

# Wind Energy Project Development

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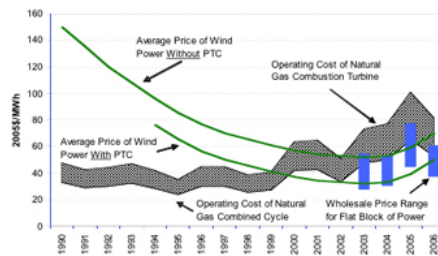
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## Wind Industry Projected Growth in the United States

- Forces Causing Wind Growth in the United States
  - Wind energy is increasingly cost competitive with gas fired energy plants and with some types of coal plants - both with and without the Production Tax Credit (PTC).
  - Concern about some energy sources (e.g., coal plants) emitting greenhouse gases causing detrimental climate change.
  - National Security - perceived need to reduce dependency on foreign power sources (oil and natural gas).
- Incentives Enacted to Foster Wind Energy Growth
  - The PTC, first enacted in 1992, and recently reauthorized in 2005, provides a 1.9-cent per kilowatt-hour credit (adjusted periodically for inflation) for electricity produced from a wind energy facility during the first 10 years of its operation.
  - State renewable portfolio standard (RPS) laws requiring renewable energy will result in 50,000 MW of wind energy by 2020 (assuming no further states enact RPS requirements)

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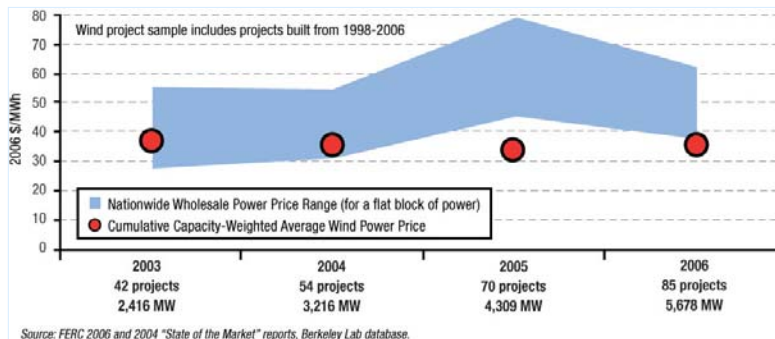
## Wind Industry Projected Growth in the United States



Comparison of Wind Power Prices with the Cost of Conventional Generation  
 Source: Lawrence Berkeley National Laboratory

Average wind power prices have trended downward over time, and are competitive with both wholesale power prices and with the cost of operating new natural-gas power plants.

## Wind Industry Projected Growth in the United States



Source: FERC 2006 and 2004 "State of the Market" reports, Berkeley Lab database.

- Wind projects built from 1998-2006 have been competitive with conventional wholesale prices as measured between 2003 to 2006.
- Wind costs represent capacity-weighted average price for wind power for entire sample of projects built from 1998-2006

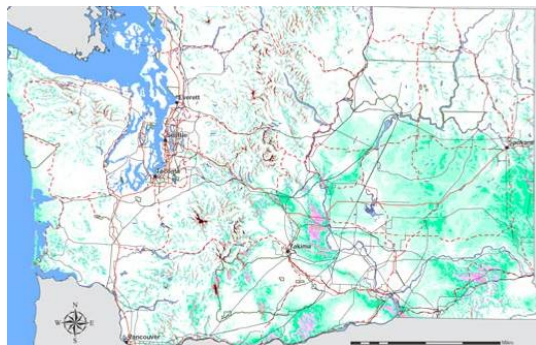
## Wind Energy Project Development

- Searching for wind development sites:
  - Wind maps
  - GIS screening (wind, environmental, terrain, land ownership)
  - Public wind data (state anemometer loan, NREL tall tower, UWRAP)
  - Fly-over
  - Physical evidence (vegetation and terrain)
  - Numerical Weather Simulations
  - Market study
  - Transmission study

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## Wind Energy Project Development

- Searching for wind development sites:
  - Wind maps



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## Wind Energy Project Development

- A good wind site has the following attributes:
  - Transmission:
    - Proximity to an electrical transmission is key.
    - Available capacity to transmit the power generated.
    - Potential power purchasers.
  - Wind
    - Consistent and predictable wind.
    - Maximum gust and turbulence are within wind turbine manufactures design specifications.
    - Strong enough, often enough so that turbines produce at least 30% of rated power on average.
  - Physical Location:
    - Geography with reasonable construction costs.
    - Acceptable environmental constraints.
  - Political Climate:
    - Land owners willing to lease.
    - Acceptance by community and local government.

