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

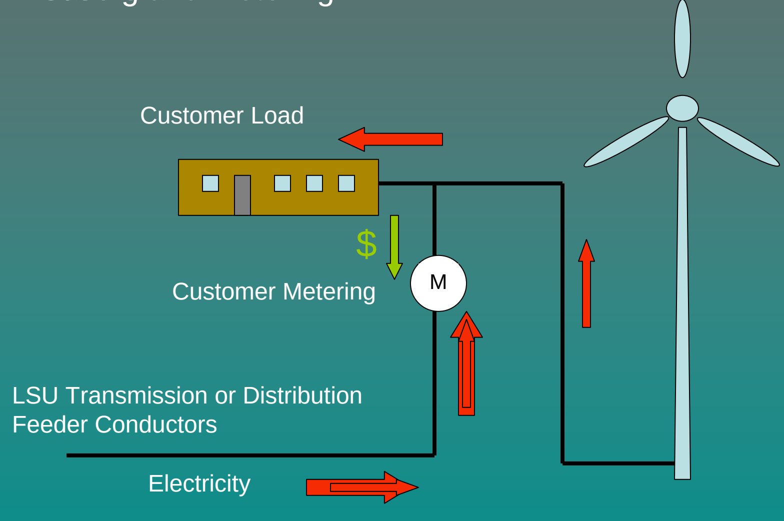
   c) Wind offers the ability to reduce energy use

   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

f) The Wind Turbine effectively acts to reduce the connected load on the utility and lowers on-site loading.

g) The Investor Owned Utility (IOU) or Load Serving Utility (LSU) provide the electricity through the 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

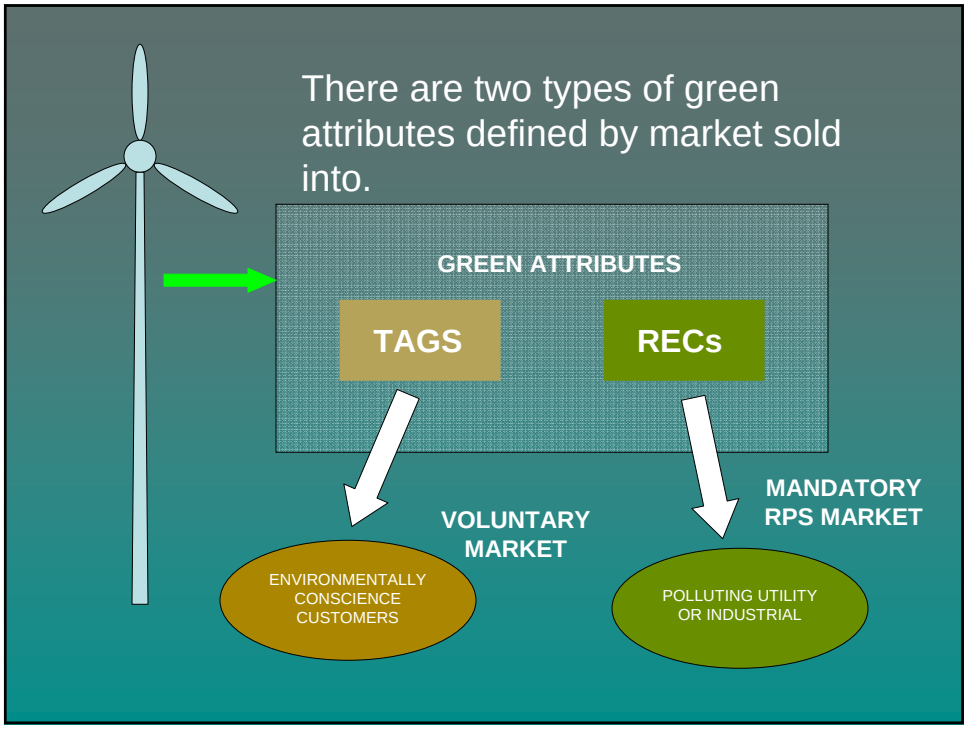
1 MW-h produces		
	SO	3 lbs.
	NOx	1.5 lbs.
	CO_2	1,100 lbs.

