New England Wind Integration Study

PAC Meeting

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New England Wind Integration Study

Presentation Contents

- Wind integration at ISO-NE
- Drivers for wind integration study
- Goals for wind integration study
- Scope of work for the New England Wind Integration Study (NEWIS)
- Status of NEWIS
- Further analysis by ISO-NE

Short & Recent History of Wind Studies

- Scenario Analysis 2007
  - Queue wind (780 MW)
  - Plus approx. 5*¼*(5.4GW,8.9GW) =6.9GW, 10.9GW
- Levitan Phase I 2007
  - Review of wind resource studies
  - AWST windmap (2003): 50m hub onshore, 100m hub offshore
    - Onshore: class 3+, pop density<=Hull, 40 MW min size
    - Offshore: class 4+, depth<=60m, min 3NM to shore, 200 MW min
- Levitan Phase II 2008
  - Refined results of Phase I
    - Onshore Nameplate Potential: 174GW
    - Offshore Nameplate Potential: 26.5GW
  - Transmission proximity

Drivers for ISO Wind Study

- Wind energy can help to meet RPS targets
- Wind energy is competitive with other new resources
- Wind energy improves fuel diversity by reducing dependence on fossil fuels
- Wind generation is quick to build
- ISO-NE Queue
  - Approx 100 MW of wind generation online
  - 3,982 MW in the Queue
    - 805 MW have System Impact Studies and I.3.9 processes complete
  - At these levels, we may experience operational issues

Interregional Wind Integration

- NYISO
  - ‘04 Studied 3.3GW of Wind
  - ~5% of Annual Energy (TWh) ~10% of Peak Load
    - 2008 NYISO “gold book”
  - Early ‘09 ~1.3GW Wind in service + ~8GW Wind in the queue
- Canada
  - Maritimes: ‘08 study 5.5 to 7.5 GW Wind by 2025
    - Early ‘09 ~3GW Wind in NBSO queue
  - ~50% to 70% of TWh ~ 75% to 100% of Peak Load
    - NPCC 2006/2007 Interregional Long Range Adequacy Overview
  - Quebec: 4 GW Wind by 2016
  - ~7% of TWh ~10% of Peak Load
    - NPCC 2006/2007 Interregional Long Range Adequacy Overview

The Goals of a Wind Integration Study

- Primarily to quantify the anticipated effects
  - Operational
    - Time frames of interest
      - Unit Commitment
      - Dispatch
      - Load-following
      - Regulation/AGC

Wind Forecasting

  - Market
    - Time frames of interest
      - Day-ahead
      - Real-time

Wind Forecasting

  - Planning
    - Resource adequacy

Goals (Part 2) of Wind Study

- What are the system operational effects vs. amount of wind penetration?
- Are there thresholds e.g., hockey stick or plateaus?
- What can be done to facilitate integration of wind resources?
- How does ISO-NE plan for large amounts of wind resources?
- What are the ISO-NE specific challenges?
- What if other system parameters change substantially?
  - DR, Plug-in electric vehicles, storage
  - Wind patterns, wind turbine improvements
  - Load forecast (including ramp rates)
  - Fuel prices

Scope of Work

- Wind Integration Survey
- Interconnection Requirements for Wind Generators
- Build New England Wind Resource Area (NEWRA) models
- Scenario Development/Analysis
- Scenario Simulation

Wind Integration Survey

- Presentation at NEWIS Kickoff
  - Background and general components of wind integration study
- Identify lessons learned
  - From UWIG wind integration library
  - From Consultant's experience
  - Identify the most useful tools in integration
  - Identify surprises
- Focus on aspects that are relevant to ISO-NE
  - Offshore, neighboring systems, technology advances, market, etc.
- Include this information in other NEWIS tasks

Interconnection Requirements

Make specific recommendations:

- Grid support functions
  - Low Voltage Ride Through (LVRT), Voltage/VAR Control
  - Blackstart coordination
  - Consider participation in Automatic Generation Control (AGC)
- “Best of” Effective Load Carrying Capacity
  - Per wind plant, zonal, system wide
- Data/Telemetry requirements
  - Required inputs (for control and forecasting)
    - Wind data (wind speed, etc.) and Non-wind data (MW, MVAR, etc.)
    - Granularity
      - Time (update rate) and Spatial (per turbine, plant wide, up to regional)
- Wind Forecasting
  - Forecast responsibility (e.g., in-house vs. plant operator)
  - Control room integration

Build Models

- Mesoscale wind model
  - Simplified computational fluid dynamics model
  - Nested grid of wind speed, direction, etc.
  - Typically ten-minute time resolution
  - Multi-year to capture El Nino effects
  - Offshore & parts of neighboring systems
- Wind Plant Model
  - Translate the wind speeds to power out
  - Place the plants in locations of interest
- Develop dynamic “historical” simulations
- ISO-NE obtains the ability to use the models
  - Possible use in wind forecast/control room integration
  - Possible links to ISO-NE production system (offline)

Scenario Development/Analysis

- Develop/ refine wind plant scenarios to identify technical issues and solutions
  - Development of scenarios under review by project team
  - Will review scenarios with PAC on August 19
- Analyze variability using wind and load data
- Identify transmission constraints (for wind)
- Develop Effective Load Carrying Capacity (ELCC) methodology for wind in New England
- Identify requirements for
  - Load following
  - Regulation
  - Reserves

Scenario Simulation and Analysis

- Identify effects of/on
  - Wind power forecasting
  - Unit commitment
  - Load Following, Regulation, and Reserve capability of online gen
  - Emissions (including carbon cost)
  - LMPs
- Suggest and investigate facilitation measures
  - Market/Operational changes (e.g., more frequent inter-area exchanges)
  - Storage
  - Demand Response

