Wind Turbines in New Hampshire

Mythical, possible, and reality.

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Apr 2014

I gave this presentation at the 2014 NH Mensa Regional Gathering (a weekend long event of talks, talking, gluttony and good beer). I forgot to bring my wristwatch and was surprised I filled 90 minutes with this. It can be done in much less time, but few people left early!

“since the spinning reserves don’t stop consuming fuel when wind generation is occurring, claims of energy savings or CO2 emission reductions are largely mythological.” - Larry Bell
http://www.forbes.com/sites/larrybell/2011/03/08/wind-energys-overblown-prospects/

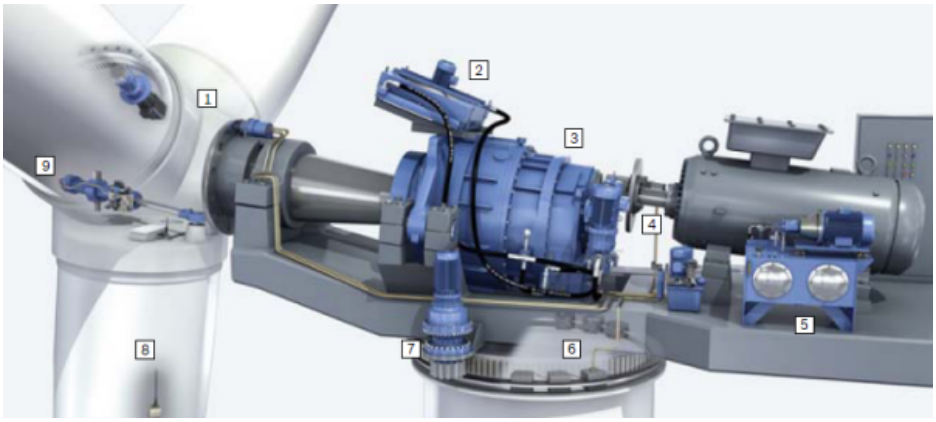
Contents

- Installations: existing to planned
- Attributes and economics
- Advantages and (many) disadvantages
- Reliability and safety
- Other alternative energy

This starts out with factual stuff, i.e. what's out there. Then what may be added. The advantages are only two items, but they are a bit specious. I wanted to say a couple good things about wind before launching into all the bad, and the rest of the presentation is about the bad and explains why they're bad.

I close with a brief mention of a couple other energy alternatives. I expected to talk about them off the cuff, but didn't have time.

Nacelle Components



1) Electromechanical pitch drives 9) Hydraulic pitch drives 8) Rotor blade condition monitoring systems 2) Lubrication system, oil cooler and oil filter	3) Main Gearbox 4) Output shaft brake 5) Hydraulic power units 7) Yaw drive 6) Yaw brake systems ?) Alternator (rare earth magnets)

Weights:

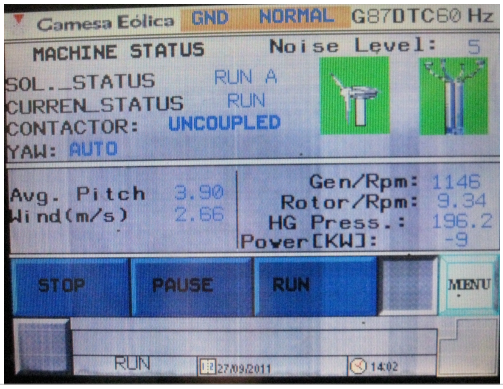
Nacelle: 75 tons
Rotor (hub and blades): 40 tons
Tower: 152 tons

From my engineering perspective, this is fairly important. I explained the blades rotate to be efficient in normal wind, extract less in high wind, stop the blades in low and extreme wind.

You can mention the failure modes and sounds of each piece and the difficulty of service. How do they get 200 gallons of oil up there anyway?

