

# SOLARTECTURE™

## Building-Integrated Wind and Solar Energy Systems

Presented by:

Reinhold Ziegler

*Managing Director*

Synergy International Inc.

*In affiliation with:*

Mariah Power Inc.

Helix-Wind Inc.

Aerotecture International Inc.

Design Earth Synergy

Perkins + Will, Architects

KMD| Stevens, Architects

# Synergy International, Inc.

with over 30 years of working experience in regenerative and renewable energy systems, presents breakthrough technology suitable for installation on, and within, most existing buildings and presents a new design initiative for all future buildings, incorporating:

Energy Design Integration

Building-Integrated wind energy systems.

Building Integrated Solar PV and Evacuated-tube hot water systems.

Building Integrated Stirling engine microturbine generators:

and other distributive energy assets and storage devices.

We call this new energy architecture:

**SOLARTECTURE™**

“Data from the US Energy Information Administration illustrates that buildings are responsible for almost half (48%) of all energy consumption and GHG emissions annually; globally the percentage is even greater.

Seventy-six percent (76%) of all power plant-generated electricity is used just to operate buildings.

Immediate action in the Building Sector is essential if we are to avoid hazardous climate change.”

*- Edward Mazria ALA  
Founder, Architecture 2030*

# Presentation Topics:

- Distributed Power Generation.
- Site Surveys of the Natural Energy Resource.
- Case Studies: Honolulu, Chicago, San Francisco, Oklahoma
- The building as energy collector.
- Wind and Solar technologies coupled to BIOTECHTURE
- 3<sup>rd</sup> Party Financing Opportunities
- The Future.



## Distributed Power by uploading and downloading it.

It is becoming clear that the future of our electric power will come less from large coal, gas and nuclear power plants, but more from millions of building-integrated micro generators and urban turbines, photoelectric solar panels mounted on the roof-tops of the city with wind and solar farms in the countryside.

Existing national power grids won't disappear. They will operate more like the Internet, as part of a complex web through which people will supply electricity, by uploading, as well as downloading it.”

*Reinhold Ziegler, Solartect*



# Wind Energy Systems Background



- Wind Energy is the greatest terrestrial medium for harvesting and harnessing solar energy.
- The most successful commercial applications have been large horizontal axis, 3 bladed, upwind rotors, constructed as Wind Farms in remote areas of the world.
- Typical construction cost with infrastructure is \$1.50 per watt.
- A 760 KW Mitsubishi machine, pictured here, would cost: \$1.14M to install.

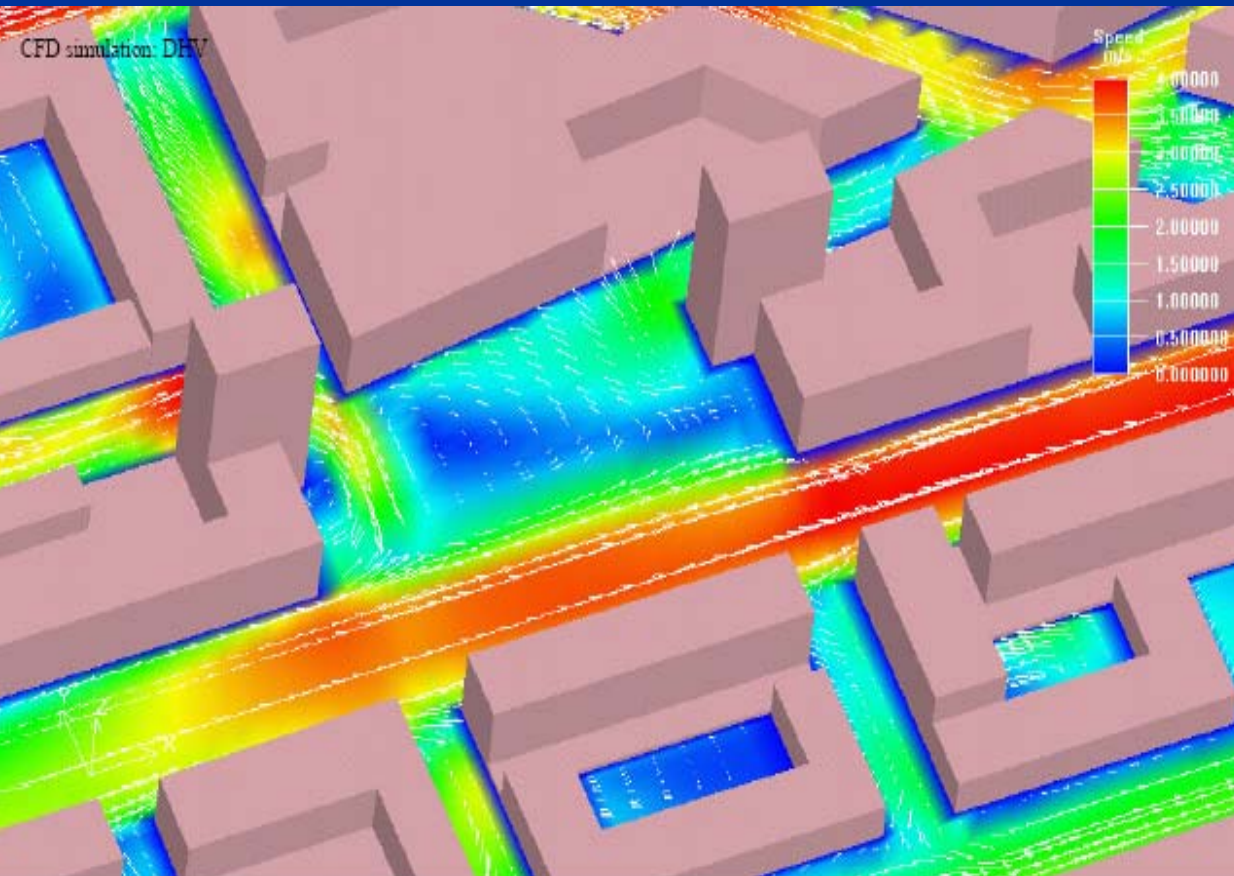


# Conventional Wind Farms in the country



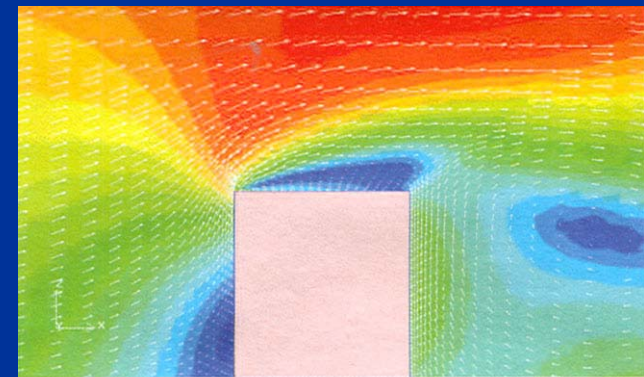
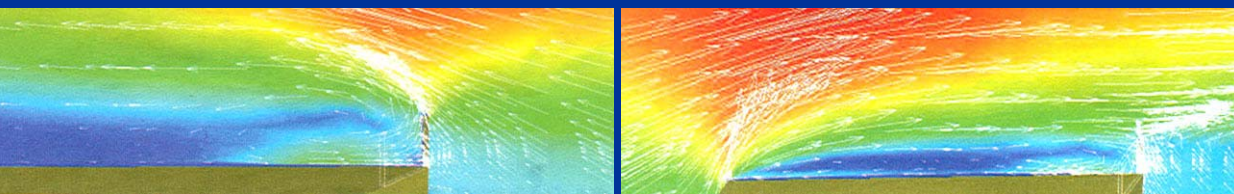


# Wind Energy in the City



When we study the movement of air in the city, streets behave as canyons and channels for accelerating and slowing down the wind.

As we incorporate wind turbines into the building the architectural designer becomes aware of how the building can shape, funnel and harness this huge source of renewable energy.



**FIGURE 1.** Airflow over building roof edge (Computational Fluid Dynamics calculation). Source: DHV



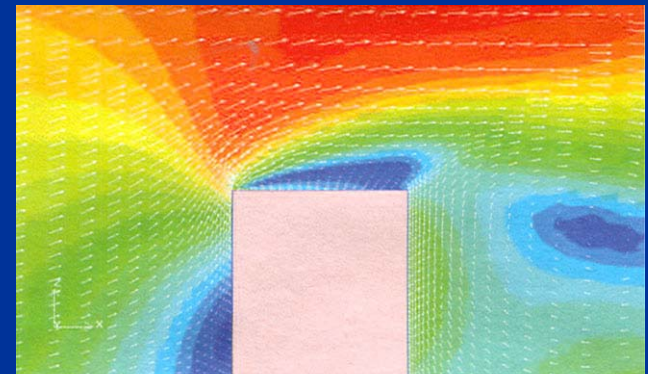
# Buildings as Platforms for Wind Energy



WIndwall in Holland

The windy side of a building can produce an updraft, which if harnessed properly, can produce thousands of KW Hours of power per year. Enough to power the building and perhaps the entire block through mini-grids.

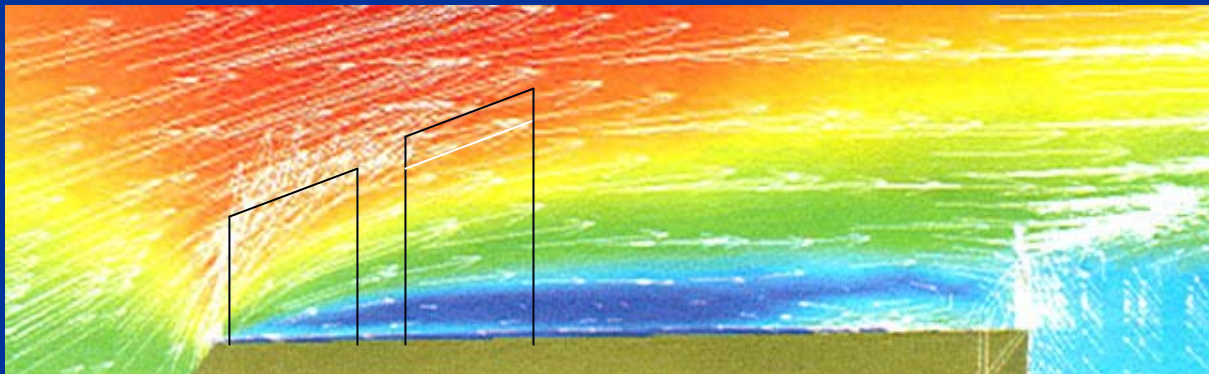
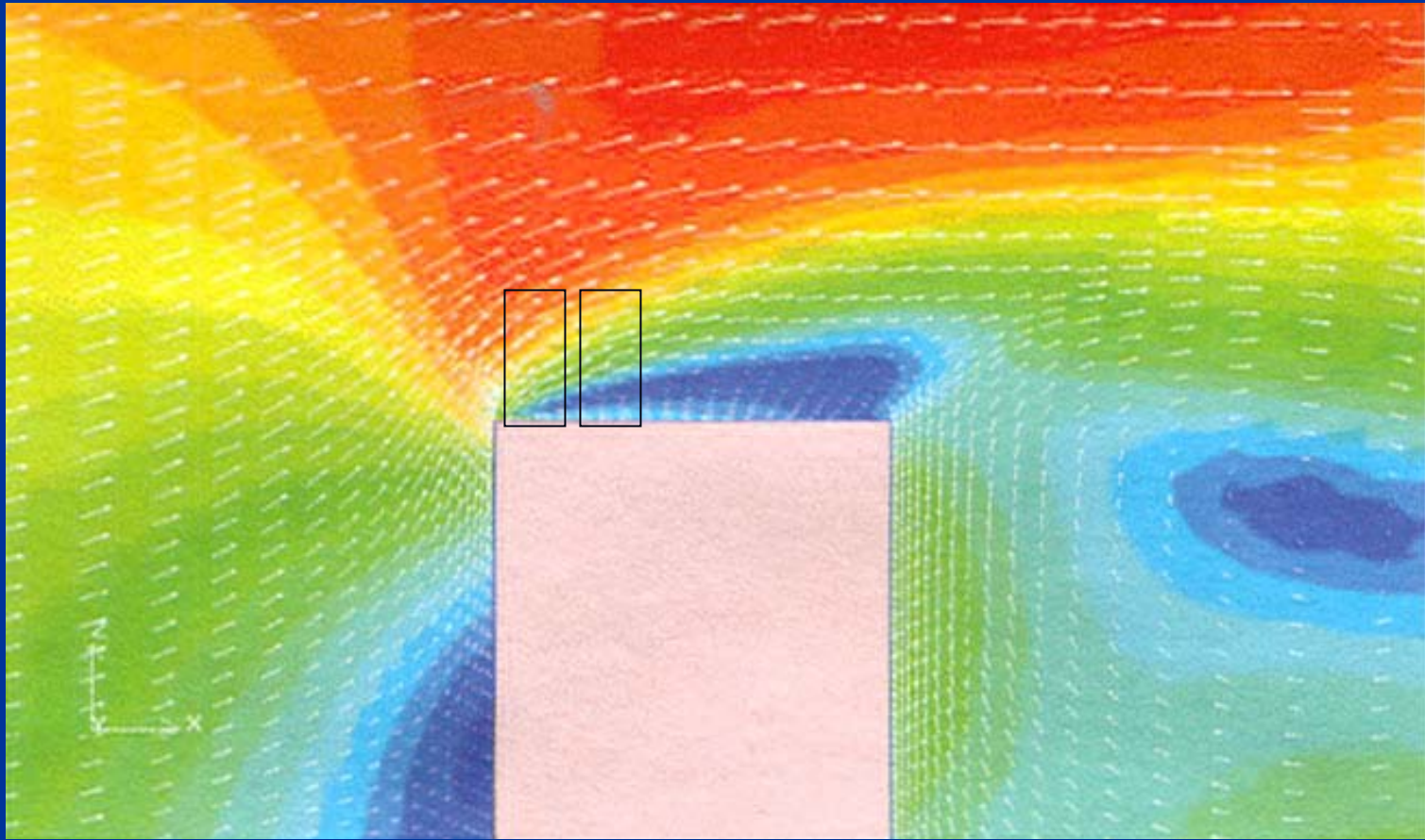
Unlike solar energy systems wind energy can work all day and all night.