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## Wind Energy Project Development

- Wind
  - Consistent and predictable wind.
    - Storm driven wind resources are less desirable
    - Seasonality helps Operation and Maintenance planning.
  - Maximum gust and turbulence are within wind turbine manufactures design specifications.
    - WTGS class II A: Avg 8.0 m/s, max 42.5 m/s, TI 0.18
    - WTGS class II B: Avg 8.0 m/s, max 42.5 m/s, TI 0.16
    - WTGS class III A: Avg 7.5 m/s, max 37.5 m/s, TI 0.18
    - WTGS class III B: Avg 7.5 m/s, max 37.5 m/s, TI 0.16
  - Strong enough, often enough so that turbines produce at least 30% of rated power on average.

Wind Power Class	50 meters		
	Wind Power Density (watts/m <sup>2</sup> )	Wind Speed (m/s)	Wind Speed (mph)
1	<200	<5.6	<12.5
2	200 - 300	5.6 - 6.4	12.5 - 14.3
3	300 - 400	6.4 - 7.0	14.3 - 15.7
4	400 - 500	7.0 - 7.5	15.7 - 16.8
5	500 - 600	7.5 - 8.0	16.8 - 17.9
6	600 - 800	8.0 - 8.8	17.9 - 19.7
7	>800	>8.8	>19.7

Source: Battelle Wind Energy Resource Atlas, for standard sea level conditions.

Note: Power density depends on air density

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## Wind Energy Project Development

- Wind development is capital intensive and risky.
- The total cost of a 100 MW wind project is nearly \$ 200 million and the developer is not paid until the project is built. Payment to the developer consists of:
  - reimbursed development costs.
  - a development fee negotiated during financing.
  - right to invest in the project's equity.
  - right to use the PTC tax equity (IRS compliant disguised debt) for the project.
  - or the right to sell the tax equity.
- Wind development is real estate development. Land control is key.

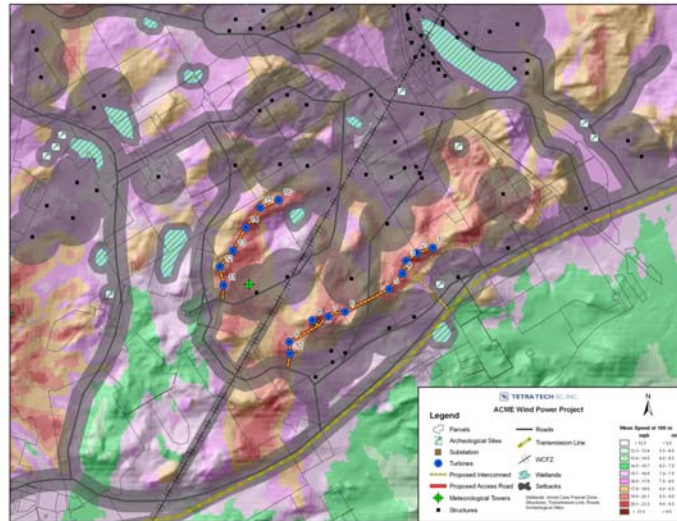
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## Wind Energy Project Development

- What a wind project is made of:
  - land control agreements for facilities, turbines and transmission.
  - permits to build and operate.
  - wind turbines.
  - access roads.
  - electrical collection system (on-site).
  - Interconnection agreement.
  - substation(s) to interconnect to transmission.
  - an operation and maintenance shop building.
  - power purchase agreement (PPA).

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## Wind Energy Project Development



Typical Wind Energy Facility Layout on a Constraints Map  
(provided by Tetra Tech EC)

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## Wind Energy Project Development

- Steps and timeline for wind site development:
  1. 0.5 to 2 years: Acquire at least partial land control. Begin wind measurement with one or two met towers.
  2. 2+ years: If wind resource appears promising, erect additional met towers. Wind flow computer simulation. Preliminary estimation of energy yield.

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## Wind Energy Project Development

- Steps and timeline for wind site development:
  2. Erect meteorological towers to study the wind - 2+ years. (continued)
    - How facility will perform is a function of the wind. Lenders, the off taker / power purchaser, and the developer, are all very concerned with collecting and analyzing the wind data.
    - Generally, lenders (now) demand two full years or more of favorable site wind data, collected from multiple met towers.
    - Wind turbine manufacturers also require multiple years of wind data to determine which model turbine and tower can be warranted.
    - The total cost of wind measurement and analysis can be several hundred thousand dollars.