Lempster Wind

- Operational Oct 2008
- 12 Gamesa G87, 2 MW each
- 396' height to blade tip, 139' blade length
- Power sold to PSNH and then NHEC



http://www.graniteviewpoint.com/2009/07/electricity-in-nh-wind-power.html

This photo is from a control unit in the base of a turbine. The wind is below cut-in, notice that the turbine is drawing 9 kW for the hydraulic pump and whatever else it needs when idling.

Granite Reliable (Dixville)

- Operational Dec 2011
- 33 Vestas V-90 turbines, 3 MW each
- $168.9 million federal loan guarantee
- $275 million construction cost
- Power sold to Vermont

https://sites.google.com/site/energysafari/wind

Second hand information says snowmobilers in the area report that the turbines are louder this season (2013/2014) than last. They describe the noise as gear noise, so perhaps the transmissions are failing already.

Indeed, an unscheduled August 2013 bearing repair led the wind company to request permission to keep the access road 16 feet wide.

“It is now apparent that the Mt. Kelsey turbines will require periodic maintenance and that this maintenance necessitates a roadway wider than 12 feet."

Groton Wind

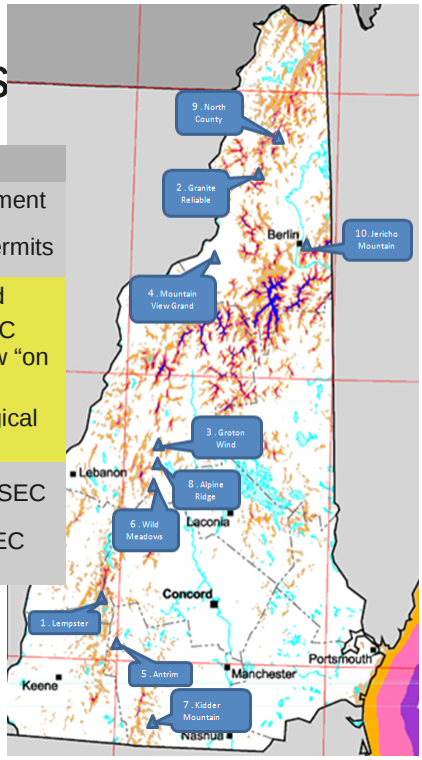
- Operational Dec 2012
- 24 Gamesa G87, 2 MW each
- 396' height to blade tip, 139' blade length
- $120 million construction cost
- Power sold to Nstar (Boston)

This was taken on an incredibly clear day – the mountains in the background are the Franconia Range, Mt Layfayette is the tallest and some 40 miles away.

The foreshortening due to the telephoto lens, random clustering or the towers, and the complex background do a good job of making an unappealing scene.

Planned Wind Farms

Name	Where	MW	Status
North County Wind	Coos County	180	In development
Jericho Mountain Wind	Berlin	8.5	Seeking permits
Alpine Ridge	Groton	45	Abandoned
Wild Meadows	Danbury, Alexandria	75	Started SEC review, now “on hold”
Spruce Ridge (not on map)	Alexandria, Groton, Hebron	60	Meteorological study
Antrim Wind Energy	Antrim	30	Denied by SEC
Kidder Mountain	New Ipswich, Temple	15	Seeking SEC review