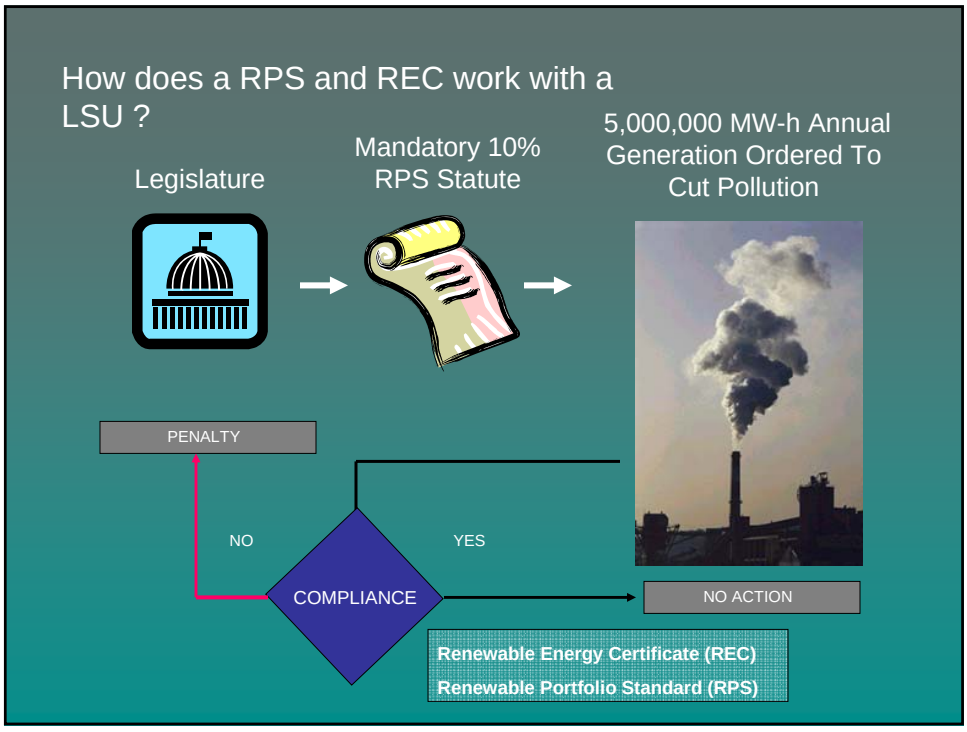
Wind Turbine

1 MW-h produces		
	SO	0 lbs.
	NOx	0 lbs.
	CO_2	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.**


There are two types of green attributes defined by market sold into.
GREEN ATTRIBUTES
TAGS
RECs
VOLUNTARY MARKET
MANDATORY RPS MARKET
ENVIRONMENTALLY CONSCIENCE CUSTOMERS
POLLUTING UTILITY OR INDUSTRIAL


How does a RPS and REC work with a LSU ?
Legislature
Mandatory 10% RPS Statute
5,000,000 MW-h Annual Generation Ordered To Cut Pollution
PENALTY
NO
YES
COMPLIANCE
NO ACTION
Renewable Energy Certificate (REC)
Renewable Portfolio Standard (RPS)

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

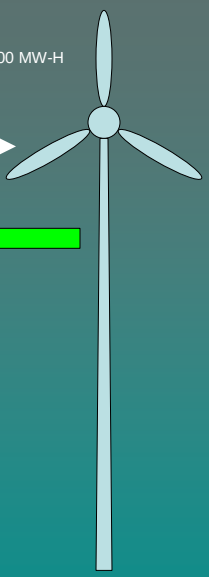
Utility Not Able To Reduce Emissions Internally

