Wind Project Case Studies
Vestas V-82 College Installations

Excerpts from Webinar “Deploying a Wind Turbine on Your Campus”, Academic Impressions, February 2008

Vestas V-82 College Installations

- Turbine description
  - NEG Micon/Vestas – NM/V 82
  - 1.65 Mw maximum capacity (1650 Kw/hr)
  - 70 meter (230 ft) steel tower – 3 sections – 130 tons
  - 3 Blades – 135 ft – epoxy/carbon-fiber – 7 tons each
  - Hub – 21 tons
  - Nacelle – houses gearbox and generator – 45 tons
  - Blade assembly pitched out 5 degrees to prevent damage (see diag.)
Three Institutions in Minnesota

Minnesota's Wind Resource by Wind Speed at 100 Meters

Wind Speed
Meters/second (mph)
- 5.8 - 6.7 (12 - 13)
- 5.7 - 6.1 (12 - 14)
- 6.1 - 6.5 (13 - 14)
- 6.6 - 6.9 (14 - 15)
- 6.9 - 7.3 (15 - 16)
- 7.3 - 7.7 (16 - 17)
- 7.7 - 8.1 (17 - 18)
- 8.1 - 8.5 (18 - 19)
- 8.5 - 9.0 (19 - 20)
- 9.0 - 9.2 (20 - 22)
Carleton’s Installation

- Independent generation – Mini-power plant
- Connected directly to Xcel Energy “grid”
- Sell all power produced
- Financed by endowment and supplemented with a State Grant and production incentives
St. Olaf’s Installation

- Self-generation - connected directly to campus “grid”
- Supplemented (when needed) by power from Xcel Energy
- Excess power produced is sold to Xcel energy
- Major funding from grant program
- Other funding from annual capital budget

U of MN at Morris Installation

- Connected directly to campus research center (West Central Research and Outreach Center, aka WCROC)
- Excess power produced is sold to the “grid”
- “Grid” supplies Center power when wind is not blowing
- Funded through grants by MN legislature
- Research opportunities
Initial Homework

- Site info – analyzing the wind resource
- Access to distribution – on/off Campus
- Permit requirements
- Feasibility of hiring a Wind Developer

Wind Resource Analysis

- Available Information – Maps, Data, etc.

- Wind Survey
  - Recommend monitoring at several sites
  - Ability to correlate site data collected with past data collected in vicinity
  - Several monitoring heights required
  - Good data allows reasonable extrapolation to other heights
Permit Requirements

- Permitting
  - Conditional Use Permit (CUP) – County (City)
  - Building Permit – County (City)
  - Driveway Permit – State or County Hwy.
  - FAA Hazard Determination

- Land Lease Agreement (if needed)
- Crop loss negotiation – with farmer

Wind Developer

- Benefits
  - Experience setting up this type of project
  - Agreements/Permitting – legal counsel
  - Local regulatory understanding – knows who to talk to
  - Local grant/incentive program (if any) familiarity
  - Your Time
  - Access to available turbines
  - May have more leverage with suppliers

Approx. 1-3% of total project cost
Defining Project Goals

- **Important Questions**
  - Why does my institution want to do this?
  - What are the “drivers”?
    - Economic investment
    - “Green” generation
    - Distributed generation
    - Institutional recognition and/or symbolism
  - What will this mean to the institution?
  - How will the results be incorporated across the campus community?
  - Is the project perceived to provide benefits beyond financial and energy considerations?
  - How do you want to do this? i.e. invest in a remote site, build your own, connect to grid, connect to campus infrastructure, etc.

Moving Forward

- **Begin four simultaneous project paths**
  - Power Company Interconnection Agreement and Power Purchase Agreement
  - State and Federal Incentive Program research and Applications – Investigate financing options
  - Permitting (including FAA)
  - Turbine selection, delivery, and construction
Requirements

- Interconnect Agreement with Power Company
  - Longest duration of negotiation
  - Outlines Terms and Conditions to Connect

- Power Purchase Agreement (PPA)
  - Outlines Payment Rates and Term
  - Rates based on local production costs
    - Current, local coal-fired and nuclear plant production costs used as basis for developing rates
    - For example:
      - Nuclear – approx. 1.8-2.0 cents/kwh
      - Coal – approx. 3-4 cents/kwh

UMM’s Installation

MN - Morris

- Project Budget
  - June/July wind assessment: $2,000
  - Foundation/Transformer/Turbine equipment: $377,900
  - Evacuation and backfill: $3,200
  - Trenching electrical line: $4,300
  - Wind assessment/air ticket: $4,700
  - Underground work Hwy 329: $6,400
  - Completion of foundation and transformer: $94,500
  - Cylinder tests/hold: $100
  - Decals for wind generator: $1,600
  - Building permit: $40
  - Delivery of WTG equipment: $1,275,000
  - Engineer hours: $2,100
  - Underground work Hwy 329: $19,100
  - Consulting fees: $1,500
  - Travel: $3,200
  - Stage payment - turbine equipment: $141,700

- Total: $1,174 / kW
  - $1,937,340
Carleton’s Installation

- **Project Budget**
  - Turbine*: $1,515,000
  - Road: $26,000
  - Site electrical: $18,000
  - Power line upgrade: $47,000
  - Phone line (monitoring): $5,000
  - Turbine installation and foundation: $215,000
  - Consult./permits/fees: $39,000

- **Total** $1,865,000**

*Final price influenced by fluctuating steel prices, the strength of the Euro in world money markets, and availability at time of purchase.