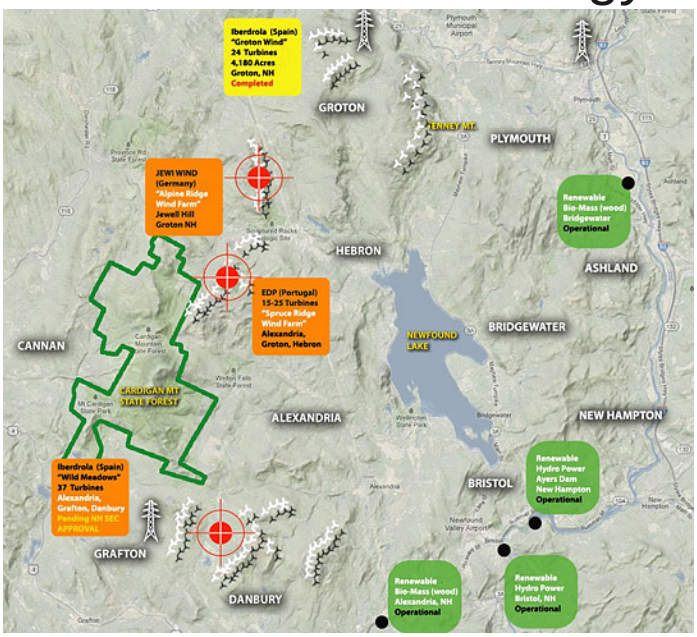


http://nhenergy.blogspot.com/2013/06/windfall-wind-energy-in-new-hampshire.html

The map shows projects that are existing, planned and denied. One small one is not worth mentioning. I included Antrim to note it was denied in part on aesthetics.

The Kidder Mountain project was voted down by the towns, so the developer is trying to get the SEC to take it over to push the towns aside.

Newfound Area Energy



http://www.nhwindwatch.org/

This shows the cluster of energy development around Newfound Lake. I have property on the SW side of Mt Cardigan, so Groton Wind was a major concern until Iberdrola decided not to go through with the turbines on the ridge closest to me. I'd rather not have the others too! I haven't checked their visibility, but should, especially because the new plans are for taller turbines.

Attributes and Economics

- Pluses:
  - Wind is free fuel!
  - No CO_2 (At least not at the turbine)
- Negatives:
  - Low density energy Groton is 48 MW, Seabrook is 1244 MW - 25X
  - Huge area requirement
  - High maintenance cost
  - [more]

The list of pluses is too short, and they're wrong anyway, but I wanted to say a few things in wind's favor before launching into all the negatives.

BTW, fuel is always free, it's just the extraction of its energy that costs money. A number of coal fired power plants are located at the mine head to save the cost of transporting coal to a power plant closer to the consumers.

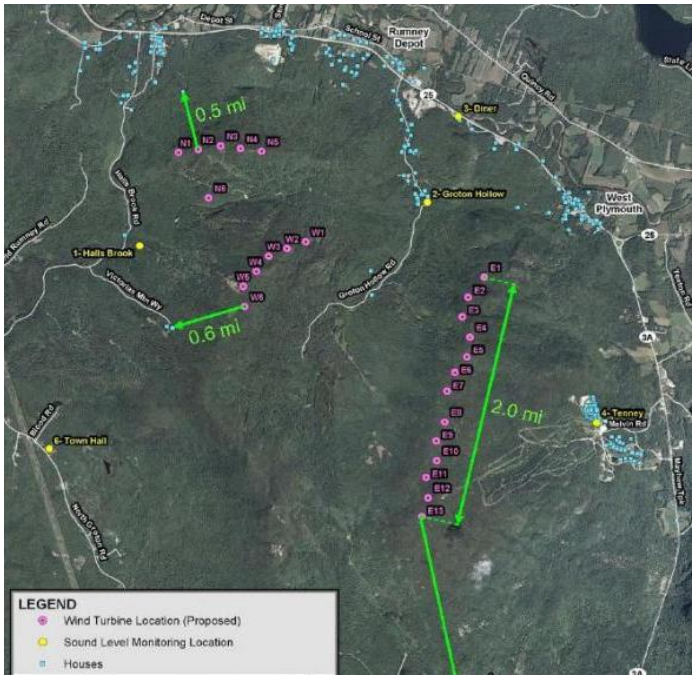
As for the negatives, they just keep on coming.

I forgot to include a slide on flicker effects from blade shadows.