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

$

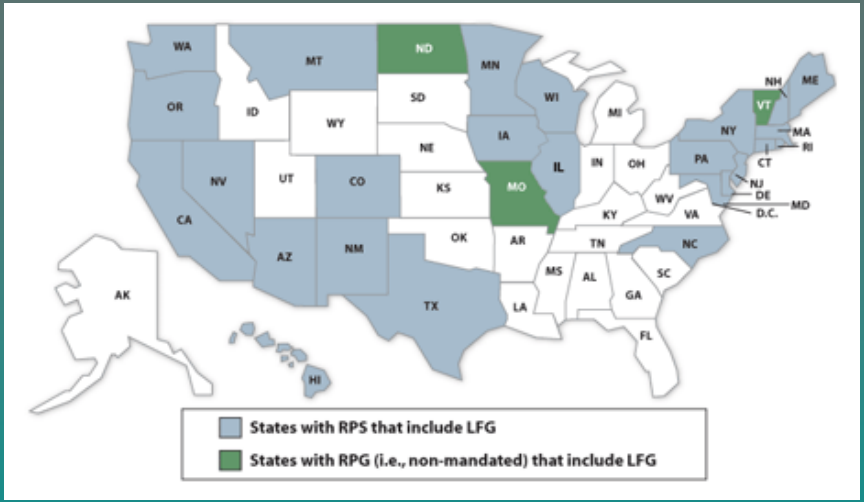
RECs

LSU BUYS 500,000 RECs from GREEN ENERGY GENERATOR

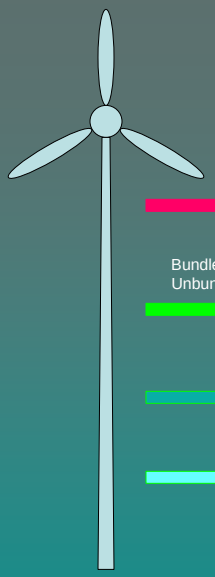


To achieve RPS Compliance

States with Renewable Portfolio Standard (RPS)



Source: U.S. Department of Energy



What exactly does a wind turbine produce?

PRESENT FUTURE

ELECTRICAL ENERGY $ → $
$35 to $90 per MW-h

Bundled or Unbundled

GREEN ATTRIBUTES $ → $
$5 to $60 per MW-h

PRODUCTION TAX CREDITS
$20 per MW-h (Scheduled to expire Dec. 31, 2008)

MODIFIED ACCELARATED COST RECOVERY SCHEDULE (MACRS)
5 year asset recovery

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.

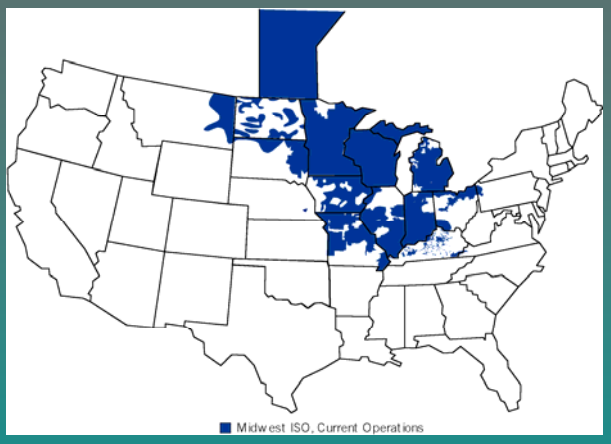
Minimum 5 MW needed to sell power into MISO transmission grid for commercial project.

WHAT ARE MY OPTIONS ?