**FIGURE 1.** Airflow over building roof edge (Computational Fluid Dynamics calculation). Source: DHV



# Airflow over a building's roof edge

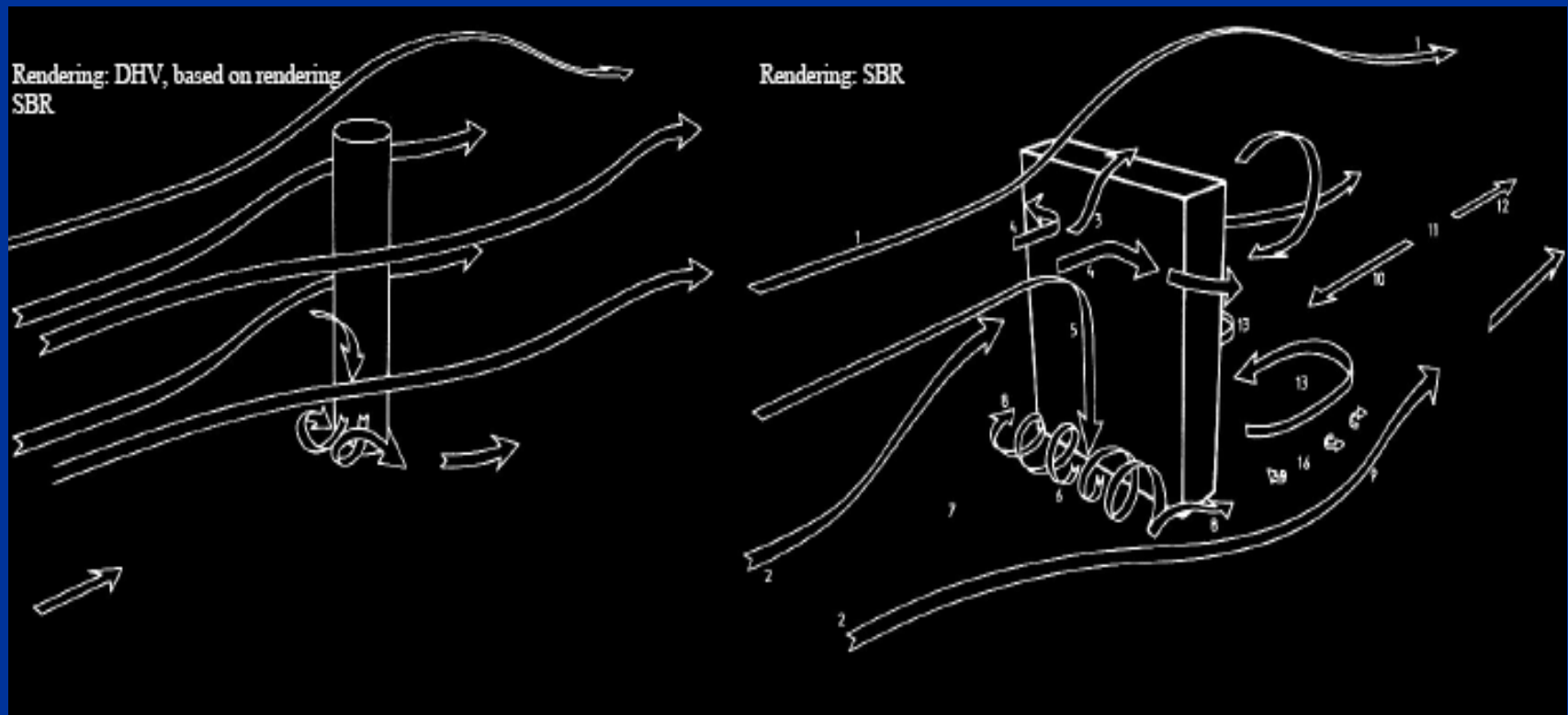


# Wind Energy in the built environment

Characterized by:

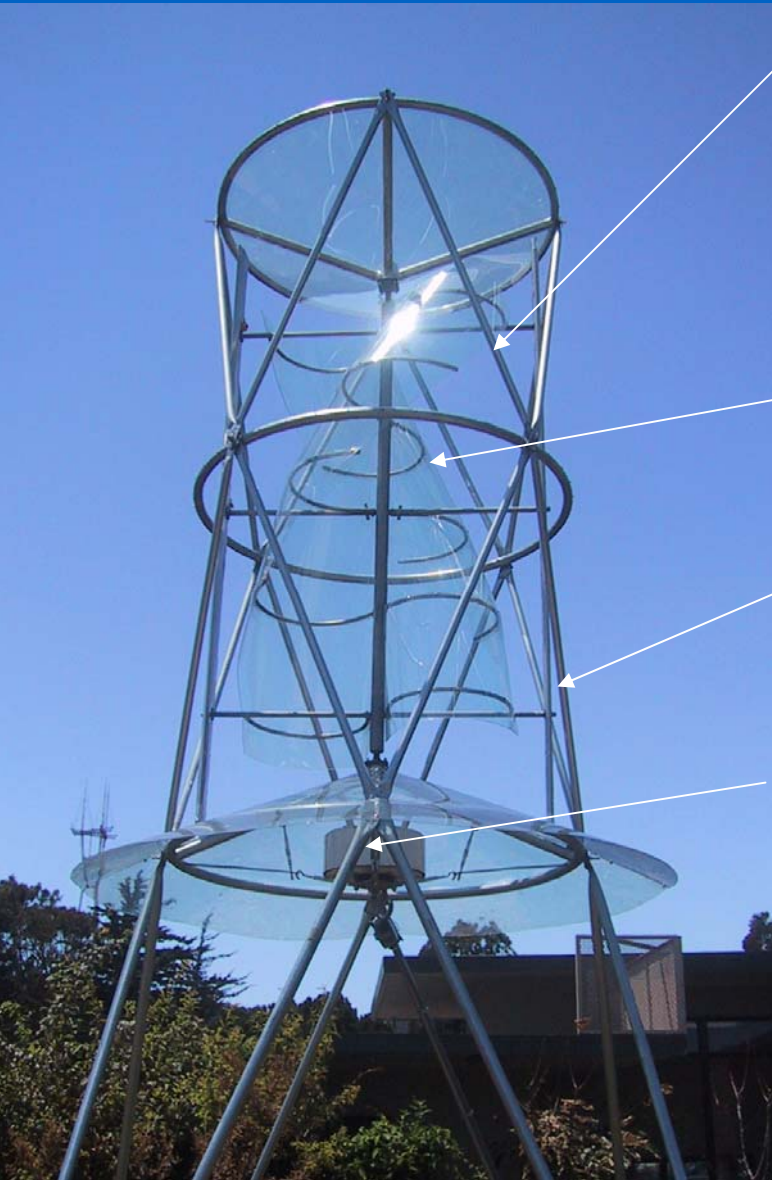
Frequent wind speed changes and frequent wind direction changes.

Compare the aerodynamic behavior of the round building vs. the rectilinear building.  
Consider the potential of the building as an ellipse pointing into the prevailing winds.



# The Aerotecture Urban Wind Turbine

## *"Turban"*



**Integrated Space Frame Tower:** 5' Diameter and 10' high. Can be mounted vertically or horizontally. Can also be enclosed with wire mesh to keep birds out or ducted for increased wind velocities.

**LEXAN Double Helix S Rotor:** a drag rotor with high starting torques. Can accept wind from any direction. Works with low-speed winds.

**Darrieus Rotor:** Two vertical airfoils produce aerodynamic lift.  $TSR = 4$  (blades go 4 times as fast as the wind).

**Boron Neodymium Permanent Magnet Direct Drive, 3 phase Alternator:** Ideal for Windy Boy and other utility inter-tie applications.

The entire system is patented.



# *HELIX-WIND Inc.*



## Specifications of Model C5:

- Rated Power 5 KW
- Rated Wind Speed 21 m/sec
- Cut-in Speed 4 m/sec
- Cut-out Speed None
- No Transmission - Silent Operation
- Maintenance Free
- 5 year Renewable Warranty
- Can take advantage of the wind augmentation of buildings and increased wind velocities at higher building elevation.

# The Mariah Windspire 1.2G Turbine:

|                     |                            |
|---------------------|----------------------------|
| Rated Capacity:     | 1.2KW                      |
| Annual Energy Prod. | 1800 at 11mph              |
| Weight:             | 500 lbs                    |
| Rotor dimensions:   | 4 x 20 ft                  |
| Swept Area:         | 80 sq ft                   |
| Height:             | 30 ft                      |
| Type:               | Giromill                   |
| Rotor Material:     | Extruded Aluminum          |
| Rotor Speed:        | 500 RPM                    |
| Tip Speed Ratio:    | 2.3                        |
| Generator:          | Air core brushless PM      |
| Inverter:           | Integrated, grid-tie 120 V |
| Rated Wind Speed:   | 25 mph                     |
| Survival Speed:     | 100 mph                    |
| Warranty:           | 5 year and extendable      |



# The AeroWind Turbine:



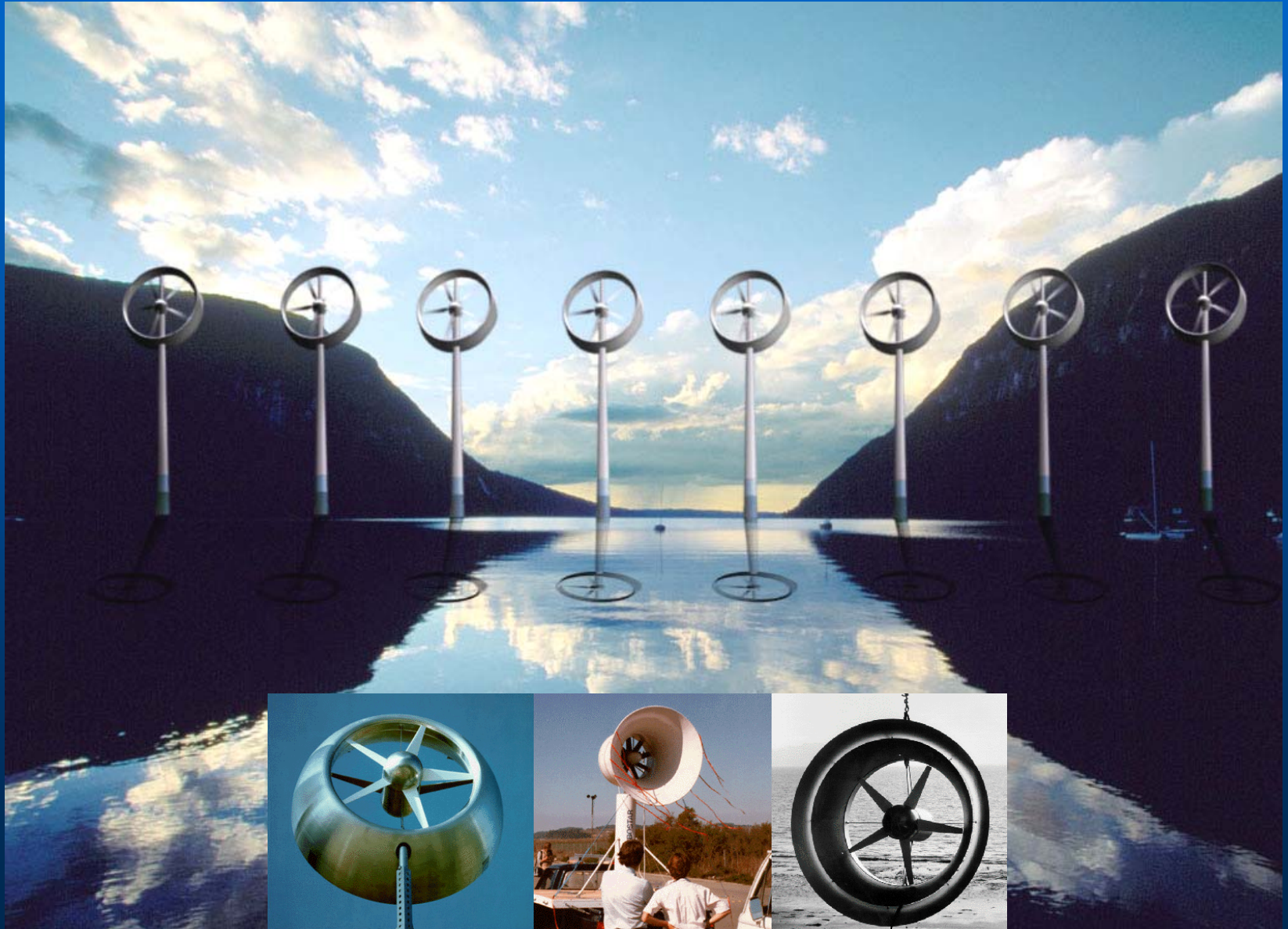
|                     |                            |
|---------------------|----------------------------|
| Rated Capacity:     | 1.2KW                      |
| Annual Energy Prod. | 1800 at 11mph              |
| Weight:             | 150 lbs                    |
| Rotor dimensions:   | 4 x 6 ft                   |
| Swept Area:         | 20 sq ft                   |
| Height:             | 6 ft                       |
| Type:               | Gorlov                     |
| Rotor Material:     | Extruded Aluminum          |
| Rotor Speed:        | 500 RPM                    |
| Tip Speed Ratio:    | 2.3                        |
| Generator:          | Air core brushless PM      |
| Inverter:           | Integrated, grid-tie 120 V |
| Rated Wind Speed:   | 25 mph                     |
| Survival Speed:     | 100 mph                    |
| Warranty:           | 5 year and extendable      |

