THE WIND ENERGY FRONTIER

Urban Retail Markets

Urban markets first require wind turbine technology that is compatible with limited spaces on rooftops and small real estate footprints. More importantly, to become viable in urban retail markets, wind energy must be available on demand, not merely when the wind blows, in order to provide the maximum economic benefit to the end user. Fortunately, at this smaller scale, the possibility of power storage becomes economically feasible. Gary Westerholm, McKenzie Bay International Ltd, USA describes an urban wind energy generation, storage & distribution system that is showing promise in the USA.

Many have searched unsuccessfully for years to find wind energy's "Holy Grail": an economic means to store wind energy for distribution on demand. Over the years, wind technologies diverged into two distinct market segments; traditional wind farms employing multiple, megawatt-sized wind turbines generating electricity for sale to utility companies and other resellers, and smaller turbines producing electricity for rural homes or other special end uses. Almost entirely overlooked has been the market for onsite wind generation for urban retail electric users. Entry into this market segment has been impaired primarily by technology constraints, but if those can be overcome, it offers much more attractive economics than the wholesale business.

Figure 1: An artist's impression of the WindStor system on top of a building

Urban markets

Most commercial electric customers in the USA - industrial facilities, large offices and apartment buildings - purchase electricity under time-differentiated utility tariffs that feature off-peak (occasionally mid-peak) and peak kWh energy rates plus demand charges that are always several dollars per kW - more than $24.00 per kW in places like New York City. Demand charges are typically based on the customer's highest kW demand during the utility's coincident weekday peak period during the month. In some regions utilities are permitted to repeat this highest demand charge every month for up to a year, even if the customer's peak period demand drops in subsequent months. When these demand charges are factored in to peak period energy charges, the effective fully loaded peak period kWh rates are multiples of off-peak kWh rates. It is not unusual to find that these fully loaded peak energy charges are US$0.30/kWh to US$1.00/kWh! The commercial customer's peak period energy usage substantially exceeds his average usage, and this excess, typically 15.0% to 25.0% of his total usage, represents an excellent load-leveling/peak-shaving opportunity. An urban compatible, rooftop or ground mounted, wind turbine capable of generating this energy, combined with a storage and distribution system to assist in providing power on demand, can seize this new wind energy frontier.

Scope of urban "rooftop" markets

A review of published U.S. government data concerning high-rise office and apartment buildings revealed that millions of buildings in the USA are capable of supporting one or more wind turbines on their roofs. Although data from outside the USA has not been examined, it seems likely that this new wind energy market could also extend to other developed urban environments worldwide.

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The market scope for retail wind energy is much broader than merely load-leveling and peak-shaving installations for high-rise apartments and office buildings. Urban retail energy markets could include installations similar to off-grid and remote access applications, where more than 50% of energy requirements could be supplied by wind. Virtually all large commercial and industrial customers in the USA, including schools, manufacturing, other industrial processing facilities, grocery stores, hospitals, prisons, municipal facilities, and many others could be users, representing a vast market for onsite generated wind energy.

Regulatory constraints

In addition to technology constraints, the urban wind market is in many places constrained by regulatory barriers to entry. Each state in the USA regulates the installation of electric generating facilities, and regulates the sale of electric power to end users at retail, in accordance with individual state laws that can vary widely.

Under the Public Utility Regulatory Policies Act of 1978 ("PURPA") and the regulations of the Federal Energy Regulatory Commission ("FERC") implementing PURPA, a wind-powered generating facility with a generating capacity less than 30 MW, including all such facilities owned or operated by the same person within one mile of each other is deemed to be a Qualifying Small Power Production Facility ("QF"). A QF and its customers have certain rights under FERC regulations including the right to require an electric utility to interconnect it with the utility's electric system. The states are not required to permit QFs to sell power to end users at retail, but if it does permit such sales, a QF is exempt under PURPA from state laws which otherwise regulate the ownership, rates and terms of sales, corporate governance, and financing of electric utilities. McKenzie Bay formed wholly owned subsidiary WindStor Power Company to own WindStor installations and sell electricity. WindStor's ownership and operating template is structured to secure QF status for all of the elements that WindStor Power Co. may own and operate.

The first issue in any state will be whether a Certificate of Public Convenience and Necessity ("CPCN") is required to be obtained from the regulatory agency before construction may begin. In most states, a CPCN is not required for the construction and operation of small-scale generating facilities. Municipal zoning regulation and height restrictions, however, also represent a potential constraint, as does the application of particular environmental impact regulations and/or height restrictions imposed by the FAA. Approximately twenty states have restructured their electric utility regulatory regimes to permit relatively unrestricted sales of power to end-users by non-utility generators. In a number of others, existing state law and regulation may be interpreted to permit such sales through one or more contractual structures. State regulatory authorities determine what physical interconnection requirements a utility may impose on a customer who wishes to install self-generation in parallel with the utility's grid. A few states, such as New York, have published standardized interconnection requirements for small-scale generators.

