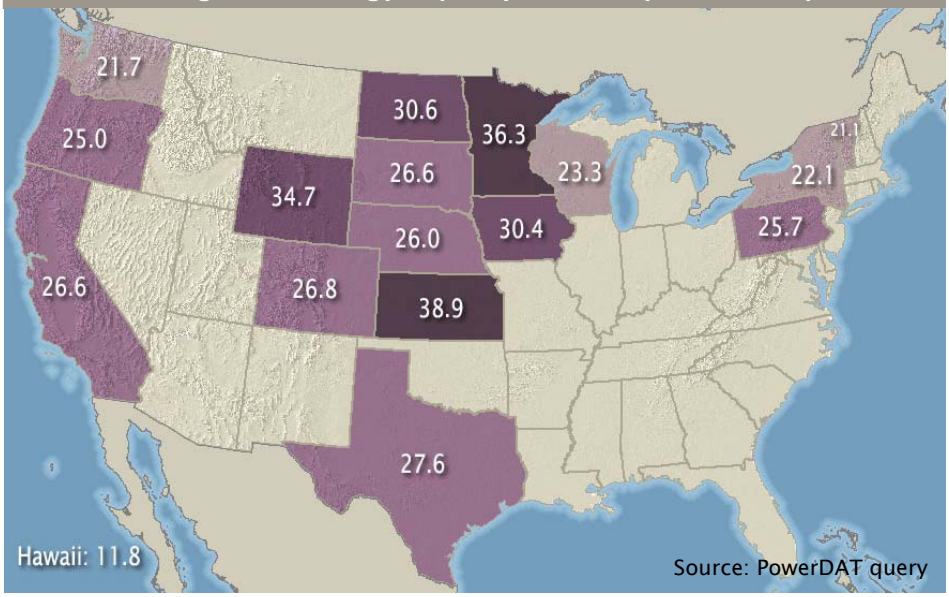
Capacity factor is a critical variable to assess when evaluating new renewable energy projects. A project's capacity factor provides a measure of average output versus its nameplate rating. Formally, it is defined as the ratio of the electricity produced by a generating unit for a period of time compared to the electricity that could have been produced at continuous full-power operation during the same period.

Intermittency is commonly listed as a drawback of renewable energy. However, biomass, geothermal and hydro power generally provide dependable capacity. Solar plant output typically correlates well with peak demand and is fairly predictable. In addition, researchers are making progress on developing reliable wind forecasts. Predictability is important to utility dispatchers planning how to meet the day's capacity needs. Ability to generate during peak hours is important because this is the highest value energy.

Next to capital cost, capacity factor is the largest determinant of renewable energy power cost. Everything else being equal, a wind project with a capital cost of $1,200/kW operating at 30 percent capacity factor would have about the same levelized power cost as a geothermal project costing $3,600/kW operating at 90 percent capacity factor. Clearly, it is vital to initially site projects to maximize capacity factor and to maintain projects at high availability once they are operating.

Capacity factor is influenced by a number of elements, including resource quality (e.g., solar radiation), technology design (e.g., wind turbine swept area), economic dispatch (e.g., cycling biomass plants daily), and availability. Increasingly, transmission congestion has also limited the capacity factor of some wind projects, particularly in Texas. The average wind capacity factor of various states in the United States is shown below.

2002 Average Wind Energy Capacity Factors by U.S. State, percent



see Renewable Capacity Factors, page 2

Renewable Capacity Factors (continued)

The recently published *Renewable Energy Annual 2002* from the U.S. Department of Energy (DOE) Energy Information Administration (EIA) provides a wealth of interesting insights on capacity factors, including the following observations and the charted capacity factor trends:

Biomass. As primarily a baseload resource, biomass consistently has one of the highest capacity factors, averaging around 68 percent. This is similar to the average coal plant capacity factor in the United States.

Geothermal. Geothermal capacity factors are also relatively high, although not as high as often quoted (90-plus percent). The majority of U.S. geothermal capacity is at The Geysers, north of San Francisco. Due to overdevelopment, the field has experienced declining geothermal fluid production for a number of years, resulting in reduced average capacity factors. Another factor that limits geothermal output is the requirement for dry cooling systems for many new plants, particularly in arid climates. The performance of air-cooled geothermal plants is highly dependent on the ambient air temperature, with plant performance dropping considerably (25 percent or more) in the summer compared to winter.

