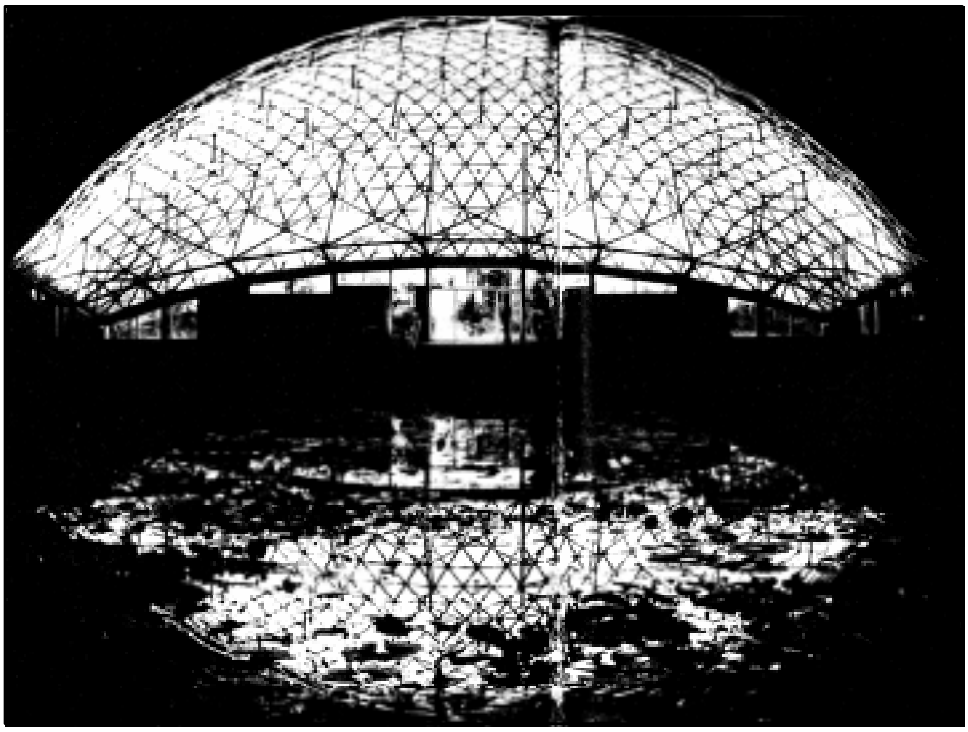
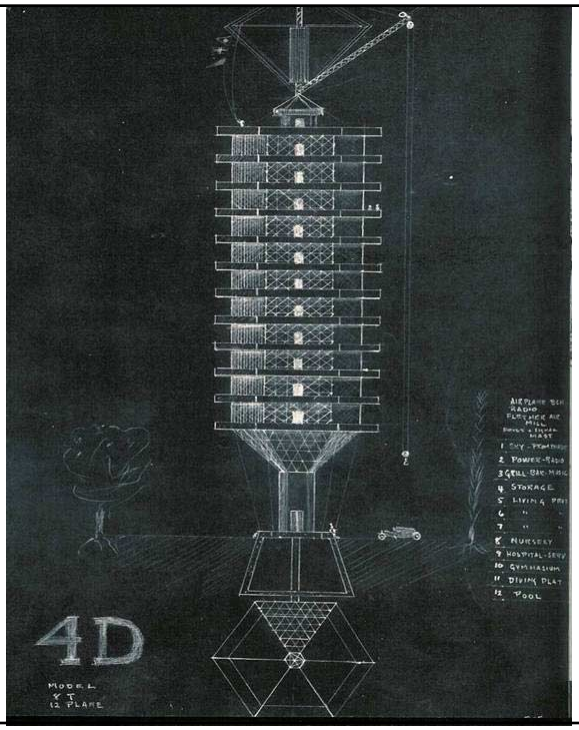
Urban Renewable Power:

Natural Electric Energy Systems In World Cities

Bil Becker, CEO - Aerotecture International, Inc.
www.aerotecture.com

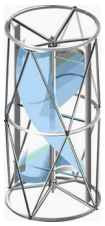




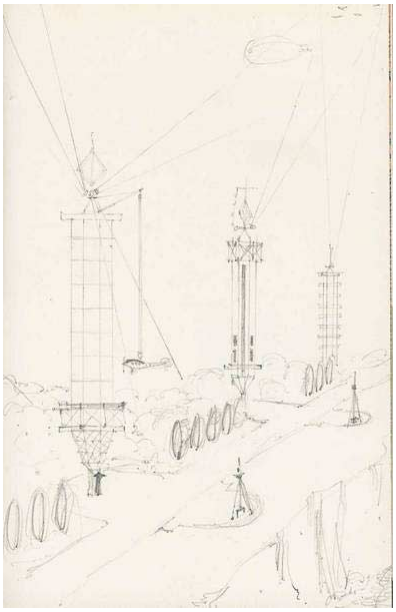
Aerotecture International, Inc.

