Wind Turbines

Building Wind Turbines Since 1979

Worldwide Leader in Installed Capacity

Thomas Mills, Aeronautical Engineer

Susan Innis, Senior Manager Government Relations
Wind Turbines

V-82 1.65 MW Technology

Proven Design, Workhorse of Fleet

Storage and Upgrades Prior to Service
Wind Turbines

Operational Safety

Emergency Planning Consideration

Falmouth WWTF Wind 1&2 Operation and Emergency Response Planning
MA Wind Turbines

40 Large Scale Wind Turbines totaling 39.6 MW at 27 locations are now operating in MA with no safety related turbine incidents reported

Turbines have been operating in MA now for 10 years

These include turbines which are ~500 feet from residential homes (Hull); next to schools (Bourne and Hull) and at a ski area (Jiminy Peak) where snow is present all winter
MA Wind Turbines

About 35 Cities and Towns in MA have passed wind turbine siting ordinances which range from 1.0 to 1.5 x structure height as appropriate safety set back
Town of Falmouth Turbines
Town of Falmouth Turbines

Public has no access to be close to turbines

Wind I is set back 1,303 feet from nearest resident and Wind II is set back 1,138 feet to nearest resident

Town has an Emergency Management Plan for the facility and local Police, Fire Rescue were included in training on hazards associated with the wind turbines

Wind I has not resulted in sound impacts greater than 10 dBA above background at any receptors
Project Economics

Project Costs

Wind I $4.98M – GOB, Loan with P&I payments

Wind II $4.89M – ARRA, Grant funded through SRF
Project Economics

Wind Project Costs (Estimated FY 2012*)

- Bond Repayments: $360,000 per year
- Service, O&M, other: $85,000 per year
- Total Cost: $445,000 per year

REC Contract with Cape Light Compact Years 1-5
REC Contracts with MassCEC for Years 6-20
REC Contracts have penalties for failure to deliver
* Excludes Capital and Operation Reserves
Project Economics

Energy Production Based on Wind Speed

Wind Speeds Measured On Site RERL

Forecast Based on Wind and Power Curve
Site Wind Speed

Average Wind Speed at 50 meters
(On Site MET Tower Data, RERL 2004-2005)
Frequency Distribution

Wind Speed Frequency Distribution

- Wind Speed (m/s)
- Frequency %

The graph shows the frequency distribution of wind speeds, with the highest frequency occurring around 10 m/s.
Turbine Power Curve

Energy Production vs. Wind Speed

- X-axis: Wind Speed (m/s)
- Y-axis: Energy Production (kW)

The graph illustrates the relationship between wind speed and energy production for a turbine.
Production Forecast

Forecasted Average MWh

January: 300 MWh
February: 250 MWh
March: 320 MWh
April: 350 MWh
May: 300 MWh
June: 250 MWh
July: 200 MWh
August: 250 MWh
September: 300 MWh
October: 320 MWh
November: 350 MWh
December: 300 MWh

3,542 MWh Annually
Value of Wind I Production

Kilowatt hours (kWh) – output over time

Renewable Energy Certificates (REC)

\[ 1,000 \text{ kWh} = 1 \text{ MWh} = 1 \text{ REC} \]

\[ 3,542,000 \text{ kWh} = 3,542 \text{ MWh} = 3,542 \text{ REC} \]
Value of Wind I Production

REC $ 45 MWh (0.045 kWh)
MWh $105 MWh (0.105 kWh)
Total $150 MWh (0.150 kWh)

\[
\times \quad 3,542 \text{ MWh}
\]

\[
= \quad $531,300 \text{ year}
\]
Value of Wind II Production

<table>
<thead>
<tr>
<th></th>
<th>REC</th>
<th>$TBD MWh (0.015 kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MWh</td>
<td>$105  MWh (0.105 kWh)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$120 MWh ~ (0.120 kWh)</td>
<td></td>
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</tbody>
</table>

\[
\times 3,542 \text{ MWh} \\
\text{= } 425,040 \text{ year}
\]
Actual Production
Actual Production

Wind Turbine Revenue

Month

Dollars

Forcast
Actual 2010
Actual 2011
Notus 2010/1
Lost Revenue
## Impact of Wind I Curtailment

<table>
<thead>
<tr>
<th>Month</th>
<th>Forecasted Average MWh</th>
<th>Falmouth 2011 MWh</th>
<th>Notus 2011 MWh</th>
<th>&quot;Lost&quot; Production MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>327</td>
<td>384</td>
<td>408</td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>308</td>
<td>498</td>
<td>466</td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>311</td>
<td>199</td>
<td>543</td>
<td>344</td>
</tr>
<tr>
<td>April</td>
<td>314</td>
<td>128</td>
<td>515</td>
<td>387</td>
</tr>
<tr>
<td>May</td>
<td>298</td>
<td>168</td>
<td>373</td>
<td>205</td>
</tr>
<tr>
<td>YTD Total</td>
<td>1,558</td>
<td>1,376</td>
<td>2,305</td>
<td>929</td>
</tr>
</tbody>
</table>
Impact of Wind I Curtailment

Forecast Jan-May  
1,558 MWh  x  $150  =  $233,700

Actual Jan-May  
1,376 MWh  x  $150  =  $206,400

YTD Of Forecast  
- 182 MWh  x  $150  = ($ 27,300)

Lost Revenue Jan-May  
- 929 MWh  x  $150  = ($139,350)

Full Year Impact  
- 1,083 MWh  x  $150  = ($162,450)
Recommendations

Increase Cut-In Speed of one turbine to 8 meters per second between the hours of 12 midnight and 3 am.

Control strategy expected to keep project within noise standards; will result in loss of ~ 174 MWh = $26,100

Increasing number of hours from 11 pm to 5 am results in forecasted loss of ~ 825 MWh = $123,750

Other mitigation strategies can be evaluated case by case