

Workshop on Renewable Energy for Minnesota

McNamara Alumni Center
2006 October 03



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American Wind Energy Association

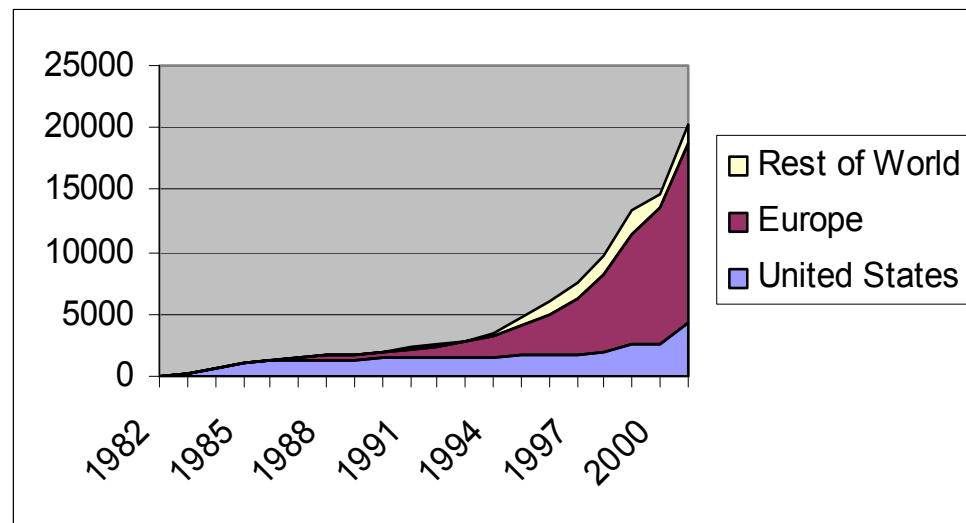


Wind Is Growing Worldwide

Global Wind Capacity More Than Tripled in Last Five Years

Total installed end 2005:

- **Germany: 18,400 MW**
- **Spain: 10,000 MW**
- **U.S.: 9,100 MW***
- **India: 4,400 MW**
- **Denmark: 3,100 MW**