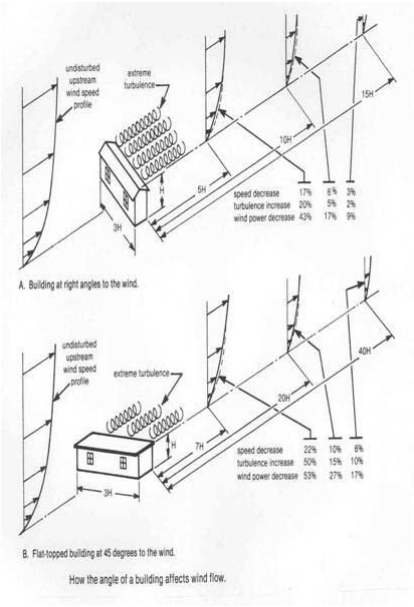
BUILDING INTEGRATED NATURAL ENERGY SYSTEMS WORLDWIDE

www.aerotecture.com

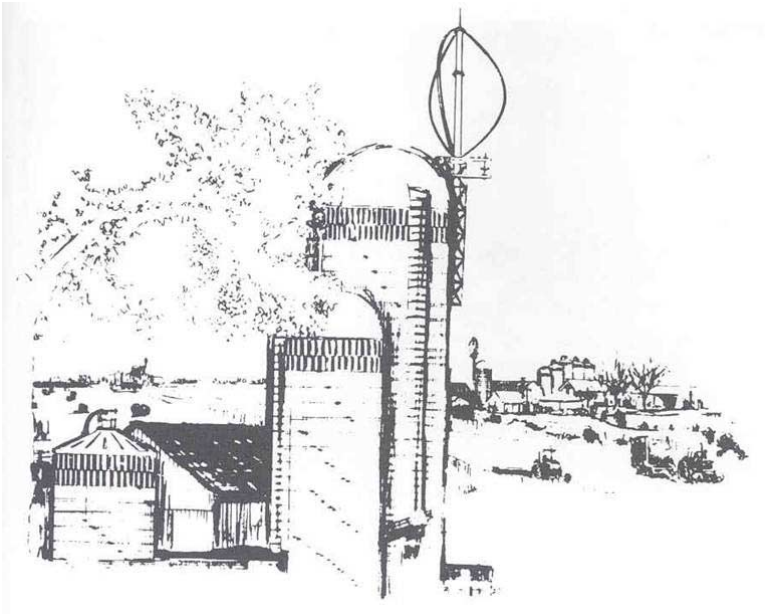


R.B. Fuller elevation, plan & perspective - Towers with wind generators aloft – Chicago,1928

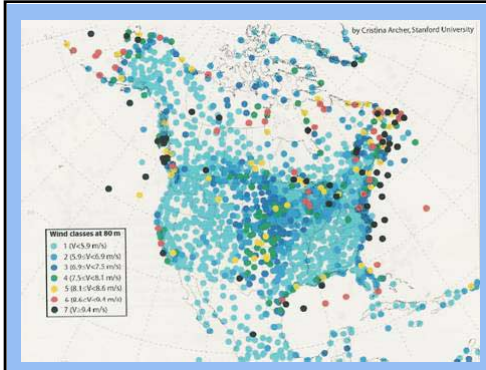




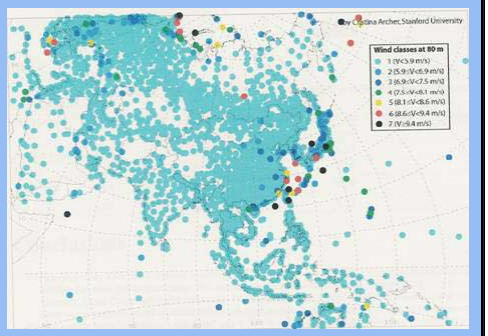
’70s Alcoa Rural Darrieus Design



Global Wind Distribution – 2000-2005



North American coastlines, Mississippi/Great Plains regions and Great Lakes coastlines have highest wind energy resources – approximating 9 TWs of available electricity out of a current global consumption of 1.6-1.8 TWs worldwide*



Indo-Asian coastlines and Himalayan regions (wind is not well measured there) offer more than 10 TWs of available wind electric power potential – within a current global total use of 1.6-1.8 TWs of electricity*

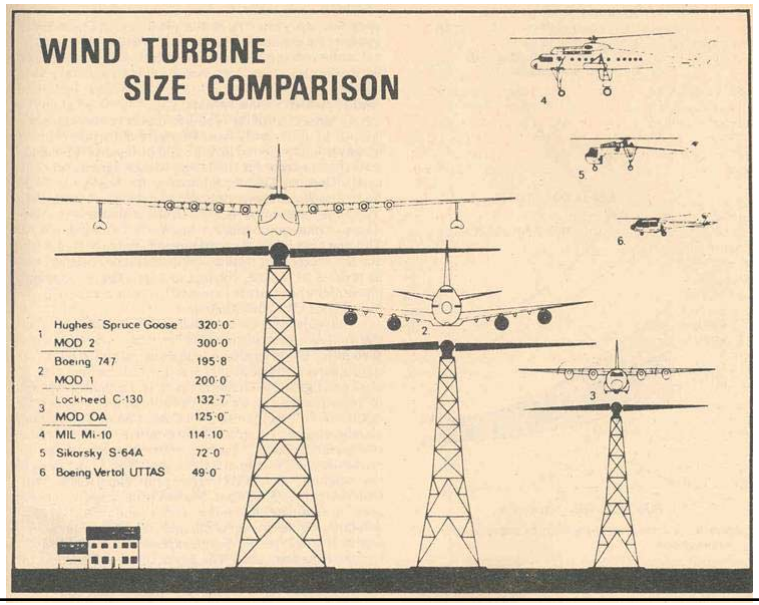
6 Billion people worldwide need low-cost, safe, quiet village/urban wind energy – of the world's current use of 1.6–1.8 TWs of electricity, wind power offers 72 TWs*

