

# OAKLAND UNIVERSITY PRESENTATION

THURSDAY, MAY 22, 2008

## AN INTRODUCTION TO WIND POWER PROJECTS

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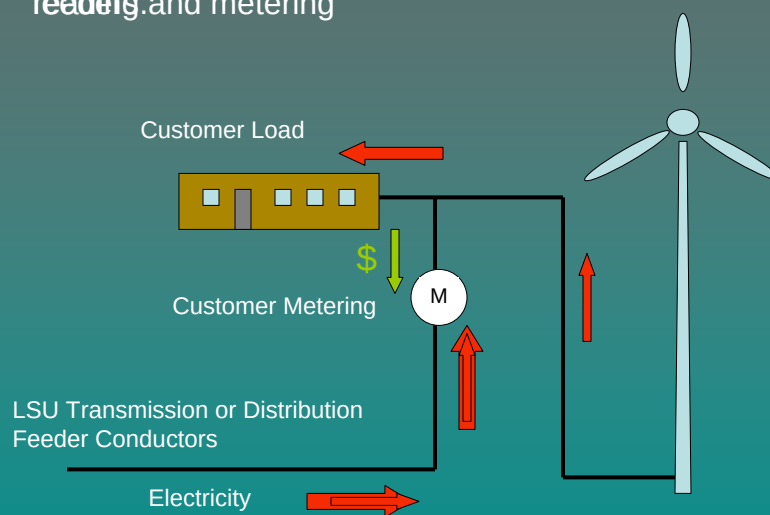
### PRESENTATION TOPICS:

1. Wind Power Basics
2. Michigan Wind Resources
3. Metering Wind
4. Wind Study
5. Feasibility Study
6. Turbine Selection

## 1. Wind Power Basics

- a) Wind is a viable renewable resource
- b) Wind may be used to generate electricity
- c) Wind offers the ability to reduce energy use
- d) Wind is one of the fastest growing energy sectors in the United States and Worldwide
- e) Wind is easily integrated for on-site generation

g) The Westford line effectively (Vols) to Load Serving  
 billing (LSD) provide the electricity and to the branch meter  
 feeders and metering



## "Green" Attributes

Renewable wind generation does not introduce pollutants into the environment.

Energy generated is free of pollutants and thus has environmental and monetary value.

Fossil



1 MW-h  
produces

|                 |            |
|-----------------|------------|
| SO              | 3 lbs.     |
| NOx             | 1.5 lbs.   |
| CO <sub>2</sub> | 1,100 lbs. |