Global Cumulative Total Over **59,000 MW** at end of 2005

* Now over 10,000 MW

Source: AWEA's Global Market Report

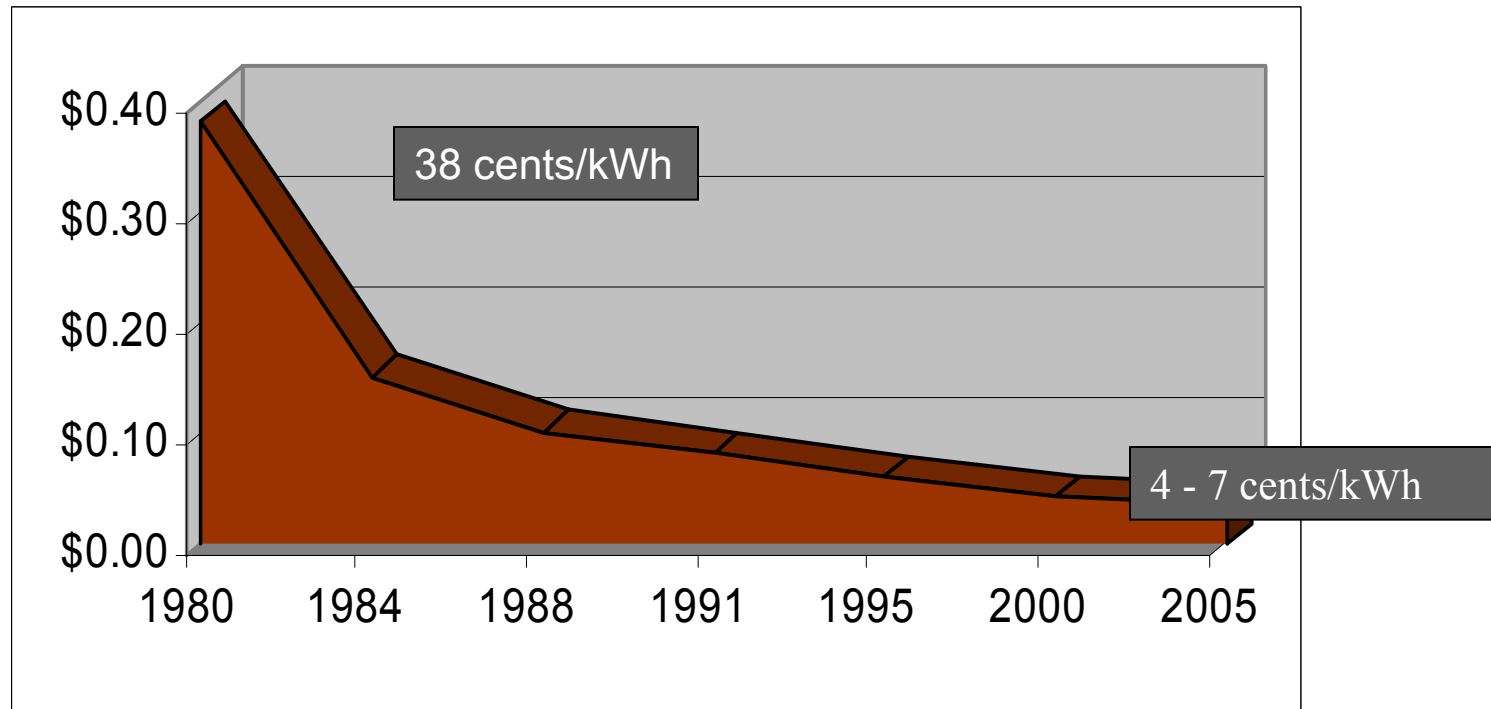


AWEA: Wind Has Hit Sustained Takeoff

- **2005 → record year in U.S. and world!**
 - 2,400 MW new capacity added in U.S.
 - >\$3 billion investment
 - +45% over previous record year
 - 12,000 MW added Worldwide
 - +45% over previous record year
 - In 2005 U.S. was again #1 in new installations (after lagging for decade)
 - +35% greater than #2 Germany
- In 2006 over \$4 billion investment expected in U.S.



Reduced Cost Driving Wind's Success



Levelized cost at good wind sites in nominal dollars, *including tax credit*



Utilities Incorporate Wind Power

- Utility demand is variable
- Wind power increases that variability marginally
- Increased cost due to wind variability about 0.5 ¢/kW.h or less



