



# Wind Energy Development in the United States



MIT-NESCAUM Summer Symposium  
MIT Endicott House  
August 12, 2009

# Agenda

## Introduction

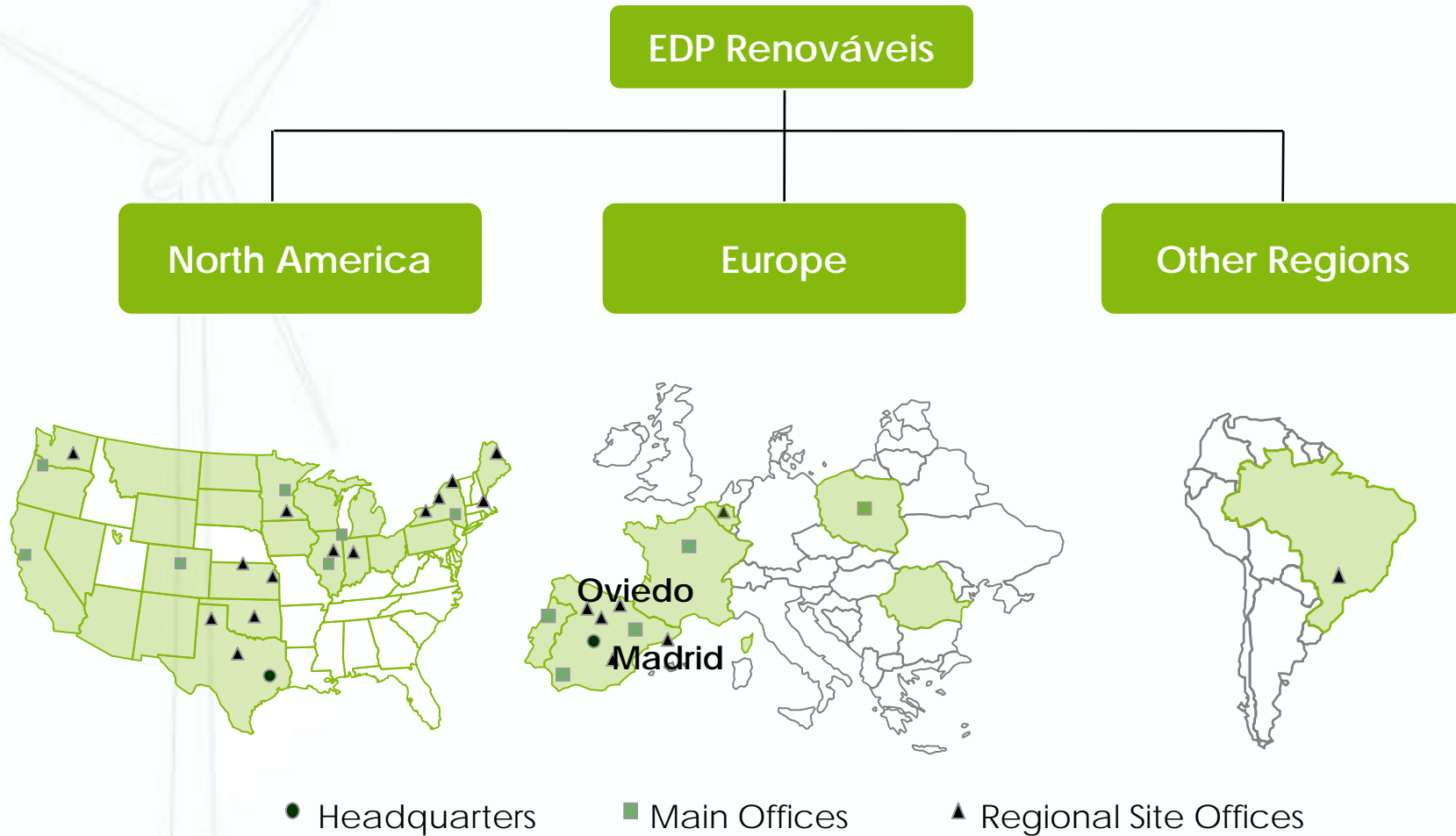
Worldwide Growth  
in Wind

Wind in the U.S.

Challenges for the  
Wind Industry



# Worldwide Presence



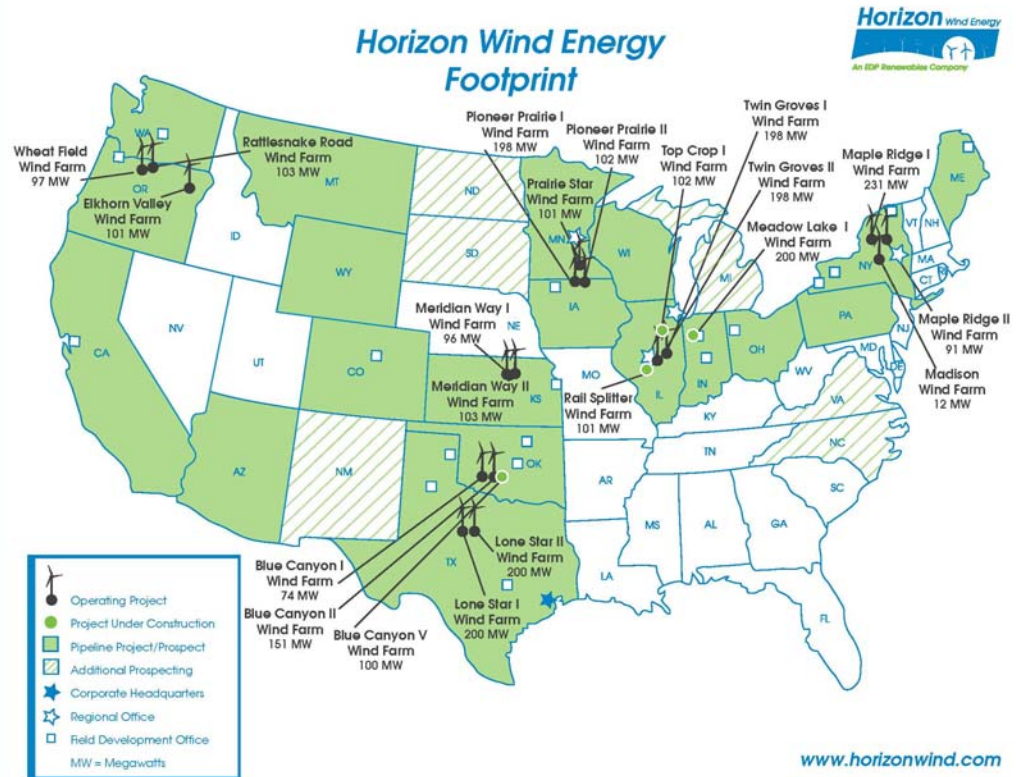
# Horizon in the US

Horizon is the 3<sup>rd</sup> largest owner of wind farms in the U.S.

- 2,000 MW installed
- Powers over 650,000 American homes
- Operating portfolio spans nine states

Horizon is owned by EDP Renovaveis

- Public company listed in Europe
- 77% owned by Energias de Portugal, Portugal's biggest company



Horizon is a leading developer, owner, and operator of wind farms in the United States



# Why Wind?

- **Environment:** Avoids the air pollution and greenhouse gas emissions from traditional sources of generation
- **Economy:** Creates high-paying, indigenous “green jobs” in construction, engineering, transportation and more
- **Energy Security:** Local energy means less reliance on foreign imports
- **Rural Communities:** New income for landowners and new tax revenues for municipalities
- **Water savings:** Traditional energy uses lots of water



