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 Wind Turbine effectively reduces the connected load on the utility and lowers the meter reading.
“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.

<table>
<thead>
<tr>
<th>Fossil</th>
<th>Wind Turbine</th>
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1 MW-h produces:
- SO: 3 lbs.
- NOx: 1.5 lbs.
- CO₂: 1,100 lbs.

1 MW-h produces:
- SO: 0 lbs.
- NOx: 0 lbs.
- CO₂: 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 electroconductivity characteristics of the atmosphere.
There are two types of green attributes defined by market sold into.

**GREEN ATTRIBUTES**

- **TAGS**
  - ENVIRONMENTALLY CONSCIENCE CUSTOMERS
- **RECs**
  - POLLUTING UTILITY OR INDUSTRIAL

**VOLUNTARY MARKET**

**MANDATORY RPS MARKET**

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**

**COMPLIANCE**

- NO
  - NO ACTION
- YES
  - 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 Non-Compliance Penalties

Cost of Renewable Energy Certificates (RECs)

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
What exactly does a wind turbine produce?

**ELECTRICAL ENERGY**
- Present: $35 to $90 per MW-h
- Future: $

**GREEN ATTRIBUTES**
- Present: $5 to $60 per MW-h
- Future: $

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

**MODIFIED ACCELERATED 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

Turbine Ownership (5MW)

Load Consolidator

INTERMEDIATE SCHOOL DISTRICT

MESC

MISO

Power and RECs

Individual Load Centers
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.

Comparing Wind Speed and Force

<table>
<thead>
<tr>
<th>Wind Speed</th>
<th>Relative Force on a Flat Surface</th>
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<tbody>
<tr>
<td>100 mph</td>
<td>180 lbs</td>
</tr>
<tr>
<td>125 mph</td>
<td>351 lbs</td>
</tr>
<tr>
<td>150 mph</td>
<td>607 lbs</td>
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Specific Power of Wind Site \(= \frac{1}{2} p \times V^3\)
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 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