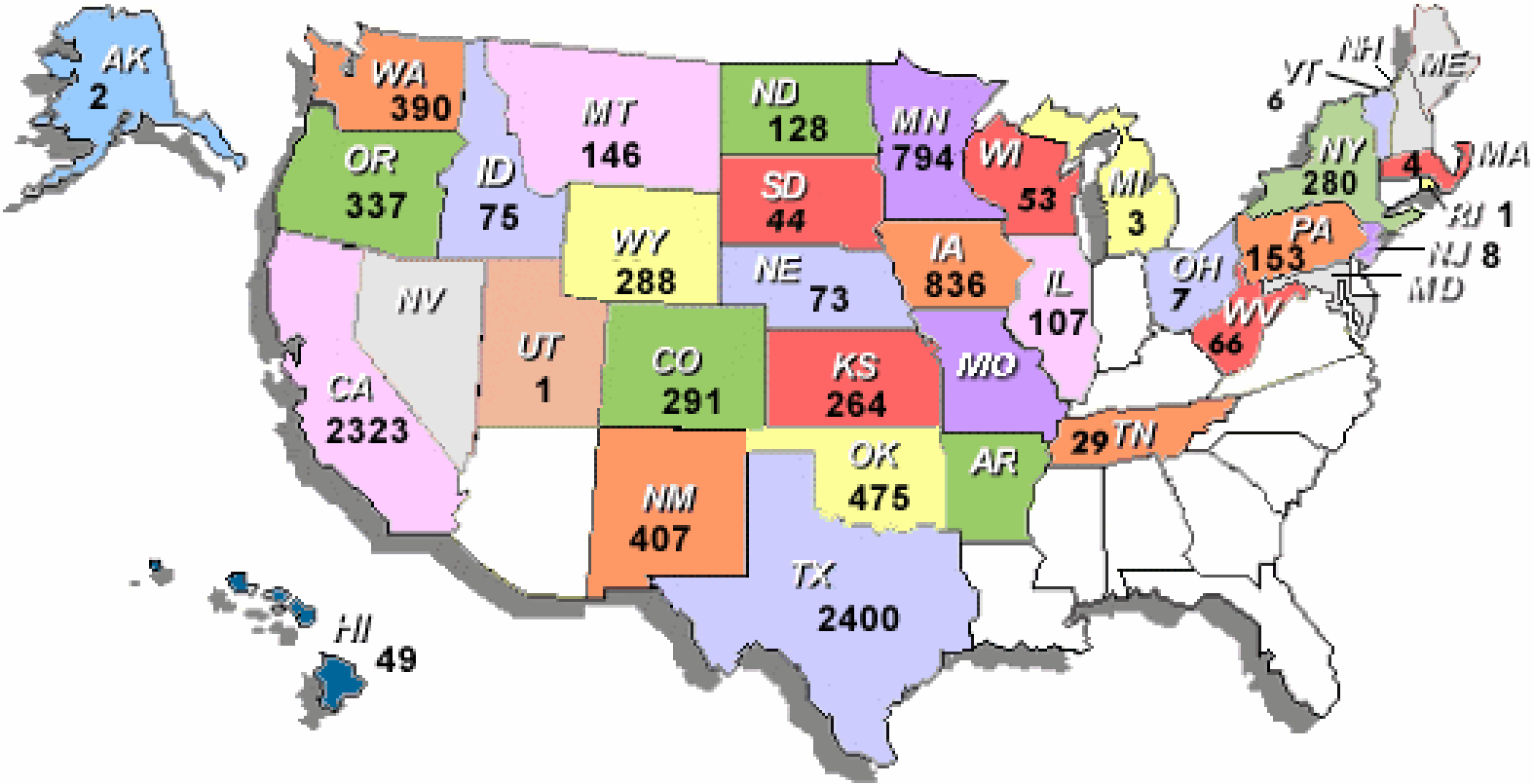
Utilities Invest in Wind Power

- Utilities owning or interested in owning wind projects
 - MidAmerican
 - Puget Sound
 - Sacramento Public Utilities District
 - We Energies
 - Alliant Energy

