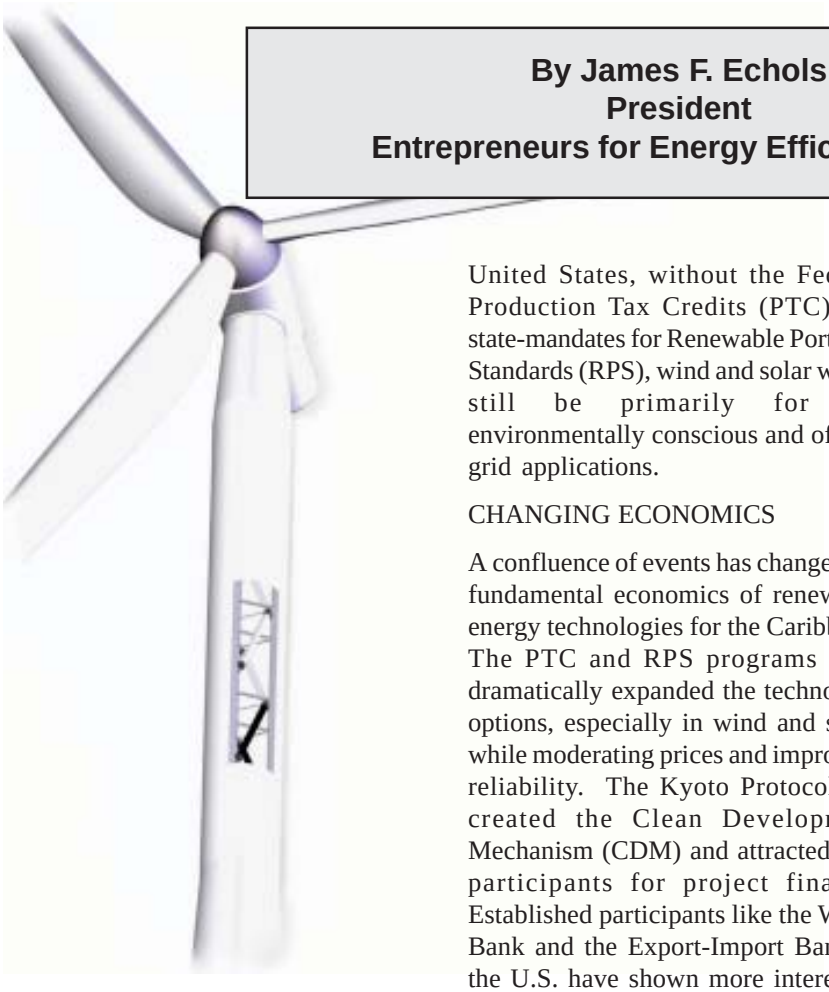
REMOVING BARRIERS TO ISLAND WIND DEVELOPMENT



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INTRODUCTION

In the Renewable Energy community, the Caribbean has been a paradox. Blessed with rich resources in wind, solar and biomass, adoption of renewable energy technologies has been slow. In some areas, electrical production is still over 95% reliant on diesel generators, which has led to some of the highest retail electric rates in the world.

The adoption of renewable energy technologies has been slow for a wide variety of reasons; high capital costs, under-performing systems, poor infrastructure, lack of incentives, both public and private, and the lack of adequate project financing. In the United States, without the Federal Production Tax Credits (PTC) and state-mandates for Renewable Portfolio Standards (RPS), wind and solar would still be primarily for the environmentally conscious and off-the grid applications.

CHANGING ECONOMICS

A confluence of events has changed the fundamental economics of renewable energy technologies for the Caribbean. The PTC and RPS programs have dramatically expanded the technology options, especially in wind and solar, while moderating prices and improving reliability. The Kyoto Protocol has created the Clean Development Mechanism (CDM) and attracted new participants for project finance. Established participants like the World Bank and the Export-Import Bank of the U.S. have shown more interest in energy-related projects with an environmental payback. Corporations are evaluating their global carbon footprint, not just their emissions in Annex I countries. With oil prices at all-time highs and little prospect for returning to historic norms, renewable energy can compete head-to-head with diesel generation, without subsidies.

While the majority of CDM Projects have been in China and India, the CDM remains a viable option and are judged by sustainable development criteria:

a) Social well being – Wind energy generates employment through construction, operations, and maintenance. General infrastructure will improve in and around the general project area through road improvements and more reliable electrical service;
b) Economic well being – Wind energy can stabilize retail electric rates, diversify national energy supply and promote economic development;
c) Environmental well being – Electricity generated by a wind turbine will offset generation by fossil-fueled power plants. A 1.0 Mw turbine, operating at a 30% capacity factor will generate 2,630 Mw-hr/yr, replacing 170,000 gallons of diesel fuel and 1,700 tonnes of CO_2. At this writing, CDM generated carbon credits are trading near €15/ tonne.
d) Technological well being – Modern wind turbine technology represents the Best Available Technology (BAT) in terms of electrical generation from renewable resources.