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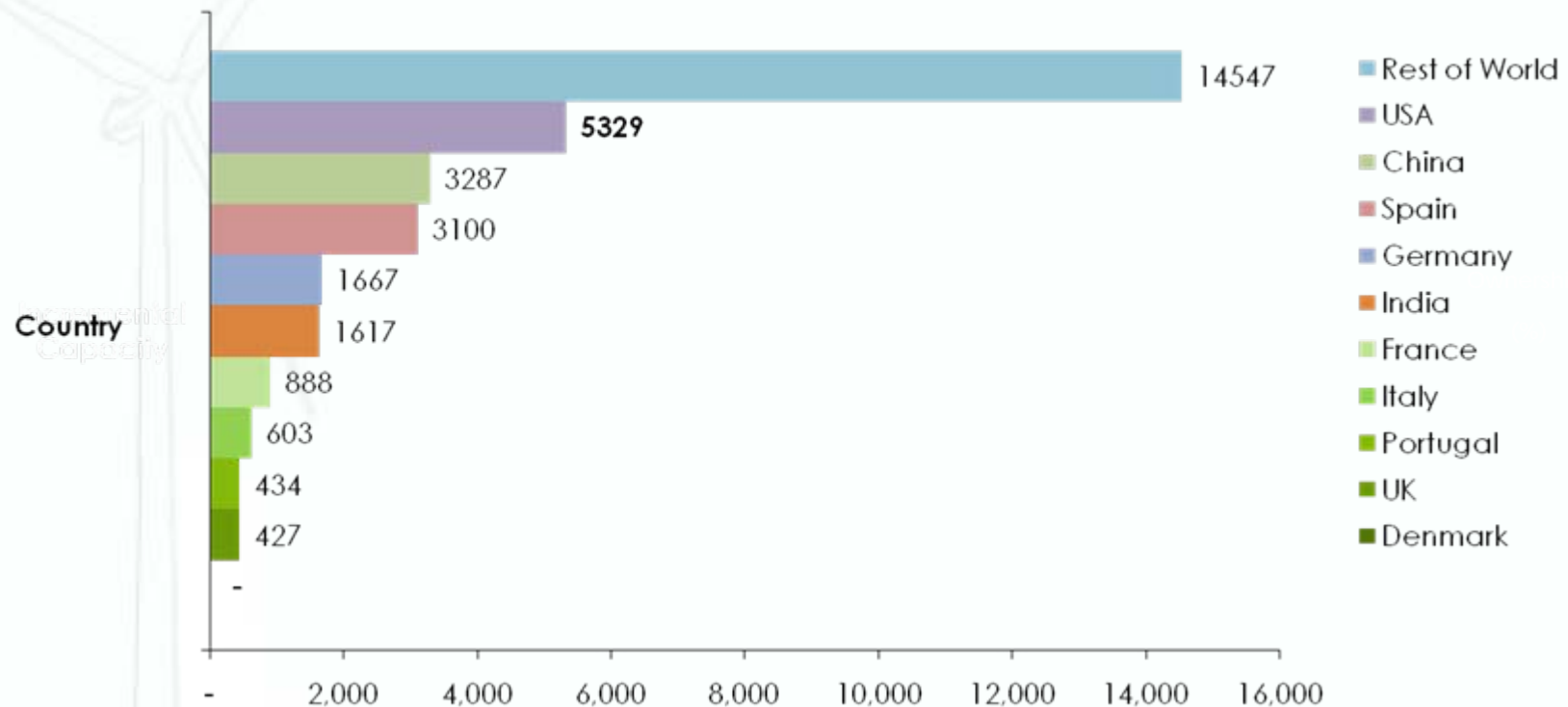
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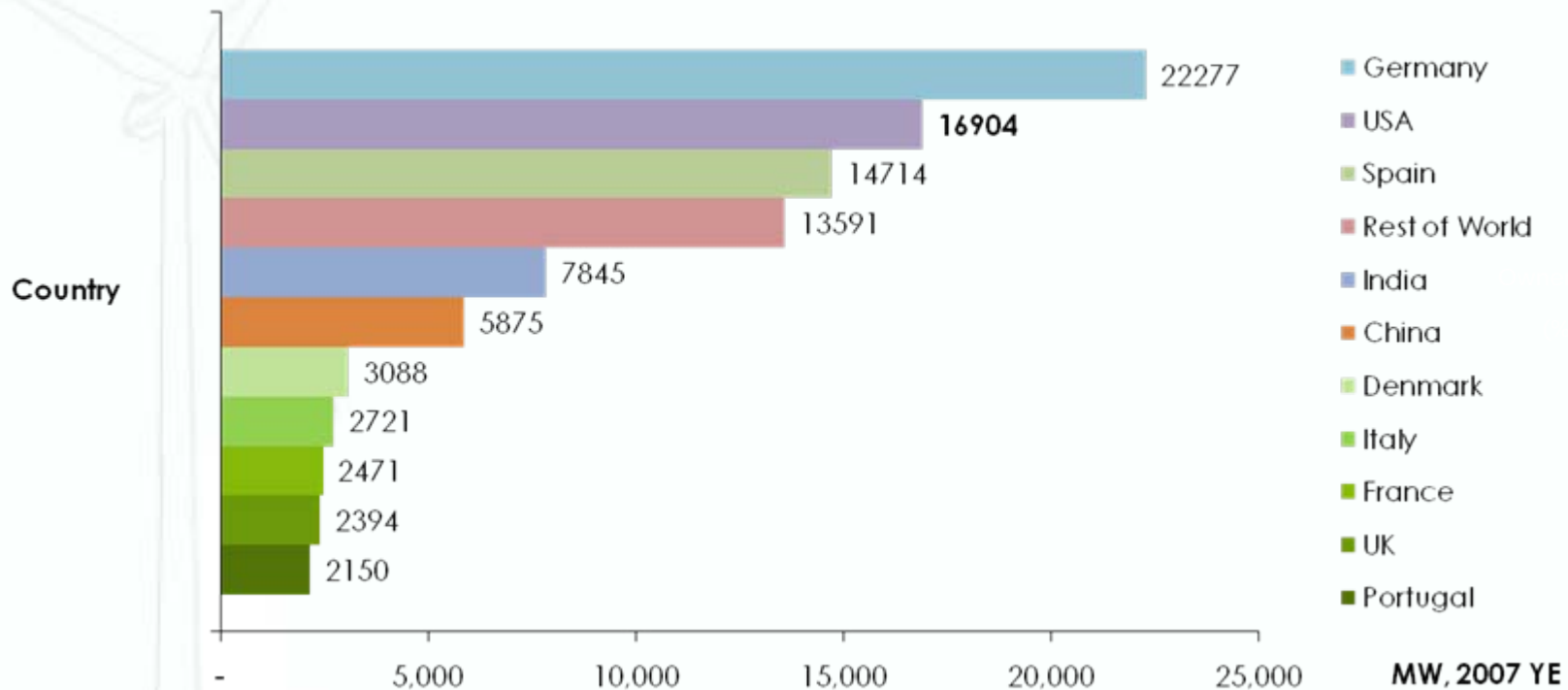


# Incremental Wind Energy Capacity



The U.S. leads the world in new wind capacity...

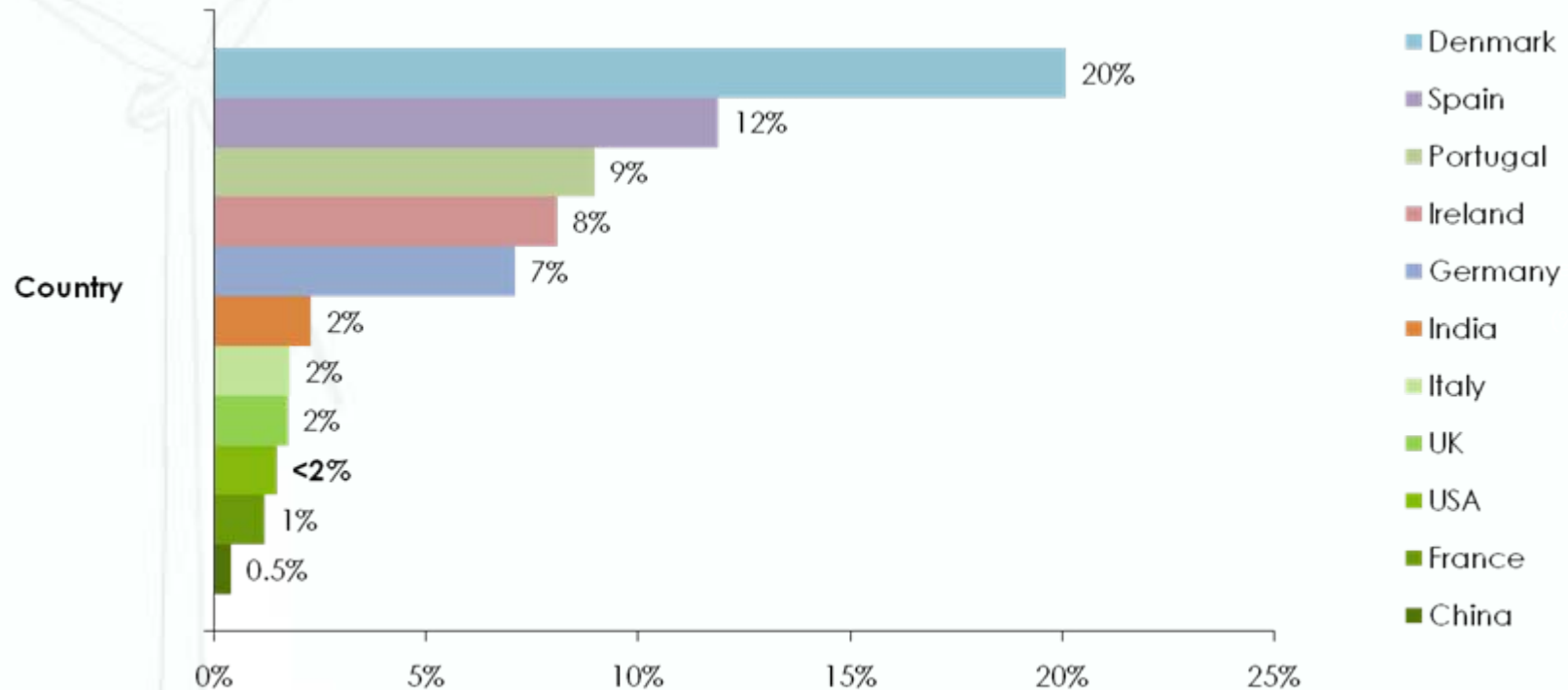
# Total Wind Energy Capacity



...and is poised to become the world's largest wind energy market by installed capacity...



