



Harvesting Wind Power in Our Urban Environment

November 26, 2007

Overview

Industry

The Wind Energy Industry

Wind Turbines

HAWTs and VAWTs

Wind and Urban
Environments

Urban Wind: Power, Noise and Vibration

Urban Solution

The Cleanfield V3.5 as a Wind Energy Solution for Urban Environments

The Cleanfield V3.5

Evolution, Competitive Strengths and Installations

Who We Are

- Cleanfield Energy Corp. is publicly-traded (TSXV:AIR)
- Founded by Tony Verrelli (President/CEO), Alexander Trica (VP Technology) and Mihail Stern (VP Operations) in December 2002
- Cleanfield has developed a modular **Vertical-Axis Wind Turbine (V3.5)** capable of generating 2.5kW, 3kW or 3.5kW depending on the length of the arms which attach the blades to the shaft
- Recognized leader in small wind energy industry



Industry Overview

- Wind Industry consists of 2 main sectors: small wind systems (100 Watts to 100 Kilowatts) and large wind systems (100 Kilowatts and greater)
- Small wind turbine market includes many applications: **on-grid** (connected to the utility), **off-grid** (stand-alone) or **grid-inner-tie** (hybrid grid connection with back up power production capabilities)
- Electricity generated from wind in the U.S: An estimated 31 billion kWh in 2007 (about 0.7% or enough to serve the equivalent of 3 million average U.S. households)*
- Industry growth rate, U.S.: 22% average over last five years (year-end 2001 – 2006)*

* American Wind Energy Association, 2007



Traditional Horizontal-Axis
Wind Turbine



Vertical-Axis Wind Turbine

Horizontal Axis Small Wind Turbines

- Numerous suppliers of turbines for tower/field installation
- Yaw to face wind
 - high mount and blade loads with rapid yaw
 - maintenance, servicing, warranties
- Non-uniform wind into turbine
- High tip speeds lead to noise



Southwest Skystream 3.7



Bergey



Abundant Renewable Energy

Vertical Axis Wind Turbines

- Combination of blade rotation and incident wind give blade lift (torque)
- Research and commercialization of medium/large VAWTs in 1970s & 1980s
- Small VAWTs mainly H-type



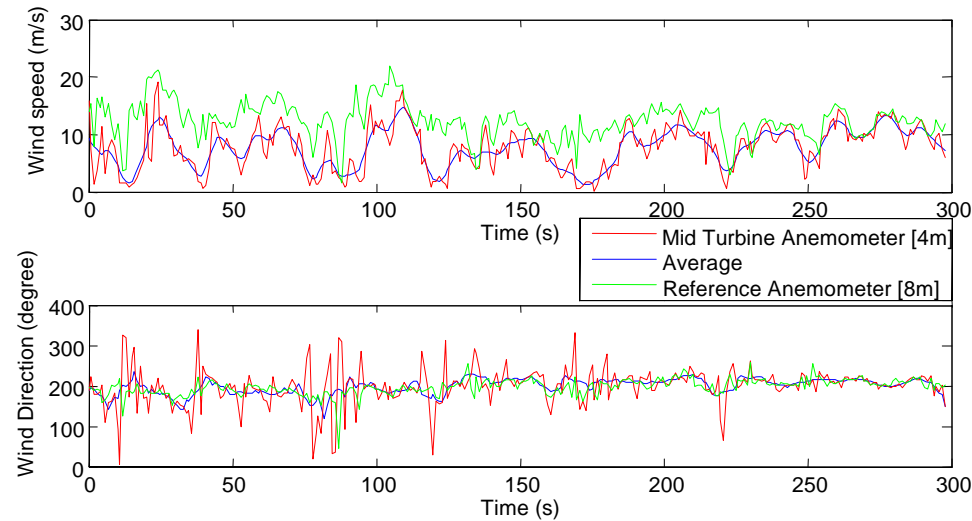
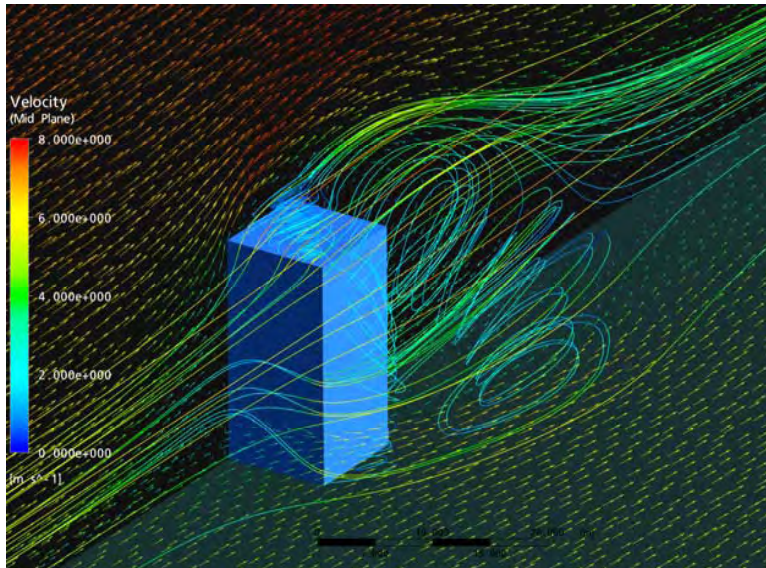
Cleanfield V3.5