Wind Turbine

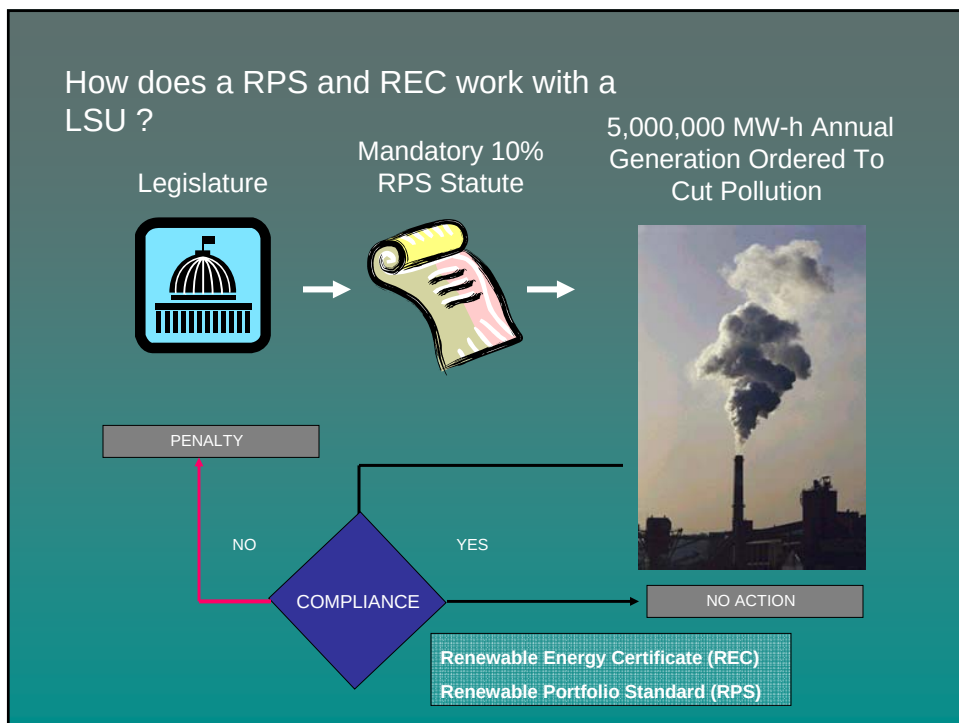
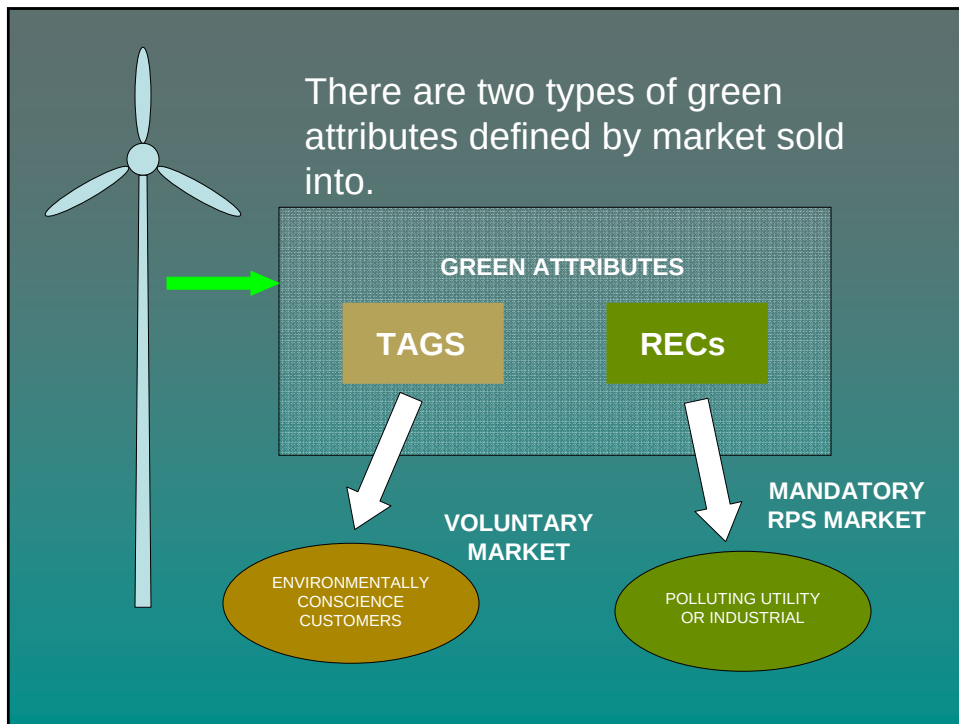


1 MW-h  
produces

|                 |        |
|-----------------|--------|
| SO              | 0 lbs. |
| NOx             | 0 lbs. |
| CO <sub>2</sub> | 0 lbs. |

## NUCLEAR ENVIRONMENTAL CONCERNS

- 1) Large tracts of land used for mining and milling are now legacy burdens upon the U.S. government for FOREVER.
- 2) Nuclear reactors emit large volumes of steam – a greenhouse gas.
- 3) Handling on spent nuclear waste – FERMI I still not resolved yet decommissioned for many years.
- 4) Emission of unique Krypton gas isotopes having long term half-life. Isotopes are thought to alter electro-conductivity characteristics of the atmosphere.