# Architectural Wind from Aerovironment:



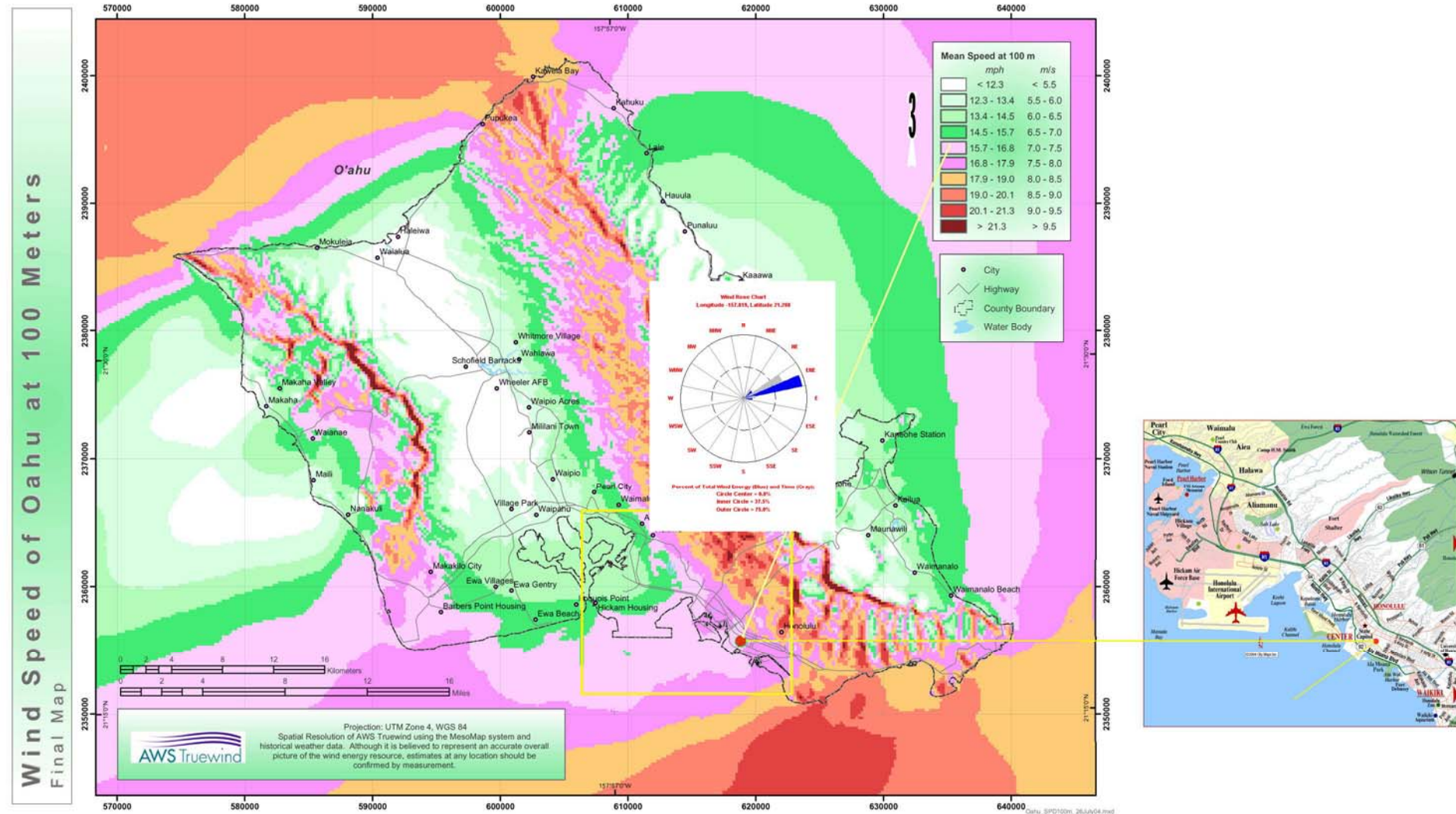


# Turbostar and Hydrostar Fluid Turbines:



# Symphony Park: Honolulu Case Study

Wind Speed and Wind Rose of Oahu at 100 meters.





# Symphony Park: Honolulu Case Study



- From wind rose and wind-spectrum information we are able to align this future building with the free natural energy gradients of sun and wind.
- The roof has 20 Aerotecture wind turbines which are augmented with an upper roof, thereby accelerating the wind further.
- 3 vertical columns of 12 Aerotecture wind turbines (36 total) will be mounted facing the prevailing wind.
- The south-southwestern side will be covered with Unisolar PV panels in the balconies.
- Solar evacuated tubes for hot water and heat-pumps for air conditioning are on the very top of the structure.

# Symphony Park: Honolulu Case Study

56 turbines producing 600 KWhrs every day.

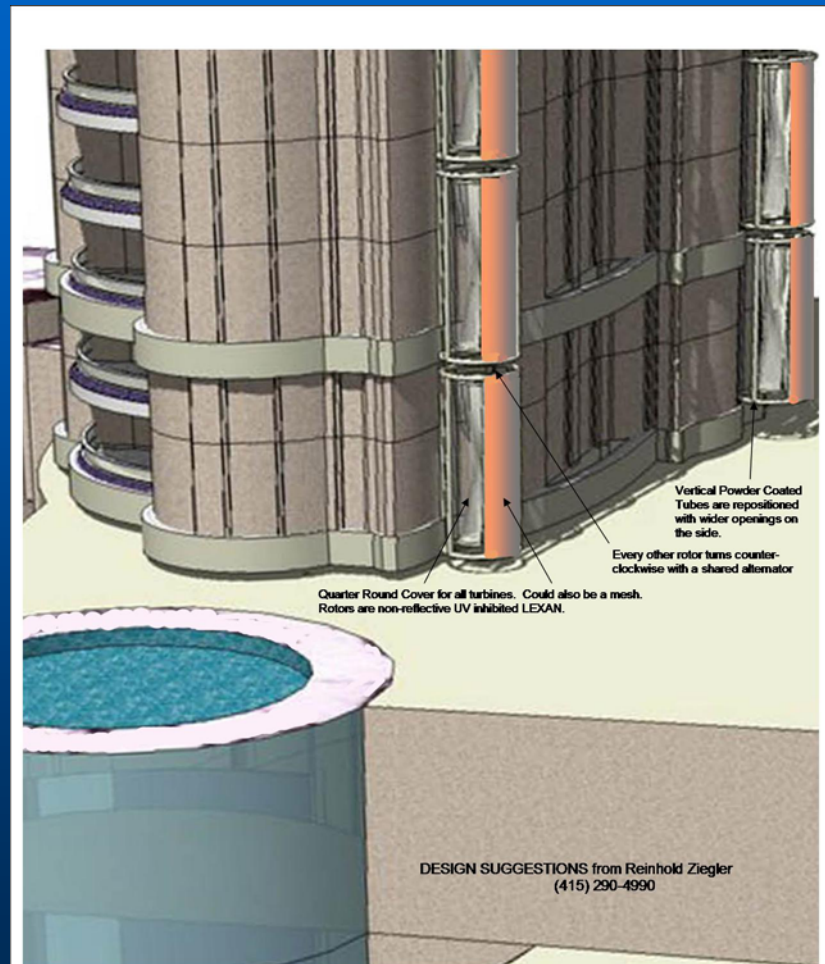


CONCEPT DEVELOPMENT PREPARED FOR:  
MR. JOE NICOLAI & MR. DON EOVINO

BY: CHRISTOPHER BELKNAP  
DESIGN EARTH SYNERGY  
JUNE 30, 2005

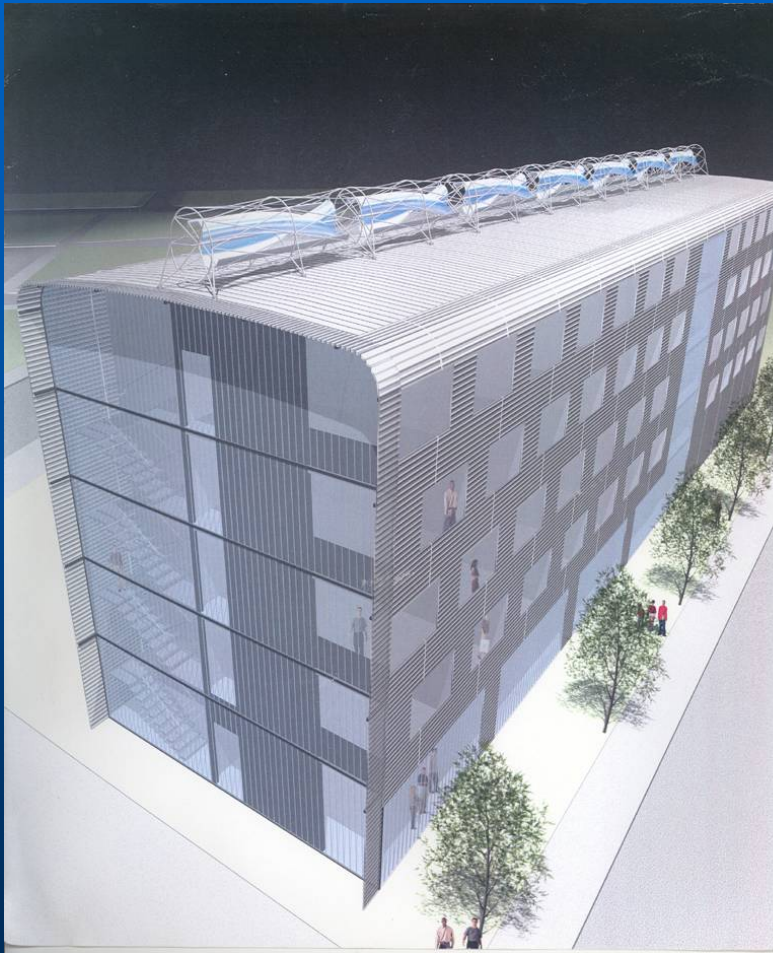
0 25' 50' 75' 100'

ONE PIAZZA TOWER - HONOLULU





# Helmut Jahn: Chicago Case Study



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# Helmut Jahn: Chicago Case Study