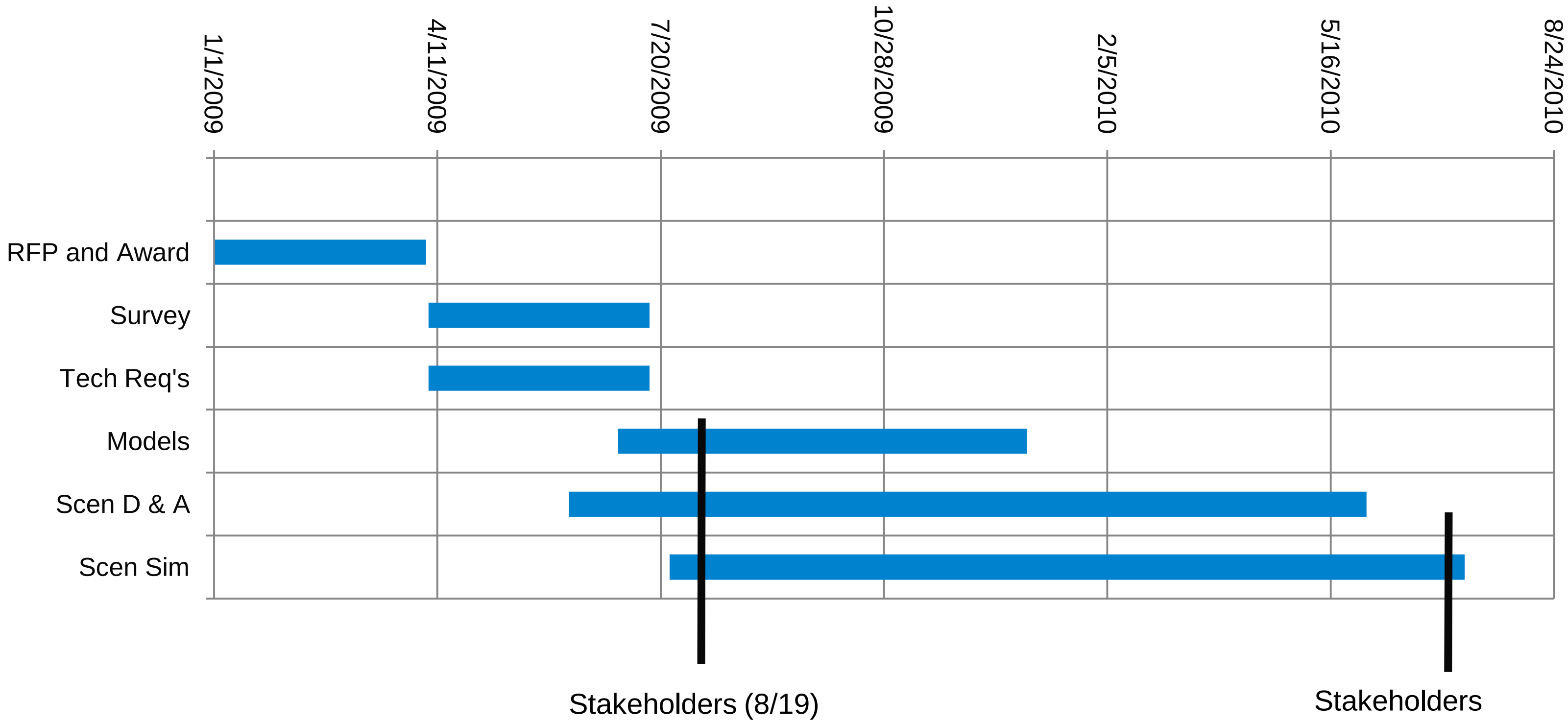
NEWIS Status

- Vendor selection: March 17, 2009
  - GE, Enernex, AWSTrueWind, WindLogics
- Kick-off Meeting: April 7, 2009
- TRC Kick-off Meeting: May 22, 2009
- Working with GE on mesoscale modeling (Task 3)
  - Inputs, Outputs, and Capabilities; Validation
- Working with GE on technical requirements for wind resources in New England (draft due early June)
- Starting discussion regarding scenario development
- Finalized project schedule & duration: ~18 Months

Team GE and the NEWIS TRC

- Team GE
  - GE Energy and Systems Engineering
    - NYSERDA (‘04, ‘05) through to CAISO (’07) and others
  - EnerNex
    - Minnesota (‘04) through to EWITS (‘09)
  - AWS Truewind
    - NYSERDA through to EWITS
- Technical Review Committee
  - J. Charles Smith: UWIG, AWEA
  - Michael Milligan, Brendan Kirby: National Energy Labs
  - Mike Jacobs: Developers/Transmission
  - Utama Abdulwahid: Wind Resource Characteristics