Technology constraints

Wind turbine, storage (battery) and system integration technology constraints must be overcome before wind energy can become viable in urban retail markets. Large (MW class) horizontal axis wind turbines are not well suited for building rooftops due to the amount of space required for operation and performance complications from turbulence caused by deflecting winds around buildings. Small (<50 kW) vertical or horizontal axis turbines do not generate sufficient energy to be cost effective. An improved vertical axis turbine in sizes ranging from 100 kW to 500 kW is the right solution for urban locations, as limited space, wind direction, and turbulence are non-issues for these omni-directional turbines. To be effective in urban applications, a battery storage system must have the ability to be charged and discharged hundreds of thousands of times without developing memory characteristics. It must recharge easily and discharge in a manner similar to a capacitor yet perform like a battery. It must operate at ambient building temperatures without cooling or special environmental consideration, contain no liquids that are hazardous, and not emit gases or have explosive tendencies. New battery technologies entering the market today exhibit these characteristics and capabilities. A system integration technology did

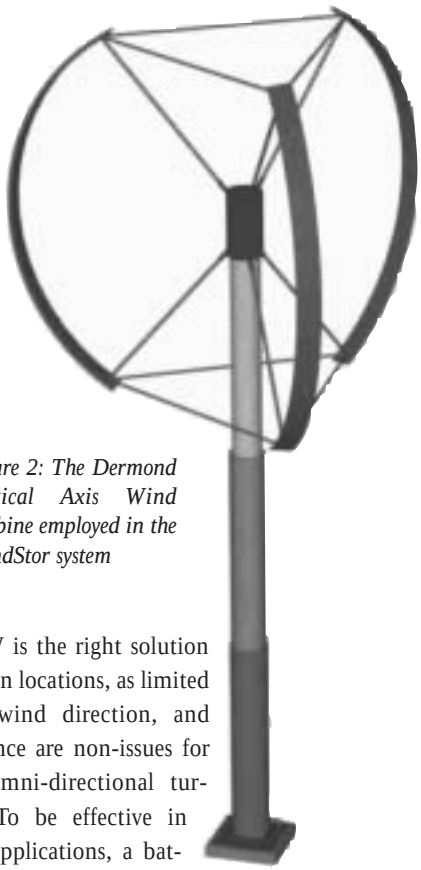

Figure 2: The Dermond Vertical Axis Wind Turbine employed in the WindStor system

Table 1: Key features of the Valence lithium battery that meet the criteria for urban retail energy markets

Operating Advantages

- High performance, low cost
- Environmentally friendly
- Highly efficient, no memory effect

Safety

- No hydrogen monitoring
- Low operating temperature
- Not pressurized

Unmatched Versatility

- Flexible form & sizing - 100 kWh is ~ one cubic yard
- Low volume and weight - 100 kWh is ~ 2,800 pounds
- Rack mountable

Superior Performance

- Capable of thousands of cycles ~ 10-15 years
- Fast recharge time
- Smart battery monitoring

not exist until WindStor, and must be developed by anyone wishing to enter this market. Market penetration is severely limited without this device.

Solution for urban markets

WindStor[SM] is an electricity management system designed to provide retail users with electricity at fixed, long-term, rates by generating electricity at the user's location with a Dermond Wind Turbine "DWT[SM]" and storing excess electricity in a battery for distribution in peak demand periods with a proprietary "System Integrator." When McKenzie Bay acquired Dermond just over two years ago, it was seeking to create a wind energy generation, storage and distribution system to pursue off-grid and remote access locations inside the Arctic Circle. After the question was asked "Why don't you put these on buildings?", a review of the criteria necessary for entry into urban retail energy markets revealed that WindStor is designed to meet or exceed all of the necessary technology requirements for entry into this new market (Figure 1).