# Helmut Jahn: Chicago Case Study



November 2006

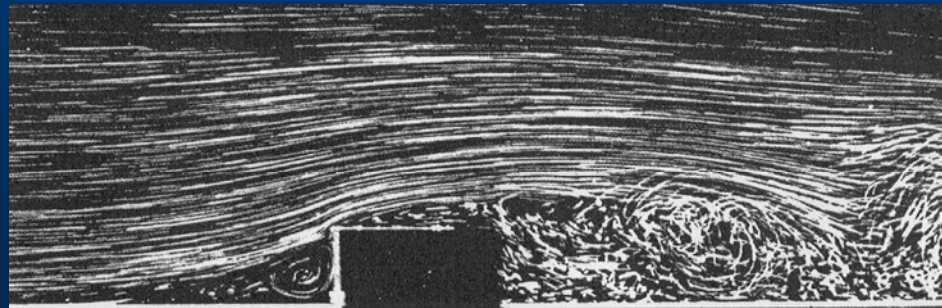


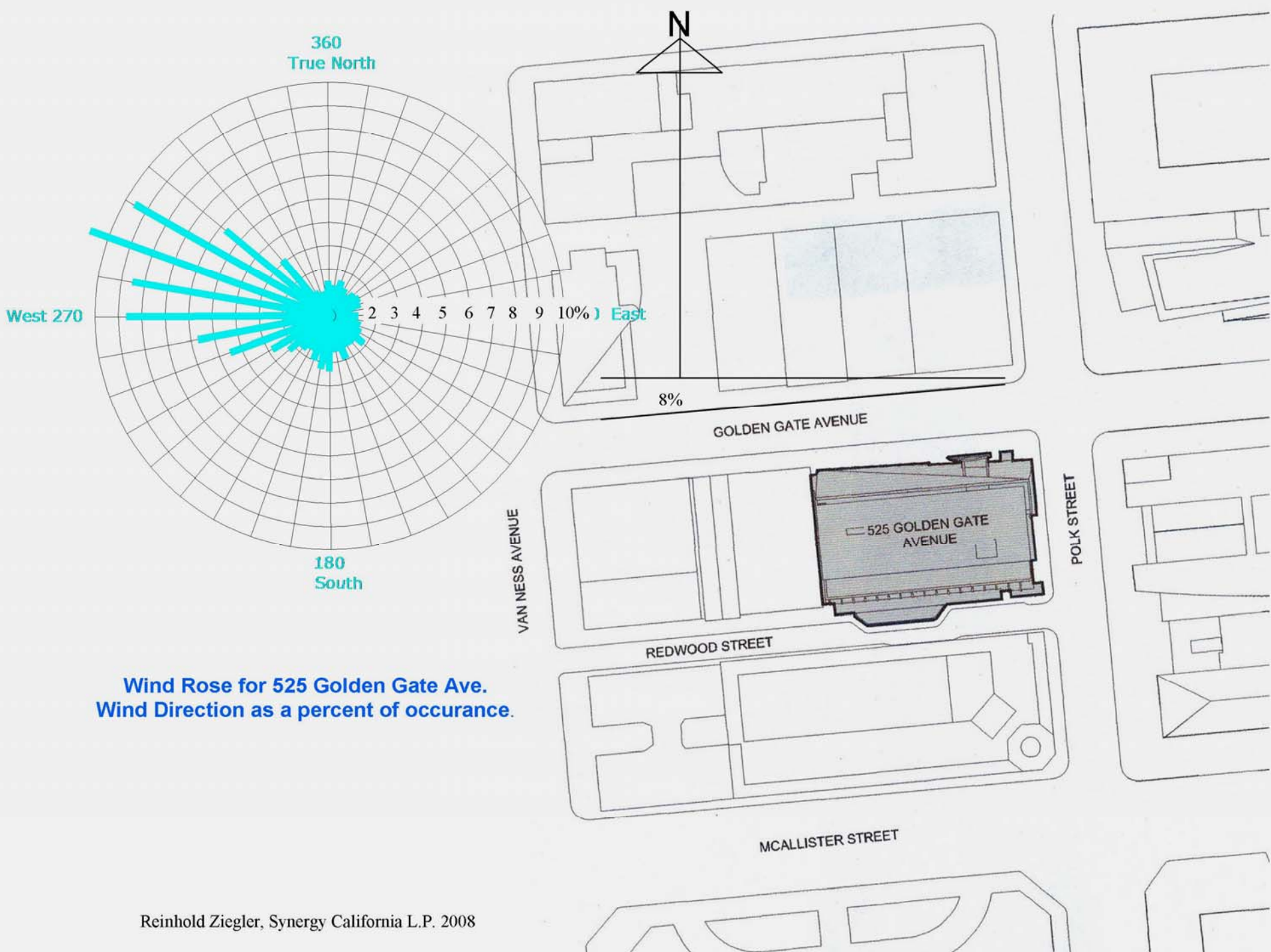
# The San Francisco Public Utilities Building



Stream lines of air from the N.W. approaching the San Francisco Civic Center and impacting the SFPUC Building.

City Rendering, Courtesy GOOGLE Earth

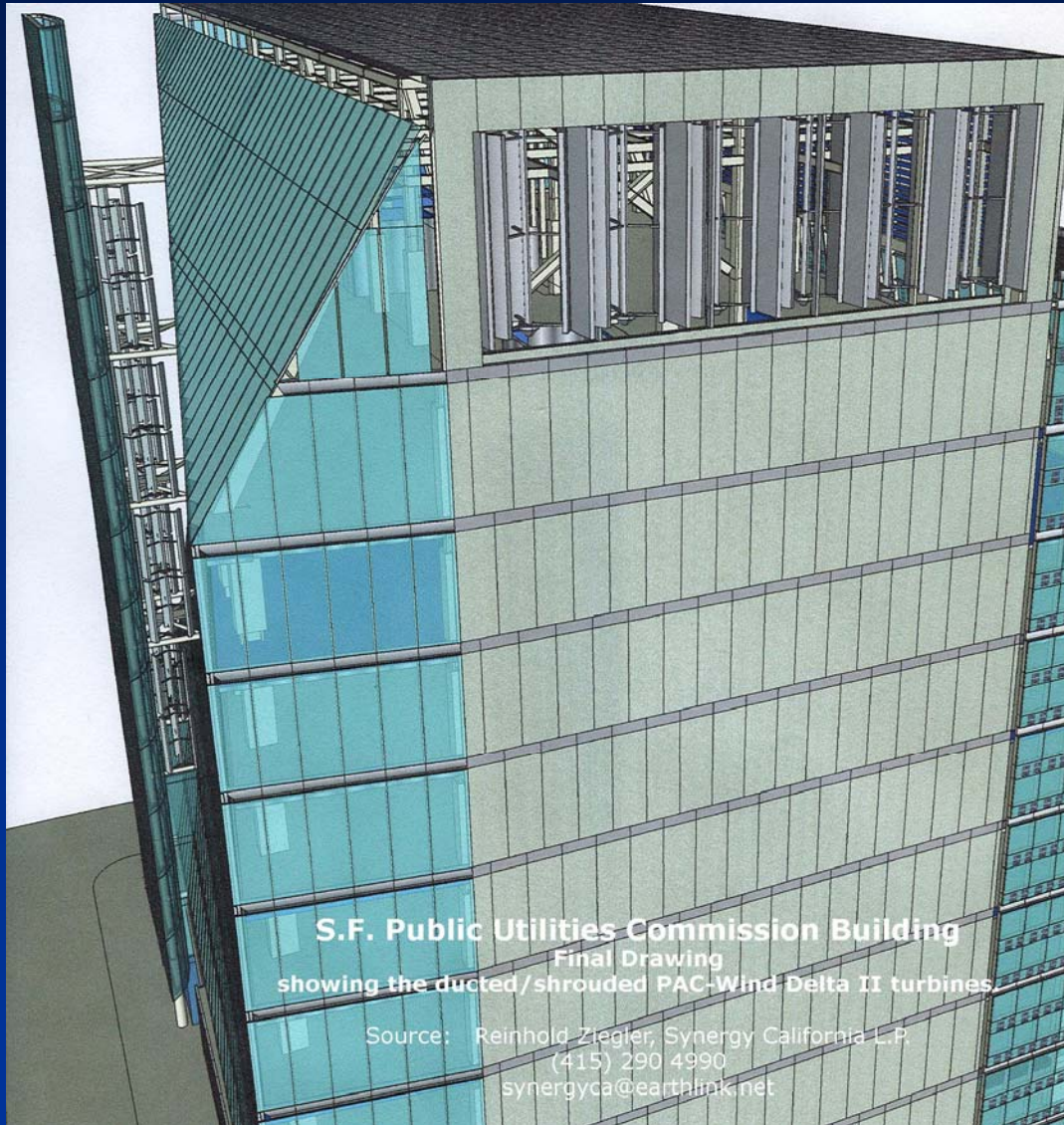




Wind Rose for 525 Golden Gate Ave.  
Wind Direction as a percent of occurrence.



# S.F.P.U.C. Building



KMD/Stevens Architects, ARUP, and Synergy are currently studying how to achieve maximum energy self reliance for this proposed building.

Aside from substantial energy conservation...

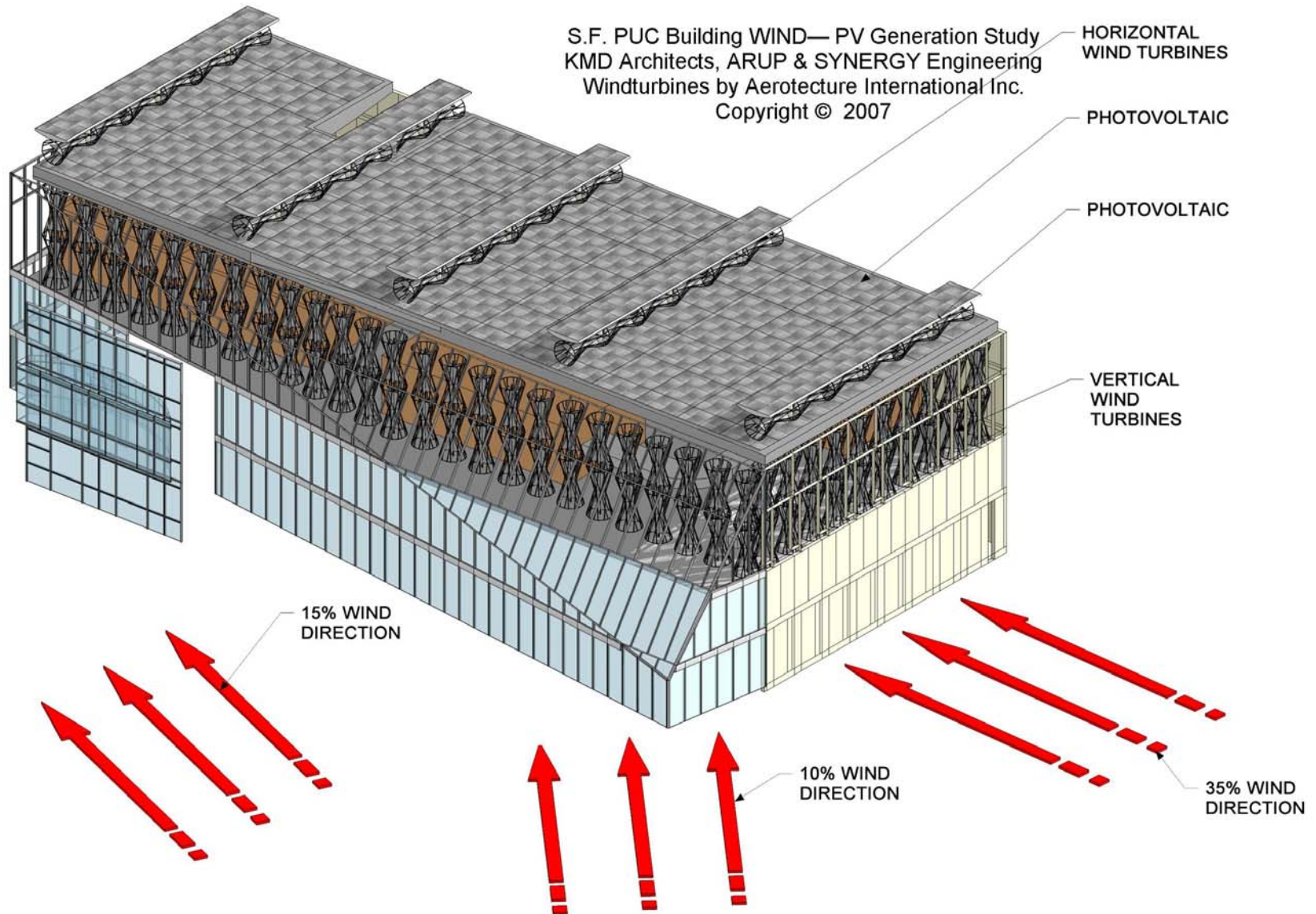
Methods are being explored for generating new energy including:

Solar PV on the roof and south façade,

Urban Wind turbines systems utilizing a ducted shroud to accelerate and control the wind.

The building will achieve Platinum LEED rating.

# S.F.P.U.C. Building Studies





# S.F.P.U.C. Building Studies





Ducted Shroud  
or Windwall.

This Airfoil acts to  
accelerate the wind  
making more  
energy available to  
the wind-turbines

Prevailing  
Winds

from the NW

Vertical Axis  
Wind-turbines

Architecture: KMD-Stevens, San Francisco





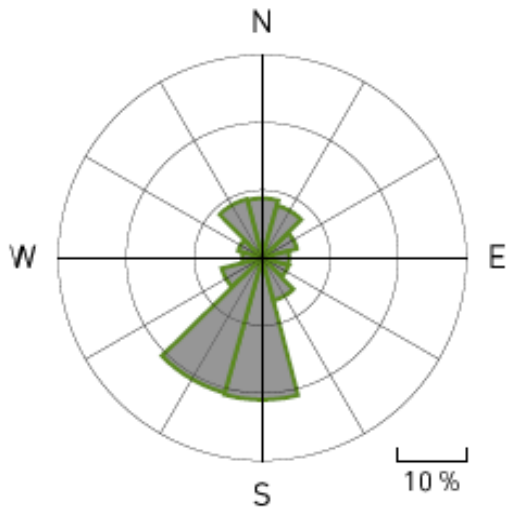
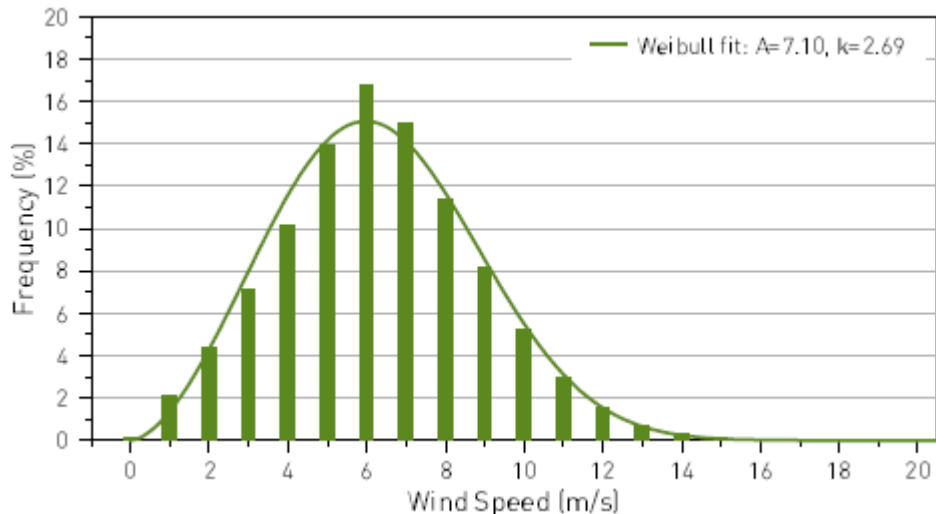
Future San Francisco Public Utility Commission Building  
Building Integrated Wind Energy Systems Design: Reinhold Ziegler, Synergy California L.P. (415) 290 4990