Wind is becoming mainstream utility practice



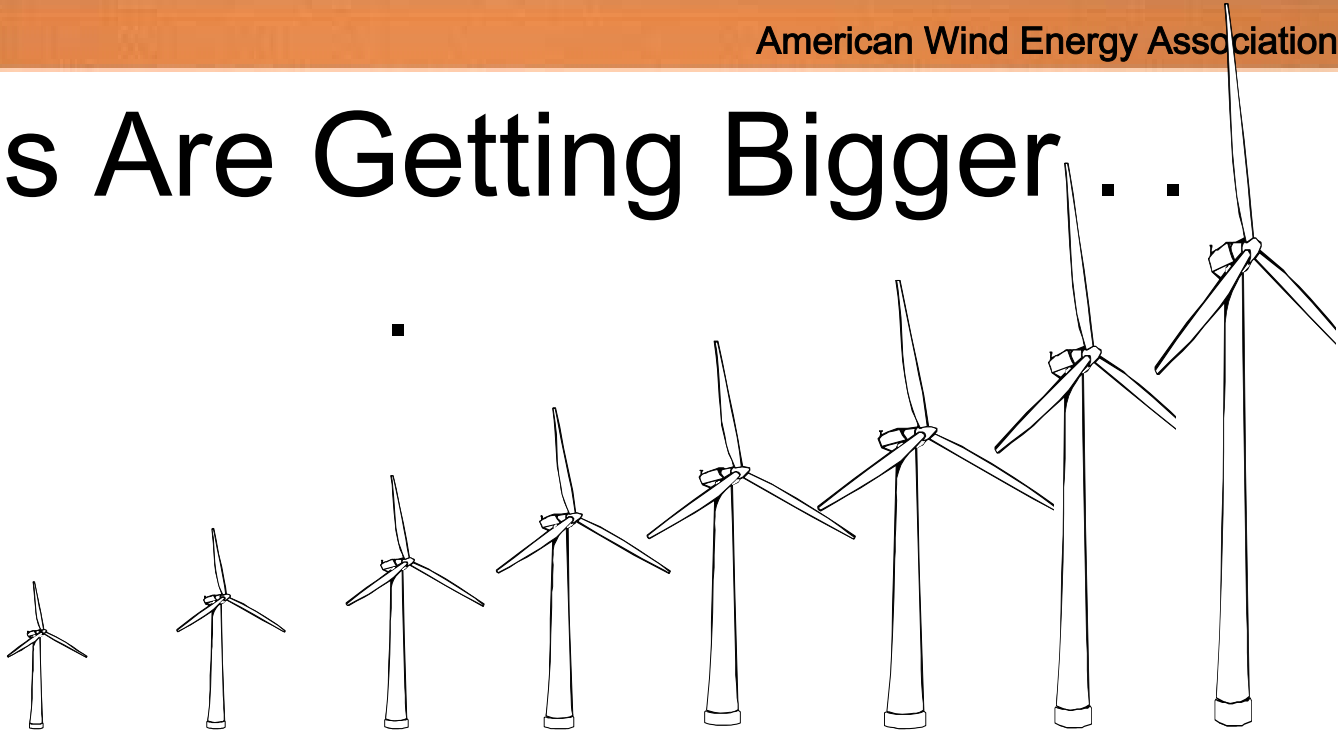
Wind power installed by state



2006 July



Turbines Are Getting Bigger . . .



	1981	1985	1990	1996	1999	2000	2005	2008
rotor diameter (in meters)	10	17	27	40	50	71	104	120
rated capacity (in kilowatts)	25	100	225	550	750	1,650	3,600	5,000

rotor diameter
(in meters)
rated capacity
(in kilowatts)



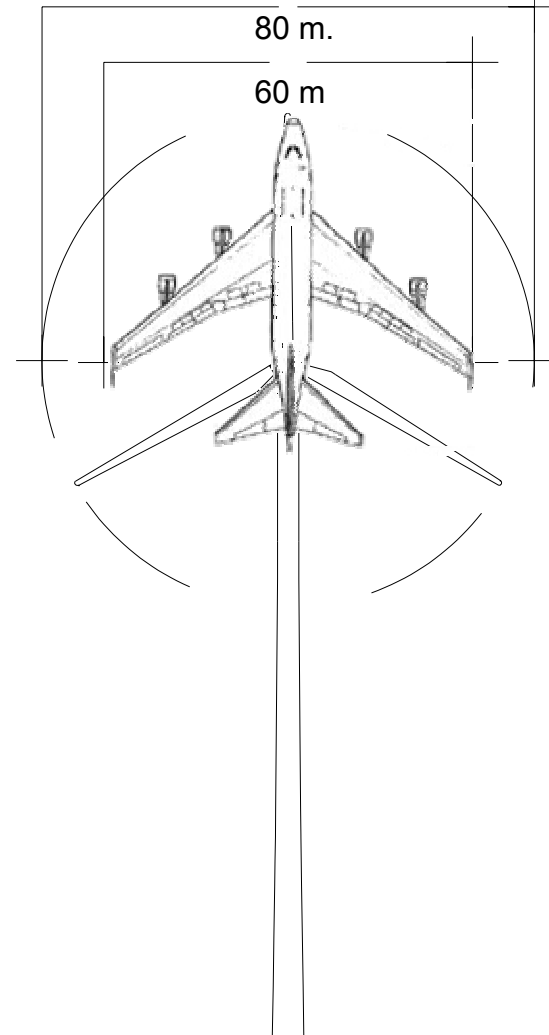
How big is a 2 MW wind turbine?