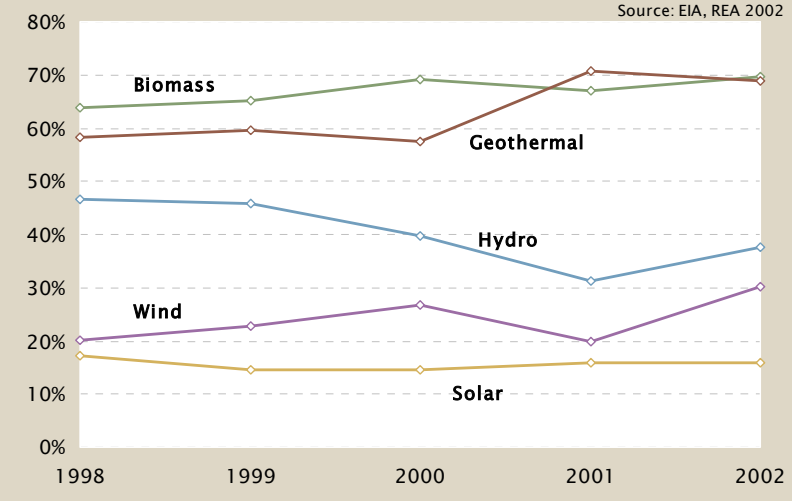
Hydro. Hydro exhibits the largest annual variability among renewables, with the average capacity factor dropping from 46 percent to 31 percent from 1999 to 2001. This decrease is largely attributed to drought conditions in the West.

Wind. Average annual wind capacity factor has risen from 20 percent in 1998 to 30 percent in 2002. In the same timeframe, wind installations more than doubled, from 1,700 MW to nearly 4,000 MW. The increased capacity factor is primarily the result of better siting of projects in new markets such as Texas and Kansas, as well as increased turbine performance and availability. There was an "off-year" in 2001 where the average capacity factor dropped substantially from the trend. The reason for this was large number of projects that were installed near the end of 2001 to meet the production tax credit deadline. Although their capacity was counted in 2001, only a small amount of energy was generated from these projects in 2001. This same partial-year reporting exists for other years, but to a lesser extent.

Solar. Solar has the lowest capacity factor, averaging 16 percent. The majority of data collected by the EIA is from the nine Solar Electric Generating Stations in California. These plants burn a substantial amount of natural gas to firm their capacity up to about 25 percent, and the data does not include the electricity produced by natural gas. Black & Veatch notes that solar thermal systems with storage can achieve higher capacity factors at higher capital costs.

For more information, please contact Ryan Pletka at 913-458-8222 or pletkarj@bv.com.

Annual U.S. Renewable Energy Capacity Factors, percent



See Us at These Upcoming Tradeshows

- PowerGen Renewable Energy, March 1–3, Las Vegas
- Oceanology International, March 16–19, London
- Global Windpower, March 28–31, Chicago
- Electric Power, March 30–April 1, Baltimore

While U.S. Policy Falters, U.K. Moves Forward

The United States and the United Kingdom may have congruent policies in some areas, but a large gap appears to be growing with renewable energy. Federal renewable energy policy in the United States appears to be at a standstill. The House of Representatives and the Senate were unable to agree on terms of a Conference Energy Bill (CEB) at the end of 2003. Major concerns were the exemption of the gasoline additive methyl tertiary-butyl ether (MTBE) from product liability lawsuits and the overall cost of the bill, projected to be over $30 billion. Failure to enact the bill before the end of 2003 resulted in expiration of the production tax credit subsidy for wind.

Attempts are being made to salvage the CEB, particularly in the Senate, where a slimmer $14 billion version of the bill has been introduced that eliminates the MTBE exemptions. Important changes to the Section 45 tax credit portion of the bill include elimination of annual tax credit inflation adjustments, no Alternative Minimum Tax relief, and removal of tax credits for landfill gas. Even with the changes, hope for the new bill is not high. House leaders are reportedly opposed to the new version, saying they had already passed the energy bill last year and will not negotiate further.