Finalized Project Timeline

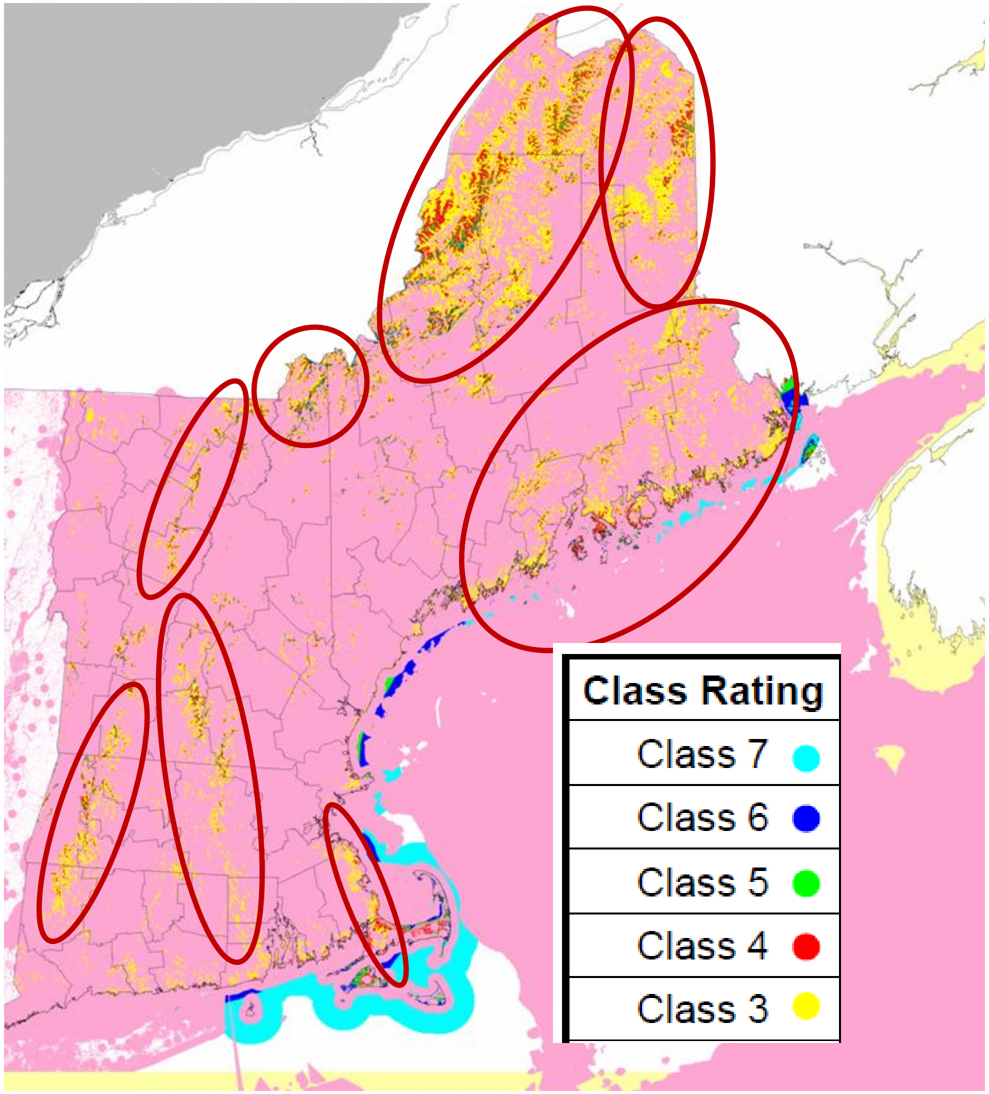


Screening Criteria for Wind Site Study Assumptions

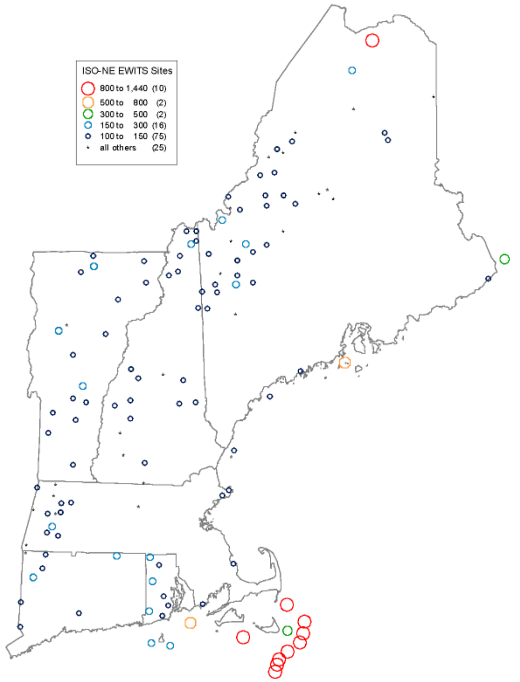
- Onshore
  - Wind speed must be >= class 4 and higher at 80m
  - Lakes, rivers, wetlands & developed areas all with appropriate buffers
  - National and State Parks with appropriate buffers
  - Elevation must be <= 3000ft, Slope must be <= 20% (11deg)
  - Appalachian and Long trails with appropriate buffers
  - Airports with appropriate buffers
- Offshore
  - Wind speed must be >= class 5 and higher at 80m
  - Outside state waters (approx 3NM limit)
  - Water Depth<= generally 30m but jacketed technology to 60m?
    - Horn's Rev: depth ~ 20m, H_s 50yr ~6m
    - Beatrice: depth ~ 45m, H_s 50yr ~15m