Boeing 747 – 60 m diameter

Vestas 2 MW – 80 m diameter

Siemens 2.3 MW turbine – 93 m diameter

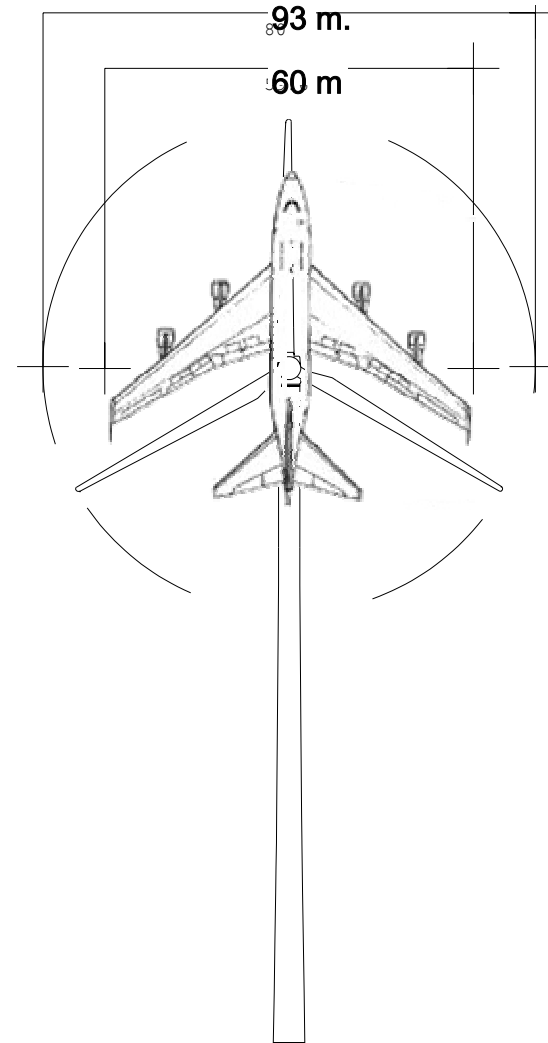
(2007 – Minnesota, Iowa, Texas)