More Negatives

- Pluses:
- Free fuel!
  - No CO_2 (At least not at the turbine)
- Negatives:
  - Low density energy: Groton is 48 MW, Seabrook is 1244 MW – 25 times more power

Groton Turbine Placement



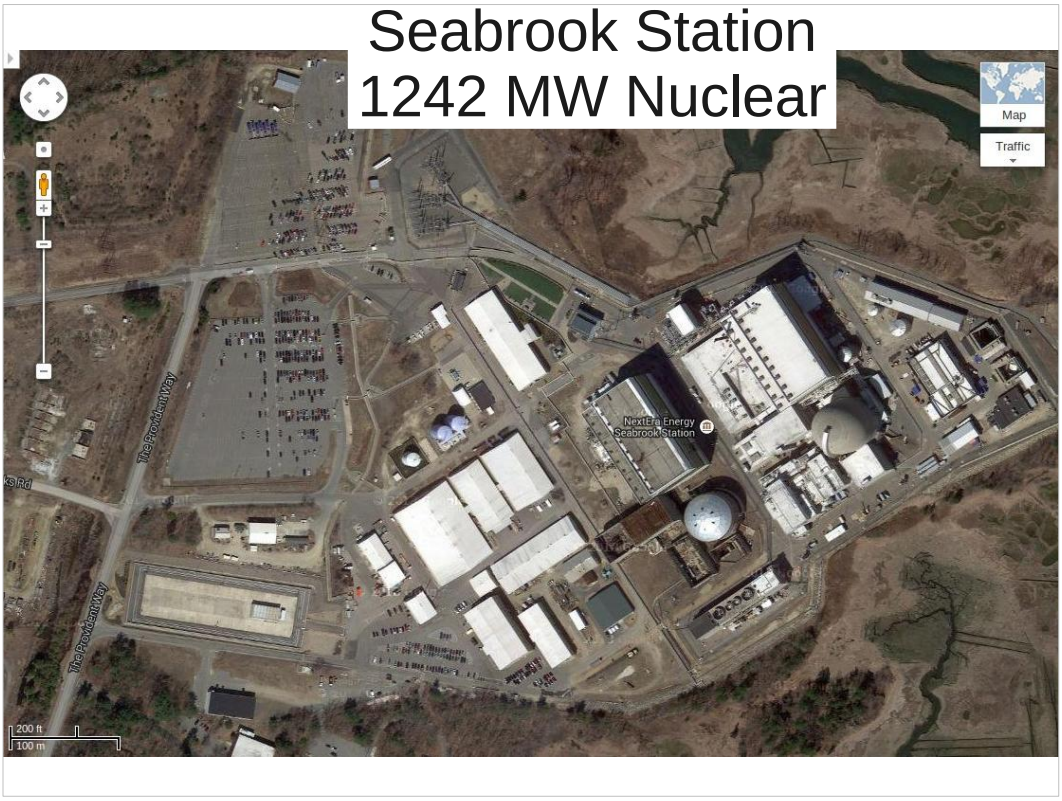
?

https://www.winnipesaukee.com/forums/attachment.php?s=1fa9ec425a0d7914d9ecd86e4cdcaa6a&attachmentid=6598&stc=1&d=1346276996

This is more on energy density.