VAWT technology

In 1988, a collaborative project between industry, government and utility, Hydro-Quebec, in Canada, engineered, built and evaluated Eole, a 4-megawatt (MW) vertical axis Darrieus-type wind turbine. Eole was (and still holds certain records as) the largest, longest running, most reliable wind turbine of either a horizontal or vertical configuration. During their tenure with Eole, three Dermond professionals envisioned several operational improvements that could greatly improve the Darrieus turbine's performance, while reducing capital and maintenance costs. These improvements (forty of which are patent pending) along with omni-directional capabilities to function in wind turbulence make the Dermond Wind Turbine ideally suited for building rooftop installations. (Figure 2)

Features and advantages that are believed to make Dermond Wind Turbines ideally suited for urban retail markets include: Urban rooftop or ground level mast installation capability; Omni-directional for optimal wind efficiency; Simple, durable, design; Minimal maintenance; Multiple blade attachments maximize safety; Optional guy-wired mast for additional stability & safety; Designed to withstand +135 mph winds; Lower operating noise compared to horizontal axis turbines; Turbine size: From 100 kW; Sensor controls to avoid harmonic and vibration zones; and Lightweight - 200 kW unit weight is ~ 10,000 pounds

New battery technologies

Valence Technology Inc (NASDAQ:VLNC) has developed lithium battery technologies that meet the criteria for urban retail energy markets. Other battery technologies being developed that may also be suitable include a Vanadium Redox Battery by Sumitomo Electric Industries and separate lithium-vanadium batteries by Kerr-McGee/Hydro Quebec joint venture Avestor and by Ener1. Other battery technologies will need to mimic the Valence battery features to be suitable for urban retail markets (Table 1).

System integration technology

Dermond engaged Envitech Inc to develop a unique system integration device for its off-grid electricity management system. Development has advanced swiftly and planning for commercial production in late 2004 has begun. This "proprietary" system integrator has been designed to perform the following functions necessary for renewable energy systems to be cost competitive in energy markets (Figure 3):

- Automatically selects and distributes the least expensive power to the user
- Manages multiple DC power inputs received from multiple DWTs plus a battery and/or other sources, to a single AC power connection for distribution
- Manages the quality of power delivered to user at the AC connection point
- Manages power production from the individual energy sources via remote and/or wired communication links
- Sends instructions to individual Turbine Controllers for Set Power or Maximum Power Mode of each DWT to match user demand
- Sets and manages a safe reserve of available power to maintain electricity stability for the user when sudden load changes occur
- Simultaneously performs data acquisition and transmission to a communication centre

"Compelling" marketing strategy

Merely having the best combination of wind, storage and distribution technologies is not sufficient to capture this great new market for wind energy. Selling electricity under long-term, fixed rate contracts directly to the end user provides the most compelling win-win proposition for WindStor systems. While the retail market provides the opportunity for faster payback on WindStor Power Co.'s investment, the user assumes no operating or capital risk, realizes an immediate benefit the first day WindStor is turned on, enjoys a hedge against future rate hikes, and augments his own capabilities with a quasi-uninterruptible power supply for the entire facility as a bonus.

Quasi-uninterruptible power supply

WindStor is expected to function as a virtual uninterruptible power supply source because the system will have a battery that is capable of supplying energy to the entire facility for any desired duration. If WindStor performs as it is expected with a properly configured battery, users will be able to enjoy an orderly shutdown of their entire facility and not have people stranded on upper floors and elevators in office buildings during extended blackouts. Premiums for business interruption insurance have risen to such high levels that many industries can no longer afford coverage for outages less than twenty-four hours in duration. The vast majority of outages are only a few seconds to a few minutes in duration but long enough to impose million-dollar costs in some operational sensitive facilities. WindStor users will not be charged separately for this added feature, a potential operational cost reduction bonus for users.

How best to market?

Prior to engaging the first sales agent, WindStor Power Co. decided that the best approach to market WindStor in the early adopter phase was to utilize the existing capacity of local businesses that are already in the energy business in some fashion. Rather than try to build an internal sales force, it is much more effective for these businesses to reach out to their business customers.

Numerous small business owners from all over the USA, who market various energy related products to building owners and businesses, have expressed a desire to become WindStor sales agents. As of this writing, sixteen sales agents across the USA have been engaged. Two agents have their own sales representatives in several states.

Building a development team

When first contemplating entry into off-grid markets some time ago, WindStor Power Co. planned a gradual, ramp-up in production requiring limited component quantities from a host of smaller providers. As the number of interested customers kept increasing, however, WindStor Power Co. realized that a very large market was at hand, creating a pressing need to form a WindStor Team that would enable as faster rollout to meet this demand head on.