New Black & Veatch Renewable Energy Projects

- Study for seven new biomass plants in the United Kingdom
- Renewable Portfolio Standards (RPS) compliance planning for Los Angeles
- Due diligence review of planned Midwest wind project
- Energy storage (ultracapacitor) renewable energy microgrid demonstration project
- Cost engineering and performance analysis of two wave

The EIA recently released an analysis of the original provisions of the CEB entitled *Summary Impacts of Modeled Provisions of the 2003 Conference Energy Bill.* The results are summarized in the chart below. Notably, the EIA is projecting strong growth for renewable energy technologies even in the absence of the CEB. This is largely due to strong state policies already in place. In fact, the projected impacts of the CEB are relatively modest, with the following two exceptions:

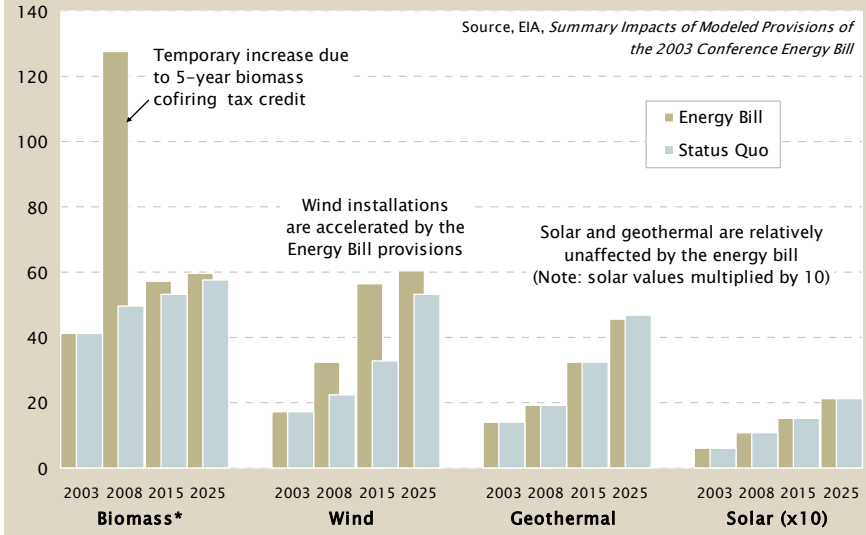
- Biomass cofiring with coal surges due to the new 1.2 cent/kWh tax credit. The credit would make many biomass resources competitive with coal. However, after the temporary 5-year credit period expires, cofiring is expected to return to lower levels. A similar phenomenon is occurring in the United Kingdom in response to restrictive schedule rules on cofiring eligibility.

- Wind energy growth is substantially accelerated. By the end of the forecast period (2025), growth is expected to taper off, with annual generation levels similar to the reference case.

Meanwhile, there have been two recent announcements of changes to the U.K.'s Renewable Obligation (RO) that refine rules and promote the country's booming renewable energy industry. The major change is that the percentage of renewable electricity required under the RO has been increased from its current target of 10.4 percent in 2010-11 to 15.4 percent in 2015-16. Because it provides certainty to the renewable energy credit market, the extension is expected to have a major effect on the bankability of the large number of renewable projects in the pipeline. The second series of changes is to technology eligibility rules and other technical aspects of the operation of the RO. The main impact is that the eligibility of cofiring has been extended from 2011 to 2016, but the cap on the total quantity that can be met by cofiring has been reduced to 10 percent after 2006, and to 5 percent after 2011. Biomass cofiring is currently providing a large number of renewable energy credits to the U.K. market.

For more information, please contact Ryan Pletka at 913-458-8222 or pletkarj@bv.com.

Projected Energy Bill Impacts on U.S. Electricity Generation, TWh



*Includes dedicated biomass plants, biomass cofiring and municipal solid waste.

Dr. Peter Mason, Hydropower Expert

In this issue, we introduce Dr. Peter Mason, divisional director of Central Asia and Hydropower, located in Black & Veatch's Redhill, U.K. office. In a career spanning more than 30 years, Dr. Mason has worked extensively on dams, hydropower stations, canals, tunnels, and associated works from concept through detailed design stages. He is recognized as an international expert on dams, applied hydraulics, structural analyses, concrete technology, and surface and underground power stations.

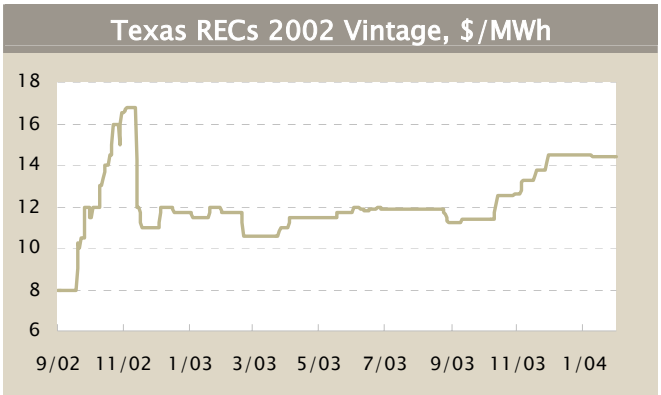
Key projects for Dr. Mason include the recent completion of the $2.2 billion Ghazi Barotha hydro project in Pakistan. Dr. Mason was a Board of Management member responsible for the 1,450 MW hydro project and for development of 115,000 hectares of irrigation. The project features over 350 km of major canals.