1 USE WIND POWER TO OFFSET OUR ELECTRICAL DEMAND

2 SELL ENERGY INTO THE MISO MARKET

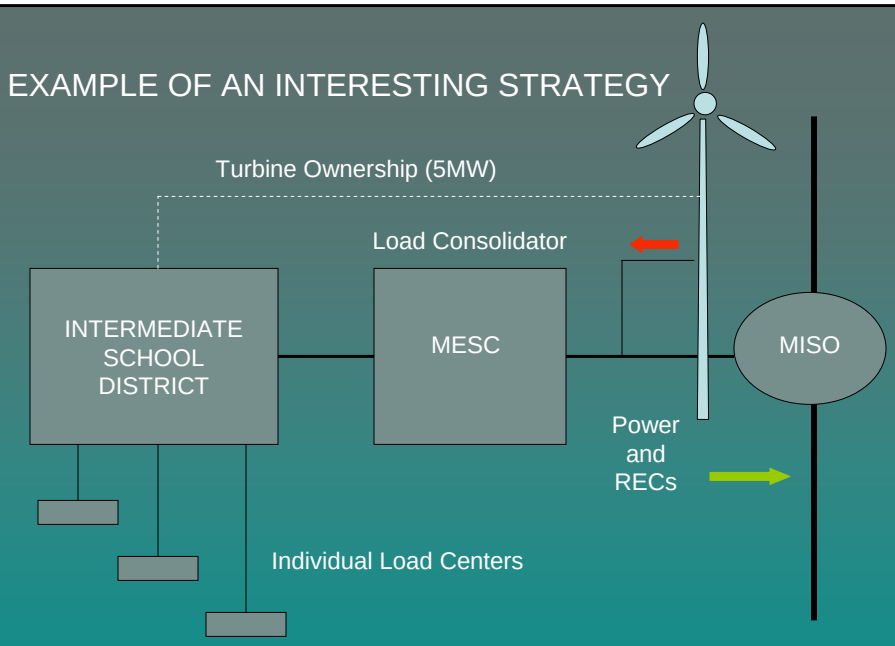
MISO at a Glance



- **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

EXAMPLE OF AN INTERESTING STRATEGY



2. Michigan Wind Resources

a) Michigan has good wind resources

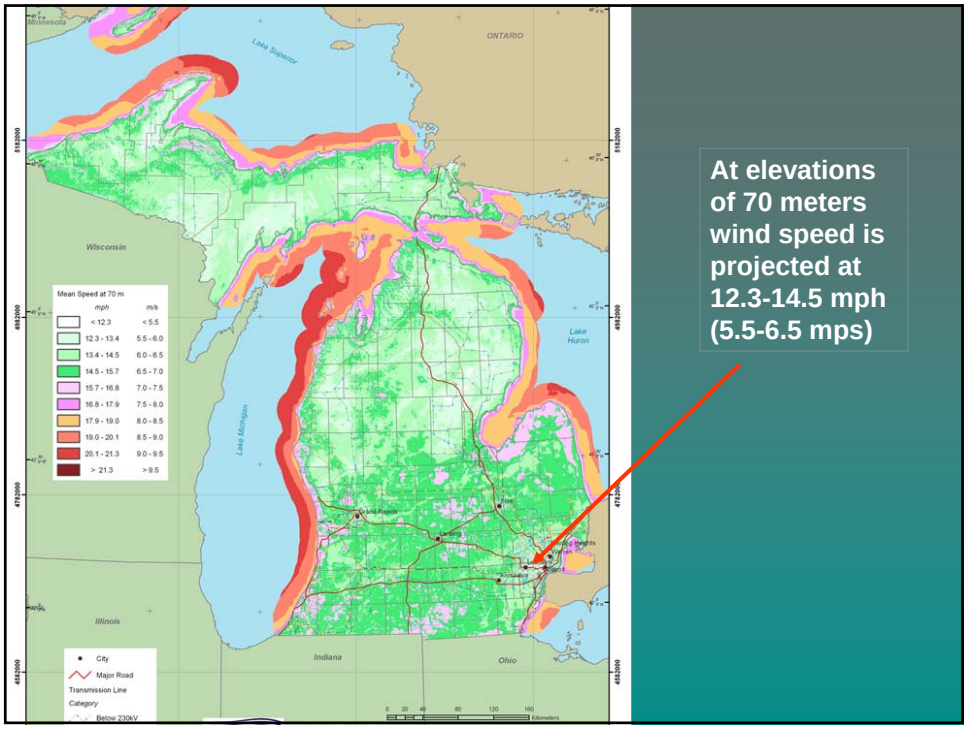
b) State's resource considered 14th in nation

c) Best wind is along lake shores, compared to open fields and ridges

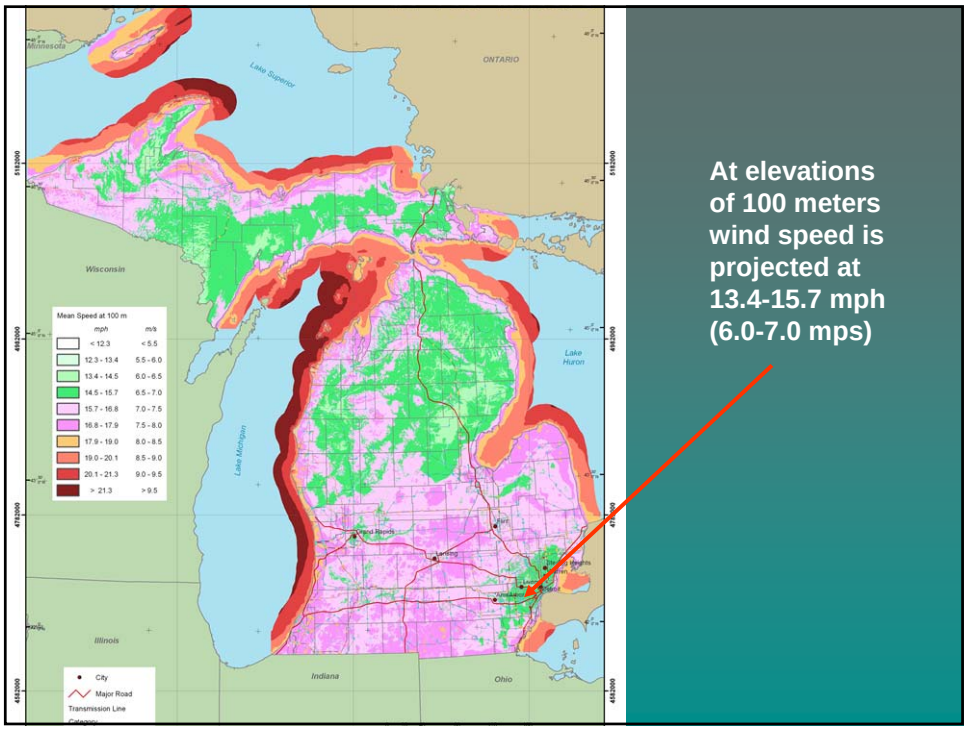
d) Useful resource available at higher elevations even in cities; provided proper turbine selected

