Wind Energy in New England Islands and Coastal Communities

Community-Scale Wind Technology

What a community needs to know about wind technology to use wind power in the 50 kW – 40 MW range for grid-connected applications

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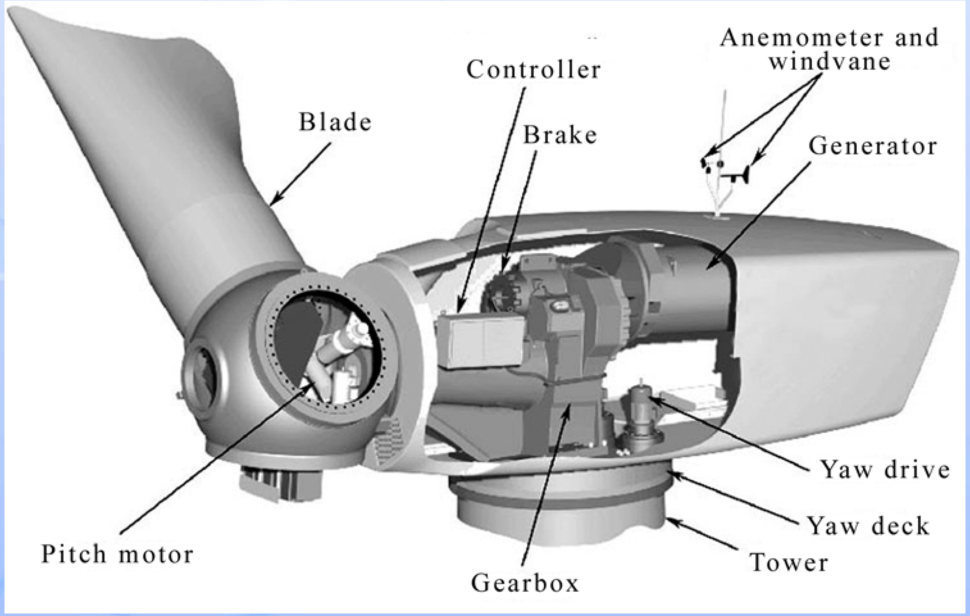
Communities are looking at Wind power

- In this scale (50 kW – 40 MW)
- Who?
  - Municipal utilities, electric co-ops, and
  - Publicly operated facilities, e.g.
    - School campuses
    - Water & Sewage treatment & desalination
  - Non-profits
- Why?
  - Public demand for green power
  - Incentives make it more attractive

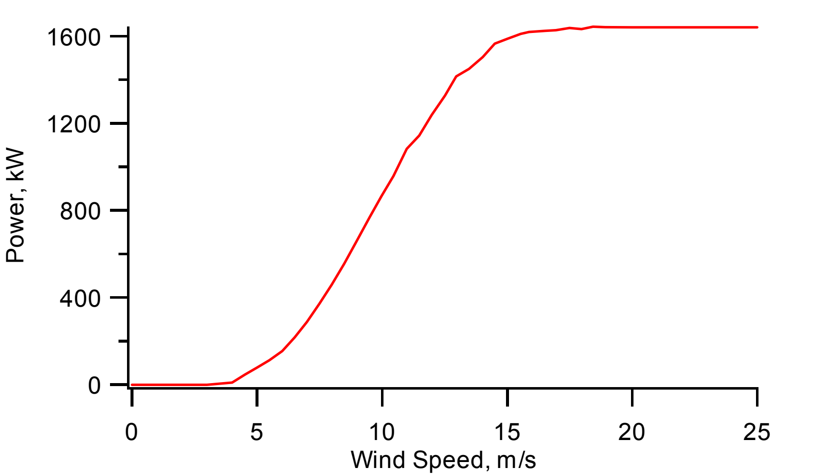
Parts of a wind turbine

- Rotor
  - 2 or 3 blades
  - Fixed/variable pitch
- Gearbox
- Brake
- Generator
- Control system
- Tower
  - Tubular vs.Lattice
- Electrical connection