***"Evaluation of Global Wind power" 2005 - C. Archer (cozej@stanford.edu), and M. Z. Jacobson (jacobson@stanford.edu)**

Paper available at www.stanford.edu/group/efmh/winds/global_winds.html

Current Large Windfarm Paradigm

Aircraft Engineers Design Giant Megawatt Windmills

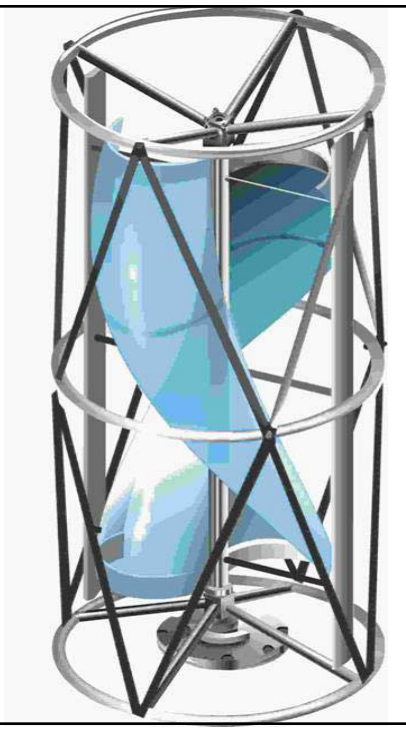


Problems for Props are Opportunities for Aeroturbines

The Becker Aeroturbine

Patent Pending Serial # 10/629,370

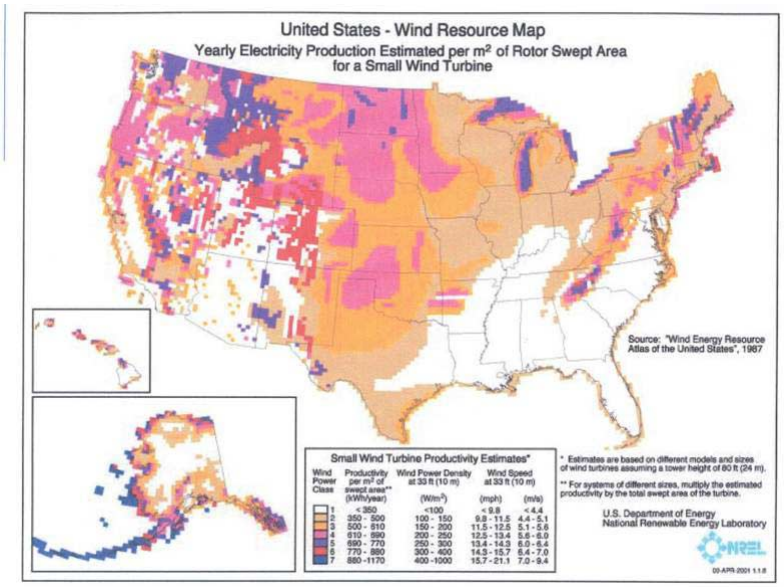
- "Enjoys" turbulent winds
- Safe – self-regulating
- Quiet – vibration-free
- Low cost
- No powerline transmission losses
- No giant powerlines needed
- Easy integration with other sources of power
- Portable and/or architecturally design compatible
- People and Bird safe



Aeroturbine Characteristics	Propeller-Type Characteristics
Urban settings best with variable & gusting winds	*Rural settings best with steady, uni-directional winds*
Integrate well with rooftop solar & PV installations	*Tower vibrations work against buildings and best PV installations*
Produce power over a spectrum of low/midrange RPMs – do not run away – with MORE power hours/year	*Produce power ONLY after spin-up to very high RPMs – running away is always a concern*
Operate with low noise & low/no vibration anywhere	*Operate best where noise & vibration are no problem*
Require minimal/no tower supports & no anti-vibration devices	*Require major structural towers & major anti-vibration devices*
Mountable INSIDE towers or ON other built structures – i.e., cell towers, noise barriers, water tank towers, etc.	*Not easily fitted to interiors of typical structural towers – hard to fit within existing structures & buildings*
Low visible rooftop profile or within other structures	*Require high profile above trees & other obstructions*
Require no special code/zoning/liability insurance, etc.	*Require exemptions, special code/zoning, & insurance*
Falls under current rooftop PV codes & zoning	*Require costly tower/noise/vibration abatement systems for safe roof mounting*
AeroTurbines run quietly & protect wildlife	*High speed blades are noisy & kill birds*
Durable systems require low maintenance & repair	*High vibration systems require high maintenance & frequent repair and attention to 'bolt loosening'*
AeroTurbines aesthetically and functionally integrate well with architectural settings	*Propeller systems prove difficult to integrate with architectural settings*

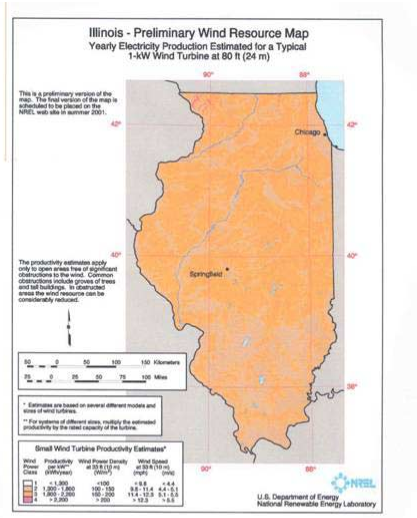
U.S. Wind Resource Map

Note: Midwest & Great Lakes Wind Resources



Illinois Wind Resources

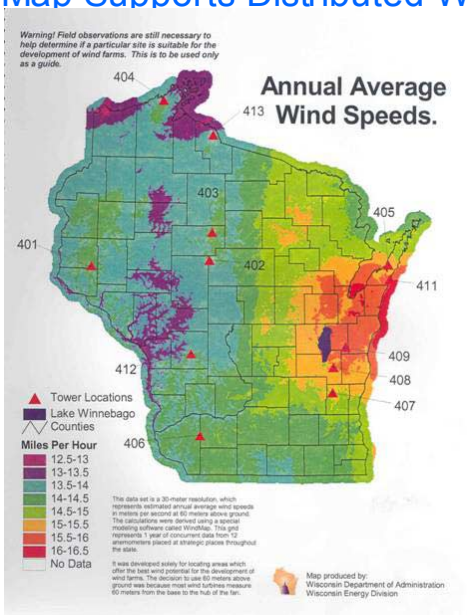
Lakefront high winds not shown?



Cover Photo: Small wind turbines, like this grid-connected 10-kilowatt Bergey, can provide supplemental power for farms and ranches. Excess power generated by the turbine is fed back into the utility grid.
Photo credit — Warren Gretz, NREL/PIX0963