Most Important Factors Affecting Power In The Wind

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



At elevations of 70 meters wind speed is projected at 12.3-14.5 mph (5.5-6.5 mps)



At elevations of 100 meters wind speed is projected at 13.4-15.7 mph (6.0-7.0 mps)

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

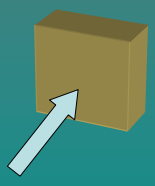
Instruments: Anemometers, Wind Vanes, Temperature and Barometric.

When people do not understand wind …

They make bad decisions (Example: Hurricane victims)

Comparing Wind Speed and Force

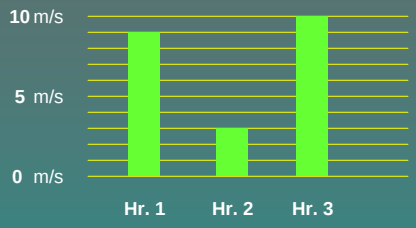
Wind Speed	Relative Force on a Flat Surface
100 mph	180 lbs
125 mph	351 lbs
150 mph	607 lbs



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

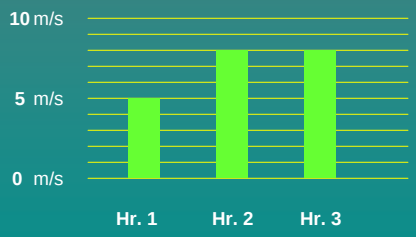
Let's examine wind data from the same 3 hour incremental blocks of time at two different locations in Michigan.

Example No. 1:



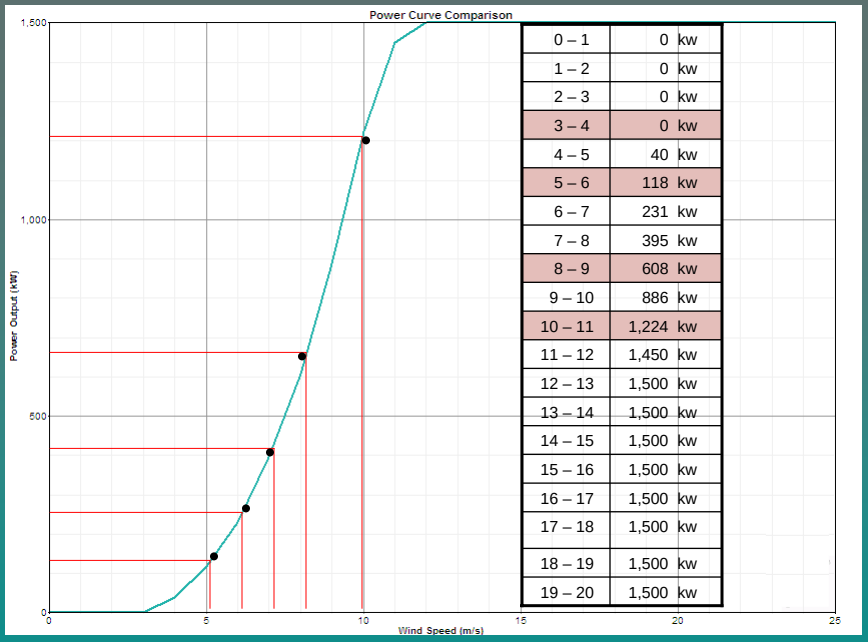
$$\frac{8 + 3 + 10}{3} = 7 \text{ m/s}$$

Example No. 2:



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

Q: WHICH IS BETTER ?