**A similar project priced today would be about $2.5-2.6 million.

$1,130 / kW

St. Olaf’s Installation

- As previous slide suggests, $2,600,000
- Prices are ratcheting up quickly in response to demand...for example...
  - Xcel Energy is projected to have 1125 MW of wind in Minnesota by 2011
  - Texas expects to have a doubling of wind MW by 2015
  - Manitoba planning for 1000 MW within the next 10 years

$1,575 / kW
Project Challenges

- Coping with the impact of a delay
  - Turbine delivery
  - Construction/erection equipment delivery or functionality
  - Weather related - wet

Project Challenges

- Construction and equipment challenges
  - Worker safety
  - Site access – equipment delivery, staging and security
  - Accidental damage/replacement parts
  - Onlookers/interested parties/reporters – liability
Project Challenges

- Managing the unpredictable
  - High winds/storms/hail
  - Strike
  - Accidental damage
  - Vandalism
  - Protests

Integration into the Curriculum

- Opportunities as a learning tool.
- Coordinating with Faculty and Dean’s Office.
- Using data from turbine to conduct research.
- Wind turbine as research tool (wind to H2).
- Learning about renewable energy possibilities with real data.
- Hosting student groups.
Marketing and Promotion

- What is your message?
- Who to Inform
  - AASHE
  - Local environmental groups
  - Alumni
  - Prospective Students
- How to get the message out
  - Campus webpage
  - Press release
  - Conference presentations
  - Student presentations
  - Invited tours
- How to talk about it

Summary

- When deploying a wind turbine
  - Make sure you understand why you want to do a project...What the desired outcomes are.
  - Determine appropriate project size and to what type of destination the power will be delivered.
  - Make sure you have monitored and determined a viable, desired wind site.
  - Make sure your site allows for access to the desired electrical delivery systems (end user).
  - Work WITH your facilities group from the beginning, as they have a direct impact on the success of the project.
  - Communicate advantages and enlist campus support (faculty, staff and student).
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Summary – cont.

- When deploying a wind turbine
  - Consider holding informal public meetings to solicit input and support of the broader community
  - Determine whether or not to enlist a wind developer.
  - Prepare initial production estimates to verify income/offset costs on an annual basis.
  - Compare income/offsets to estimated annual expenditures, (i.e. debt service, maintenance, insurance, lease costs (if any), etc.)
  - Confirm value of “soft” income, (i.e. educational benefits, sustainability initiatives, institutional recognition, recruiting, etc.) as there may be reasons beyond economic viability to do this.
Summary – cont.

- When deploying a wind turbine
  - Begin the four simultaneous planning efforts.
    - Interconnection Agreement and PPA
    - Investigation of available grants/incentives/CREBs
    - Investigate and procure applicable permits
      - In particular, don’t forget the FAA Hazard Determination!
    - Turbine selection and procurement process

Summary – cont.

- When deploying a wind turbine
  - Select vendor and negotiate agreement.
    - Performance
    - Price
    - Delivery schedule
    - Maintenance support
    - Warranty *(Remember the extended warranty!)*
  - Determine the delivery and construction schedule.
  - Complete the installation.
  - Share your success!
John Deere Harvest Wind Farm Project

- Deere is currently operating (75 MW), constructing (238 MW) and are approved for construction (303 MW) of wind facilities in 7 states
- Deere and Wolverine are rural based
- Deere and Wolverine have a strong community focus
- Deere’s core values of quality, integrity, innovation and commitment resonated with Wolverine
- Most viable Michigan renewable project of all projects evaluated

Excerpt from 2008 MiAPPA Conference at CMU by John Miceli, Mar 08
## Project Information

<table>
<thead>
<tr>
<th>Developer</th>
<th>John Deere Wind Energy</th>
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</thead>
<tbody>
<tr>
<td>Facility Name</td>
<td>Harvest WindFarm L.L.C.</td>
</tr>
<tr>
<td>Location</td>
<td>Between Elkton and Pigeon in Huron County, MI</td>
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<tr>
<td>Size</td>
<td>Over 3,200 acres</td>
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<tr>
<td>Equipment</td>
<td>Thirty-two 1.65 MW Vestas V-82 Turbines (52.8 MW Total)</td>
</tr>
<tr>
<td>Turbine Specifics</td>
<td>80 meter hub height (262 feet)</td>
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<tr>
<td></td>
<td>40 meter blade length (131 feet)</td>
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<tr>
<td></td>
<td>120 meter overall height (393 feet)</td>
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<tr>
<td></td>
<td>283 tons total weight</td>
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<tr>
<td>Operational Data (operational in March 2008)</td>
<td>Cut-in wind speed – 7.9 mph</td>
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<tr>
<td></td>
<td>Cut-out wind speed (10 minutes) – 44.7 mph</td>
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<tr>
<td></td>
<td>Cut-out wind speed (1 minute) – 53.7 mph</td>
</tr>
<tr>
<td></td>
<td>Cut-out wind speed (1 second) – 71.6 mph</td>
</tr>
</tbody>
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$2,333 / kW
Crane Assembly

The Crane
Tower Assembly
Setting the Base Section
Setting the Nacelle

Setting the Blades & Hub
Finished Products

Rural Integration
How Many Turbines to Power Michigan?

130,000,000,000 kWhr per Year Consumed in Michigan

= 130 million MW-hrs per Year

8,760 Hours per Year

32% Estimated Capacity Factor

= 46,376 MW Capacity Required of Wind

1.65 MW Vestas V82 Turbine

= 28,106 Vestas V82 Turbines

15% Renewable Portfolio Standard

= 4,216 Wind Turbines

= 132 Harvest Wind Farms

About $16B, Investment

Questions

Vestas V-82 (1.65MW) Wind Turbines