# Wind Power as a Percentage of Supply



...but is well behind Europe as a percentage

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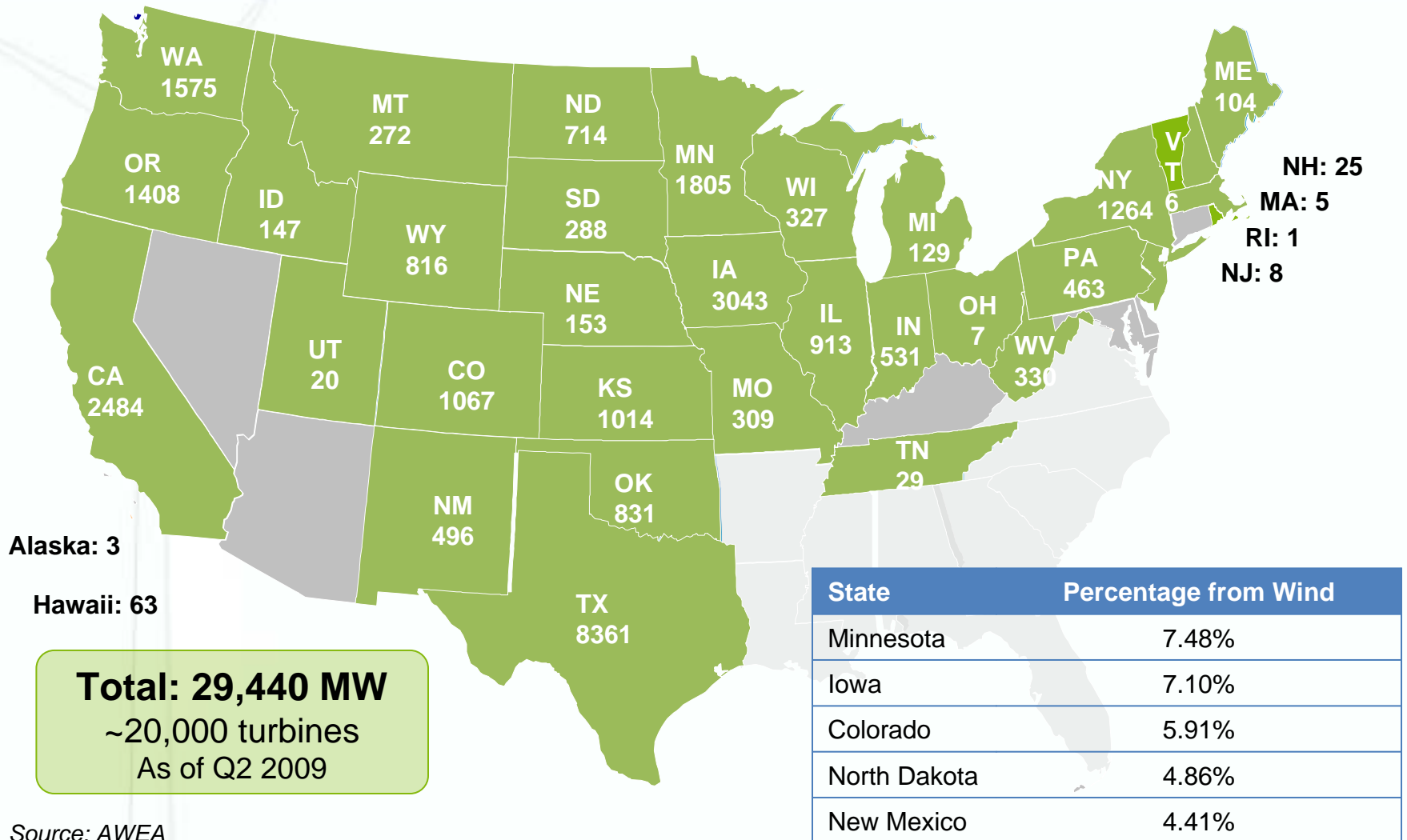
Growth in Wind  
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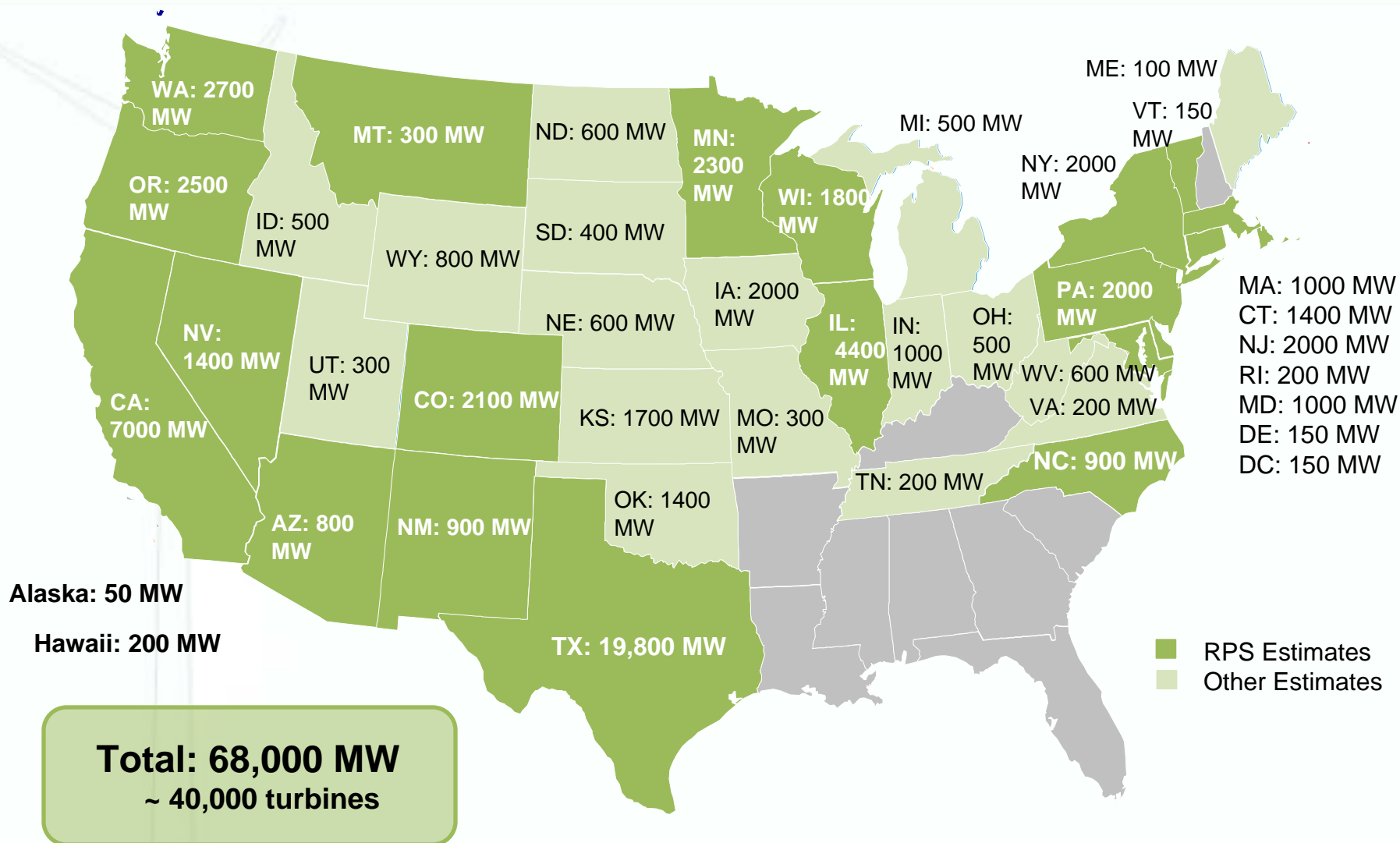


# Total USA Installed Wind Capacity 2008



Source: AWEA  
Turbine estimate based on 1.5MW machine

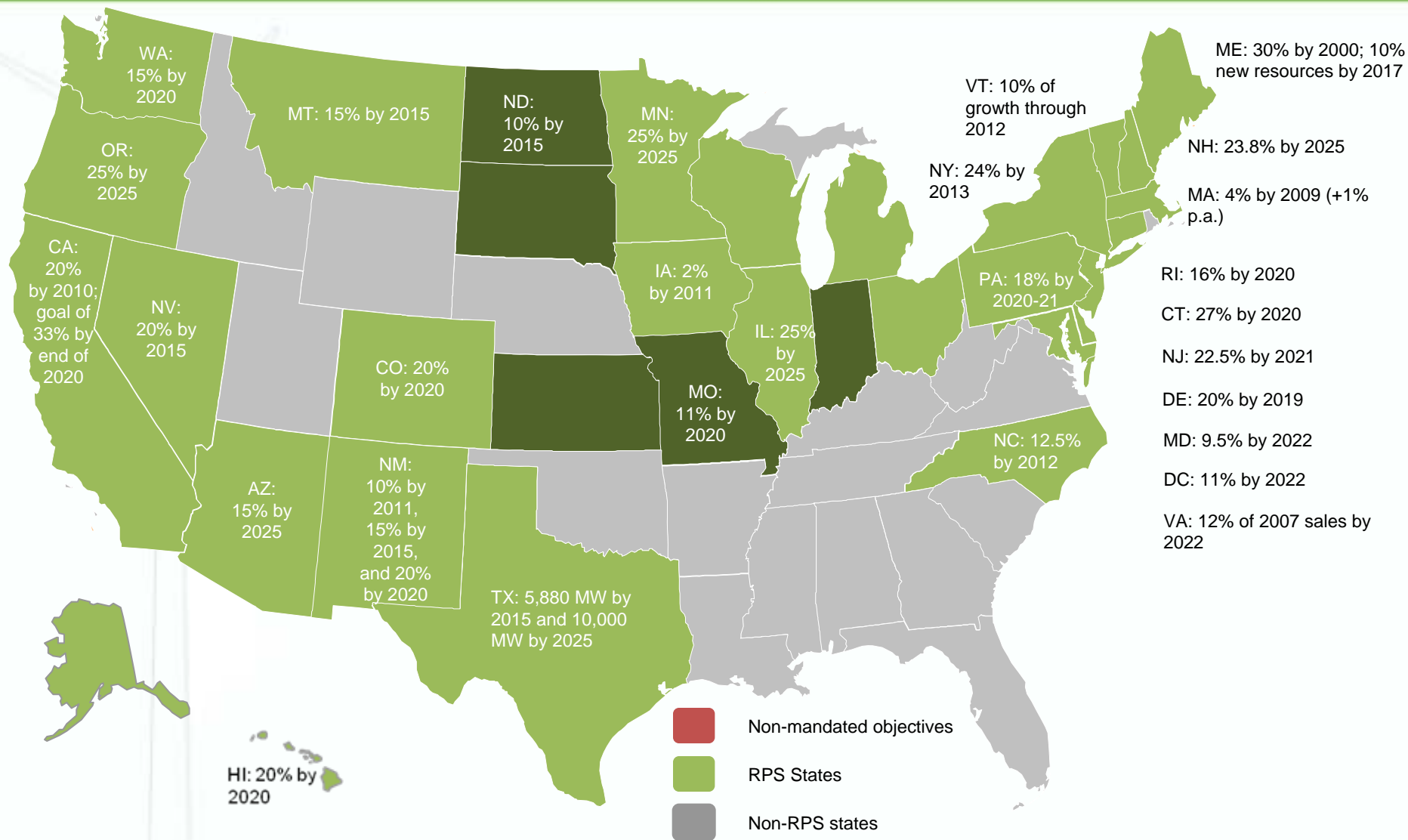
# Anticipated Wind Energy Demand by 2015



