



Wind Energy and the US NAVY

Monday August 6, 2007 10:30 – 12:00



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Introductions

- Stephan Baker – Naval Facilities Engineering Command, San Diego, CA
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Presentation Outline

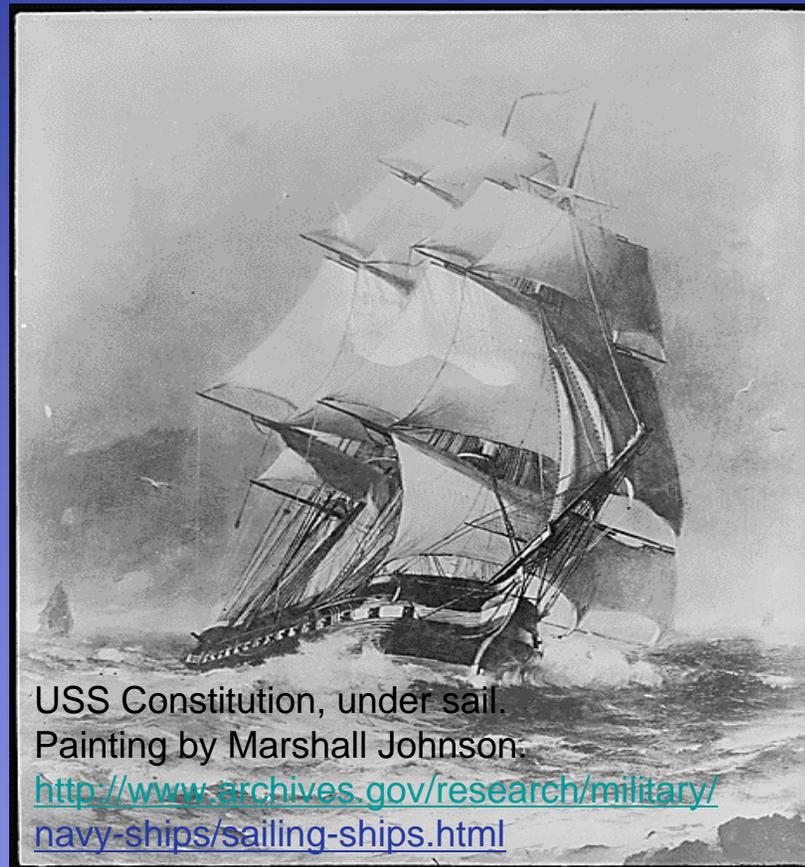
- Wind Energy Fundamentals
- Key Policy related to renewable energy
- Industry / Navy Wind Rules of Thumb
- Navy Wind Economics
- Update on Current Navy Wind Projects
- Navy Wind Energy Challenges
- Overview of Navy / NREL Efforts



Early Wind Energy Applications



Dutch Windmill. Source:
<http://www.flickr.com/photos/hjsa/130685080/>



USS Constitution, under sail.
Painting by Marshall Johnson.
[http://www.archives.gov/research/military/
navy-ships/sailing-ships.html](http://www.archives.gov/research/military/navy-ships/sailing-ships.html)





Wind Energy Today

Potential Energy of Wind/vec
 $P = \frac{1}{2} \rho A v^3$ $P = \frac{1}{2} \rho A v^3$

Air Density, ρ , (kg/m³)
 Wind velocity, V , (m/sec)

Air Temp. 50 °F
 Air Density 1.225 kg/m³

Wind direction 90° to 330°
 Wind velocity 10 m/sec

Wind Turbine

It can shape mountains.
 It can move oceans.
 Now the wind can even
 heat up your toaster.

Together, all the GE Energy wind turbines in the world could produce enough power for 4.6 million US homes. Something to chat about over your next rounds of toast. It's yet another example of our blueprint for a better world.

Imagination at work

ecomagination.com



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Pictures from 07 AWEA Conference





Wind Energy - Fundamentals

Wind Turbine Generators (WTG) convert kinetic energy in the wind to electricity

~30% annual average growth over past 5 years

Globally, 74 GW WTG capacity installed (through 2006)

Germany 20.6 GW; Spain 11.6 GW; US 11.6 GW; India 6.3 GW; Denmark 3.1 GW; China 2.6 GW...

US Wind Industry / Presidential Goal: 20% of US Power Consumption provided by wind by 2030

30 GW by 2010, 60 GW by 2015, 120 GW by 2020, 180 GW by 2030



Wind Energy - Fundamentals

WTG Unit Sizes:

Utility Scale > 100 kW – 5.0 MW

Small Scale 1 kW – 100 kW

Major WTG Manufacturers:

General Electric (USA) – 1.5 MW

Vestas (Denmark) – 1.5 + MW

Siemens (Germany, Bonus/Denmark)

Mitsubishi (Japan) – 1.0 MW

Gamesa (Spain) – 2.0 MW

Suzlon (US) – 1.25 MW +



Key Policy Driving Federal Renewables

Energy Policy Act of 2005

- Section 203 requires Federal Agency renewable energy consumption:
 - 3% in FY 2007
 - 5% in FY 2010
 - 7.5% in FY 2013 and thereafter