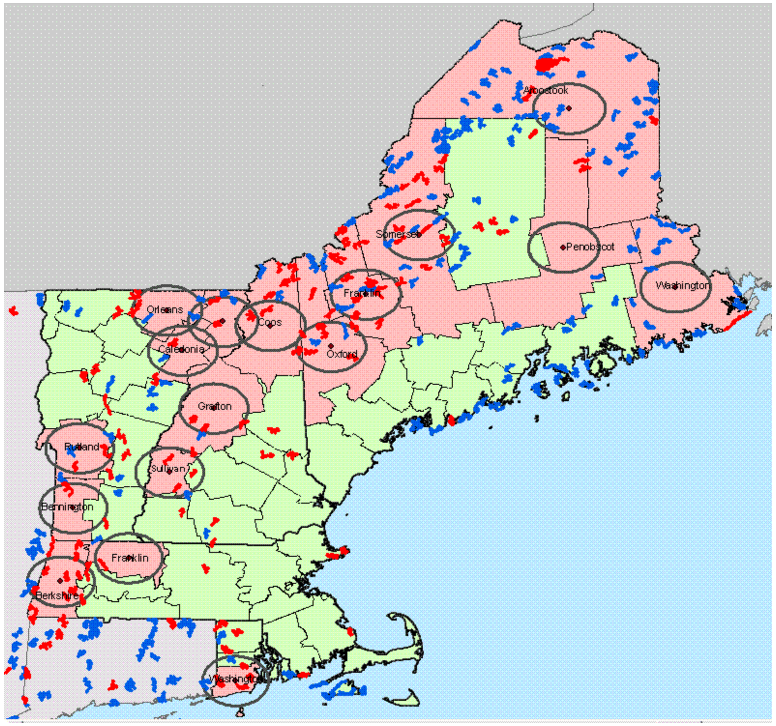
Potential Wind Resource

- 2003 AWST 70m map
- Screened out areas are pink
- Red ovals are large regions of onshore wind
- Approx 115GW onshore
- Approx 100GW offshore



Mesoscale Modeling: what to include





- Include ISO-NE Queue projects
- Include capability to further cull (or expand) potential sites due to e.g., siting restriction changes
- Discussing with Team GE

Questions?

New England Wind Integration Study

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Appendix

Outline

- Integration challenges and examples
- Selected other wind integration studies
- Wind is new kind of generation
- Wind resource map of Northeastern America

Integration Challenges: Operational

- Near-term forecast uncertainty
  - Can cause over/under commitment
- Variability
  - Regulation time-scale
    - May require increased regulation capability
  - Load following time-scale
    - May require additional ramping capability
  - Day ahead time-frame
    - Complicates unit commitment
- Minimum generation issues
  - e.g., spill wind to maintain system security
- Congestion management
  - e.g., spill wind to maintain thermal limits

Challenges: Operational (Part 2)

- Coordination with other Balancing Areas
  - Share the variability (and reduce overall variability)
- Spinning reserve
  - Usually no effect—only large generators/lines
  - Unless loss of wind (or forecast error) exceeds 2nd largest contingency
- Non-spin reserve
  - High wind cutout can cause loss of generation on the order of approximately 25% wind plant output per hour
  - Wind may increase non-spin reserve requirements

Challenges: Markets & Planning

- Markets

Over–commitment	Under–commitment
Inefficient use of resources May depress LMPs May raise NCPC	Can increase price volatility

  - Real-time vs. Day-ahead
  - Do we need a load following market? e.g. non-spin fast start
  - What are the effects of increased reserve requirements?
  - What are the effects of virtual bids? Negative bids?
- Planning
  - Resource adequacy calculations
  - What is ELCC for wind?
    - System wide, Zonal, Per generator (incremental)?
  - Is there an effective way to plan including wind on a probabilistic or an energy basis?