*Turbine estimate based on 1.8MW machine*



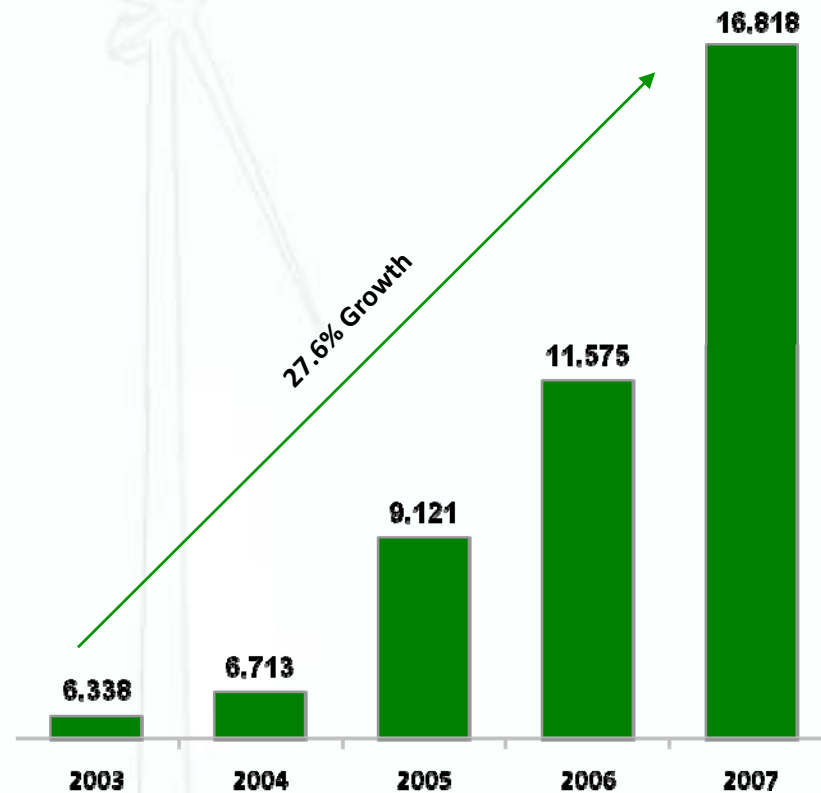
# State Renewable Portfolio Standards



# Recent Growth in US Wind Power

## Compound Annual Growth (CAGR) of Wind capacity in US

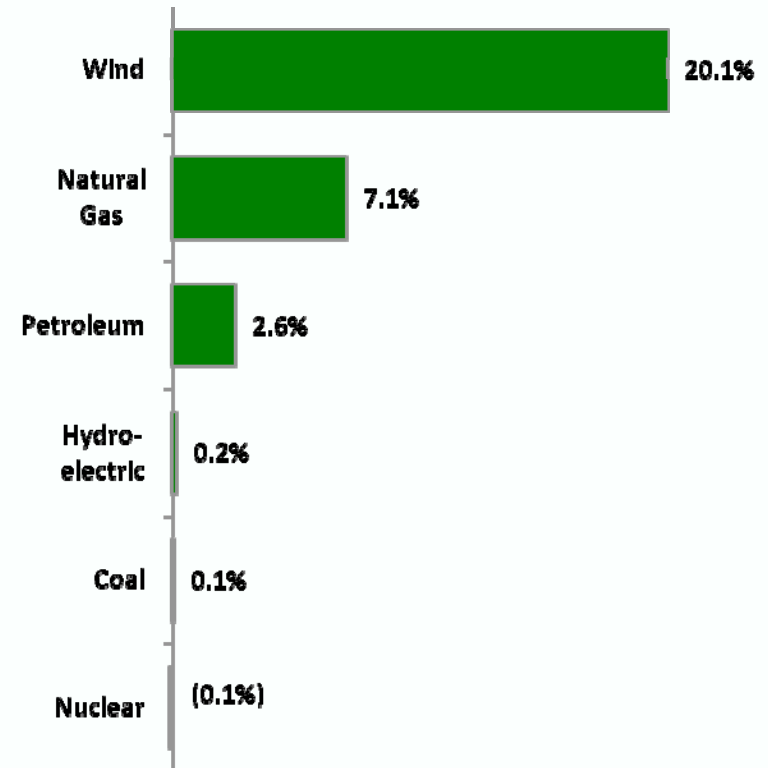
(MW, YE)



Source: AWEA (2007YE)

## Growth (CAGR) of energy technologies 1996-2006

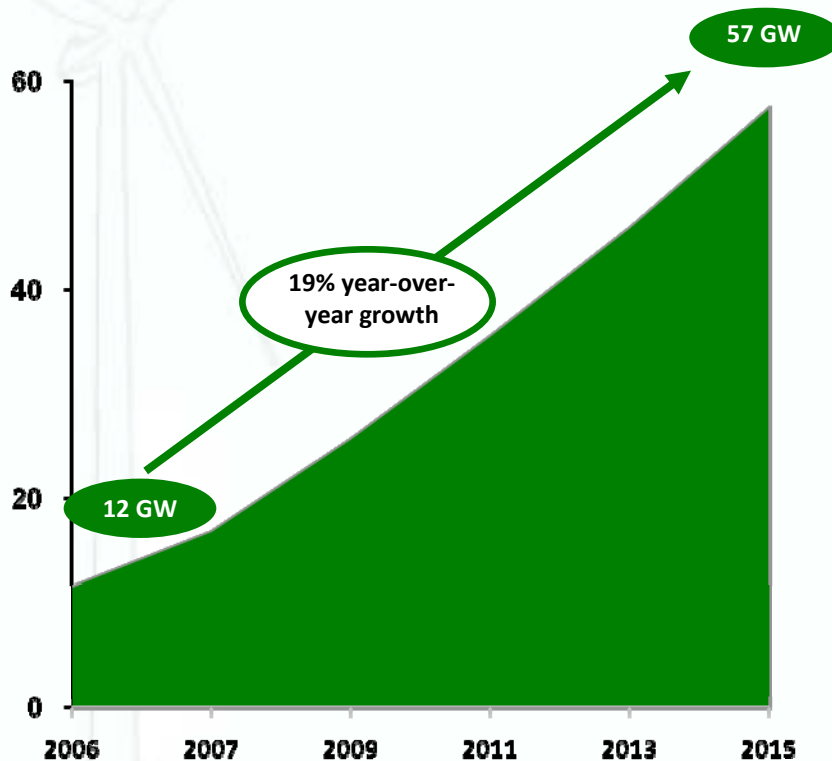
(%)



Source: 1949-1984 Energy Information Administration (EIA) estimates. 1985 - 1988 EIA, Form EIA-860, "Annual Electric Generator Report" 1989 - 1997 EIA, Form EIA-860, "Annual Electric Generator Report," and Form EIA-867, Annual Nonutility Power Producer Report." · 1998-2000 EIA, Form EIA-860A, "Annual Electric Generator Report" Utility," and Form EIA-860B, "Annual Electric Generator Report" Nonutility." · 2001 forward EIA, Form EIA-860, "Annual Electric Generator Report."

# Future Growth Projected to Stay Strong

## US wind market expected to continue to grow (Projected installed capacity, GW)



Source: AWEA for 2006 and 2007, EER for projections (2007YE)

## Growth drivers

- State and Federal policy
- Increasing energy demand
- Increasing cost of traditional energy
- Environmental benefits
- Desire for greater energy security
- Desire for rural economic development

Wind has added more new power to the U.S. grid than any other renewable technology

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# Challenges Facing the Wind Industry

## Cost

- Turbine prices have increased dramatically
- Wind needs to be competitive to achieve large market share

## Transmission

- Best wind resources are in remote areas
- Transmission is problem for U.S. in general

## Siting

- Environmental Issues
- Opposition/competition
- Low hanging fruit has been picked

## Policy

- No long-term, consistent, national policies in place
- Current policies have produced boom-and-bust cycle

**The wind industry must address these challenges in coming years...**

# Wind Energy Challenge: Rising Costs

## Operating Costs



## Total Costs

Operations  
(25%)

## Construction Costs

Construction  
(75%)

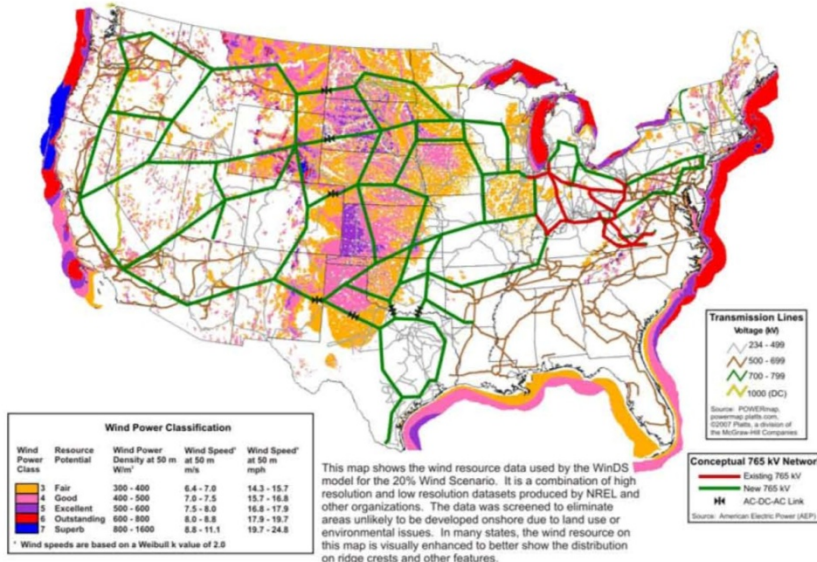
BOP (25%)

Turbine (75%)

The turbine market has softened, but materials costs, lower power prices and a weak dollar present new challenges

# Wind Energy Challenge: Transmission

Figure 1-10. Conceptual transmission plan to accommodate 400 GW of wind energy (AEP 2007)



- Most of the U.S. wind resources are far away from end-users, which translates into losses
- Significant transmission upgrade required for wind power to provide a large portion of U.S. energy
- Transmission upgrades are costly and sometimes contentious

Policymakers have begun investing in new transmission. Every dollar spent will return more in jobs, electrical reliability, energy security, rural development, water, and air pollution control

# Wind Energy Challenge: Siting

*With hundreds of onshore wind farms in commercial operation, many of the easier sites have been developed.*

*Other siting challenges include:*

- Transmission
- Wind speed, direction, consistency
- Wildlife / endangered species
- Culturally protected areas
- Topography / engineering constraints
- Aviation / radar issues
- Land use (gas, mining, recreation, etc.)
- Local opposition



**Offshore development does not have many of these issues, but cost and community opposition can cause more problems than offshore solves.**

**Cape Wind is a bellwether.**



# Wind Energy Challenge: Policy Consistency

The current PTC is set to expire on December 31, 2009

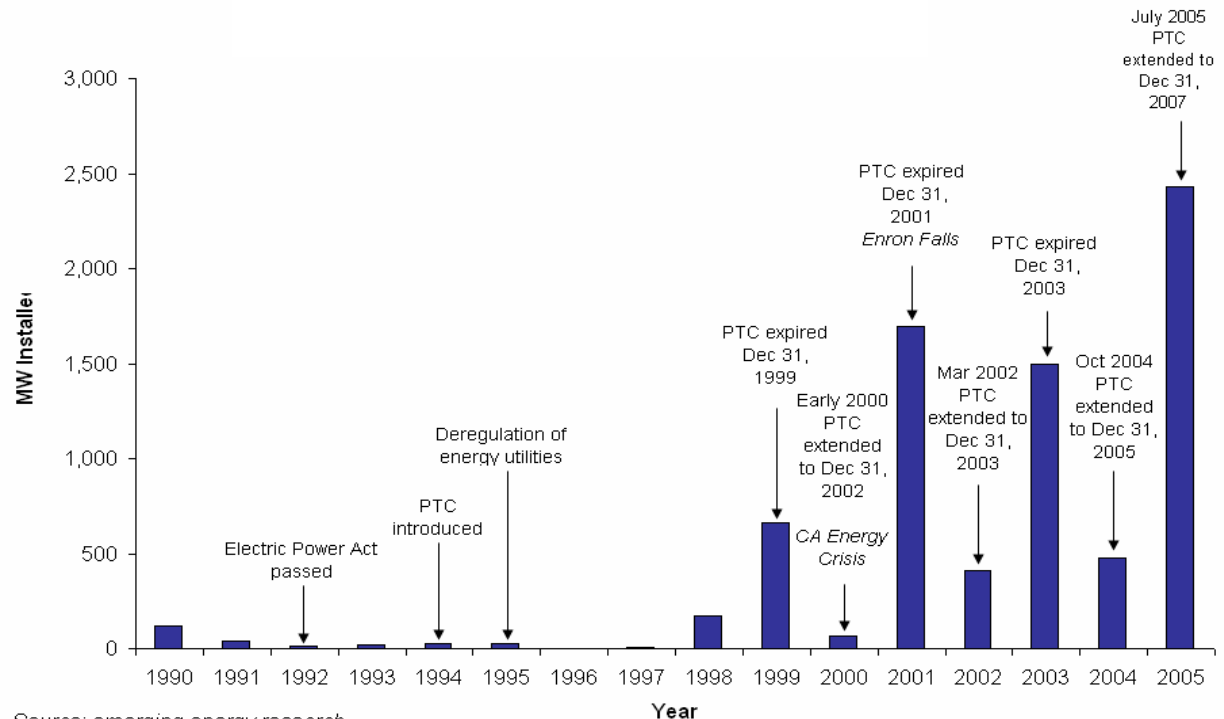
The PTC was extended as part of the Financial Bailout package