Wisconsin Wind Speeds

Detailed Map Supports Distributed Windpower

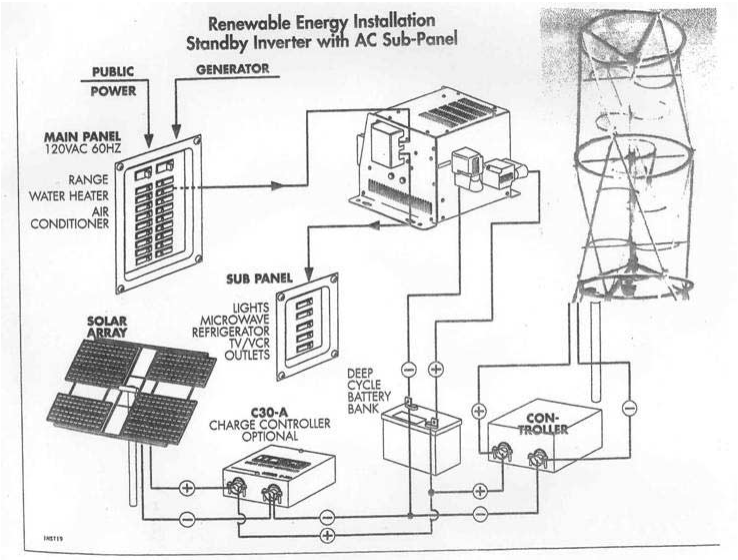


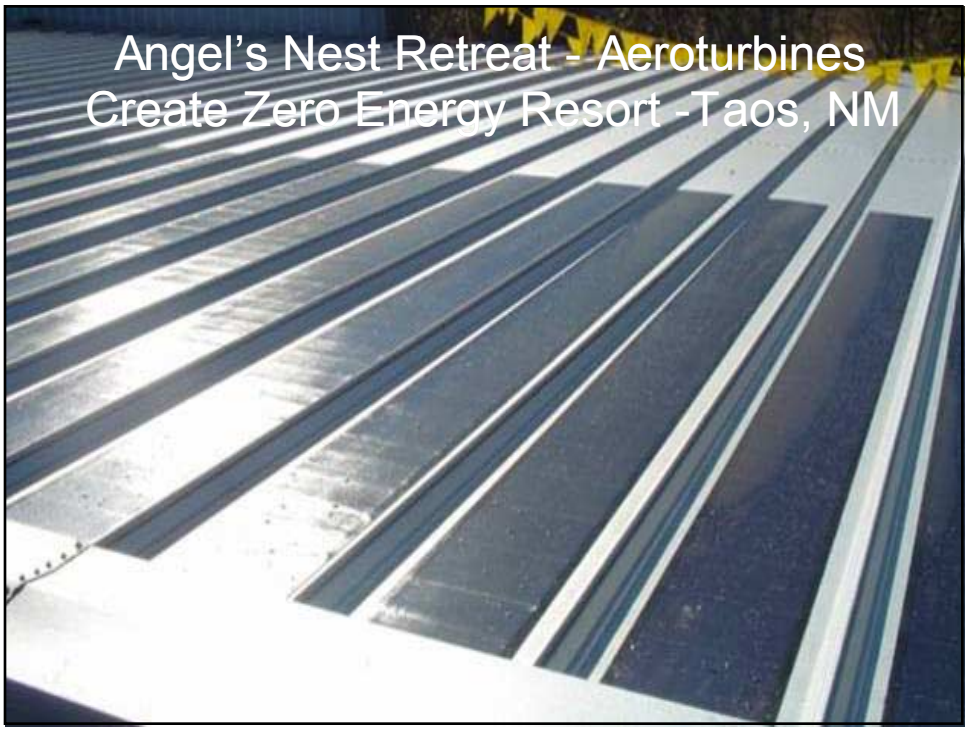
Randall Museum Vertical Aeroturbine

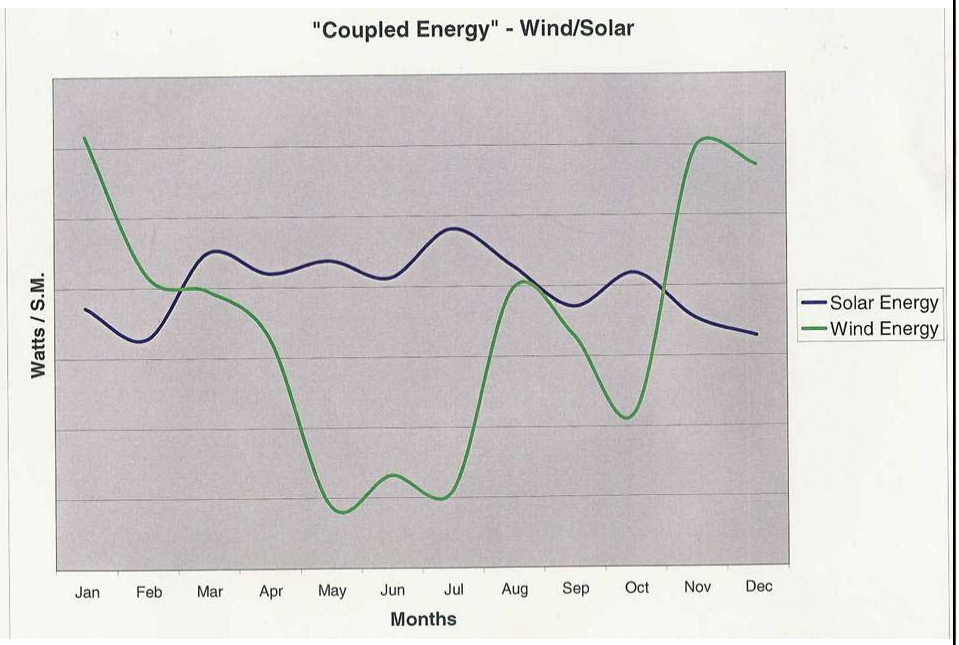
San Francisco, CA

Diagram of Hybrid RE Elements

PV and Wind Power Systems on Single Inverter





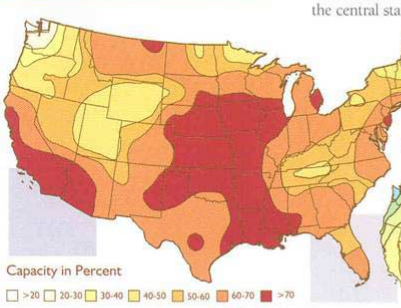


PV's Value Profile

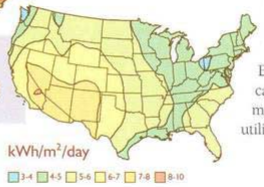
PV's Value as a Technology that Adds Capacity

- **PV has tangible value to utilities in generating capacity.**
- **Regions of high ELCC do not always overlap with regions traditionally targeted for solar energy.** For example, note the high ELCC values in southern California, the central states, and the Mid-Atlantic seaboard states. The "traditional solar areas" of Florida and the arid Southwest states have lower PV ELCC values despite their greater solar intensity values, because PV output doesn't match the loads as well in those areas.
- **Areas of high PV ELCC are associated with regions that have certain characteristics:**
  - Intense summer heat waves
  - High daytime commercial demand
  - Small electric-heating demand.
- **Isolated pockets with high PV ELCC values may exist within a region having lower PV ELCC values.** For example, high-density urban areas may have a high daytime demand in the commercial sector and thus have a high ELCC value for PV.