Sandia 34 m Darrieus
Sandia National Labs

Urban Wind

- Lower wind velocity due to larger ground roughness within urban environments
- Rooftops can give height Complex vortical flow structures over and around buildings
- High turbulence levels



Numerical Modeling of a Building with Normal Flow to the Building's Face

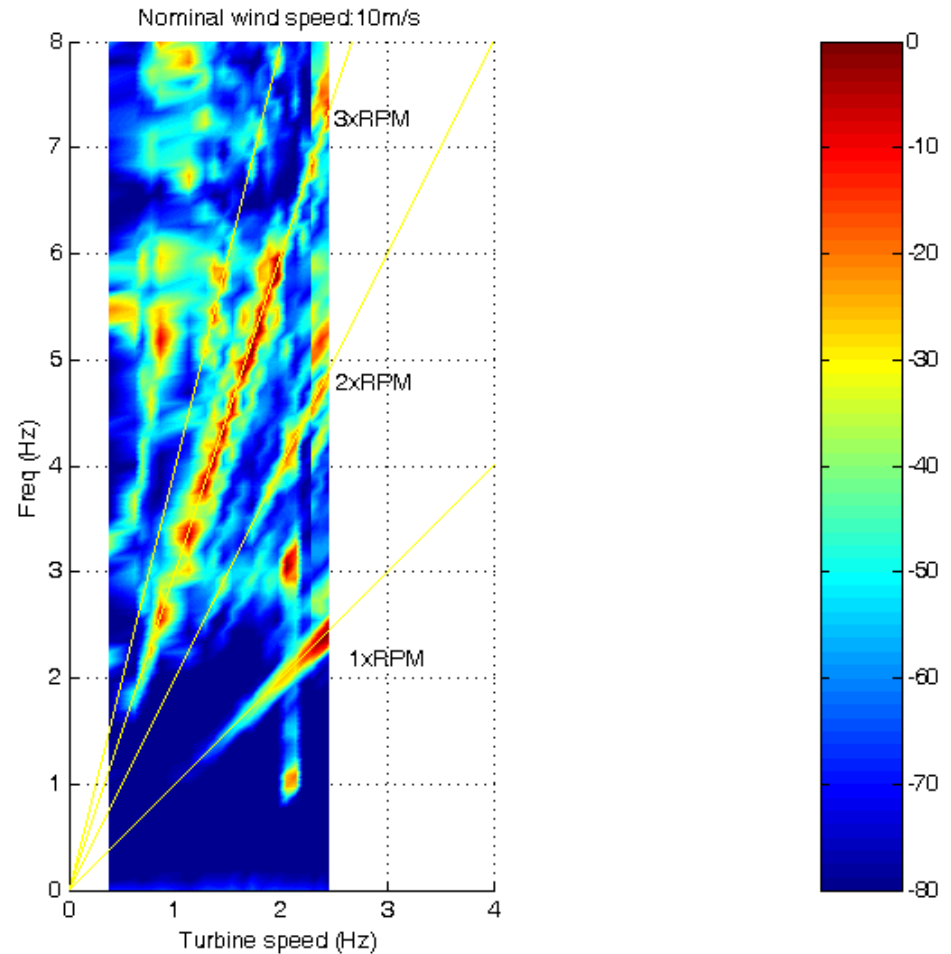
Noise

- One of the positive aspects of VAWTs - relatively quiet
- Noise is proportion to blade velocities
- Blades are all at the max radius,
 - no high speed tips
 - actual blade speeds are low relative to HAWTs
 - low noise



Vibration

- Coincidence between structural modes and excitation frequencies
- Structural modes affected by installation, tower, turbine
 - Whirl
- Sources of excitation:
 - unbalance,
 - aerodynamic loading of blades
- Rooftops are not usually designed or built for such loads



Vibration Spectra - Campbell Diagrams

VAWTs in “Dirty” Air

- Non-directionality
- Ability to handle unsteady, non-uniform, turbulent wind
- Renewal of interest in VAWTs for urban installation
 - Turby
 - Quiet Revolution
 - Cleanfield Energy
- Issues: Power Performance, Noise and Vibration