The PTC is the primary governmental incentive for wind power

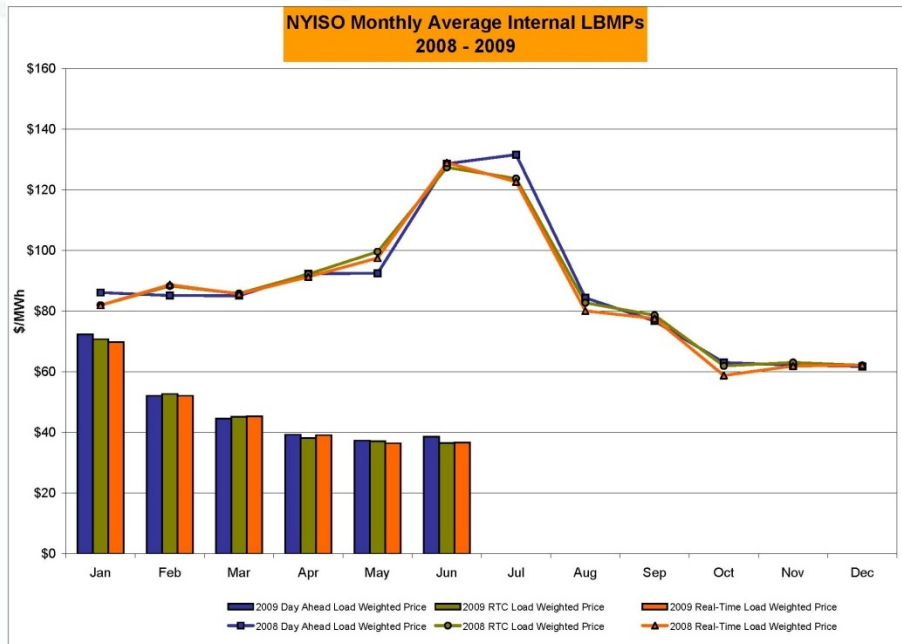
There currently is no long-term national policy relating to wind energy

Short-term extensions of the **Production Tax Credit (PTC)** have historically lead to a boom and bust cycle in the industry

**Policy-makers need to pass a long term extension**



# Wind Energy Challenge: Price Volatility



## New York Power Prices

- June 2008: ~\$130/MWh
- June 2008: ~\$38/MWh

Renewable Energy Credit (REC)  
market recently funded

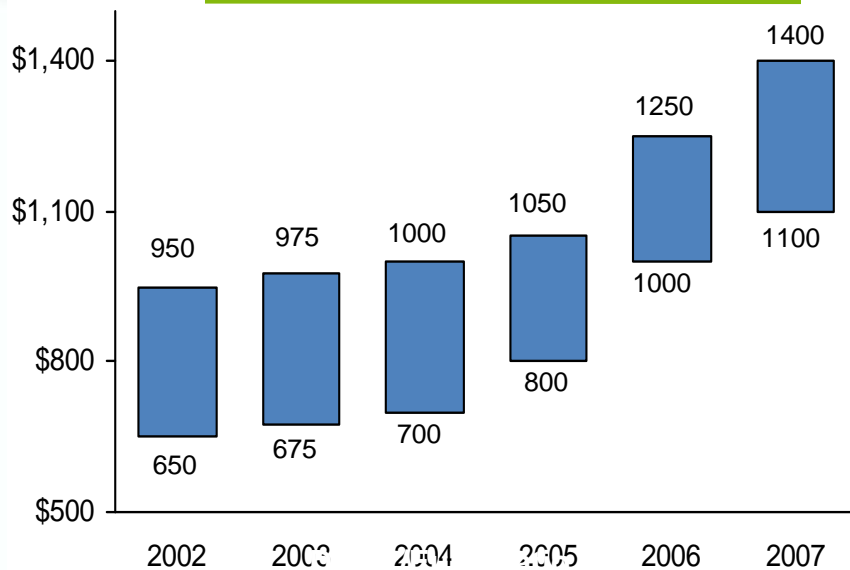
New York (and much of the  
Northeast) is dependent on  
natural gas -- prices  
correspond closely with oil

In this pricing climate, coal-  
dependent Midwestern  
states are more attractive

To offset volatility, developers prefer long term purchase agreements, which protect both buyer, seller and end-user. **Policymakers need to encourage long-term agreements as well as renewable energy credit markets.**

# Changing Challenges

Average Turbine Prices



While the challenges are much the same as they were two years ago, some have taken on greater importance....

## Challenges 2007

- Rising Turbine/Equipment Costs
  - Community Acceptance
- Government Policy Support
  - Siting and Permitting

## Challenges 2009

- Project Financing
- Renewable Energy Credit Markets and Power Purchase Agreements
- Transmission

# THANK YOU! Questions?

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Phone: 518.322.9369

[www.horizonwind.com](http://www.horizonwind.com)





# Appendix: Avian

Newer turbines have slow rotor RPMs and tubular towers (no perches)

Pre and Post construction bird studies are required for permitting most wind projects (req. 1-2 yrs)

Proper siting critical

More birds are killed by buildings , cats, cars than wind turbines

Several studies have shown that birds fly around turbines (mortality rates ~1-2/turbine/yr)

## “Birds Choose to Fly Around Turbines”

**Source: Windpower Monthly – 2001**

*Enron offshore study*

### Birds choose to fly around turbines

**JACK JACKSON**  
*Windpower Monthly*  
Assistant Editor

Not a single bird, has been “disturbed” so far from the new 10.5 MW offshore wind farm at Utgrunden, according to ongoing research carried out by the project’s developers, Enron Wind of the US and Swedish Vindkompaniet. In fact, flocks of migrating birds that follow a traditional route over Kalmar Strait in Sweden,

enough for 760,000 homes.

First though, consent must be forthcoming from federal shipping office Bunde-

planning offshore projects of 1800 MW and 200 MW in the North Sea, as well as a 70 MW development in the Irish sea.

where the project is located, shift their course well in advance to avoid coming near the turbines, ornithologists have observed.

Utgrunden consists of seven 1.5 MW Enron Wind turbines some 12 kilometres from the Swedish mainland and eight kilometres from Öland island. Researchers, led by expert ornithologist Jan Pettersson, have followed the course of 4300 flocks of birds, or more than 180,000 birds in all, reports Enron’s Thomas Stalin.

The analysis began in the autumn, when all seven turbines were erected, though some were not rotating. Bird watchers manned three

posts – on Öland, the mainland and Utgrunden’s lighthouse. They saw that the majority of flocks migrated past Utgrunden from a long distance, but those flocks that were headed directly towards the wind turbines reacted noticeably. “They saw the turbines from a few kilometres distance, and then they changed their course,” Stalin says.

Eider and other duck species were the dominant sort viewed along with geese and cranes, all of whose routes through Kalmar Strait were mapped in detail. The monitoring has continued into the spring, and Enron plans to keep it up for another three to five years until it has valid enough results to launch a more wide scale international environmental impact study, Stalin says.

The results support those already conducted in both Denmark and the Netherlands and bird behaviour with regard to both offshore and onshore wind plant.

*Reservations about most offshore sites*

### Defence ministry prepares for battle

**JANICE MASSY**  
*Windpower Monthly*  
UK

The Ministry of Defence (MOD) is understood to have reservations about most of the proposed offshore wind farm sites around the UK coast. The Crown Estate – landowner of most of Britain’s territorial seabed – consulted



PHOTO: GUNNAR BRITSE

**Not a problem:** Yet another study reveals that birds fly around rather than into wind turbines offshore

# Appendix: Construction Photos



Foundations



Access Roads



Assembled Rotor



Trenching Cable



# Appendix: Environmental Support

- 1. Peter Iwanowicz, **American Lung Association of New York State, Albany, New York**
- 2. Adrienne Esposito, **Citizens Campaign for the Environment, Syracuse, New York**
- 3. Rob Moore, **Environmental Advocates of New York, Albany, New York**
- 4. Jim Tripp, **Environmental Defense, New York City, New York**
- 5. James W. Pitts, **Green Gold Development Corporation, Buffalo, New York**
- 6. John Coequyt, **Greenpeace USA, Washington, D.C**
- 7. Michael d'Estries, **Groovygreen, Ithaca, New York**
- 8. Manna Jo Greene, **Hudson River Sloop Clearwater, Poughkeepsie, New York**
- 9. Kit Kennedy, **Natural Resources Defense Council, New York City, New York**
- 10. Eddie Lopez, Jr./Joanne Derwin, **New York City Apollo Coalition, New York, New York**
- 11. Edward Bennett, **New York Interfaith Power and Light, Ballston Lake, New York**
- 12. Marcia Bystryn, **New York League of Conservation Voters, New York City, New York**
- 13. Jason Babbie, **New York Public Interest Research Group, New York City, New York**
- 14. Fred Zalzman, **Pace Law School Energy Project, White Plains, New York**
- 15. Gordian Raacke, **Renewable Energy Long Island, Bridgehampton, New York**
- 16. Lisa Rainwater van Suntum, **Riverkeeper, Inc., Tarrytown, New York**
- 17. Warren Reiss, **Scenic Hudson, Poughkeepsie, New York**
- 18. Annie Wilson, **Sierra Club Atlantic Chapter, Albany, New York**
- 19. Beth Ellen Clark Joseph, **Tompkins Renewable Energy Education Alliance, Ithaca, New York**
- 20. Alan Nogee, **Union of Concerned Scientists, Cambridge, MA**
- 21. Walter Simpson, **Western New York Sustainable Energy Association, Buffalo, New York**
- 22. Bob Knoer, **Wind Action Group Buffalo, New York**