## Decisions, Decisions, Decisions ...

Cost of Pollution  
Controls or Build  
New Generating  
Plants with  
Lower Emissions



Cost of Renewable  
Energy Certificates  
(RECs)



Cost of Non-Compliance  
Penalties

## Utility Not Able To Reduce Emissions Internally

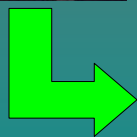
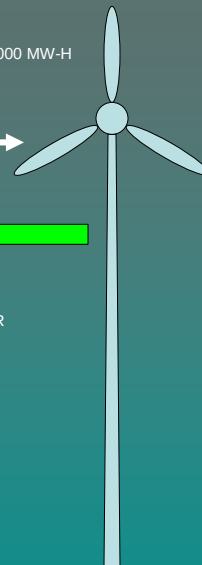
UTILITY MUST REDUCE DIRTY EMISSION BY 500,000 MW-H



\$

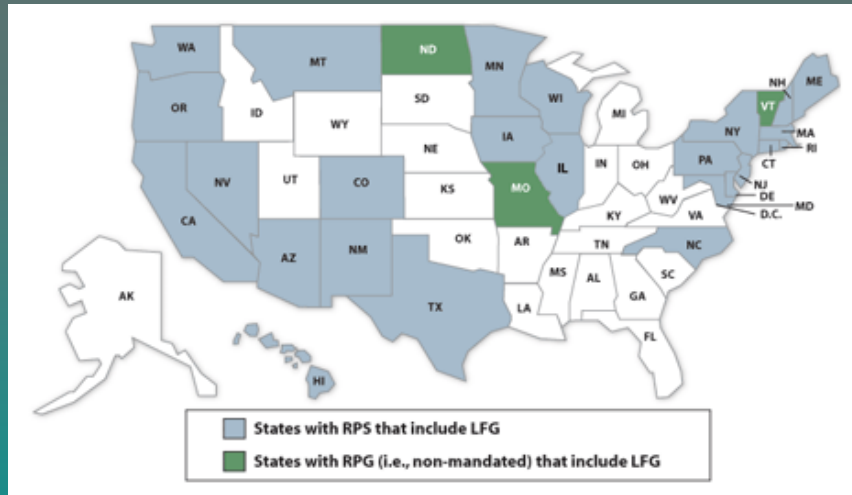


LSU BUYS 500,000 RECs from  
GREEN ENERGY GENERATOR



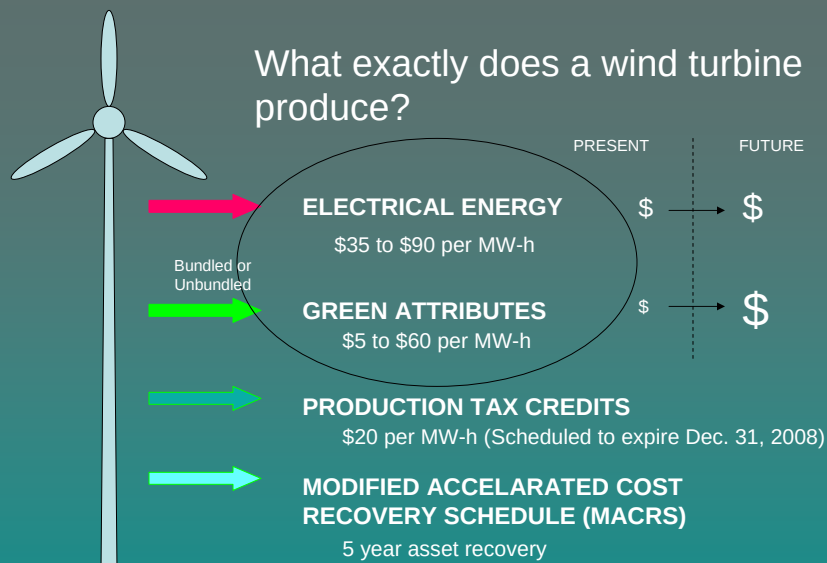
To achieve RPS  
Compliance

## States with Renewable Portfolio Standard (RPS)



Source: U.S. Department of Energy

## What exactly does a wind turbine produce?



WE BELIEVE THAT THE COST OF ENERGY WILL INCREASE AND THAT THE VALUE FOR GREEN ATTRIBUTES MAY POSSIBLY EXCEED THE PRICE OF ENERGY ON A PER KW-H BASIS.

Minimum 5 MW  
needed to sell  
power into MISO  
transmission grid  
for commercial  
project.