Turby



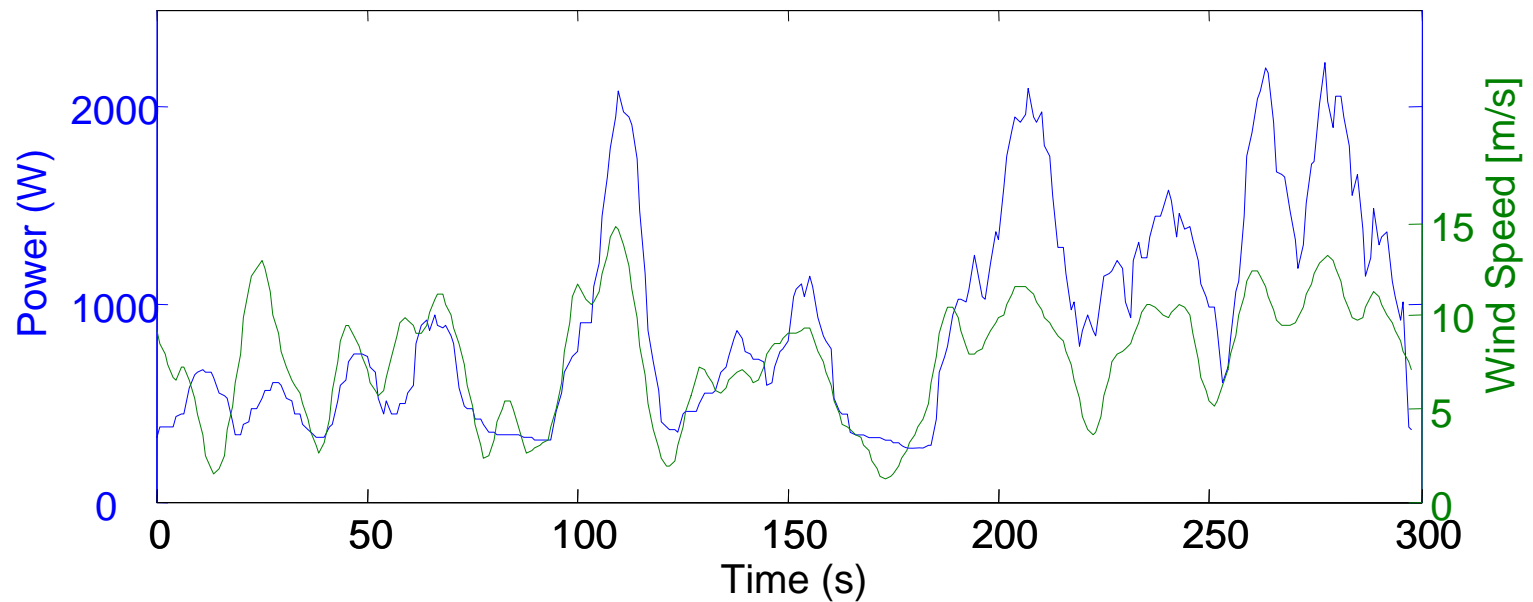
Quiet Revolution QR5



Cleanfield V3.5

Power Performance

- Peak power tracking
 - e.g. using known “clean” wind performance curves
- Even look at constant RPM