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## Wind Energy Project Development

- Steps and timeline for wind site development (continued):
  3. 1 to 3 years: Environmental and Regulatory work
    - Environmental, cultural resources, and engineering studies may be required in order to obtain permits and authorizations to build and operate the project.
      - Avian, bat, wildlife, flora, cultural heritage, transportation, geotechnical, etc.
      - In most states, a local permit is necessary:
        - » CUP or permit under the wind ordinance. Building permits and road use agreements.
      - State permits:
        - » State environmental review. State resource permits (such as wetland permits), and in some states, statewide energy facility siting legislation.
      - Federal permits:
        - » federal land use authorization (BLM, USFS)
    - Lenders generally require **significant** environmental studies before construction and operation of the wind facility.
    - Depending upon the location, environmental and regulatory compliance will range from a few hundred thousand dollars to one or two **million** dollars.

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## Wind Energy Project Development

- Steps and timeline for wind site development (continued):
  4. 1 to 3 years: Transmission Interconnection
    - Interconnection request
    - Studies (Feasibility Study, Systems Reliability Impact Study, Facility Upgrade Study)
    - Large Generator Interconnection Agreement which must be ratified by FERC
    - Total cost may be two hundred fifty thousand dollars.
  5. After 1 plus years: Turbine selection
    - The location of turbines on a site is dependant upon the make and model selected. Turbines typically are 70-80% of a project's cost.
    - Obtaining financing for turbines is risky and expensive - developers typically will spread the risk of turbine financing across several projects, then allocate the turbines purchased for a particular year to the most profitable project and / or whichever project obtains a PPA. Developer must own turbines to obtain a PPA.

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## Wind Energy Project Development

- Steps and timeline for wind site development (continued):
  5. 1 to 2 years: Developmental Engineering
    - Developmental engineering - really part of permitting process.
    - Transportation Study - Identifies routes for transport of heavy and oversized turbine components/construction equipment. Public road improvements (road widenings, culvert replacements) often indicate federal wetland permits and thus require resource studies.
    - Civil Engineering - Survey site, perform geotech analysis
    - Electrical Engineering -develop plans and costs for substation, collection system, and high voltage transmission lines from project substation to point of grid connection.
    - Cost of \$500 hundred thousand to more than **\$1 million**.

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## Wind Energy Project Development

- Steps and timeline for wind site development (continued):
  6. Markets and Power Purchase Agreement (PPA) - Ongoing.
    - To obtain construction and term financing, project must have a guaranteed revenue stream sufficient to assure lenders and equity investors their investment will be repaid.
    - Typically, in the western United States, this is done with a PPA between the project company and a utility that agrees to buy the power for some long period. 20 years is a common term for a PPA.
    - The developer will consider likely markets / PPA counter parties at the same time it decides to acquire land control and install meteorological towers. Negotiation of a PPA with a willing off taker may take six months or more, and cost fifty to one hundred thousand dollars (including legal fees).

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## Wind Energy Project Development

- Steps and timeline for wind site development (continued):
  7. Finance - 3 months.
    - Most energy projects are financed. Hence all wind projects are developed with project agreements (e.g., leases, easements) that allow project financing.
    - Project finance is the finance of a project based upon that project's projected revenue stream, and typically without recourse to any person but the project company itself.
    - This concept is simply stated, but complex in execution.
    - Financing a wind project typically involves 80% debt from a tax investor who can use the PTC, and 20% equity. For tax reasons the tax debt portion of the finance is structured as equity but with IRS compliant debt attributes.
    - Between banking and legal fees financing may cost \$ 1 million or more. These fees may be paid by the developer, who still has risk of not recouping these fees if there are problems with construction and the project doesn't meet its contractual on-line commitment.

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## Wind Energy Project Development



Source: 17<sup>th</sup> Annual Renewable Energy Growth Forum, 18 – 20 October, 2004, Power Point presentation by Ed Feo / Milbank Tweed Hadley & McCloy

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## Wind Energy Project Development

- Steps and timeline for wind site development (continued):
  8. Construction - 3 to 6 months.
    - Project is built by an Equipment Procurement and Construction (EPC) contractor, several Balance of Plant (BOP) contractors (most common), or the wind developer acts as the general contractor and manages many individual construction companies.
    - Construction is rapid - 3 to 12 months, depending upon the size of the facility; disruption to landowner property should be minimal.
    - Construction cost - exclusive of turbine cost - is typically 20-30% of total project cost.

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## Wind Energy Project Development

- Steps and timeline for wind site development (continued):
  9. Operation - 20 years plus.
    - After commissioning and acceptance testing, and acceptance by the PPA counterparty, the operating wind facility is accepted by the project company from the EPC contractor.
    - Commercial operation.

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## Wind Energy Project Development

- Questions?

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## References

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- American Wind Energy Association - <http://www.awea.org/>
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- Milbank Tweed Hadley & McCloy - <http://www.milbank.com/en>
- Robert Ellis, Ridgeline Energy - [rellis@rl-en.com](mailto:rellis@rl-en.com)
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