#### WHAT ARE MY OPTIONS ?

- # 1 USE WIND POWER TO OFFSET OUR ELECTRICAL DEMAND
- # 2 SELL ENERGY INTO THE MISO MARKET

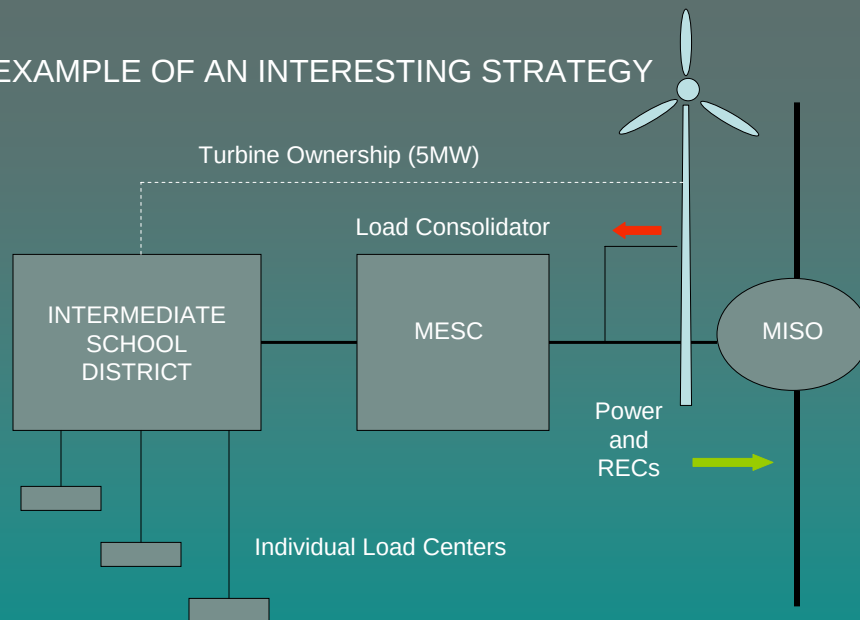
# MISO at a Glance



- 108,000 MW peak load
- 122,000 MW generating capacity
- 100,000+ miles of transmission lines
- 16.5 million customers
- \$12.6 billion installed assets

[www.midwestiso.org](http://www.midwestiso.org)