How a Wind Turbine Works

- Control system
  - Turns it on and off, control operation
  - Manages all components for safe operation
- Power Curve
  - Cut-in wind speed
  - Rated wind speed
  - Cut-out wind speed
  - Rated power
    = highest power



Steps to Developing Windpower

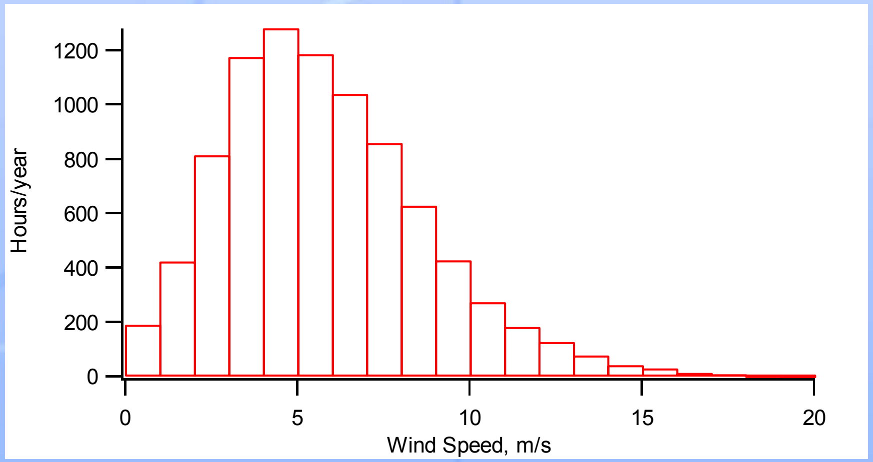
- Predevelopment
- Site Selection
- Choosing a size
- Economics
- Permitting/Planning
- Public Outreach
- Going out to bid
- Procurement and Installation

Predevelopment

- Learn about wind power
- What is the local average wind speed?
- Discuss possibilities with other groups
- Consider possible wind monitoring sites
- Measure the wind resource
- Outline a plan for developing wind power

Predevelopment

- Measure wind resource
  - "Weather stations" won't do
    - meteorologists measure wind differently than we do
  - At least 1 year of data at 40m or higher
    - Mean wind speed mean
    - Wind speed distribution
    - Turbulence



Site Selection

- Consider many criteria
  - Wind, power lines, neighbors, zoning
- Securing rights to site
  - An agreement to agree on details at a later date
  - Required for grid interconnection studies
  - Needed to measure wind resource at site

Choosing a Size - Considerations

- Wind resource
- Power needs
- Visual and noise concerns
- Site constraints
- Availability of wind turbines
- Utility interconnection
- Nearby airports

Choosing a Size – Wind Resource

- Higher average wind speed
  - More energy in the wind
  - More electrical energy (kWh)
  - More hours of operation
- Low wind speeds
  - May require a larger rotor for same power

Choosing a Size – Power Needs

- Planning to power specific loads?
  - Electric loads often don't coincide with wind power production
  - May have excess electricity at times
- Sell excess power?
- Power line upgrade needed?

Choosing a Size – Visual Issues

- Wind turbines need to be tall
- Computer programs can be used to determine visibility from various locations
- Coloration and lights may be needed for safety
- Look at other wind turbines
- Layout for multiple wind turbines

Choosing a Size – Noise

- Measured in decibels (dB)
- Measured with respect to background noise
- Standards for allowable noise over background
- Manufacturer can provide noise data
  - Standards for turbine noise measurements

Choosing a Size – Site Constraints

- Foundation design depends on:
  - Turbine size
  - Soil properties - Need to do soil testing
- Foundation is usually cement pad or tube
- Site access may limit turbine size
  - Blades and tower sections
  - Construction equipment

Choosing a Size – Availability of Wind Turbines

- 50 kW – 250 kW
  - Atlantic Orient Corp.
  - Fuhrlander
  - Lagerwey
  - Northern Power
- 660 kW – 1500 kW
  - Much greater selection

Choosing a Size – Utility Interconnection

- If you have a consistently large electric load – can connect "inside the fence"
- Usually connect directly into the distribution lines, at high voltage
  - Transformers
- No uniform interconnect standard now
  - local utility can demand special equipment
- See RERL website for links to some current rules