A team of extremely well qualified, high profile, strategic partners was required that would enable WindStor Power Co. to tackle any foreseeable opportunity or issue at any installation location. Integration of the breadth of expertise and depth of experience of team members and their commitment to renewable energy make the team uniquely qualified to lead WindStor and DWTs to this new wind energy frontier. Team members include large, multi-faceted, international companies, a host of smaller companies with industry specific expertise and experience, and governmental agencies. Members include Siemens Westinghouse (NYSE:SI), ABB (NYSE:ABB), Marsh McLennan (NYSE:MMC), Carter & Burgess Inc., Sumitomo Drive Technologies Inc, Valence Technology Inc. (NASDAQ:VLNC), and many others.

Progress update

Construction of the first ground mounted WindStor installation is underway in Rouyn-Noranda, Quebec, Canada and at the time of writing was expected to be completed in July 2004. The first rooftop mounted WindStor installation is planned for September 2004 at a Department of Energy Laboratory. Both will be demonstration installations. Eight commercial installations are being scheduled for November and December 2004 with rapid escalation thereafter. As of June, 2004, potential urban WindStor installations requiring more than one thousand DWTs were at various stages in the development pipeline in Michigan, New York, Nevada, California, Texas, Hawaii, Pennsylvania, Connecticut, New Mexico and New Jersey. Each is subject to confirmation of suitable wind for an economic installation that would result in a cost reduction for the customer. Inquiries are continually being received from all over the world.

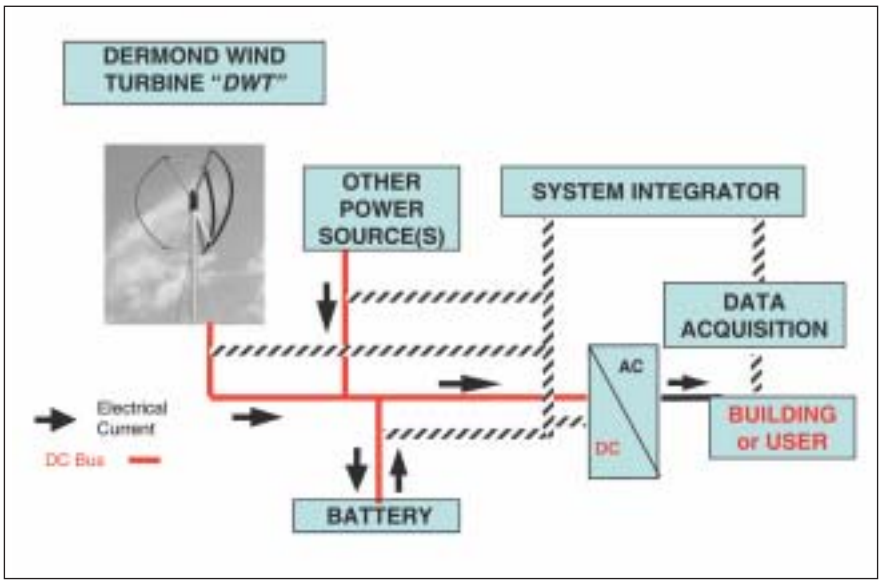

Figure 3: WindStor functional diagram outlining the system's architecture

Freedom Tower

In December, 2003, Silverstein Properties, Inc announced their intent to install a "Vertical Wind Farm" in the upper section of the proposed 1776-foot tall Freedom Tower, which will be the first building erected on the site of the former World Trade Center. This vision for a Vertical Wind Farm has spawned new concepts and ideas for even greater market possibilities. When installed, no greater statement could be made for establishment of the new wind energy frontier. The WindStor Team is currently participating in the bidding process being conducted to become the preferred contractor for this great project.

Other features

WindStor's ability to perform peak-shaving (load-leveling) will help solve several issues for utilities such as: Reduce spinning reserve requirements during peak periods; Reduce operating time for older, less efficient, "peaker" plants resulting in lower operating costs; Reducing emissions from peaker plants; Minimize the need to buy electricity from expensive, external sources; and Reduce need for additional transmission capacity. WindStor's expected ability to generate onsite-distributed energy diversifies the USA's power grid in a manner much sought after by its Office of Homeland Security. Each WindStor installation will operate independently, thus, isolated power disruptions at a few WindStor sites would not have any impact at the remaining sites (potentially thousands) making it virtually impossible to simultaneously cause power disruptions at every WindStor site.

Summary

There exists a great demand among urban commercial and industrial electric customers to manage and reduce energy costs, both for today and future, and for their energy supply to be provided by renewable and sustainable resources. The scope of urban retail markets is difficult to assess at this early stage of the market's development, and the barriers to entry are considerable. However, it is very apparent that the promise of this new wind energy frontier is enormous. It is believed that WindStor provides a compelling business proposition for both the owner and the customer and is positioned economically and technologically to meet its challenges.