## EXAMPLE OF AN INTERESTING STRATEGY



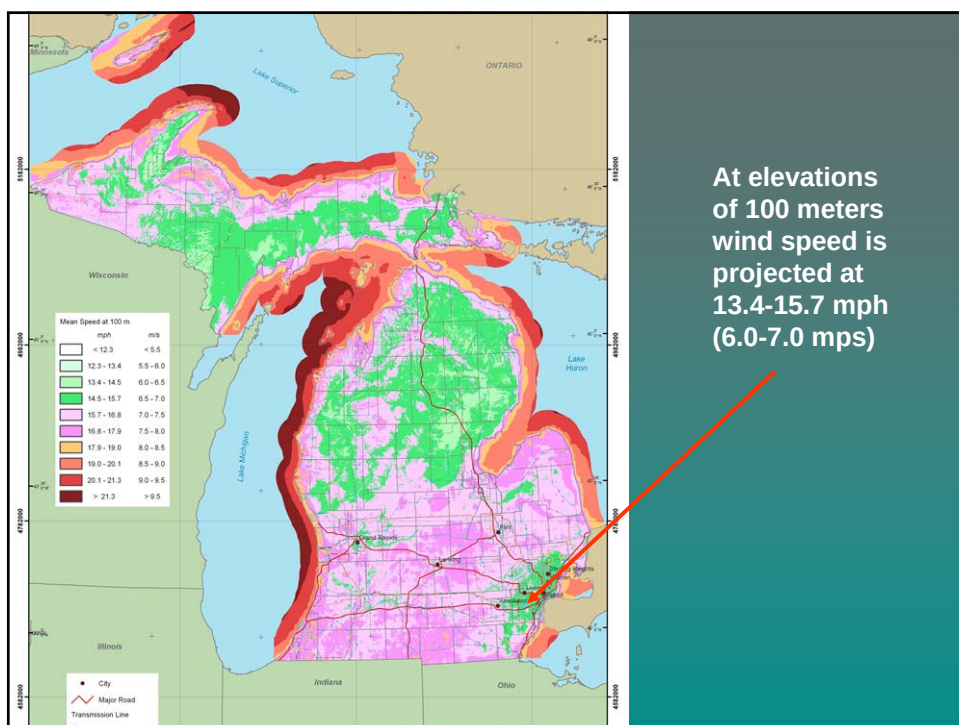
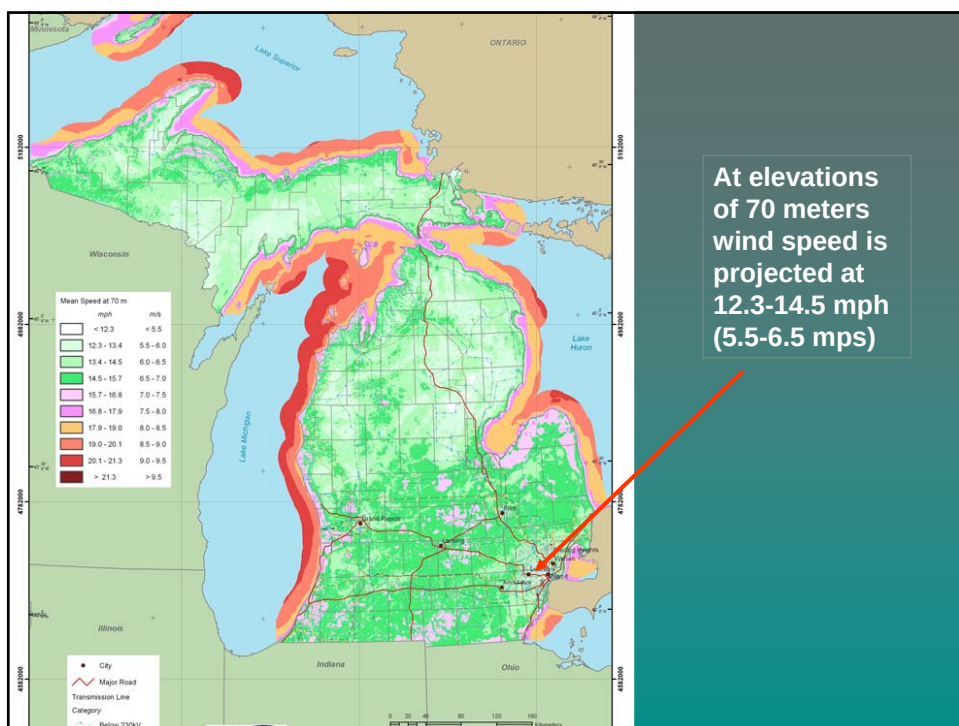


## 2. Michigan Wind Resources

- a) Michigan has good wind resources
- b) State's resource considered 14<sup>th</sup> in nation
- c) Best wind is along lake shores, compared to open fields and ridges
- d) Useful resource available at higher elevations even in cities; provided proper turbine selected

## Most Important Factors Affecting Power In The Wind

- 1) Wind Velocity
- 2) Turbine rotor height
- 3) Frequency Distribution



### Meteorological Towers

Height: 30m to 80m

Material: Galvanized steel tube 6" - 10" diameter, larger diameters are preferred for regions prone to icing.

Weight: 1,250 lbs to 3,000 lbs

Zoning: Requires variance

Installation: 4 days

Anchoring: Steel-Concrete, Screw-In, or Arrowhead earth anchors with multiple guy-wires

Instruments: Anemometers, Wind Vanes, Temperature and Barometric.



When people do not understand wind ...

They make bad decisions (Example: Hurricane victims)

### Comparing Wind Speed and Force

#### Wind Speed

100 mph

125 mph

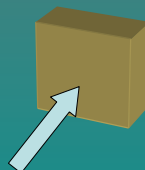
150 mph

#### Relative Force on a Flat Surface

180 lbs

351 lbs

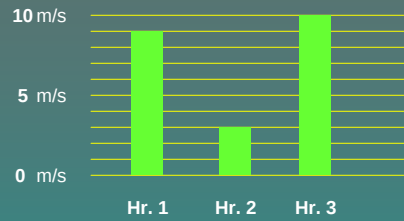
607 lbs



$$\text{Specific Power of Wind Site} = \frac{1}{2} \rho \times V^3$$

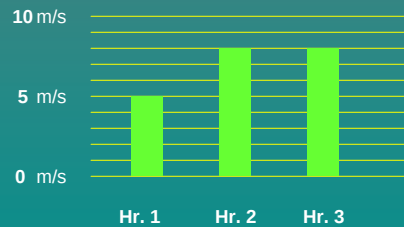
Let's examine wind data from the same 3 hour incremental blocks of time at two different locations in Michigan.