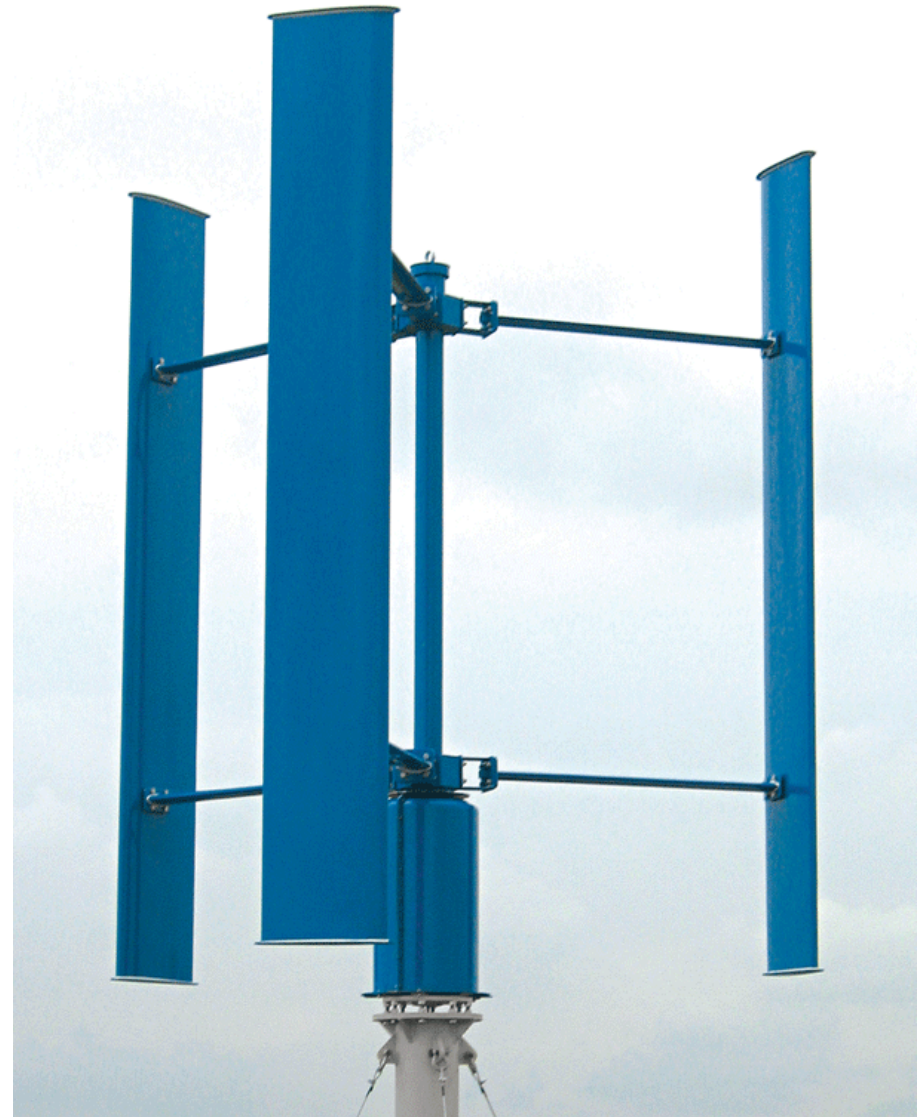
The Product

Cleanfield V3.5

- 3.5kW (3500 Watts)
- Produces up to 9,000kWh annually
(can provide up to 90% of an average household) (Average annual consumption in **North America is 9600kWh**)