0 – 1	0 kw
1 – 2	0 kw
2 – 3	0 kw
3 – 4	0 kw
4 – 5	40 kw
5 – 6	118 kw
6 – 7	231 kw
7 – 8	395 kw
8 – 9	608 kw
9 – 10	886 kw
10 – 11	1,224 kw
11 – 12	1,450 kw
12 – 13	1,500 kw
13 – 14	1,500 kw
14 – 15	1,500 kw
15 – 16	1,500 kw
16 – 17	1,500 kw
17 – 18	1,500 kw
18 – 19	1,500 kw
19 – 20	1,500 kw

Example No. 1:

8 m/s 3 m/s 10 m/s

1, 224 kw x 1h = 1, 224 kw-h

0 kw x 1h = 0 kw-h

608 kw x 1h = 608 kw-h

1, 832 kw-h

Example No. 2:

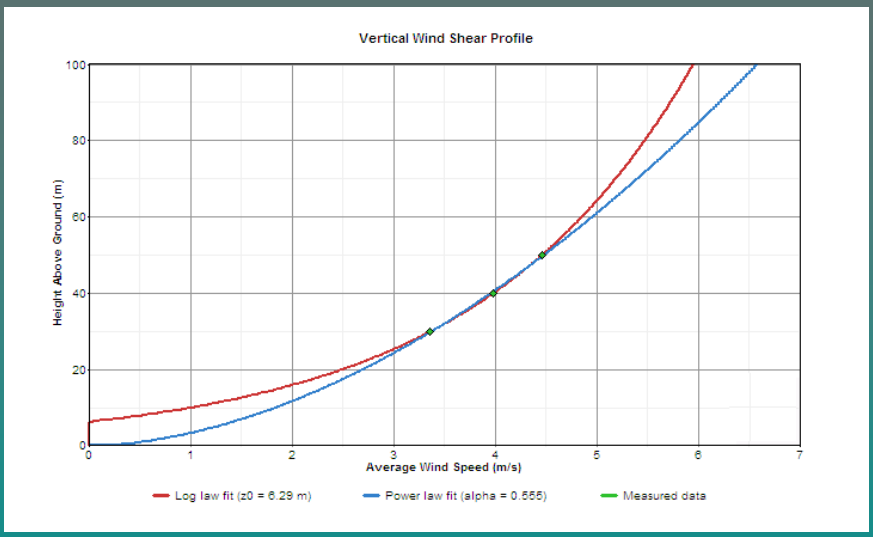
5 m/s 8 m/s 8 m/s

608 kw x 1h = 608 kw-h

608 kw x 1h = 608 kw-h

118 kw x 1h = 118 kw-h

1, 334 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

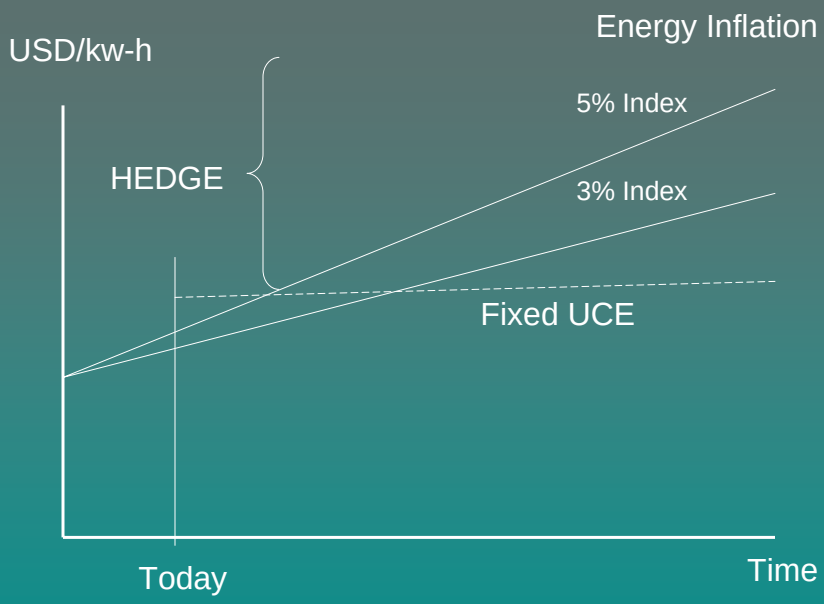
b) Power Curve, Resource and Capture Matching

c) Initial Warranty Period, Extended Warranty

d) Service Contract

e) Turbine Availability Guarantee

f) Rotor Blade Power Curve Guarantee



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