Example No. 1:



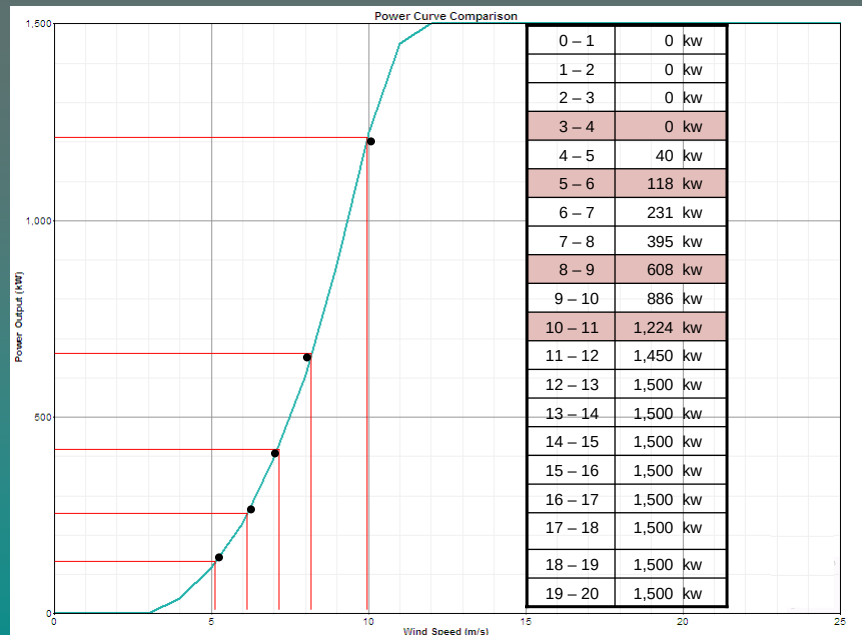
$$\frac{8 + 3 + 10}{3} = 7 \text{ m/s}$$

Example No. 2:



$$\frac{5 + 8 + 8}{3} = 7 \text{ m/s}$$

Q: WHICH IS BETTER ?



Example No. 1:

8 m/s   3 m/s   10 m/s



$$1,224 \text{ kw} \times 1\text{h} = 1,224 \text{ kw-h}$$

$$0 \text{ kw} \times 1\text{h} = 0 \text{ kw-h}$$

$$608 \text{ kw} \times 1\text{h} = 608 \text{ kw-h}$$

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$$1,832 \text{ kw-h}$$

Example No. 2:

5 m/s   8 m/s   8 m/s



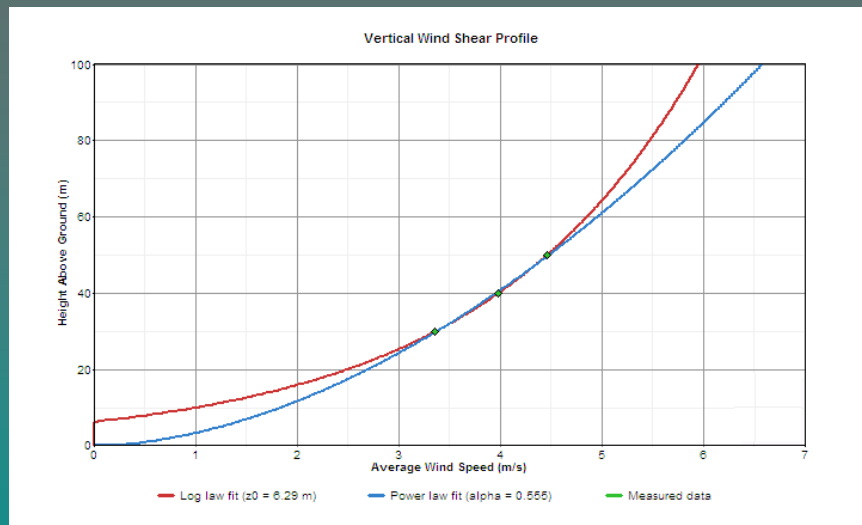
$$608 \text{ kw} \times 1\text{h} = 608 \text{ kw-h}$$