Main design objectives:

- Quiet system
- On-grid and off-grid
- Universal Installation
- **25 year useful life**
- Low maintenance
- Turn-key system



Evolution of the Cleanfield V3.5



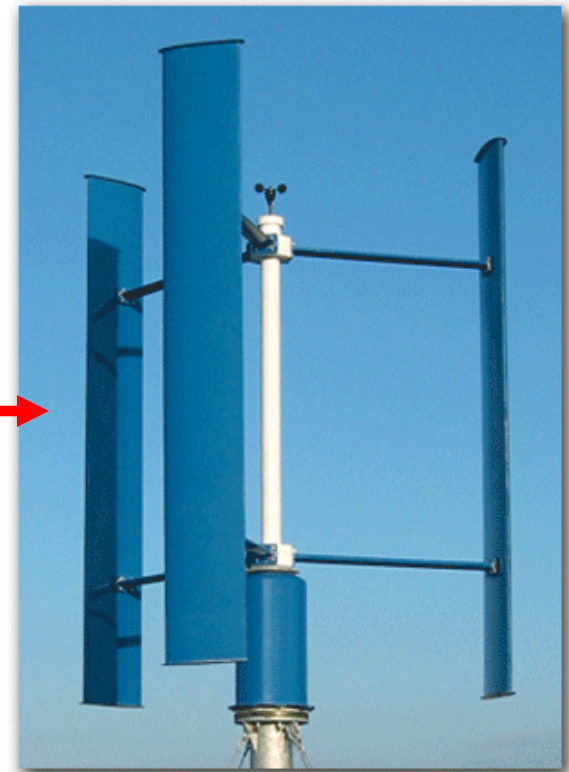
Prototype 2.5kW

- Self-Starting System
- V-Shaped Struts
- Clutch System



Prototype 3.5kW

- Starts via generator
- Airfoil Struts
- Modified Shaft
- Reinforced Blades
- 2.75m Diameter



Commercialized V3.5

- Aluminum Struts
- Improved Blade Design
- Improved Braking
- Local supply chain

Competitive Strengths

Turbine:

- Simple design resulting in fewer moving parts (compared to traditional systems) and increased reliability
- Accommodates grounding for lightning protection
- Low nominal RPM resulting in lower tip speeds and low audible noise

Power Electronics (Converter/Inverter):

- Sophisticated means of monitoring voltage, frequency, and current without external sensors
- Variable speed operation
- **Ability to skip RPMs that cause vibration at resonant frequencies**
- Ability to connect additional renewable sources of energy such as solar and external battery storage
- Design allows for universal application and operation
- Custom-developed which interfaces with the inverter for data collection, supervision, and protection of the turbine which increases reliability and life expectancy
- Monitors turbine vibration, generator, ambient temperature and RPM
- **Offsite monitoring by Cleanfield via web enabled connection for preventative maintenance**

Suppliers



Fibreglass Blades
Manufactured in Hamilton
Capacity 1,000+ (pending tooling)

Aluminium Struts
Manufactured in Mississauga
Capacity 1,000+

Steel Shaft (lifetime warranty)
Manufactured in Ancaster
Capacity 1,000 (pending tooling)

Power Electronics (Inverter/Controller)
Manufactured in Burlington
Capacity 1,000+

Permanent Magnet Generator
Manufactured in Romania
Capacity 1,000

9 Current Installations of the Cleanfield V3.5



Hamilton
Incubator of Technology
Hamilton, Ontario
(1) rooftop installation



Cleanfield Head Office
Ancaster, Ontario
(1) rooftop installation



MNR - Fire Management
Headquarters
Kenora, Ontario
(5) monopole installations



McMaster University's
Innovation Centre
(2) rooftop installations

Contact Us

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