These new findings about PV's ELCC should make decisions on capacity additions and demand management a little easier for U.S. utilities.



PV ELCC map of U.S. (based on 500 utility loads)



"Traditional" solar-energy map

Oxford House Zero-Energy, Manufactureable, Net+Energy Home

Aeroturbines complete well documented approach–
NOTE: square plan allows South roof orientation on ANY site.

Pfister/Uni-Solar Project

Project Type:

Solar Energy

Site:

Flemington, NJ

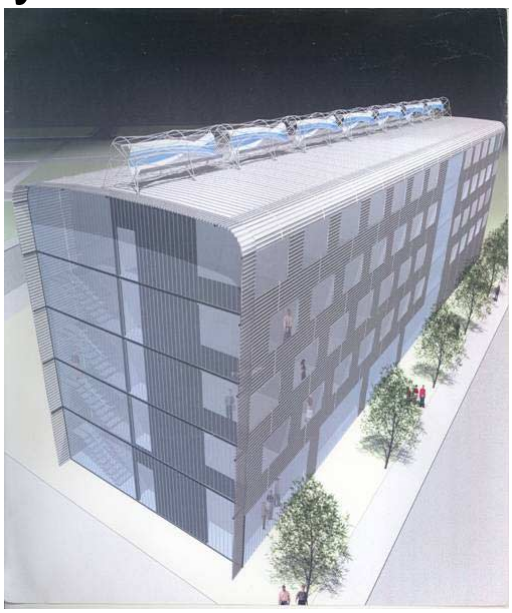
Solar Manufacturer:

Uni-Solar

Project Size:

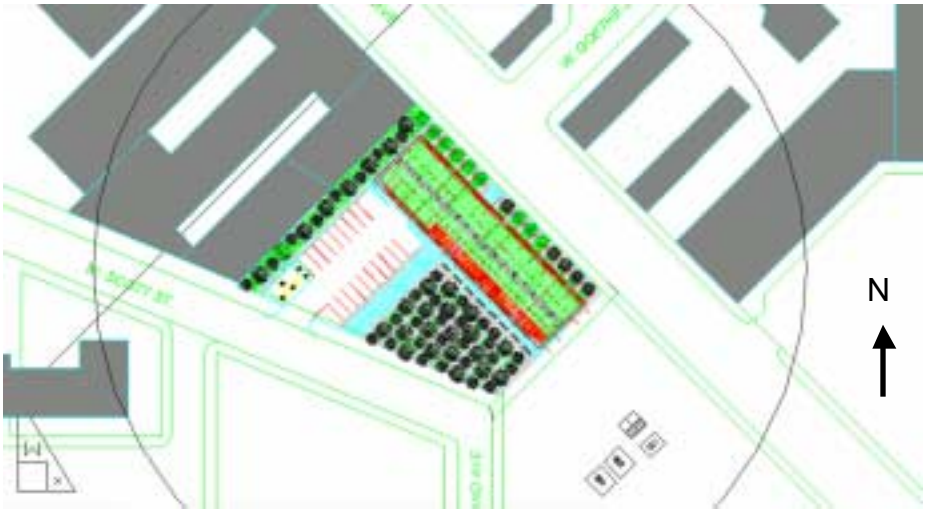
40 kW

Murphy/Jahn MHL-Aeroturbines

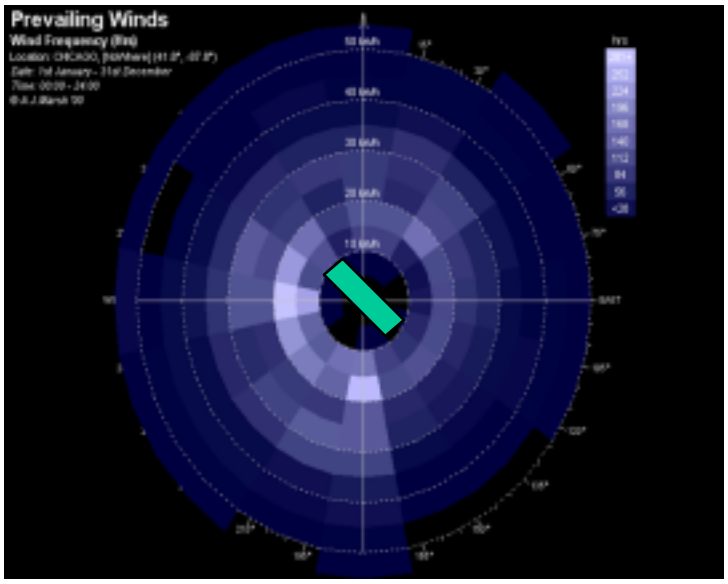


Mercy Housing Lakefront Aeroturbines
are based on 6 Years of Earlier

Mercy Housing Lakefront Site
Clybourne & Division Sts., Chicago

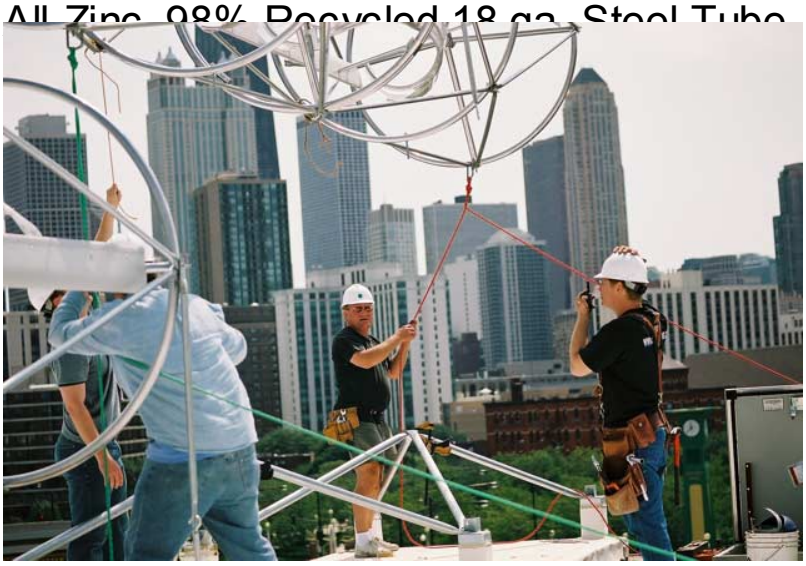


Chicago Windrose - main winds from Southwest & Northeast

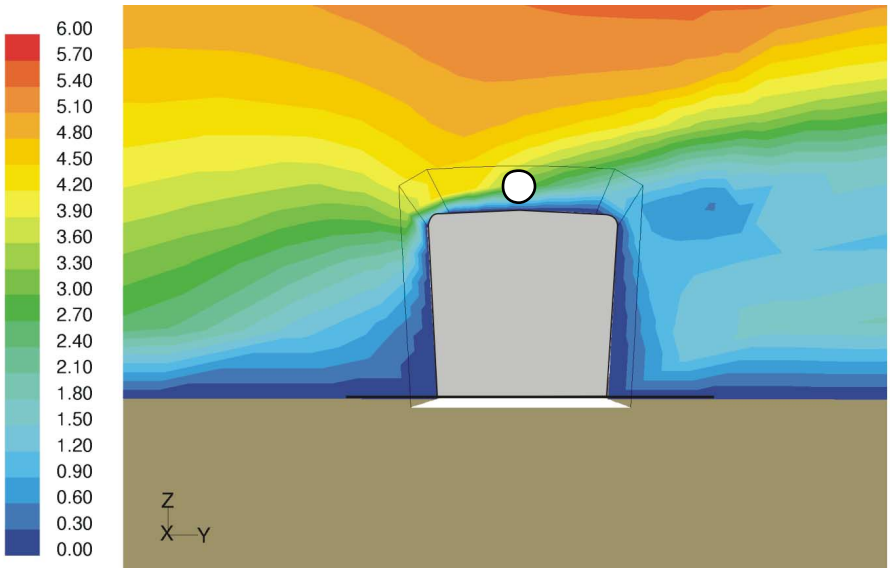


Murphy/Jahn MHL-Aeroturbines
'Big Lift' – August 11, 2006

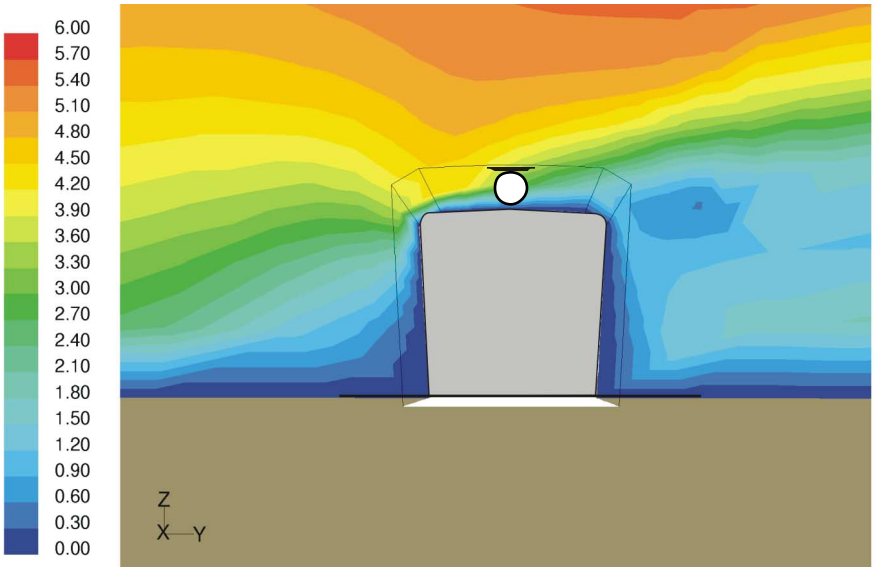
Aeroturbine 'Pyramid' Tube Bases
All Zinc, 98% Recycled 18 ga. Steel Tube



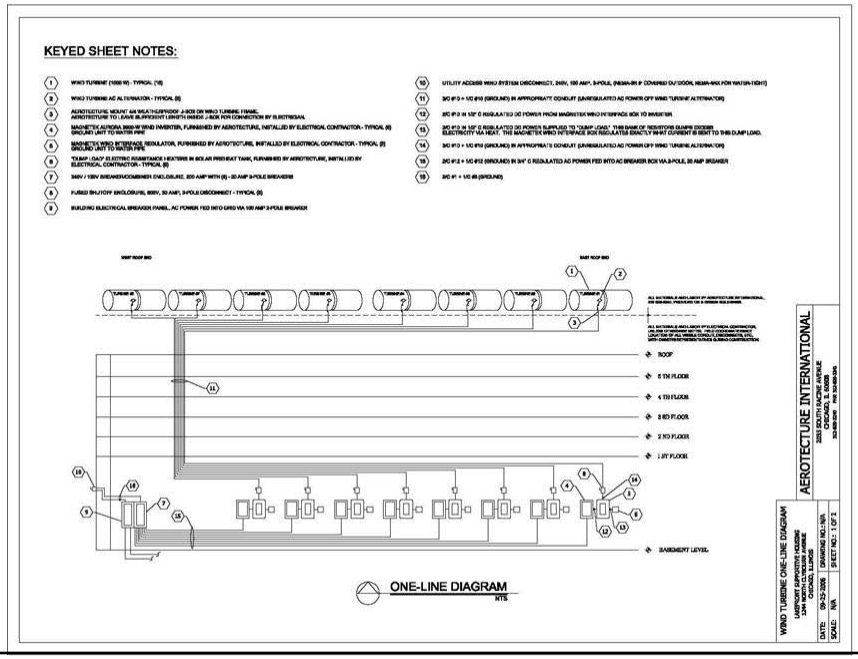
Computer simulation of over-streaming winds & Aeroturbines roof location