Challenges: Recent Examples

- BPA water spilling (06/30/2008)
  - Communication issues – high wind/low load
- ERCOT low frequency event (02/26/08)
  - Wind forecast/control room integration – unanticipated wind loss
- Denmark high wind cut-out (01/08/05)
  - Forecast failure/High wind cutout – Hurricane causes loss of 2,000 MW (83%) over 6 hours
- Other events
  - Variable LMPs: NY
  - Large ramps increase load following duty: CAISO Summer 2006

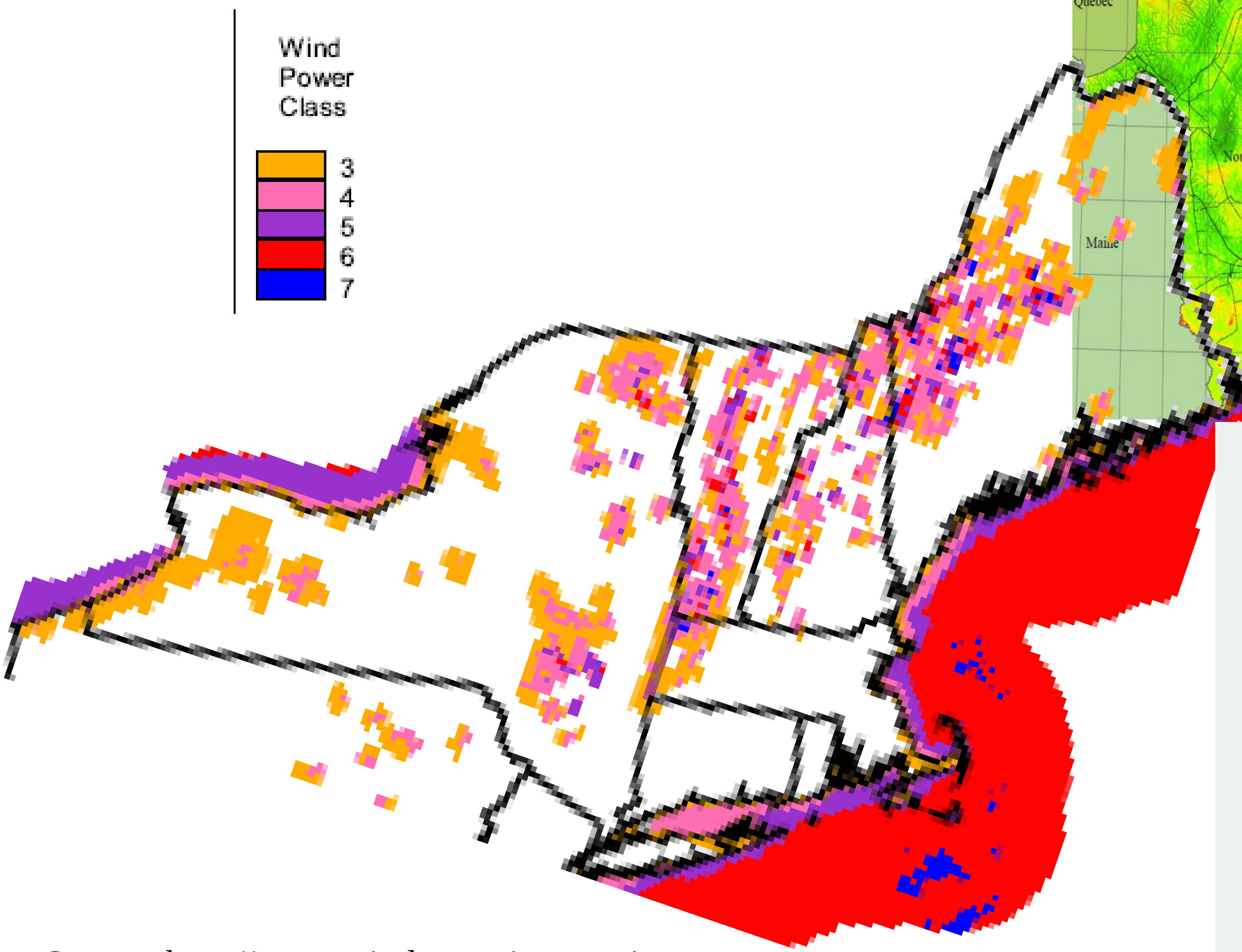
Other Studies

Region	Year	Penetration
Minnesota/MISO	2004	15% - 25% Energy
Germany/Dena	2005	<20% Energy
NYISO	2005	10% Capacity
Colorado/Xcel	2006	10% - 20% Capacity
CAISO/CEC	2007	<20% - <33% Energy
ERCOT	2008	8% - 23% Capacity
Ireland/All Island	2008	23% - 59% Capacity
EWITS/JCSP	2008-2009	20% - 30% Energy
NERC IVGTF	2008-2009	N/A