# Oklahoma Medical Research Foundation, Oklahoma City, OK



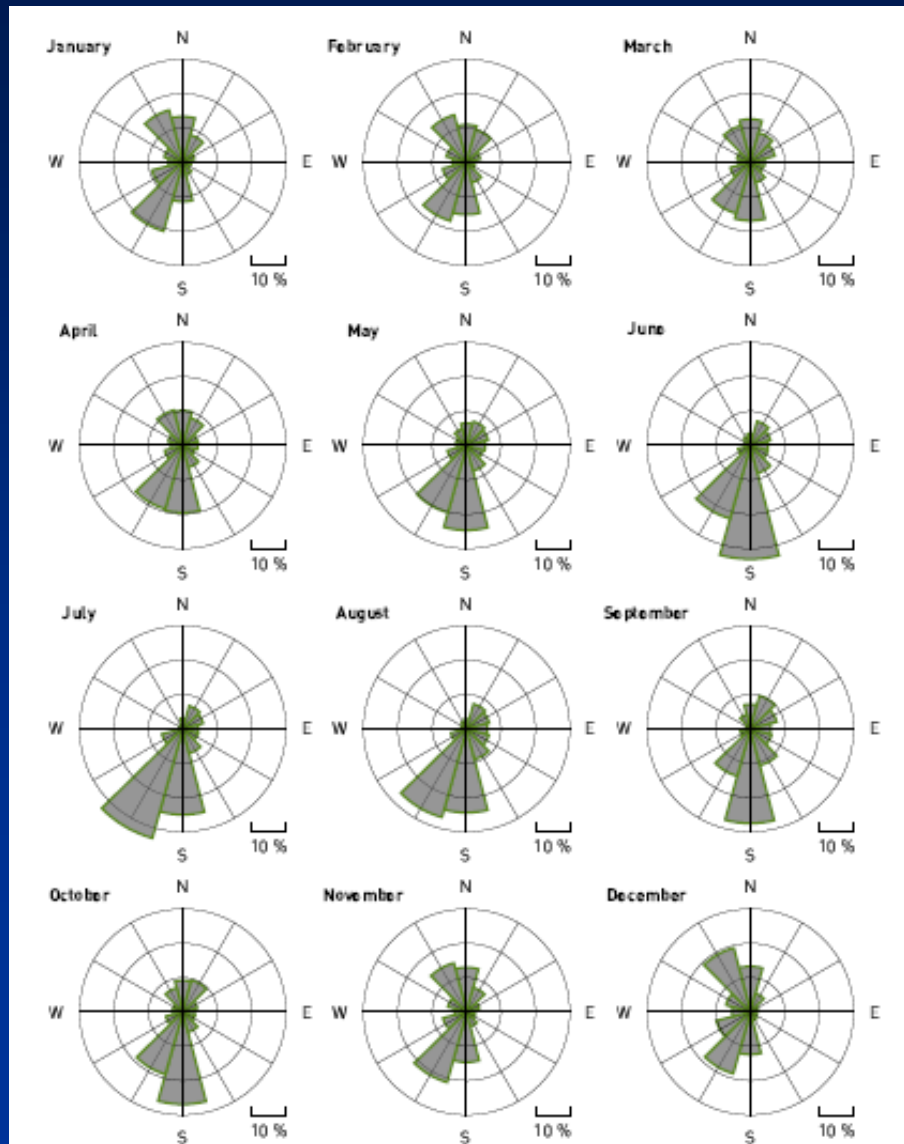
Architects: Perkins +Will Inc.   Solartects: Synergy California L.P.   Windturbines: *HELIX-WIND Inc.*

## Wind Spectrum and Wind Rose Summary



# Oklahoma Medical Research Foundation,

## Monthly Wind Roses





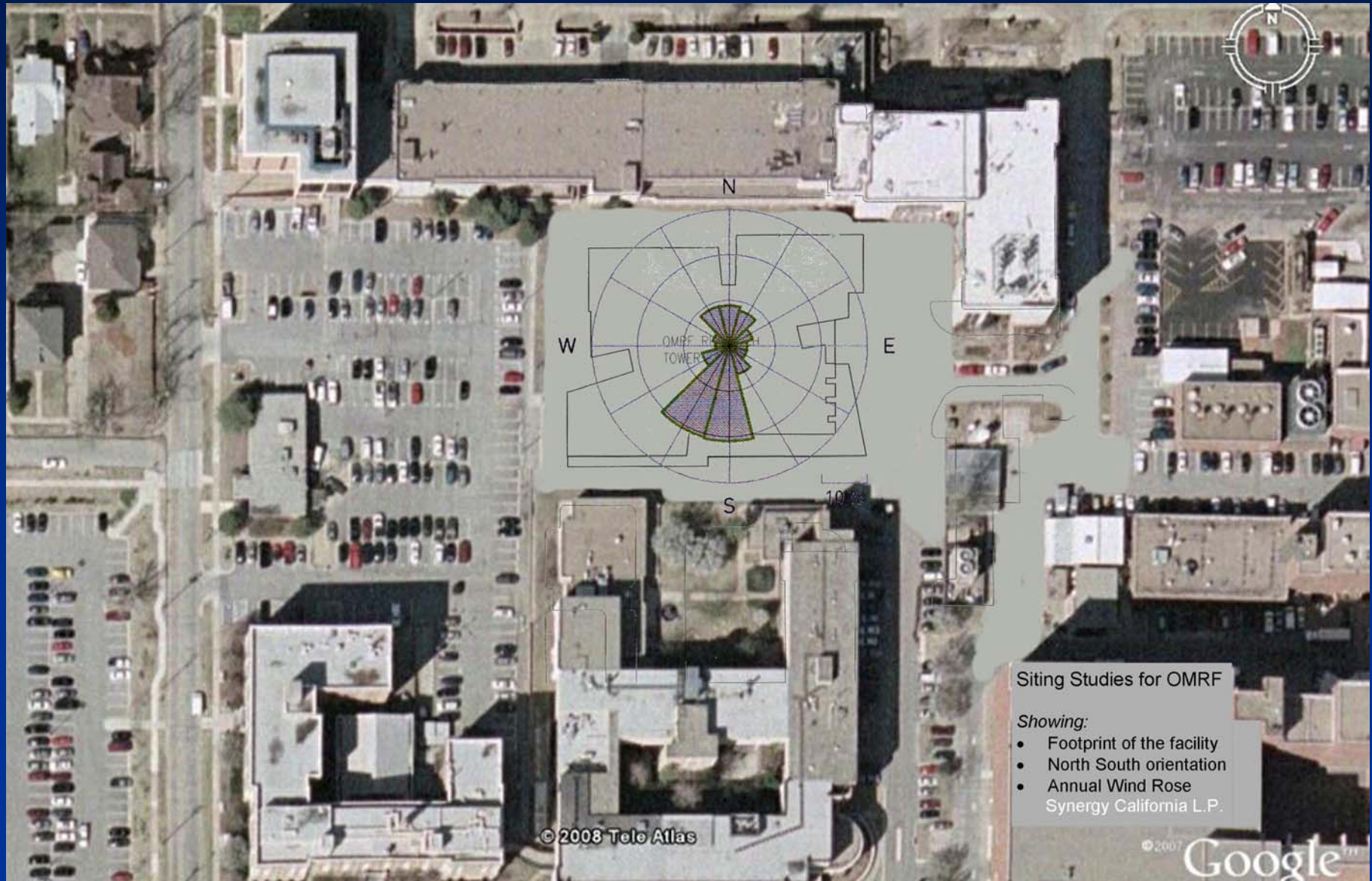
# Oklahoma Medical Research Foundation,

## Hourly Mean Wind Speed:

| hour | jan | feb | mar | apr | may | jun | jul | aug | sep | oct | nov | dec | avg |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 00   | 5.9 | 6.1 | 6.4 | 7.1 | 6.6 | 6.3 | 5.6 | 5.2 | 5.5 | 5.9 | 6.1 | 6.1 | 6.1 |
| 01   | 6.1 | 6.1 | 6.4 | 6.9 | 6.4 | 6.0 | 5.5 | 5.3 | 5.8 | 6.1 | 6.2 | 6.1 | 6.1 |
| 02   | 6.2 | 6.2 | 6.6 | 7.1 | 6.8 | 6.4 | 5.9 | 5.7 | 6.0 | 6.3 | 6.3 | 6.2 | 6.3 |
| 03   | 6.2 | 6.3 | 6.6 | 7.3 | 7.1 | 6.8 | 6.2 | 6.1 | 6.2 | 6.4 | 6.3 | 6.3 | 6.5 |
| 04   | 6.2 | 6.3 | 6.7 | 7.4 | 7.3 | 6.9 | 6.4 | 6.2 | 6.3 | 6.4 | 6.3 | 6.3 | 6.6 |
| 05   | 6.3 | 6.2 | 6.7 | 7.4 | 7.4 | 7.1 | 6.5 | 6.2 | 6.3 | 6.5 | 6.3 | 6.3 | 6.6 |
| 06   | 6.3 | 6.2 | 6.6 | 7.5 | 7.4 | 7.0 | 6.6 | 6.3 | 6.2 | 6.5 | 6.3 | 6.3 | 6.6 |
| 07   | 6.3 | 6.2 | 6.6 | 7.5 | 7.3 | 7.1 | 6.7 | 6.3 | 6.2 | 6.5 | 6.3 | 6.3 | 6.6 |
| 08   | 6.3 | 6.1 | 6.8 | 7.4 | 7.4 | 7.1 | 6.6 | 6.3 | 6.2 | 6.4 | 6.3 | 6.3 | 6.6 |
| 09   | 6.2 | 6.1 | 6.8 | 7.4 | 7.4 | 6.9 | 6.5 | 6.2 | 6.0 | 6.4 | 6.3 | 6.3 | 6.5 |
| 10   | 6.2 | 6.1 | 6.8 | 7.3 | 7.3 | 6.7 | 6.3 | 6.0 | 5.9 | 6.3 | 6.2 | 6.2 | 6.5 |
| 11   | 6.2 | 6.2 | 6.8 | 7.3 | 7.2 | 6.7 | 6.2 | 5.9 | 5.8 | 6.3 | 6.2 | 6.3 | 6.4 |
| 12   | 6.2 | 6.1 | 6.8 | 7.2 | 7.1 | 6.6 | 6.1 | 5.7 | 5.8 | 6.2 | 6.2 | 6.3 | 6.4 |
| 13   | 6.3 | 6.1 | 6.8 | 7.1 | 6.8 | 6.1 | 5.6 | 5.4 | 5.8 | 6.4 | 6.3 | 6.4 | 6.2 |
| 14   | 6.3 | 6.0 | 6.6 | 6.9 | 6.7 | 6.2 | 5.6 | 5.1 | 5.3 | 6.2 | 6.3 | 6.4 | 6.1 |
| 15   | 6.1 | 5.8 | 6.6 | 7.2 | 6.8 | 6.3 | 5.6 | 5.1 | 5.5 | 5.9 | 6.0 | 6.2 | 6.1 |
| 16   | 5.9 | 5.8 | 6.8 | 7.5 | 6.9 | 6.2 | 5.4 | 5.0 | 5.5 | 6.1 | 6.0 | 6.0 | 6.1 |
| 17   | 6.0 | 6.0 | 6.9 | 7.6 | 6.8 | 6.1 | 5.3 | 4.8 | 5.4 | 6.3 | 6.2 | 6.0 | 6.1 |
| 18   | 6.2 | 6.2 | 7.0 | 7.6 | 6.8 | 6.1 | 5.2 | 4.8 | 5.4 | 6.3 | 6.3 | 6.2 | 6.2 |
| 19   | 6.3 | 6.3 | 7.0 | 7.6 | 6.8 | 6.1 | 5.2 | 4.8 | 5.4 | 6.4 | 6.3 | 6.3 | 6.2 |
| 20   | 6.3 | 6.4 | 7.0 | 7.6 | 6.8 | 6.2 | 5.3 | 4.9 | 5.4 | 6.4 | 6.4 | 6.3 | 6.2 |
| 21   | 6.3 | 6.5 | 7.0 | 7.7 | 6.8 | 6.2 | 5.3 | 4.9 | 5.4 | 6.4 | 6.3 | 6.3 | 6.3 |
| 22   | 6.2 | 6.5 | 7.0 | 7.6 | 6.8 | 6.3 | 5.3 | 5.0 | 5.5 | 6.4 | 6.2 | 6.1 | 6.2 |
| 23   | 5.9 | 6.3 | 6.8 | 7.5 | 6.8 | 6.3 | 5.5 | 5.1 | 5.5 | 6.1 | 6.0 | 5.8 | 6.1 |
| avg  | 6.2 | 6.2 | 6.8 | 7.4 | 7.0 | 6.5 | 5.8 | 5.5 | 5.8 | 6.3 | 6.2 | 6.2 | 6.3 |