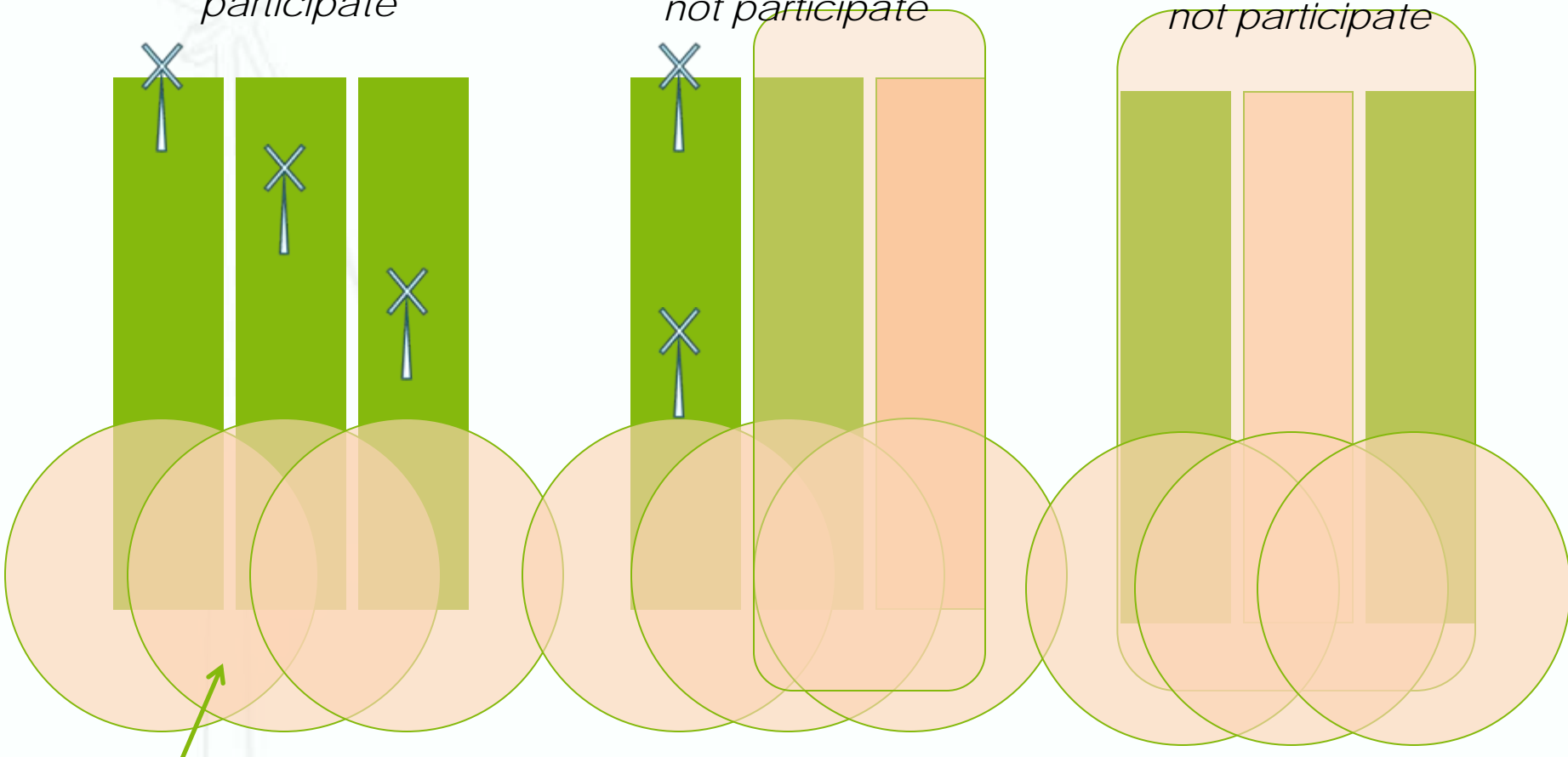
# Appendix: Land and Setbacks

How many acres does it take for a turbine? It depends.

*All landowners participate*

*East landowner does not participate*

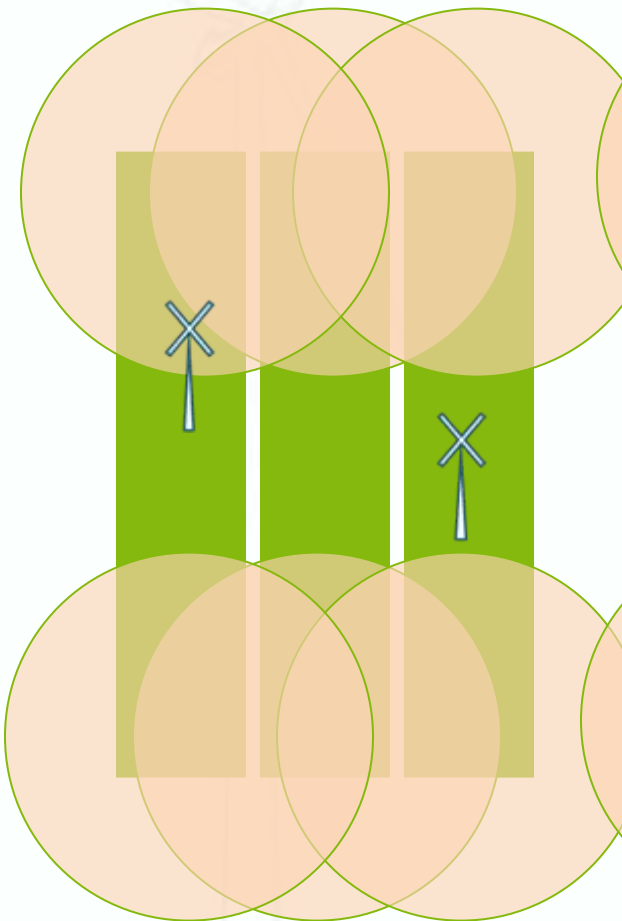
*Center landowner does not participate*



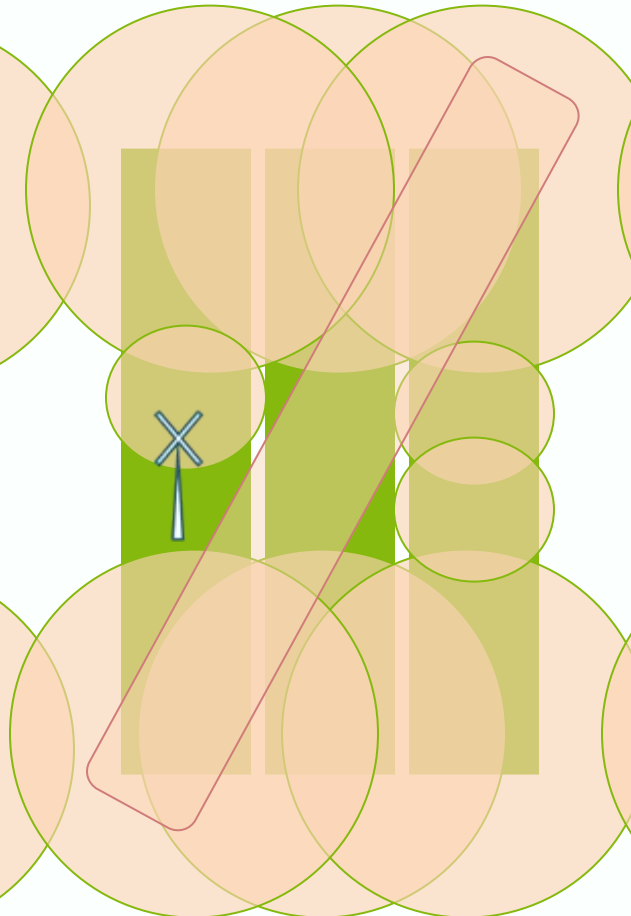
House setbacks

# Appendix: Land and Setbacks

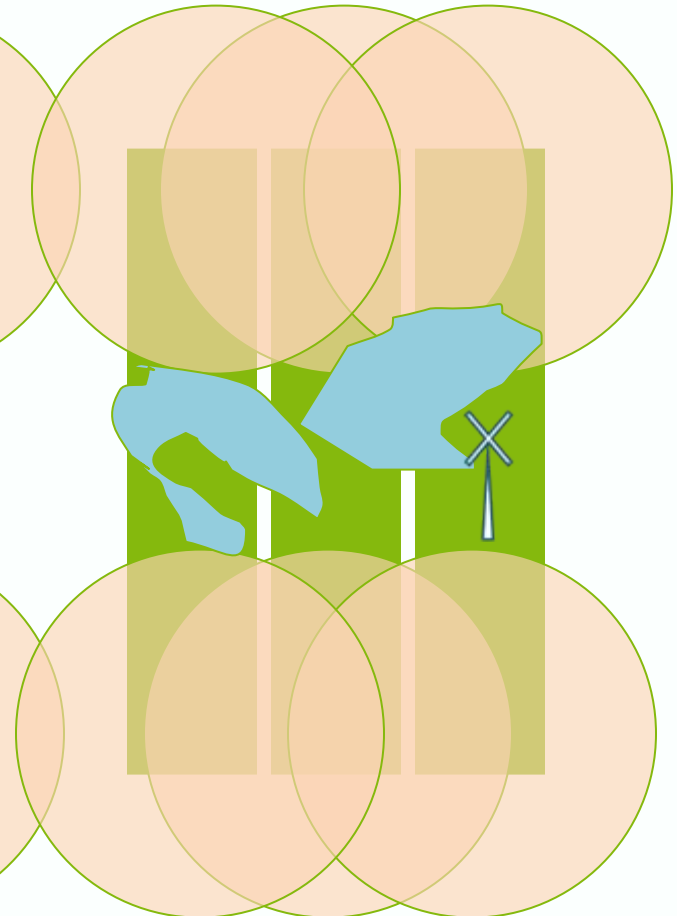
*Roads on both sides*



*With gas wells and gas line*



*With Wetlands*





# Appendix: Permitting

## For these agencies....

- Department Environmental Conservation (DEC)
- New York Independent System Operators (NYISO)
- Public Service Commission (PSC)
- State Historical Preservation Office (SHPO)
- U.S. Fish and Wildlife Service (USFWS) Input
- Army Corps of Engineers (ACoE) – wetlands
- Federal Aviation Administration (FAA)

## We do these Studies...

- Transmission line/interconnection studies
- Avian and wildlife studies
- Communication/television studies
- USFWS consultations
- Airport flight path studies
- Environmental and wetland studies
- Historical and archaeological studies
- Noise and sound analysis
- Road and transportation studies
- Visual Impact Assessment
- Geotechnical studies
- Groundwater studies

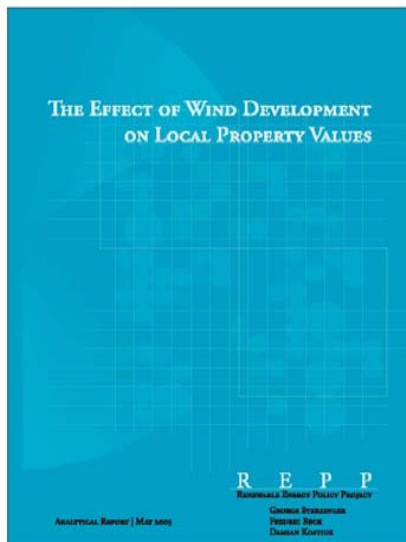
These are just some of the agencies involved, local and county agencies and school districts are all involved in parts of the process...