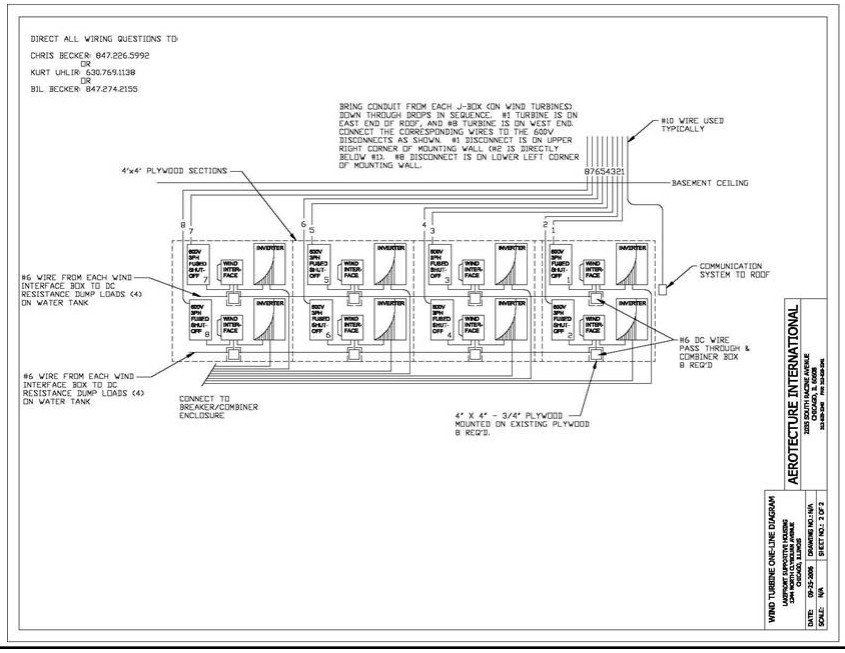
Adding a Venturi wing above the Aeroturbines (PVs could be added)

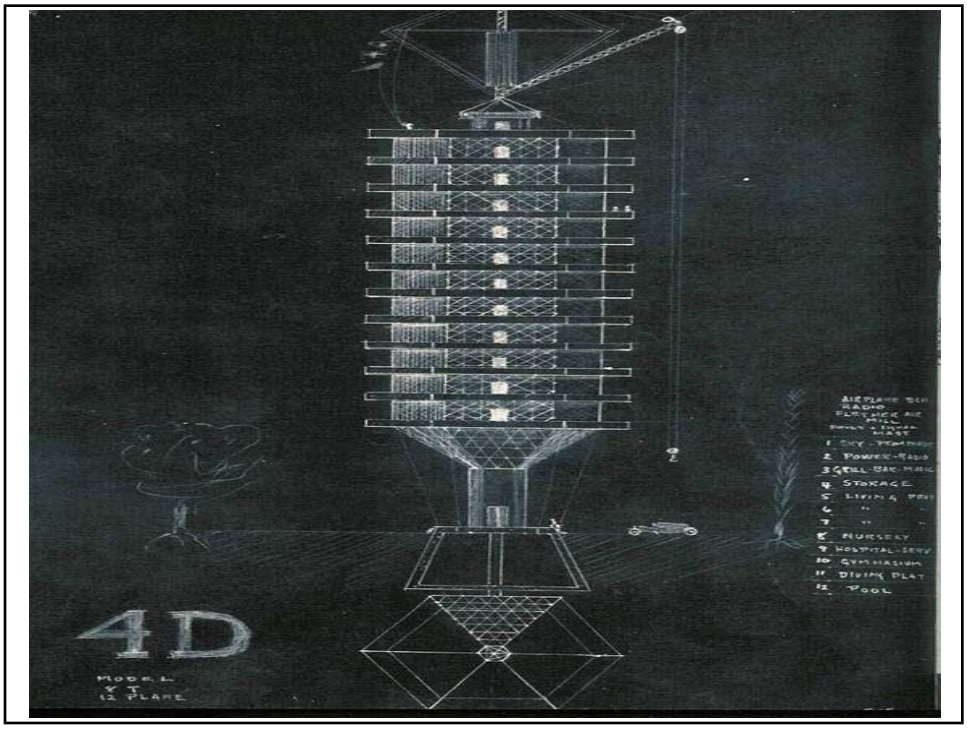


MHL One Line Diagram – 8 Systems



MHL Control Panel Layout – 8 Systems





This document provides ComEd's requirements for interconnecting wind and photovoltaic (PV) generation systems 40 kW in size or smaller. ComEd's primary concern is that these systems be interconnected safely and in accordance with all applicable codes and regulations without adversely affecting ComEd's electrical utility system. Wind and photovoltaic systems larger than 40 kW require additional equipment not covered in this document. Interconnection requirements for systems not covered by this document are identified in "Guidelines for Interconnection of Generation to the ComEd System," available from ComEd for a nominal price.

Wind and Photovoltaic Systems

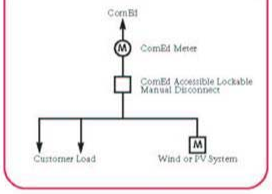
Wind systems utilize a wind turbine to catch the wind's energy with their propeller-like blades. Usually, two or three blades are mounted on a shaft to form a rotor. A blade acts much like an airplane wing. The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to make electricity.

Photovoltaic (PV) systems convert sunlight directly into electricity. This is accomplished when solar cells are exposed to light. The electricity generated by a multitude of these cells can be channeled into an inverter for conversion into a usable AC power source.

ComEd requires the following for interconnection of wind and photovoltaic generation systems 40 kW or smaller:

- Wind and PV systems must comply with all applicable codes, laws and regulations.
- Wind and PV systems must not adversely affect the power quality, reliability or safety of ComEd's system.
- Wind and PV systems must automatically disconnect from ComEd's system when ComEd's source is lost.
- A manual disconnect that is visible and accessible to ComEd and lockable with a ComEd lock must be installed.
- Appropriate wiring and metering must be installed if the customer wishes to receive compensation for excess energy transferred to the ComEd system.
- Approval for operation in parallel with the ComEd system must be obtained prior to operation to assure that the wind and PV systems will not adversely affect the safety, reliability or quality of local electric service.

Wind or Photovoltaic Interconnection Diagram



Code Requirements

Customers are responsible for designing, installing, operating, and maintaining their own equipment in accordance with all applicable codes, laws and regulations.

For example:

- Photovoltaic equipment installed on top of a building or wind/PV equipment installed on the ground needs to meet local building codes and zoning laws.
- Wind and photovoltaic electrical equipment needs to be designed, installed and tested in accordance with the National Electrical Code and/or local code.

Power Quality

All power sources, including wind and PV generation systems, must NOT adversely affect the quality, reliability or safety of the ComEd system. The wind or PV system must meet or exceed the power quality requirements as stated in the most current version of IEEE 929.