# Oklahoma Medical Research Foundation,

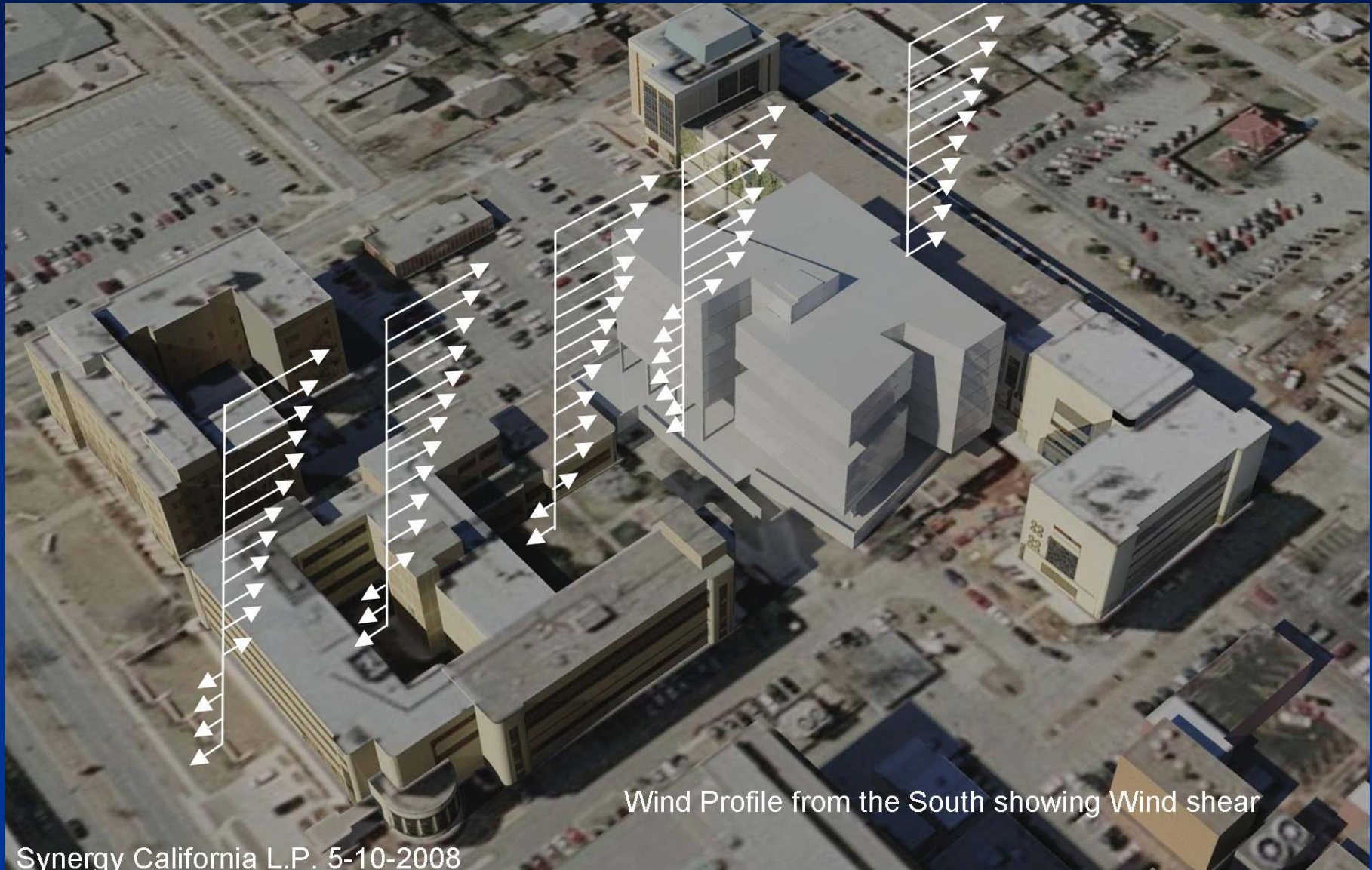
Wind Rose superimposed over the future building site.





# Oklahoma Medical Research Foundation,

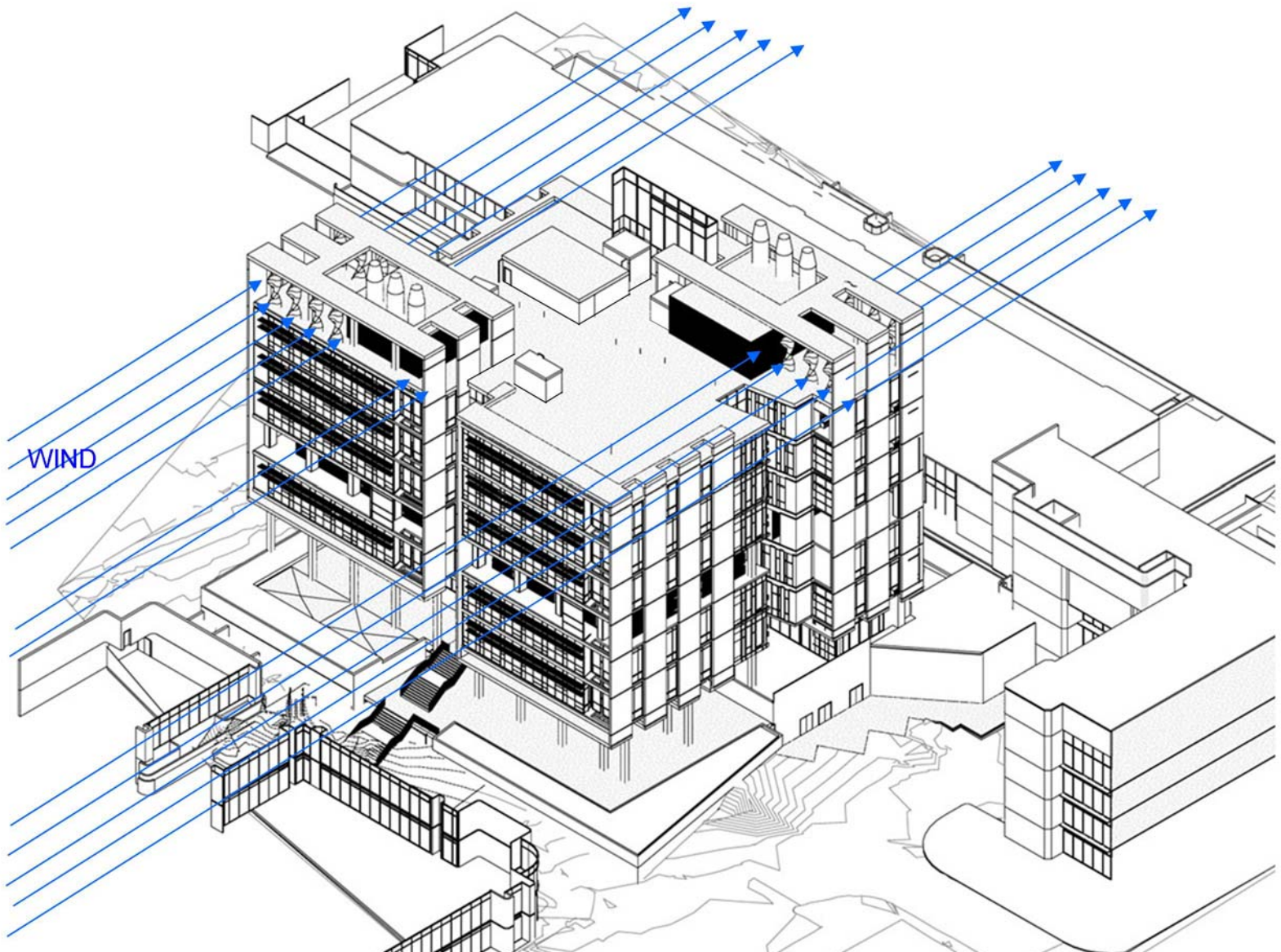
Wind Profile superimposed over the massing study.