## Appendix: Production Tax Credit (PTC)

The PTC is the primary government incentive supporting wind power

- Tax credit of \$19/MWh, adjusted annually for inflation
- The Production tax credit is the primary government incentive supporting wind power
- A 100 MW project will generate PTCs on the order of \$6 million - \$7 million per year
- Earned for first ten years of wind farm operations
- Given to wind farm owner
- Historically has led to boom-bust industry cycles
- Current PTC is set expire on December 31, 2009

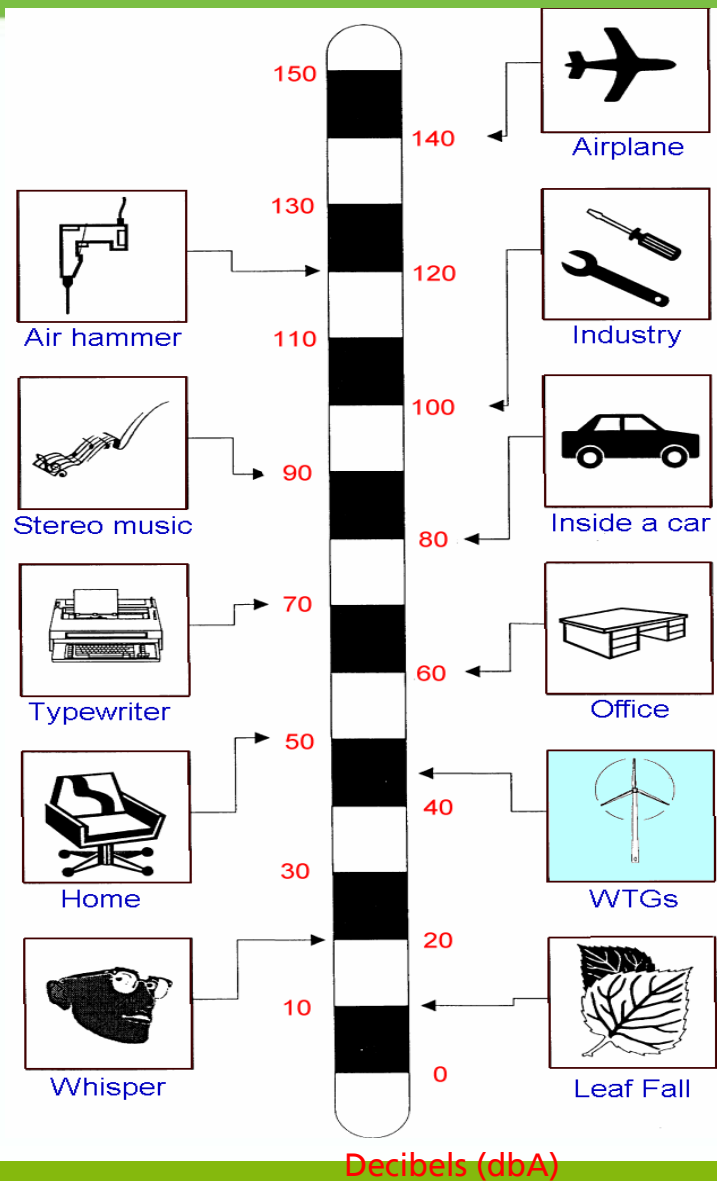
# Appendix: Property Values



- In a comprehensive study sponsored by the DOE, a study of home sales at 9 wind farms showed no effect on property values
- More recent evidence continues to back this up
- Local studies part of DEIS
- Researcher lamented that no data points for landowners with turbine leases – turbine lessors not selling

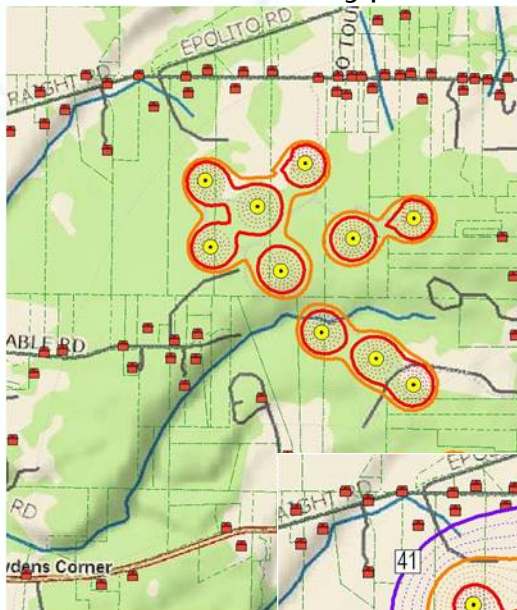
# Appendix: Sound

- Sound of a modern turbine is roughly equivalent to a refrigerator running
- Ambient noise measured throughout project area – usually 4-8 survey points
- “Leaf on” and “Leaf off” measurements taken
- Sound contours developed based on ambient noise readings

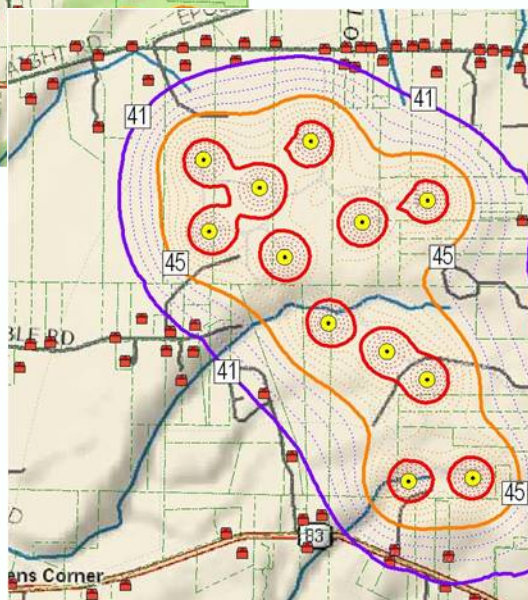


# Appendix: Sound Studies

Summertime Typical



Wintertime  
Worst-  
case



“Worst-case” scenario:

- No leaves
- No insects
- No snow on ground
- No rain
- Frozen ground
- Ambient noise at lowest recorded level
- Wind at 6m/s, strong enough to blow the turbine, but not cause excess ambient noise

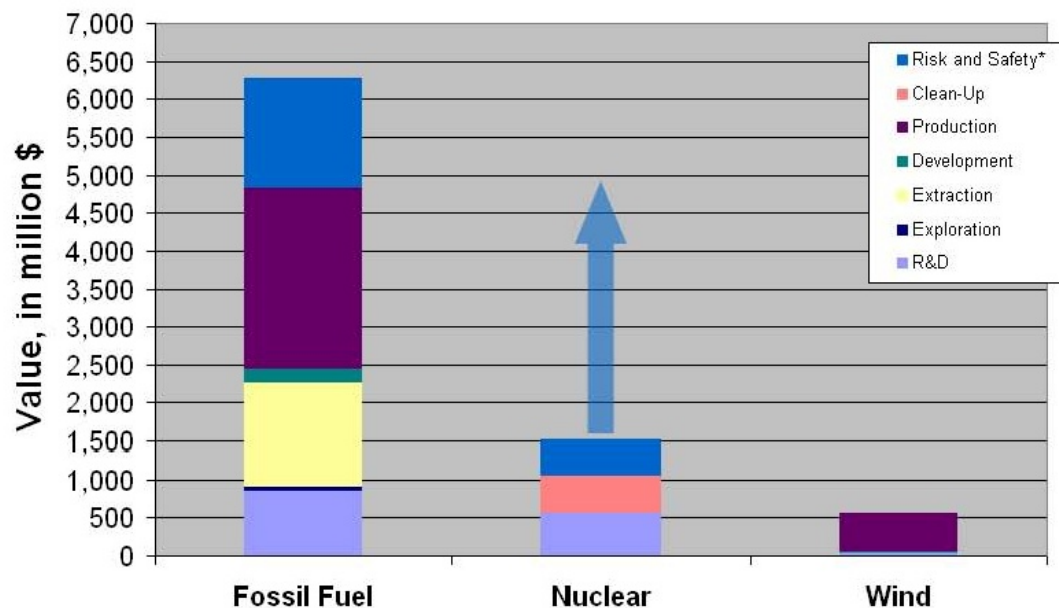
“Worst case” scenario typically happens for a few hours in the months of November and April



# Appendix: Energy Subsidies

## Wind Energy and U.S. Energy Subsidies, continued

### A Glance at Federal Energy Subsidies for Fiscal Year 2006



Source: AWEA

Wind is subsidized for the renewable energy production, but fossil fuels receive subsidies for exploration, extraction, development and safety, not to mention the unknown cost of health and environmental externalities

# Appendix: Turbine Specifications

- Hub height: 262 - 330 ft
- Tip height: 397 - 492 ft
- Footprint (w/access road): ~1/2 acre
- Windmill spacing: 1,000-1,300 feet
- Rotation: ~7 – 15 rpm