Loss of ComEd Supply

One of the primary safety concerns associated with independent power sources is their ability to produce energy regardless of ComEd's supply connection. The loss of ComEd supply can be caused by a variety of conditions (e.g., a short circuit on the distribution line, maintenance outage, etc.). During an outage on a ComEd supply line to which a wind or PV system has been interconnected, the wind or PV system has the ability to back-feed ComEd's line, creating a hazardous condition. To prevent this from occurring, wind and PV systems shall automatically disconnect from ComEd's system when a loss of ComEd's supply occurs. Wind and PV systems shall be installed in accordance with current IEEE 929 standards and be UL1741-listed using utility interactive (non-islanding) inverters with non-adjustable setpoints.

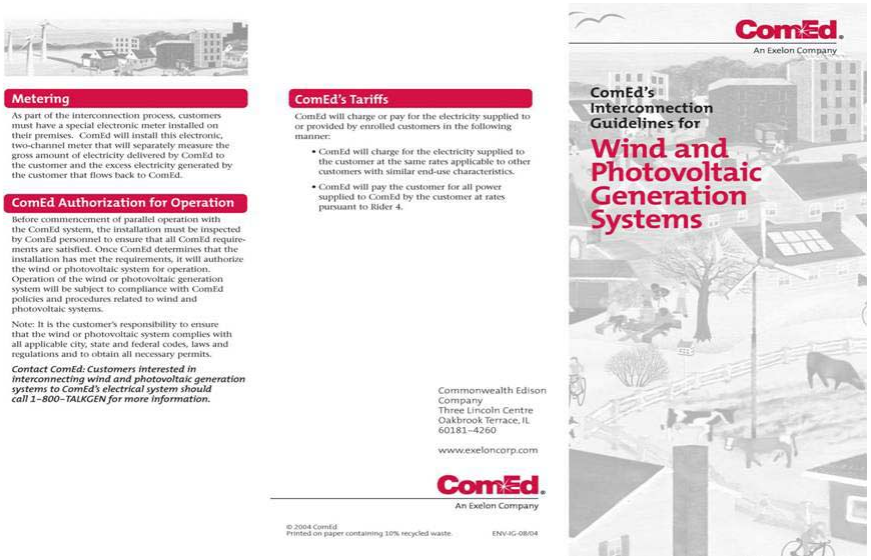
Lockable Manual Disconnect

A manual load break disconnect switch that is accessible to ComEd and lockable by ComEd is required to allow ComEd personnel to disconnect the wind or PV generation system from ComEd's system for maintenance, reliability and safety concerns. ComEd will have the right to disconnect the wind or PV generation system for maintenance, reliability and safety concerns.

8 – 2000 Watt Aeroturbines, in 10-110 mph winds, will produce 24,000

Golden Gate Aeroturbines

AeroSun Highways Start with Chicago Expressway Simulation in 2007



Metering

As part of the interconnection process, customers must have a special electronic meter installed on their premises. ComEd will install this electronic, two-channel meter that will separately measure the gross amount of electricity delivered by ComEd to the customer and the excess electricity generated by the customer that flows back to ComEd.

ComEd Authorization for Operation

Before commencement of parallel operation with the ComEd system, the installation must be inspected by ComEd personnel to ensure that all ComEd requirements are satisfied. Once ComEd determines that the installation has met the requirements, it will authorize the wind or photovoltaic system for operation. Operation of the wind or photovoltaic generation system will be subject to compliance with ComEd policies and procedures related to wind and photovoltaic systems.

Note: It is the customer's responsibility to ensure that the wind or photovoltaic system complies with all applicable city, state and federal codes, laws and regulations and to obtain all necessary permits.

Contact ComEd: Customers interested in interconnecting wind and photovoltaic generation systems to ComEd's electrical system should call 1-800-TALKGEN for more information.

ComEd's Tariffs

ComEd will charge or pay for the electricity supplied to or provided by enrolled customers in the following manner:

- ComEd will charge for the electricity supplied to the customer at the same rates applicable to other customers with similar end-use characteristics.
- ComEd will pay the customer for all power supplied to ComEd by the customer at rates pursuant to Rider 4.

Commonwealth Edison Company
Three Lincoln Centre
Oakbrook Terrace, IL
60181-4260

www.exeloncorp.com

ComEd.
An Exelon Company

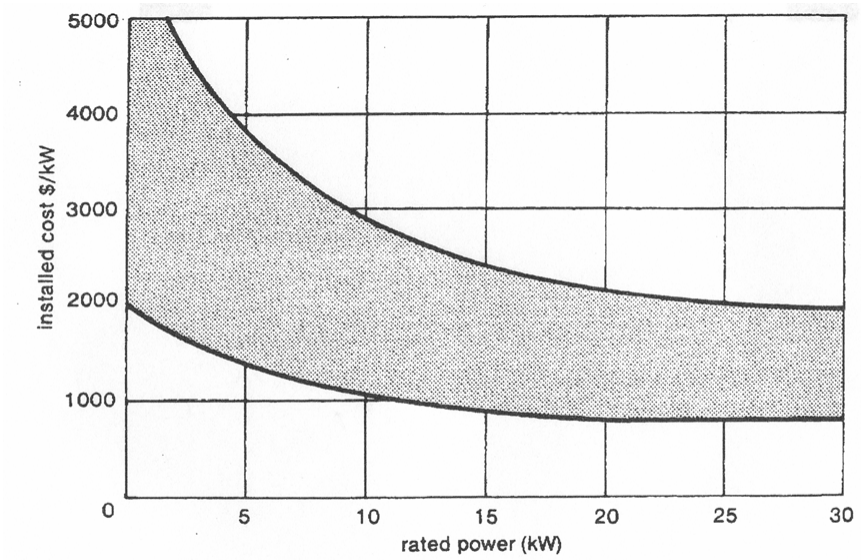
© 2004 ComEd
Printed on paper containing 10% recycled waste. ENV-IG-08/04

ComEd.
An Exelon Company

ComEd's Interconnection Guidelines for

Wind and Photovoltaic Generation Systems

Installed Costs/Rated Power



Costs of complete wind electric systems.

Aerotecture International, Inc.

BUILDING INTEGRATED NATURAL ENERGY SYSTEMS WORLDWIDE

www.aerotecture.com