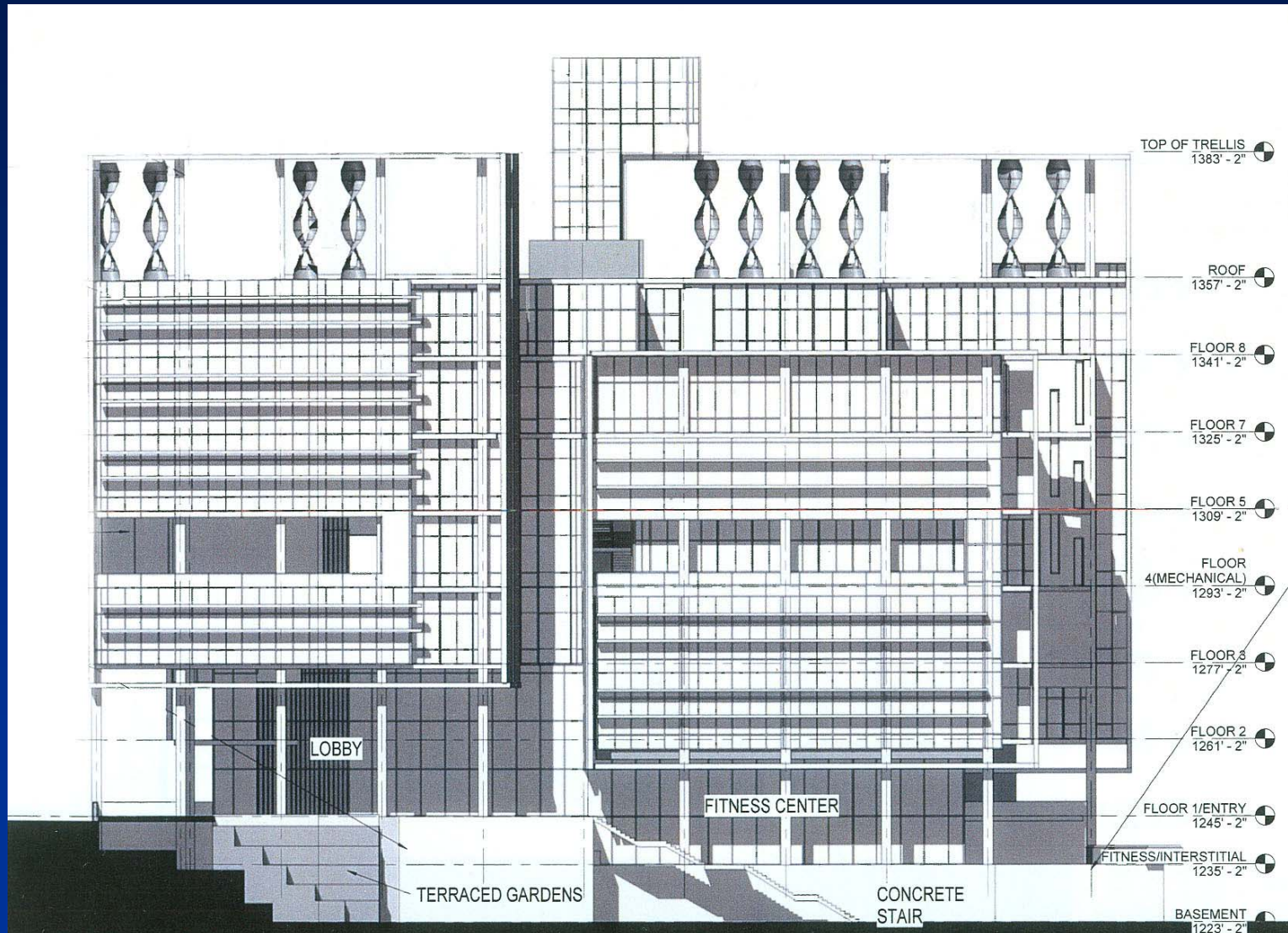
# Oklahoma Medical Research Foundation,

## The Roof as solar and wind energy collector



# Oklahoma Medical Research Foundation,

## The Alcoves as ducted shrouds and PV platforms





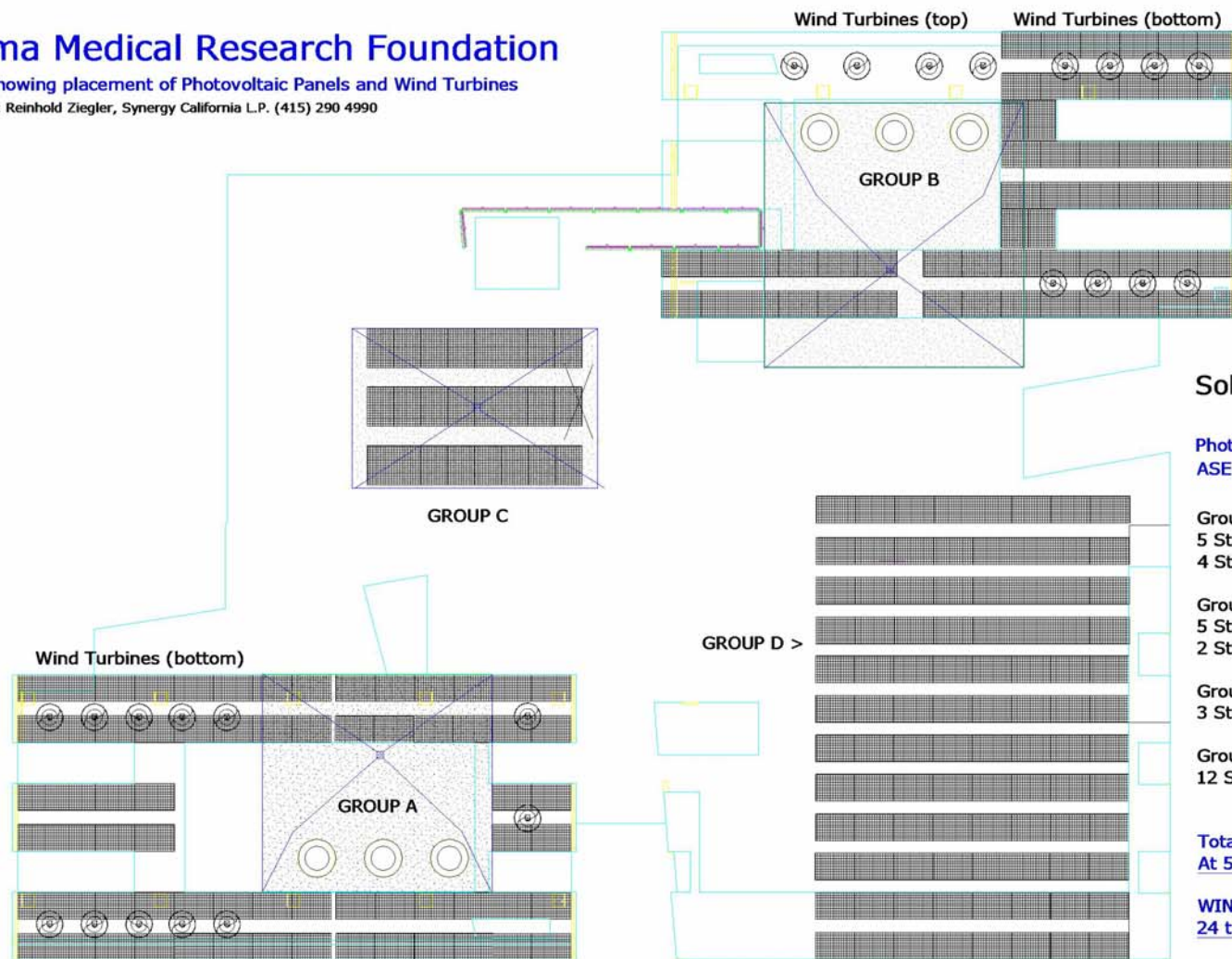
# Oklahoma Medical Research Foundation,

## The Roof Plan showing the placement of solar and wind energy collectors

### Oklahoma Medical Research Foundation

Roof Plan showing placement of Photovoltaic Panels and Wind Turbines

Energy Design: Reinhold Ziegler, Synergy California L.P. (415) 290 4990



### Solar and Wind Energy Assets:

#### Photovoltaics (PV)

ASE-300-DGF/50 300 watts output

#### Group A

5 Strings of 8 = 40 panels  
4 Strings of 7 = 28 panels  
Total: 68 panels = 20,400 watts

#### Group B

5 Strings of 7 = 35 panels  
2 Strings of 8 = 16 panels  
Total: 51 panels = 15,300 watts

#### Group C

3 Strings of 8 = 24 panels  
Total: 24 panels = 7,200 watts

#### Group D

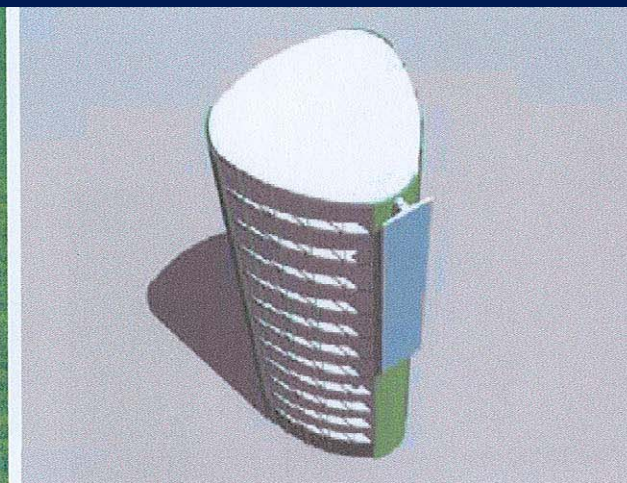
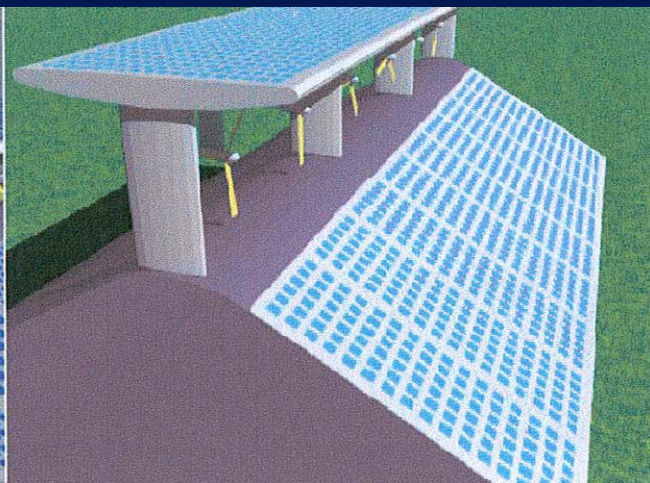
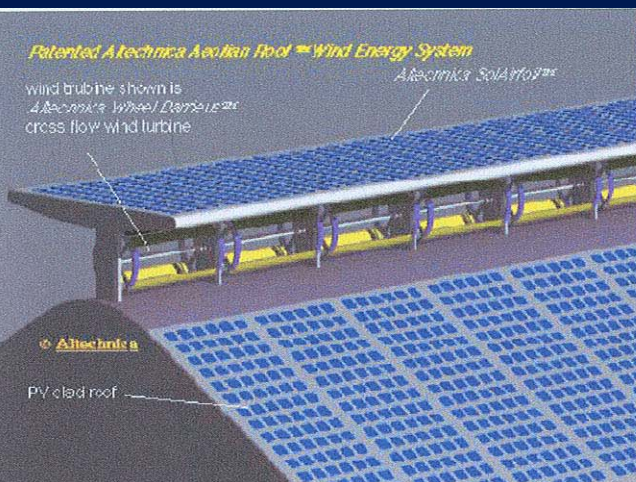
12 Strings of 8 = 96 panels  
Total: 96 panels = 28,800 watts

Total PV Capacity on Roof = 71,700 watts  
At 5.5 hours/day = 394,435 watt hours/day MAX

#### WIND: Helix Wind turbines

24 turbines generating 158,640 watt hours/day

# Architectural Energy Elements



The new energy architecture will have diffusers and augmentors for the wind turbines. These building elements will accelerate the mass flow of air through the turbines. Diffusers can be horizontal across the roof or mounted vertically along a high-rise. In some cases these shrouds can also be mounts for PV collectors. The diffusers can also have inlet and outlet screens to keep birds out. An increase of 2.5 mph in windspeed through the shroud will double the output of a wind turbine.



# “Aero Highways”

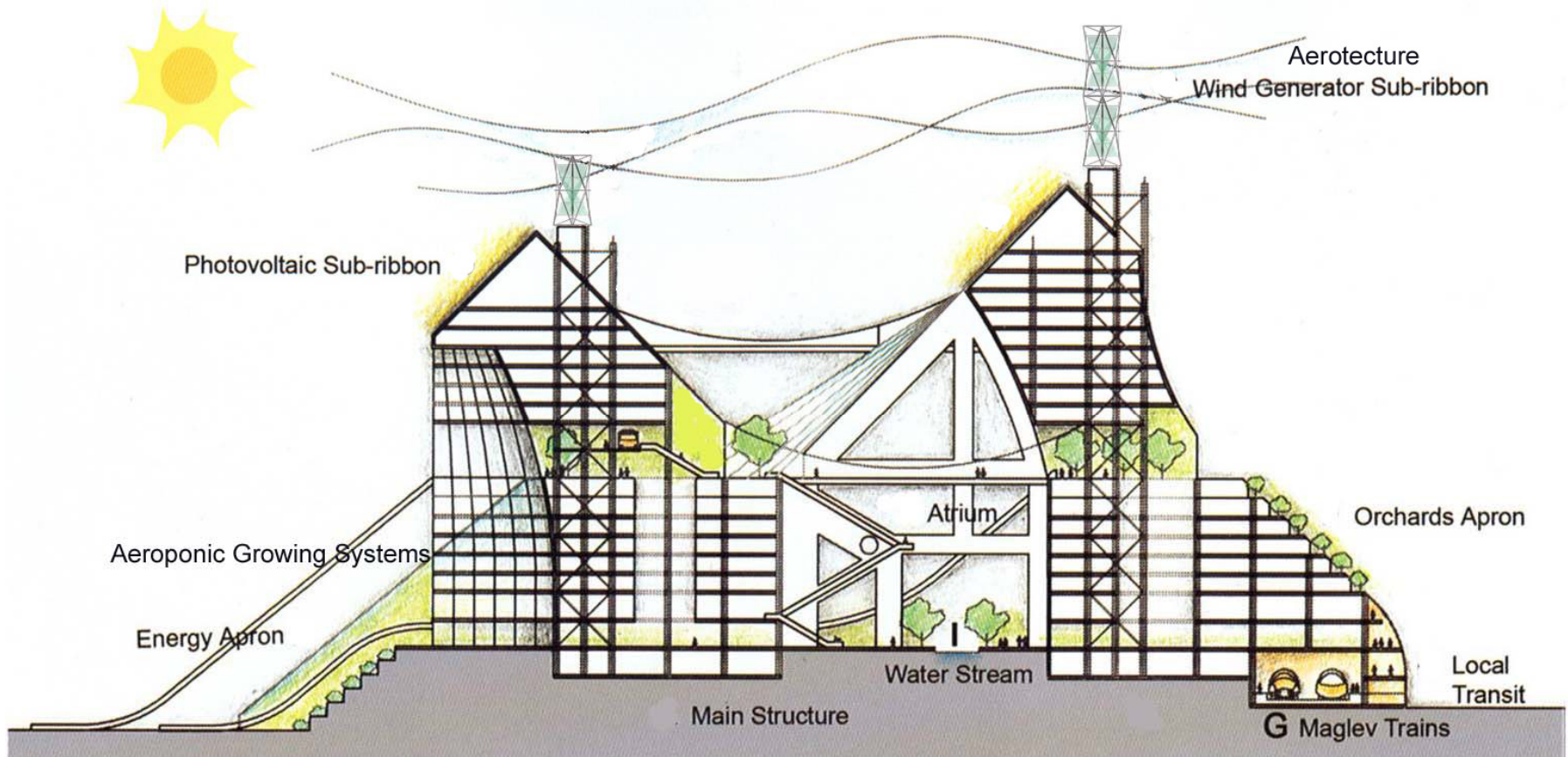


For the California Transportation Agency (Caltrans) and the Illinois Department of Transportation we are proposing “Aero Highways”.

These wind-turbines mounted in the center divider of the highway will be capable of harnessing energy from automobiles going in opposite and similar directions.



# A Linear Green City for China



## LEAN URBAN RIBBON CITY

**Architectural Design:** Paolo Soleri, Cosanti Foundation

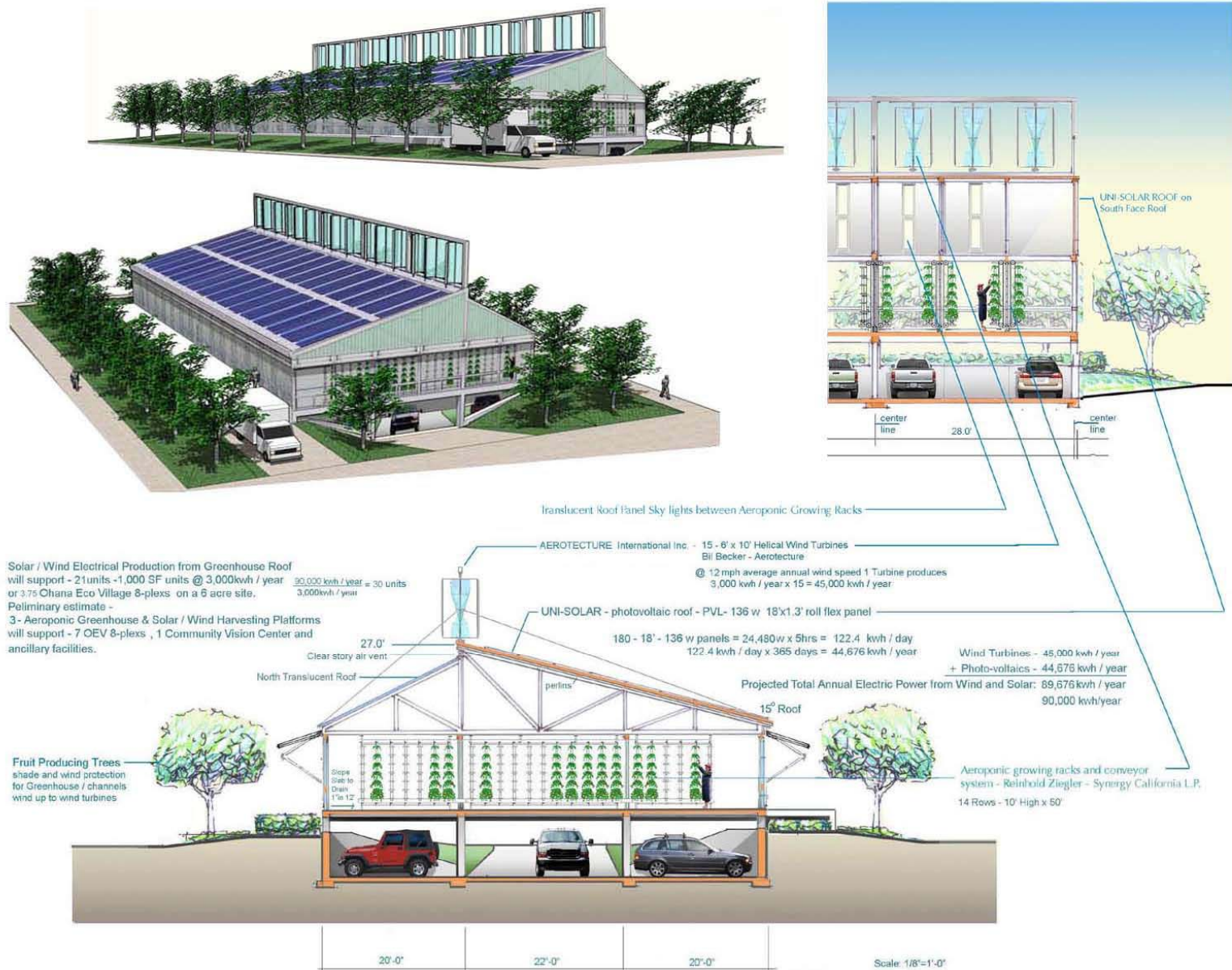
**Energy Systems:** Aerotecture, Ltd, Synergy Developers