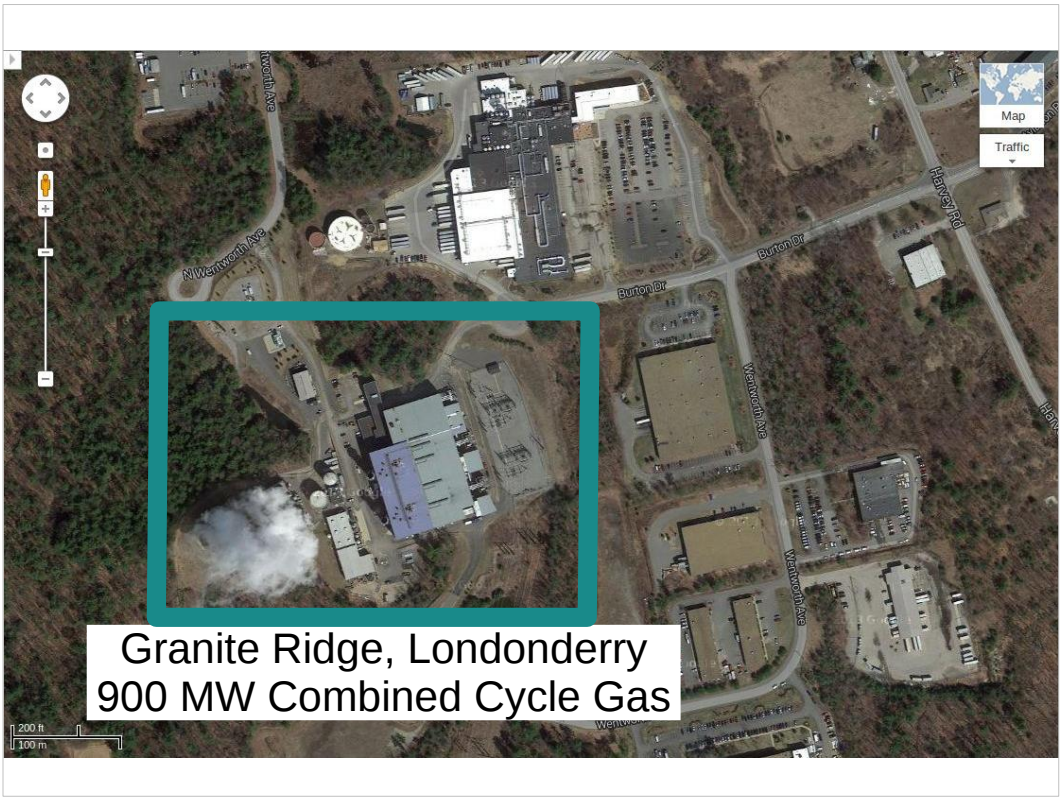
Note the “smudge” in the lower left corner. It's very close to the same scale as the large image.

I didn't notice it during my talk and hence didn't ask people if they recognized it.



And this is the smudge blown up to a useful size. The original plans were for two plants, only the one on the right was completed. The round buildings are the reactor containment structures, the turbines are adjacent, up and to the left.

Seabrook just sits there and puts out full power 90% of the time.



Even more compact is the 2nd largest power station in New Hampshire, Granite Ridge, located next door to the larger Stonyfield Farms

Natural gas is burned in gas turbine. The exhaust is hot enough to boil water and is used to make steam which is fed to a steam turbine. It's output is cooled by water cycling through the cooling tower.

http://sitingcommission.vermont.gov/sites/cep/files/Siting_Commission/Publications/SiteVisit012313/GRE%20Presentation%20012313.pdf

More Negatives: Cube Law

- Power varies with cube of wind velocity
  - For Gamesa G87 and Vestas V 90:
    - Connects to grid at 4 m/s (9 mph) wind
    - Produces full power from 13 to 25 m/sec (29 to 56 mph)
- Typical “capacity factor” is 20-35%, so these 2 MW turbines produce 0.4 – 0.7 MW on average.
- Typical “capacity credit” is near 0%, so backup power must be available.
  - Hydro and natural gas plants are best options.

Unlike Seabrook, you're never quite sure what you'll get from a wind farm, except that it's rarely 100%.

“Capacity credit” is the amount of power you can count on from the project except during planned shutdowns. It's used to estimate the reserve power needed to cover normal operation.

Gas fired backup is often single stage plants that are quick to come online but don't have the slower startup second stage steam turbine. A turbine drawing on gas backup is releasing more CO2 than the similar power from a combined cycle plant.