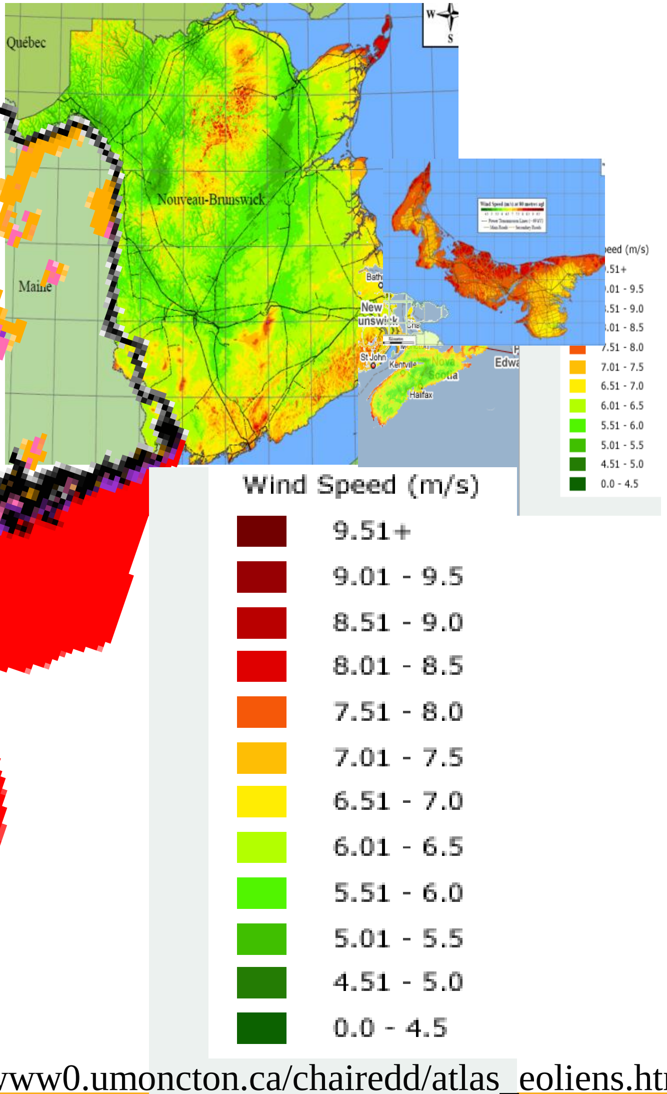
Wind is novel for large scale generation

- Variable and somewhat unpredictable generation
  - Semi-dispatchable: down, not up (caveat)
  - Doesn't usually correlate well with use pattern
  - Forecast accuracy improves as time horizon shrinks
- Locationally constrained
  - Can't ship the wind in
  - Often best resources are distant from load centers
- Young technology
  - Evolving grid-awareness/support
  - Power electronics (on most machines) make them very flexible
- Small unit size (in MW)
  - Distributed Generation ~15 MW – a handful of turbines
  - Wind "farms" up to say 1GW – tens to hundreds of turbines

North Eastern American Wind Resource



Source: http://www.windpoweringamerica.gov



Source: http://www0.umoncton.ca/chairedd/atlas_eoliens.html