**Trains and Group Transportation Systems:** Transitplaza

**Landscaping:** Green Century Institute

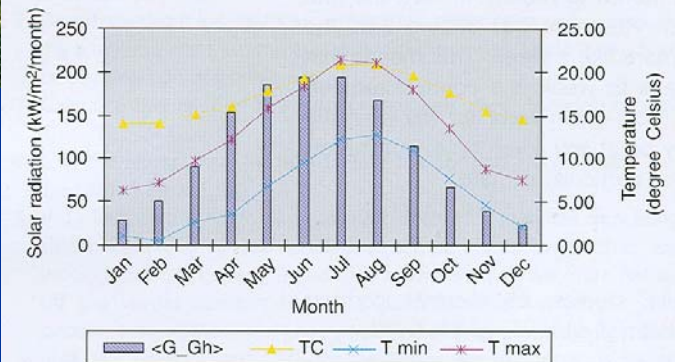
From a Proposal for a Linear Green City for China

# Aeroponic Greenhouse & Solar/Wind Energy Harvesting Platforms

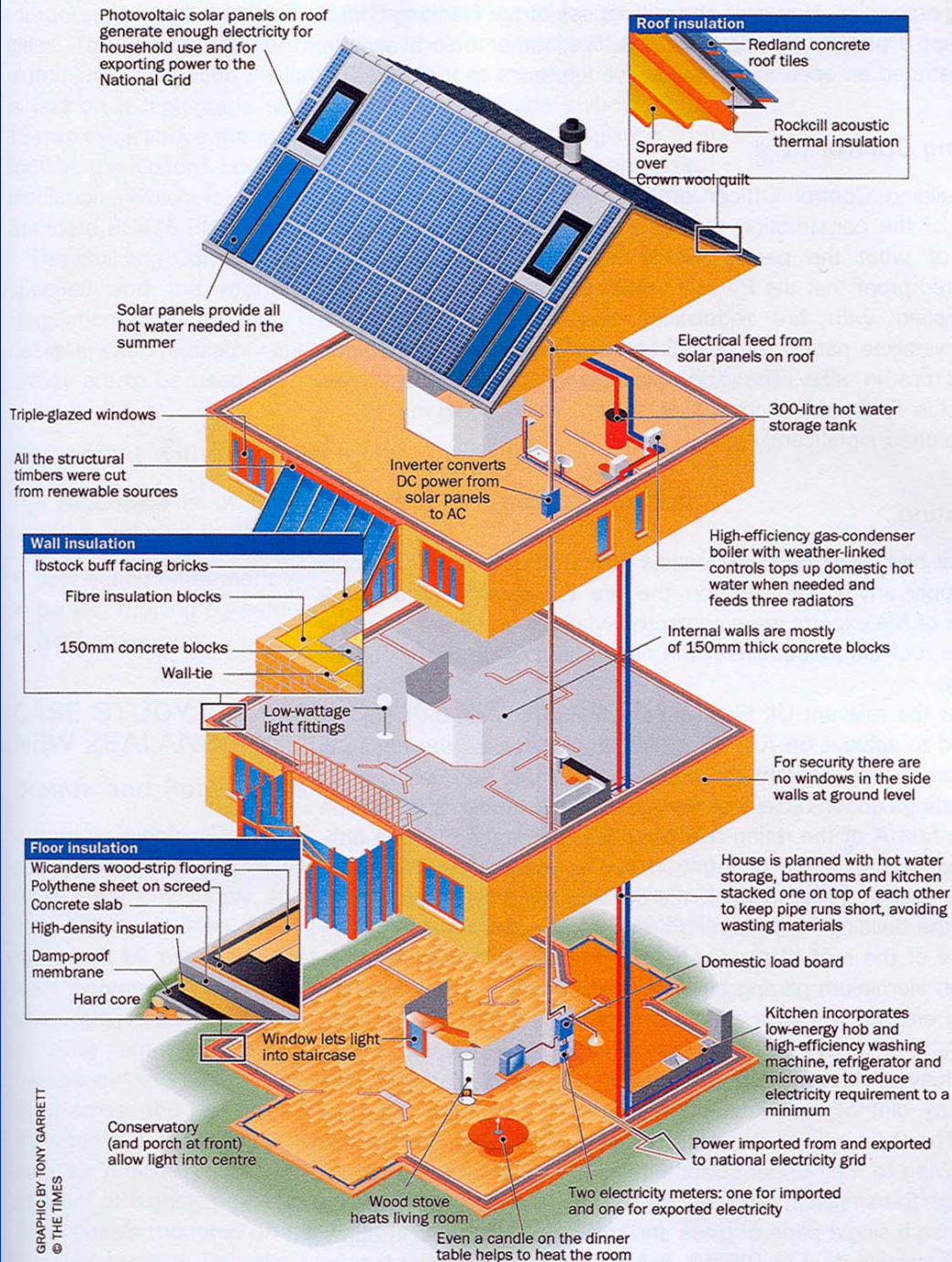




# Building Integrated Solar Photovoltaic Buildings









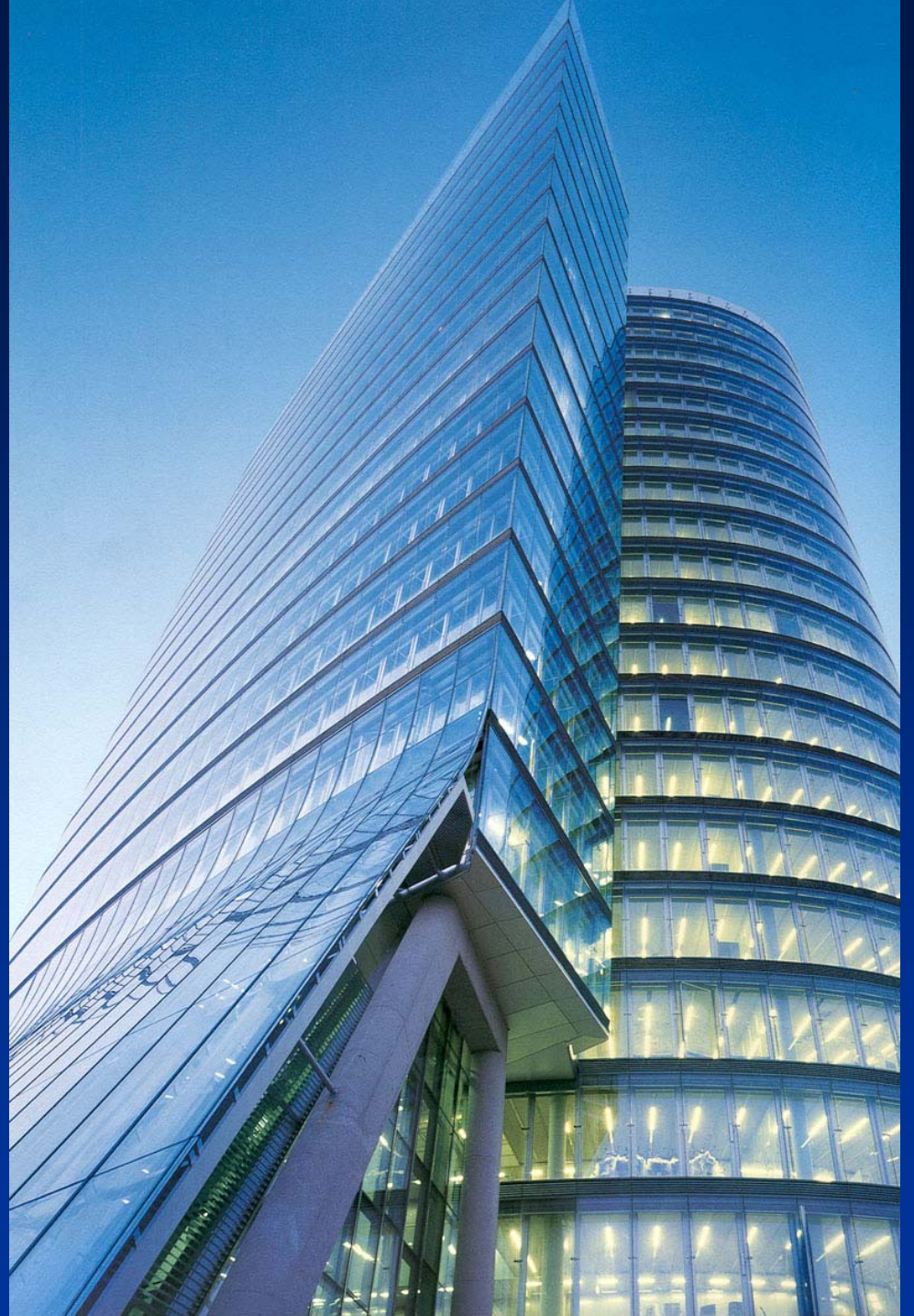


South Facing  
Building-Integrated  
Photovoltaic Panels  
25 year warranty  
50 year life.

Courtesy: Schueco, Germany









# The Market

Conservatively, there are in excess of 10,000,000 institutional, commercial, and industrial buildings located in the United States and Canada that would recognize significant energy savings from the use of building integrated wind and solar energy systems.

Add to that the demand coming from China and Europe for new and daring architecture coupled with renewable energy, and I would say, that there is, and there will be, great demand for the new

**SOLARTECTURE™**



# Clean & Green

We are integrating wind-turbines, photovoltaic panels and other energy assets into existing and new buildings. These technologies make it possible for the building to become an energy conserver & producer and to co-generate with the local power grid.

Building owners can now take the first step in energy independence by proving that we don't need to go to war over Mid-East oil. Every roof, on every building can be an energy generator. We can create clean and green energy.

This is the mission of **Synergy International** and our work with **SOLARTECTURE™**



Olympic Stadium Proposal for NYC 2012

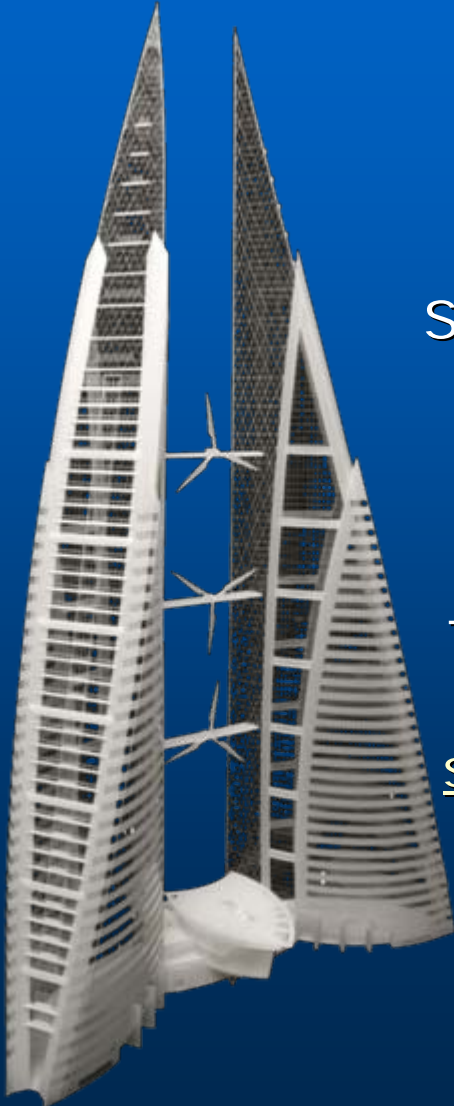


# The Future is Now !

Contact us:

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