NH Renewable Portfolio Standard

- By 2025, NH legislation targets producing 13% of our electricity from wind energy or sources like tidal, hydrogen, or geothermal.
- On average, NH uses 1,240 MW, (almost exactly what Seabrook produces).
- To match that (on average!) from 2.0 MW wind turbines with a 30% capacity factor, we'd need 1,240 / (2.0 x 0.30) = 2070 turbines.
- We currently have the equivalent of 84, and most of that power is sold to neighboring states.
- 24X the current supply? Won't happen.

Note that while building 2070 turbines would employ a lot of people, raising our standard of living depends on increasing the work force's productivity to warrant raising salaries. Jobs are nice, jobs that add to the economy are much better.

The renewable targets vary over time and energy source. Details are at http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm

Subsidies and Incentives

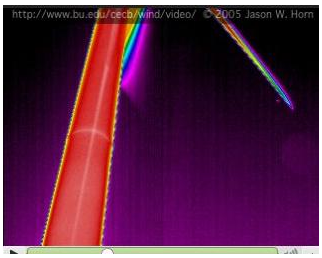
[Needs work]

- PTC - 2.3 cents/kWh and this increases with inflation, currently not available to projects that have not started construction.
- US Loan guarantees - allows for low borrowing rates
- RPS - requires local utilities purchase renewable energy otherwise pay a financial penalty.

I didn't have time at the moment to figure out enough about the subsidies. This is 2.3 cents/kWh but there are others, e.g. the cost of connecting to the grid, payments when power can be generated but is either unnecessary or the transmission lines are overloaded, etc.

Bird and Bat Kills

- Current estimate: 140,000 and 328,000 birds and 600,000 bats.
- US Interior Dept: 30-year permits allowing wind farms and other projects to accidentally kill federally protected eagles.
- US cats: 1.3 billion to 4.0 billion birds.



http://wattsupwiththat.com/2013/11/15/study-shows-wind-turbines-killed-600000-bats-last-year/

http://www.bu.edu/cecb/wind/video/bat-wind-turbine-video-17/

https://www.sciencenews.org/article/cats-kill-more-one-billion-birds-each-year

The majority of birds killed by cats are claimed to be wild cats. I think these are small birds, not the long lived raptors that rely on updrafts around ridgelines.

Noise Issues

- Vortex shedding – whoosh, whoosh sound
  - Blade tips move at nearly 200 mph
- Transmission noise - gears meshing
- Generator whir/whine – 1800 RPM shaft
- Blade infrasound and wakes – poorly appreciated
- Blade pitch and nacelle yaw motors

There are many distressing videos on Youtube about the effect of noise on nearby (within a couple miles) residents. Effects lessen with distance, but are still significant.

See this testimony from a New York State resident who came to New Hampshire to tell our senate his story.

http://www.youtube.com/watch?v=-e6FeBtnzPI&feature=share

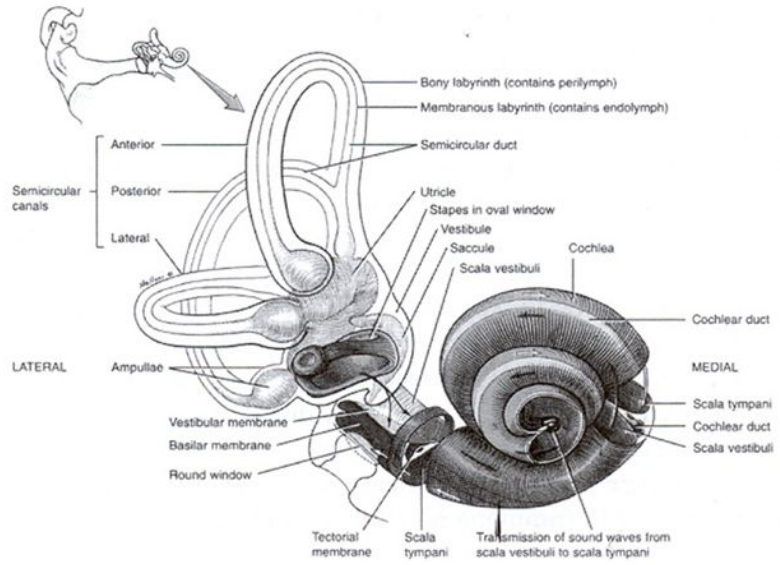
Infrasound

I first noticed from seeing several similar reports from around the world about:

- Middle ear related: vertigo, tinnitus, ear popping
- Heart palpitations, high blood pressure, nausea, sleep disturbance, foreboding
- Concentration deficit, fatigue, demotivation
- Feeling better away from home and turbines

I'd like to have some infrasound recordings frequency shifted to make audible that part of the sound spectrum. I'm working on it, but took time off to write this presentation. I'm targeting having something I can play for the NH SEC when they consider Wild Meadows.

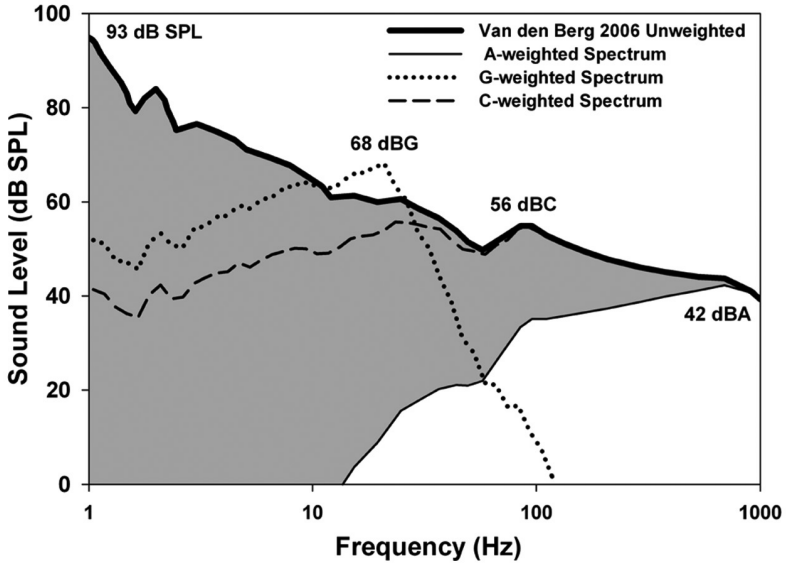
Inner Ear / Vestibular System



The semicircular canals detect rotational velocity in three axes.

The utricle and saccule detect linear acceleration and are likely affected by infrasound coming in from the nearby stapes. The cochlea detects audible sounds, but electrical potentials change with infrasound so it may be involved too.

Noise Spectrum



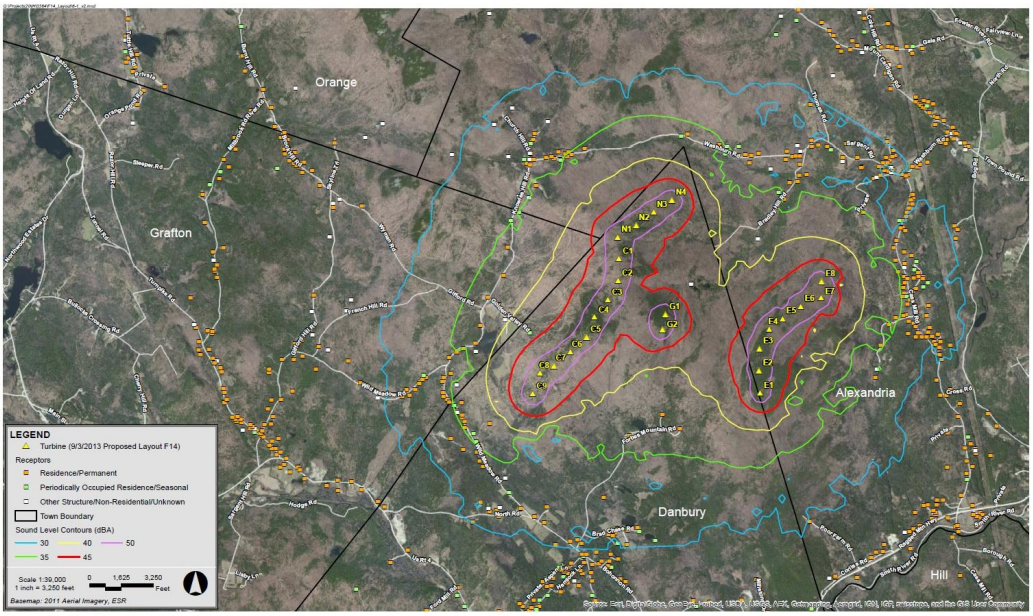
This shows:

- The audio spectrum of a large wind turbine
- The effect of dBA weighting in deemphasizing low frequency and infrasound.
- The dBC and dBG weightings that allow some infrasound to be logged.

“Always wonder if a manufacturer is hiding something when you see A-weighting specs.”

-Rane Corporation

Wild Meadows Sound Contours



Wild Meadows Wind Project Alexandria and Danbury, NH

Epsilon

Figure 6-1

Predicted Project-Only Sound Levels -- Vestas V112-3.3 (94m HH)

Note that the contours are dBA weighted and that the infrasound will be much louder.

The original plan had turbines on another ridge to the west on the other side of Grants Pond. The pond is just left and down from the center of the image.

Longterm Reliability

- Design lifetime 20 years, but it's not being met.
  - Blades: Western NY repairing blades only 2-3 years old. Not recyclable.
  - Transmissions: Portsmouth RI stuck with failed turbine, manufacturer bankrupt, used transmission available. As transmissions wear they get louder.
  - Oil (200 gallons): Typically synthetic oil.
  - Fiberglass: most fires start with lightning strikes igniting the nacelle's cover.

I had thought most fires were started by hot bearings igniting transmission or bearing lubricants, but apparently not.

An interesting claim is that turbines are more likely to be hit by lightning if they are operating. The best explanation is that the blade is picking up a static charge from the friction between blade and air, making the environment more conductive.

State Actions

- NH Site Evaluation Committee (SEC)
- 2013 HB580 – (failed) Establish a moratorium
- 2014 SB281 – Firmer guidance for the SEC
- 2014 HB245 – Redesign of the SEC
- Gov. Hassan supports wind power
- Several environmental groups support wind, but that is beginning to change.

The Audubon Society seems to be spending more time aligned with other conservation groups and American Bird Conservancy seems to be taking on Audubon's past interest in bird protection.

See http://www.abcbirds.org/

“Alternative” Energy

- Northern Pass – Hydro Quebec (large hydro is often not “renewable” in part because it doesn't need subsidies)
- Natural gas – increasing supply, needs distribution
- Coal – EPA is running that into the ground
- Solar – Better for rooftop than large plant
- Thorium atomic power – US experiments in the 1960s, China making push now.
- LENR (cold fusion) – Andrea Rossi's E-Cat

http://northernpass.us/index.htm

http://wattsupwiththat.com/2012/10/03/cheap-natural-gas-but-wait-theres-more/

http://web.ornl.gov/info/ornlreview/rev26-34/text/colmain.html

http://energyfromthorium.com/essay3rs/

http://www.e-catworld.com/what-is-the-e-cat/

Additional resources

- http://www.nhwindwatch.org/
- https://www.facebook.com/groups/NHWindWatch/
- http://wermenh.com/wind

The photograph of off-shore turbines is the best photo I've seen that shows the airflow changes caused by turbines. In this case, note the downstream turbines, they're generating significantly less electricity being in the slowed wind.

This photo is used in many places and reports and is one of the most important in the literature.

http://wermenh.com/wind/images/vattenfall-image_300.jpg