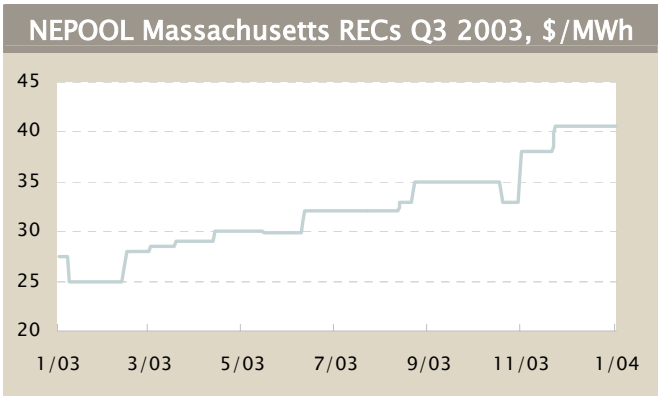
Dr. Mason's work has taken him around the globe to over 30 countries. Projects have ranged in size from massive public works such as the Ghazi Barotha project to studies assessing the potential for small hydro resources in Cameroon.

To contact Peter Mason call +44 1737 856 324 or email masonp@bv.com.

Renewable Energy Credit Market Price Report

The renewable energy credit (REC) market has recently emerged as a method to financially support renewable energy. RECs represent the environmental attributes of renewable energy. RECs can be purchased and sold separately from the commodity electricity produced by renewable energy power plants. RECs are a tradable instrument used to satisfy compliance requirements for RPS programs in some states. In our Fall 2003 International Renewables Review, we discussed REC market offers by technology and by region. In this issue we present REC data for two states, Texas and Massachusetts, which have the most active compliance markets. RECs over a 12-to-15-month period are shown below (based on data from Evolution Markets).





Charts based on February 2004 data from Evolution Markets (www.evomarkets.com). Used with permission.

Black & Veatch Teams with Wind Specialists

Wind power is one of the fastest growing renewable energy technologies. Many utilities have or are exploring adding wind power to their resource mix. Recognizing the importance of wind, Black & Veatch has developed tools and alliances for providing wind power services to our clients.

One of wind power's most critical requirements is a site's wind resource. It is not sufficient to specify that a site has a "good" resource, nor is an annual average wind speed enough to evaluate a potential or existing project. Black & Veatch, while possessing strong internal capabilities in assessing wind resources, has recognized that resources for some projects can be better addressed by industry specialists. Therefore, we are developing alliances to offer clients enhanced wind energy services.

Black & Veatch has entered an agreement with Windots LLC to perform wind resource analyses as part of our independent engineering services for wind projects. Windots, lead by principal Rich Simon, will supplement Black & Veatch's wind resource evaluations and production estimates. Such analysis will be combined with Black & Veatch's technical evaluations of project designs, contracts, permitting, and other attributes in a comprehensive independent report for developers, lenders or investors.

Black & Veatch recognizes that while having data collected on-site is critical to determine a site's wind power potential, collecting data over many years is not always practical. Knowing the long-term wind resource allows developers and utilities to better manage a project's risk. To address this need, Black & Veatch has partnered with WindLogics for projects in Europe. The power of WindLogic's atmospheric modeling and long-term weather data, combined with Black & Veatch's technical, environmental and commercial experience yields a unique suite of services for developers, utilities and investors. Black & Veatch and WindLogics are exploring a similar arrangement for the United States.

For more information, please contact Ryan Jacobson at 913-458-8775 or jacobsonr@bv.com.

About Black & Veatch

Black & Veatch Corporation is a leading global engineering, consulting and construction company specializing in infrastructure development in the fields of energy, water and information. Founded in 1915, Black & Veatch serves its clients with conceptual and preliminary engineering services, engineering design, procurement, construction, financial management, asset management, information technology, environmental, security design and consulting, and management consulting services.

All Sources All Services All Over the World

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For more information, please contact us at:
phone: 877-355-7100, email: renewable@bv.com, web: www.bv.com