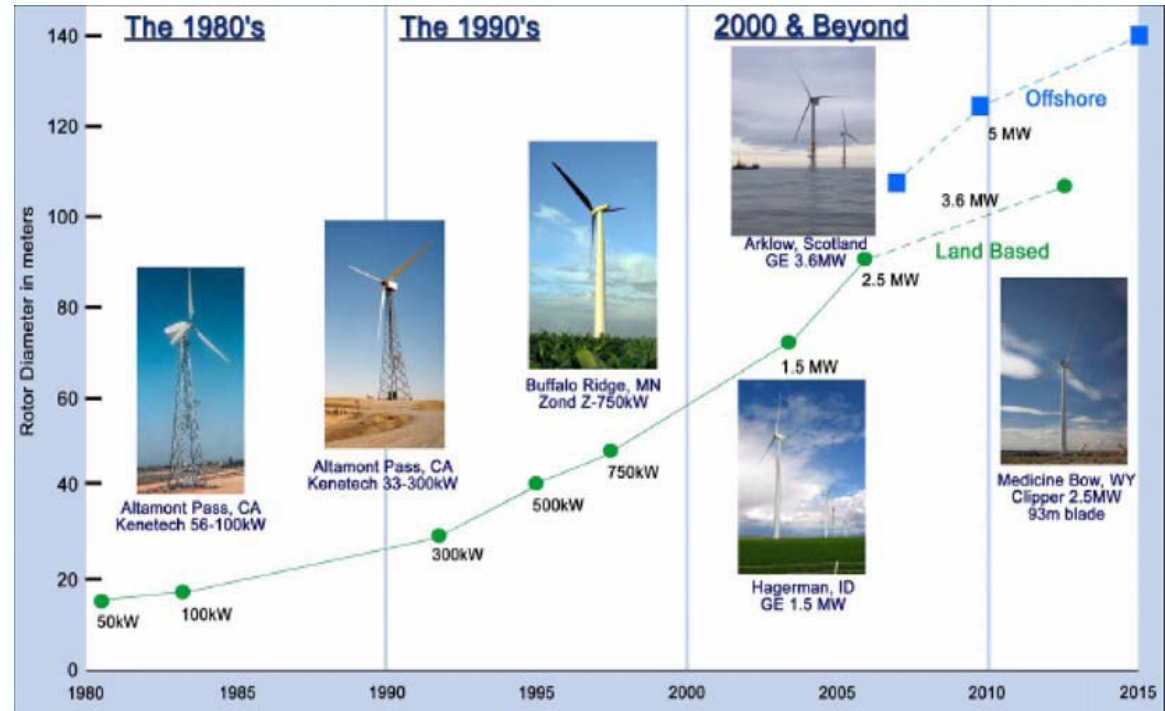


# What's next: Technology

## New Turbines?

*Wind Turbine Technology has advanced quickly. New turbines are:*

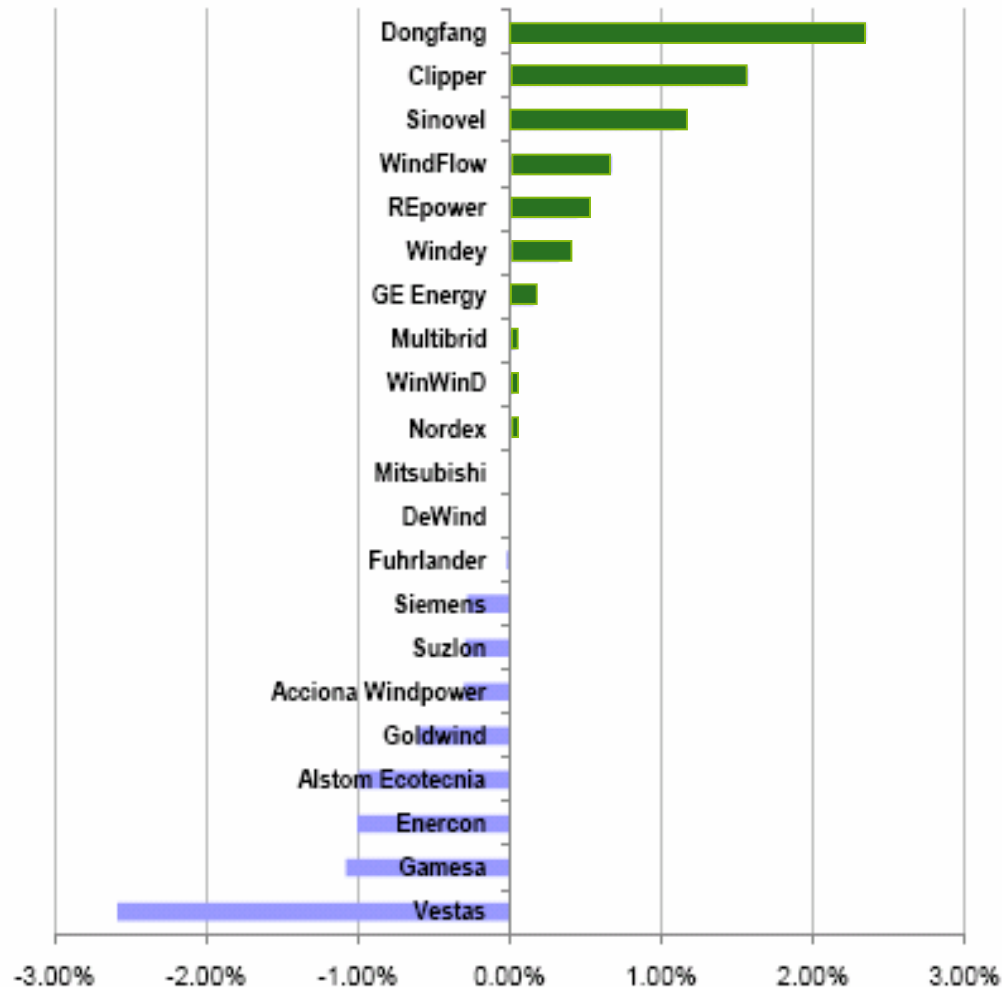
- Bigger, more efficient
- More eco-friendly design
- Greater aesthetics, slower rotation



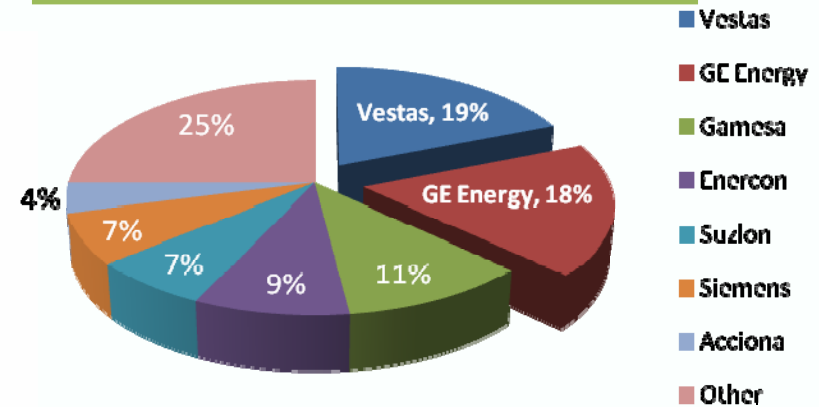
Onshore technology is relatively mature, with turbine manufacturers now focusing more on reliability, cost and deliverability rather than wholesale new designs. Most new designs are for offshore applications.

# Turbine Suppliers...

Market Share % Change by Vendor (2007 to 2008)



Turbine Supplier Market Share (2008)

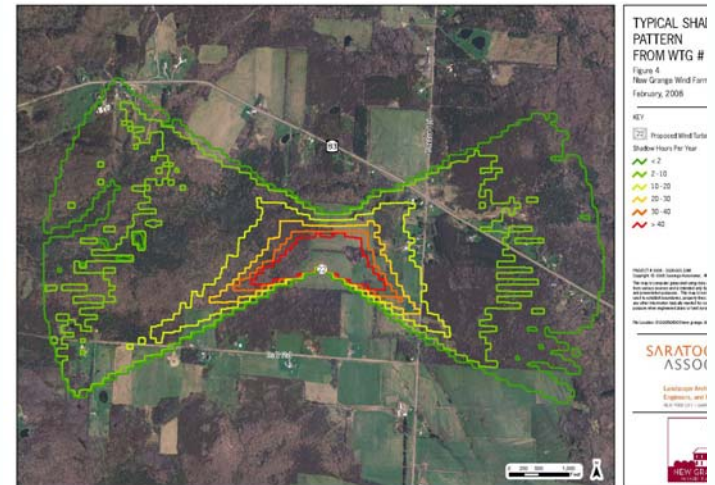


GE and Clipper are gaining ground, but the Europeans still control the market



# Appendix: Visual

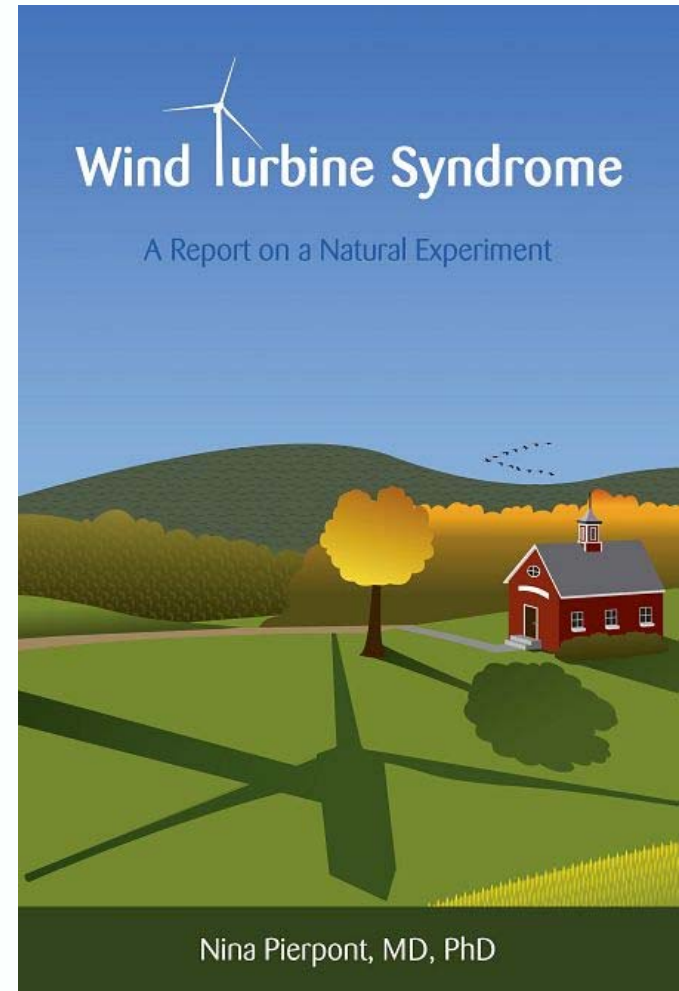
- Visual studies primarily consist of two pieces: Photosims and Shadow flicker analysis
- Photosims simulate the appearance of the wind farm before it is built
- Shadow Flicker analysis estimates the “worst case” shadow flicker at homes



- Shadow Flicker “worst case” considers no cloudy days (annual over 200), no tree cover
- Greatest impacts in Arkwright are over 30 hours a year (Worst case)

# Appendix: “Wind Turbine Syndrome”

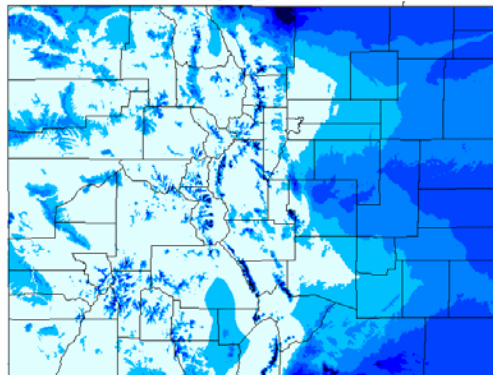
- Despite coverage in USA Today and other outlets, book has not been published, thoroughly peer reviewed or replicated
- Handful of data points (expected to be 10-20) pales in comparison to more comprehensive studies
- Expected that most “data” in the survey pool were opponents to wind farm beforehand
- Opponents to wind projects before construction are over 30x more likely to report problems



# Appendix: Wind Measurement



Meteorological Tower



Horizon spends 2+ years measuring the wind to find the windiest spots on your land and to predict generation

- Secure meteorological tower permits
- Erect towers
- Monitor the wind and quality control data
- Analyze data in-house and with outside meteorologists
- Verify the strength and characteristics of the wind resource
- We have installed the first met tower at xxx location, and look forward to its readings over time