Choosing a Size – Utility Interconnection

- Net metering
  - For small systems
  - Put it “behind your meter”
- If you have a consistently large electric load
  - Power production offsets power purchase
  - e.g. municipal electric companies
- Power purchase agreement for excess

State Net Metering Limits

- CT: <=100 kW
- VT: <=150 kW for farm systems
- ME: <=100 kW
- MA: <=60kW
- NH, RI: ~25kW

Choosing a Size – Nearby Airports

- Glide path height restrictions
- Visible coloration
- Obstruction Lighting
  - Usually needed on turbines over 200 ft
  - Lights not usually needed on all turbines in multi-turbine installations
  - File FAA form: Notice of Proposed Construction or Alteration
- Obstruction of radar and landing systems

Economics

- Big picture: The market balances the value of wind power to society against the costs
- Costs of conventional generation
  - Cost of fuel, plants and power production
  - Pollution, health effects, global warming
- Costs of wind power
  - Cost of wind turbines and operation

Economics

- Value to wind power to society:
  - Value as electricity
  - Provides environmental benefits
- Value of wind power reflected in:
  - Price of bulk energy sold at wholesale
  - Monetarized value of social benefits
    - Federal Wind energy production tax credit (PTC)
    - MA renewable energy portfolio standard credits (RECS)
- Monetarized benefits increase wind power's market value

Economics

- Costs of wind power
  - Equipment and installation, C (~$1000/kW)
  - Operation and Maintenance, O&M (~0.5-1.0 ¢/kWh)
  - Debt repayment costs
- Simple cost of energy (COE) calculation
- COE = (C*FCR)/E +O&M
  - FCR = Fixed charge rate
    - Fraction of installed costs paid annually for debt repayment
    - Typically 10 %/yr to 20 %/yr
  - E = Annual energy production, kWh/yr

Economics

- Representative example of cost of energy
  - 660 KW wind turbine
  - Equipment and installation, C = $700,000
  - Operation and Maintenance, O&M = $0.011/kWh
  - Fixed charge rate, FCR = 12 %/yr
  - Annual energy production, E = 1.5 million kWh/yr
- Cost of energy = 6.7 ¢/kWh

Economics

- Possible sources of income
  - PPA: electricity sales (~ 4 ¢/kWh)
  - Displaced purchases (~ 10 ¢/kWh)
  - Production tax credit (PTC) (~ 1.8 ¢/kWh)
  - Renewable energy portfolio standards (RPS) certificates (RECS) (~ 2.5 ¢/kWh)

Economics

- Selling power
  - MA: Register as a generator with ISO-NE to get RECS
  - Register with FERC
  - Power purchase agreement (PPA) to sell power
  - Multiple ways to sell power
    - Sell to aggregator (bulk energy supplier)
    - Sell on day-ahead market
    - Sell to utility on spot market

Permitting/Planning

- Lease for land
- Zoning
- Building permits
- Conservation commission and state environmental permits
- FAA permit
- Interconnection agreement
  - Local utility or ISO New England

Public Outreach

- Public outreach is very important
- Educate the public about wind power
- Solicit support and concerns
- Attempt to address concerns
  - Adapt siting, project size

Going Out to Bid

- Write up bid specs
  - Scope of Work
  - Liability, Warranty, and Performance
  - Delivery Schedules
- Identify potential turbine manufacturers
- Evaluate bids
- Choose final proposal

Procurement and Installation

- Purchase contract
  - Cost, timeline requirements
  - Commissioning requirements
  - Warranties
  - Maintenance contract
  - Turnkey installation or local control
- Installation supervision

Conclusions

- Community scale wind power is here!
- Numerous issues to consider
  - The wind resource
  - Turbine location, size
  - Economics
  - Development process
- A variety of information resources available

Hull's Installation Experience

- Installed November 2001
- Vestas V-47
  - 660 kW
  - Hub height
    50 m = 164 ft
  - Diameter
    47m = 154 ft
- 1.5 million kWh/yr