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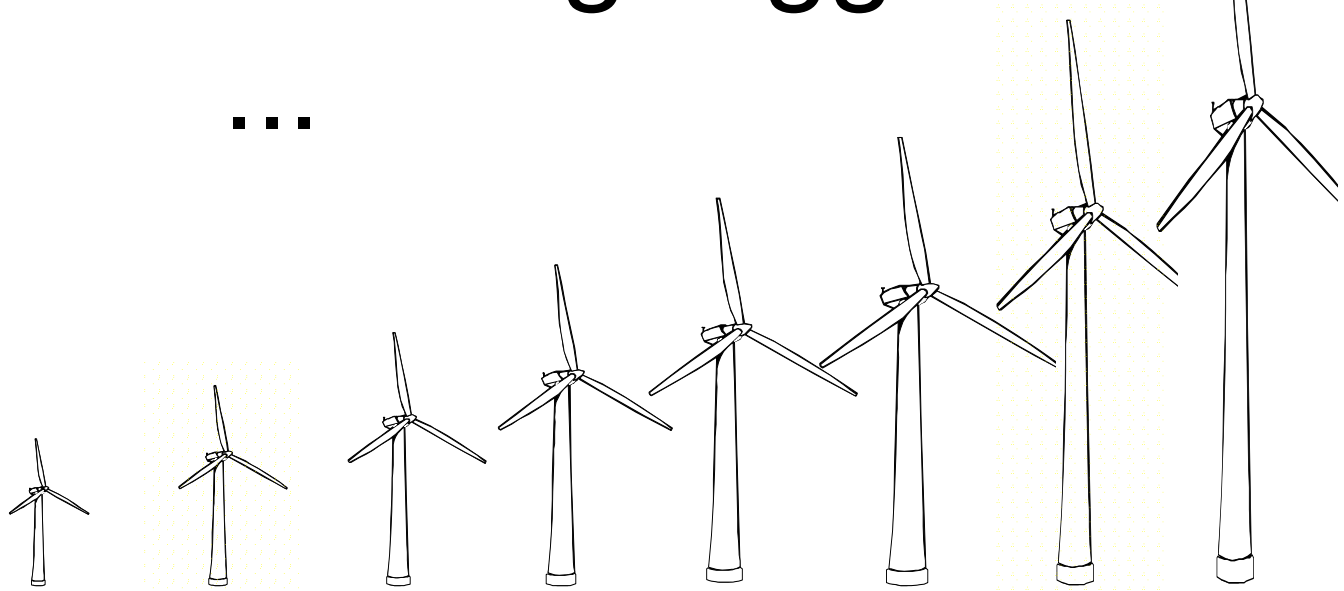
Boeing 747 –
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Siemens 2.3 MW turbine –
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rotor diameter
(in meters)
rated capacity
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Altamont Pass Wind Development Area



Livermore, CA
-1982



- 2006 August
- Southern MN
- Also being installed in MN, ND, TX
- Siemens 2.3 MW turbine
- 93 m diameter rotor
- 80 m towers



Siemens blades, Port of Duluth, 2006 August



Consequences of larger turbines

- Rotor Diameter
 - Early turbine ~ 15 m
 - Modern Turbine ~ 93 m
- Rotor Speed (function of rotor diameter)
 - Early turbine ~ 75 rpm
 - Modern turbine ~ 12 rpm (rotate every 5 seconds)
- Tower Height
 - Early Turbine ~ 22 m
 - Modern turbine ~ 80 m
- Ground Clearance
 - Early Turbine ~ 15 m (barn peak)
 - Modern Turbine ~ 39 m (10-story building)



Consequences of larger turbines (con't)

- Total Height at tip of blade
 - Early Turbine ~ 30 m
 - Modern Turbine ~ 122 m
- Wind Speed at tip height
 - Ratio: Modern / Early Turbine ~ 130%
Due to less “shear” with ground
- Wind Power Density at tip height
 - Ratio: Modern / Early Turbine ~ 230%
 - Power/energy/revenue ~ cube of wind speed



Consequences of larger turbines (con't)

- Distance between turbine rows
 - Early Turbines ~ 90 m
 - Modern Turbines ~ 550 m (1/3 mile)
- Turbines per 160 acres
 - Early Turbines ~ 30
 - Modern Turbines ~ 1
- Turbine cost, installed
 - Early Turbine \$195,000
 - Modern Turbine \$4 *million*



Most important physical
and financial
characteristic impact:

- Location
- Location
- Location



Benefits of Wind Power

- Energy Security
- Economic Development
- Cost Stability
- Resource Diversity
- Air Pollution
- Global Warming Pollution



Wind Turbines and Radar Interaction

1. Wind turbines becoming more accepted
2. Wind projects becoming more widespread
3. Wind turbines becoming much larger
4. National security concerns rising

WIND TURBINES ↔ RADAR



Wind Turbines and Radar Experience

- Documented experience with wind turbines and radar
 - Air Force largest purchaser of green power in U.S.
- Wind turbines operate near military installations
 - Warren AFB, Guantanamo Bay, near Edwards AFB and Dyess AFB...)
- FAA has reviewed every potentially hazardous wind turbine site in U.S.
 - Of 4225 turbines evaluated, 4 received hazardous determination rating