$$608 \text{ kw} \times 1\text{h} = 608 \text{ kw-h}$$

$$118 \text{ kw} \times 1\text{h} = 118 \text{ kw-h}$$

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$$1,334 \text{ kw-h}$$



### 3. Wind Studies

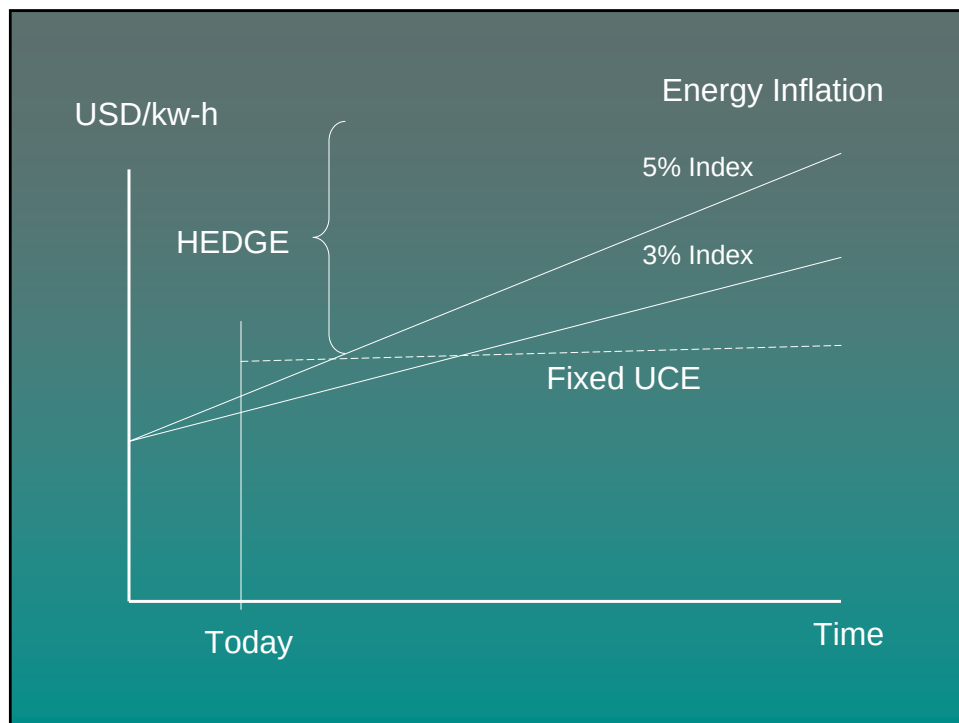
- a) Suitable met tower height
- b) High quality anemometers
- c) Temperature and barometric sensors
- d) Direction vanes
- e) Minimum of 180 days data collection
- f) Copy of original raw data files
- g) Optional data communication link
- h) Quarter site visits for inspection of tower
- i) Investment grade report on wind resource

### 4. Feasibility and Pro Forma Studies

- a) Cost of wind turbine generator
- b) Cost differential on tower height
- c) Cost for transportation, taxes and tariffs  
currency fluctuations
- d) Cost for engineering, construction, legal and  
permitting
- e) Grants, Loans, Forward Sales of RECs and PTCs
- f) Consideration of MACRS for equity investors
- g) Legal structure for project ownership
- h) Net present value of investment over 25 years

#### 4. Wind Turbine Selection

- a) Fixed Speed or Variable Speed
- b) Power Curve, Resource and Capture Matching
- c) Initial Warranty Period, Extended Warranty
- d) Service Contract
- e) Turbine Availability Guarantee
- f) Rotor Blade Power Curve Guarantee



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