WHY NOT WIND?

Wind energy has been the big winner in renewable energy, often being competitive with natural gas-generated electricity, without subsidies. However, those efficiencies have come at a cost. The physics of wind energy has not changed. The power output of a wind turbine is determined by wind speed and the swept area of the rotors. This has lead to ever larger machines on ever taller towers. Wind farms have grown from four or five megawatts to four or five hundred megawatts. In Figure 1, a heavy-lift crane raises the rotor on a

Fig. 1 - Heavy-lift crane installation

Fig. 2 - Cutaway view of Dynamic Damping System

tubular tower on a typical U.S. wind farm location; flat, no obstructions, plenty of room to operate. These economies of scale are more about construction and transmission than turbine technology.

With the current technology, 25% of the total cost of a wind turbine is in the tower; typically a rolled steel, three-piece, conical design. These towers incur an exponential cost increase with height because of 1) the additional steel required to overcome the greater thrust load moments, 2) more steel to suppress the increased vibration and harmonics tendencies of taller towers and 3) the rapidly escalating transport logistics of excessively heavy and oversize towers. It is the towers that have become the barrier to wind project development, not the capacity, reliability or cost of the turbine itself. In the Caribbean, the logistics of transporting and erecting the current state-of-the-art machine have priced it out of the market.

A NEW APPROACH

A new technology, now in early deployment, allows megawatt-scale wind turbines to be erected in island and remote locations. Wind Tower Systems, LLC (WTS) Space Frame™ Tower combines the efficiencies of a strut-based frame with a dampening system to control harmonic loads, reducing the steel content by 35-60%. This enables on-site assembly and dramatically reduces transport logistics. The combined benefit of lower weight and easier transport lowers tower costs by more than 25%.

The Space Frame technology was developed to address the problems inherent in tubular steel towers through a 2002 U.S. Department of Energy grant, with additional funding by a 2004California Energy Commission project solicitation. In much of the U.S., the Class 5 and 6 wind sites that are compatible with the current technology are under development . The key to wide-spread application of wind energy is to utilize the lower wind speed areas. Taller towers access better wind conditions and can support lower wind speed turbines using larger rotors. A 20 m increase in hub height can increase power production 20%.

In the design process, several factors needed to be addressed. The extremely-large, base diameters for lattice towers was unacceptable. A footprint similar to tubular towers would enable the application of non-structural cladding to achieve the aesthetics of tubular towers. The cladding also eliminates potential nesting sites, which became a major source for avian mortality. With the elimination of open lattice towers, birds face a far greater threat from domestic and feral house cats that turbine blade collisions.

Since tower diameter could not be increased to obtain stiffness and heavier members were not desirable, an alternative solution was needed. Damped strut members emerged as the optimal solution. (See Fig. 2) Maximum dynamic loads occur primarily during extreme wind events when the rotor is parked to prevent damage to the gearbox and generator. In this case, broad-band wind gusts can overexcite the tower like a bouncing spring. A SpaceFrame Tower has a low natural frequency so wind gusts become coherent with the tower's natural frequency. Unlike the weight-stiffening methods of a tube tower, the SpaceFrame is designed where a few of the steel diagonal struts are swapped out with a new technology; a stiff energy absorbing strut. Highly effective at suppressing the tower dynamic loads, the damped strut does not add appreciable weight.

In the Caribbean, height is not the determining factor in economics, but

Fig. 3 - Hi-Jack Lifting System

Fig. 4 - Lifing Nacelle

recurring maintenance costs. The goal isn't to erect 100 turbines on a site, but two or five. That places a premium on construction logistics and maintenance. A major component failure on a modern, wind turbine in year ten of a project can ruin the economics of a project. WTS has designed the innovative Hi-Jack™ lifting system that does away with expensive, heavy-lift cranes. (See Fig. 3) Construction of the tower uses a common Gin Pole assembly, a mature technology that has been used in the broadcast tower industry for decades to erect towers up to 2,000 feet tall. A key component of the system is the Lifting Frame, which is attached to the top of the tower and uses the tower itself to support the lifting of the 150,000 pound nacelle and rotor components. (See Fig. 4)

FUTURE PATH

The Caribbean region can break the reliance on liquid petroleum energy sources. While the supply of natural gas in the region will increase as Venezuela develops their offshore acreage, transportation, either by LNG, CNG or pipeline, remains a major obstacle. Renewable energy technologies offer great promise for diversifying energy supply. Biomass-derived ethanol and biodiesel can supply economically viable transportation fuels. A new type of tower for megawatt-scale wind turbines is a truly enabling technology that can unlock the region's main renewable resource. The Space Frame Tower from Wind Tower Systems, LLC opens new sites unavailable to current technology, while reducing the cost of installation and offering a new model for distribution generation.

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