And yet, Congress moved to “study” the issue



Radar-Wind Interaction Study Time Line (2006)

- | | |
|-------------|---|
| January 06 | President signs National Defense Authorization Act |
| March 21 | DOD issues Interim Policy |
| May 23 | DOD contacts select wind farm operators regarding collaborative research on existing projects |
| April – May | Letters of “Presumed Hazard” to wind farm operators |
| May 07 | Report from DOD due |
| June – Sept | Occasional letters of “Determination of no hazard” |
| Sept 27 | DOD issues report |
| Sept 28 | AWEA assails report |



National Defense Authorization Act for Fiscal Year 2006

- **SEC. 358. REPORT ON EFFECTS OF WINDMILL FARMS ON MILITARY READINESS.**
- “Not later than 120 days after the date of the enactment of this Act, [DOD shall submit to Congress] a report on the effects of windmill farms on military readiness, including [an analysis of] the operations of military radar [and] windmill farms ... and technologies that could mitigate any adverse effects on military operations identified.” (Emphasis added)



DOE/DHS Joint Program Office Interim Policy – March 21

DOD/DHS will “contest any establishment of windmill farms within radar line of site* of the National Air Defense and Homeland Security Radars.** This is to remain in effect until the completion of the study and publishing of the Congressional Report.”

* Radius: 60 miles around each radar station

** 810 radars nationally



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Impact of “Presumed Hazard”

- Project development brought to immediate stop
- Uncertainty whether utility agreements can be honored
- Project delay may result in inability to utilize current Production Tax Credit that expires at end of 2007
- Financial institutions alarmed by risk of financial loss and threatened to pull out of agreements



September ~25: FAA Releases Projects

- FAA approved 614 applications for individual turbines
 - > 1000 MW of new projects
 - Power for 250,000 homes; value \$1.5 billion
 - Wisconsin, Illinois, Minnesota, South Dakota



The Effect of Windmill Farms on Military Readiness – DOD (2006 September 27, 143 days late)

- Report raises issues but doesn't address them:
 - Wind turbines may affect radar
 - Wind turbines may impact military training sites
 - Wind turbines may impact Test Ban monitoring sites
 - Wind turbines may impact Federal Aviation Administration
 - Wind turbines may impact National Weather Service
- Report only states that mitigation measures (aside from not building the wind turbine) need further investigation



Wind Industry Issues Statement

(2006 September 28)

- In spite of specific congressional instructions, report does not address mitigation measures
- Wind turbines can and do coexist safely near radar stations
- Technical and siting mitigation measures have been successfully implemented if wind turbine impacts were detected or predicted
- Rep. Tammy Baldwin led 36 bipartisan Members of Congress to admonish the Administration to fulfill the entire directive from Congress



Wind Industry Issues Statement

(2006 September 28)

- Impact of report on wind development expected to be small
- Wind energy market growth expected large
- U.S. projected to be world's largest sustained wind energy market by 2015



The Future of Wind Power?

President Bush was correct
when he said on February 21 of this year:

**“Wind can supply up to 20% of
U.S. electricity”**



Develop Action Plan: Optimizing Wind Power

- Explore wind power growth options
- Examine issues regarding energy supply
- Look at business opportunities



20% Action Plan

- Vision: At least 20% of U.S. electricity from wind power
- Collaborators: AWEA, DOE, NREL
- Other collaborators welcome – please contact AWEA



20% Action Plan

- Task Forces
 1. Utilities and Transmission
 2. Environment and Siting
 3. Resources
 4. Technology and Applications
 5. Markets and Acceptance
 6. Communications and Outreach
 7. Supporting Analysis
- Time Line
 - Release Action Plan at WINDPOWER 2007 in June



Impact of 20% Wind Power

- Up to 350 GW of wind power installed in U.S.
 - 10 GW total wind power installed today
- To achieve 20% in 35 years – new installations need to *average 10 GW per year*
- Investment required -- \$0.5 trillion at today's costs



Contact AWEA

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