Key Policy Driving Federal Renewables

Executive Order 13423

- Signed on January 24, 2007, includes the following goals:
 - Energy efficiency to be improved and greenhouse gas emissions reduced by way of reduction in energy intensity by (i) 3 percent annually through FY 2015 or (ii) 30 percent by FY 2015, relative FY03 baseline.
 - 50% of statutorily required renewable energy consumed has to come from new (new = renewables placed in service after Jan 1, 99) renewable sources
 - Also includes phasing out of RECs that will count towards RE goals
- For Federal Agencies an EO equals the Law



DOD Renewable Goal

Defense Authorization Act FY 2007

SEC. 2852. DOD GOAL REGARDING USE OF RENEWABLE ENERGY TO MEET ELECTRICITY NEEDS-

“...not less than **25 percent** of total quantity of electric energy within DOD facilities and activities **during FY 2025 and thereafter** from renewable energy sources (as defined in section 203(b) of the Energy Policy Act of 2005)...”



Renewable Energy Technology Options

“Renewable Energy” as defined by 2/20/07 DOE draft guidance for implementing EO 13423:

“Renewable Energy means energy produced by solar, wind, biomass, landfill gas, ocean (including tidal, wave, current, and thermal), geothermal, municipal solid waste, hydrokinetic, or new hydroelectric generation...”

FEMP still working on revised guidance



Navy Current Renewable Energy Projects

- Wind:
 - San Clemente Island: 675Kw installed, ~10-13% island energy from wind
 - Guantanamo Bay: 3.8 Mw installed, ~ 5-7% island energy from wind
 - Solar:
 - Twenty-Nine Palms 1.2 MW Solar PV
 - Naval Base Coronado 750Kw Solar PV installed
 - A number of smaller solar applications at various bases, mainly in SW
 - Geothermal:
 - China Lake Geothermal Plant, PPV, a 270 MW plant
 - Ground-Source Heat Pumps:
 - Numerous facilities (now, mostly privatized family housing totaling approx. 20,000 tons installed and operating in the Navy
 - Biomass:
 - Plant at Naval Shipyard – Norfolk, produced 133 GWh's in FY06
- Total Renewable Electricity Produced in FY06: ~ 308 GWhs



Wind Energy Economics

<i>Wind Energy Rules of Thumb</i>	<i>Industry</i>	<i>Navy</i>
Land requirement to Generate 1 MW of Windpower (acres)	5 - 50, ridgeline to flat terrain	¹ Can be less
Wind Turbine System Cost (\$ / kW)	1100 - 1600	Same cost for component
Wind Turbine Installed Cost (\$ / kW)	1600 - 2500	² 1600 - 6000

1. Navy wind strategy distributed generation, small # turbines, minimize wake effects, reduce land requirements
2. High variance due to unique site locations for Navy, (i.e. GTMO, SCI), DG strategy = Navy unable to take advantage of economies of scale, finally Navy unable to capture production tax credit.



Wind Energy Economics

<i>Wind Energy Rules of Thumb</i>	<i>Industry</i>	<i>Navy</i>
Turbine Backlog (Years)	1-3	³ Can be less
O & M Cost (\$ / kWh / Year)	0.01	⁴ same, possibly more
Typical cost of Wind Energy (\$ / kWh)	0.04 - 0.06	⁵ Can be more
Typical Wind Capacity Factor (%)	25%	⁶ Can be less

3. Since Navy only looking for small # of turbines, possibly can get turbines other vendors cannot use.
4. Due to remote locations of Navy and M & V requirements might increase O & M cost.
5. Due to increased installation cost and operation and maintenance cost for Island or remote located WTG's, also no PTC for Navy.
6. Again Navy can tolerate lower wind resources due to potentially higher cost of local energy sources.



Wind Energy Economics

WIND RESOURCE SIMPLE PAYBACK, THEORETICAL CALCULATION FOR TWO DIFFERENT WIND TURBINES

Wind Class	50 Meter Windspeed M/S (MPH)	Annual Energy Generated 600 kW turbine (kWh)	Annual Energy Generated 1500 kW turbine (kWh)	Annual Savings 600kW (\$)	Annual Savings 1500 kW (\$)	Simple Payback 600 kW (yrs)	Simple Payback 1500 kW (yrs)
1	< 5.6 (12.5)	1,017,000	2,058,000	\$ 101,700	\$ 205,800	11.80	14.58
2	5.6 - 6.4 (12.5-14.3)	1,553,000	3,293,000	\$ 155,300	\$ 329,300	7.73	9.11
3	6.4 - 7.0 (14.3-15.7)	2,064,000	4,546,000	\$ 206,400	\$ 454,600	5.81	6.60
4	7.0 - 7.5 (15.7-16.8)	2,286,000	5,122,500	\$ 228,600	\$ 512,250	5.25	5.86
5	7.5 - 8.0 (16.8-17.9)	2,452,800	5,699,000	\$ 245,280	\$ 569,900	4.89	5.26
6	8.0 - 8.8 (17.9-19.7)	2,890,800	6,195,000	\$ 289,080	\$ 619,500	4.15	4.84
7	> 8.8 (19.7)	3,153,600	6,482,400	\$ 315,360	\$ 648,240	3.81	4.63

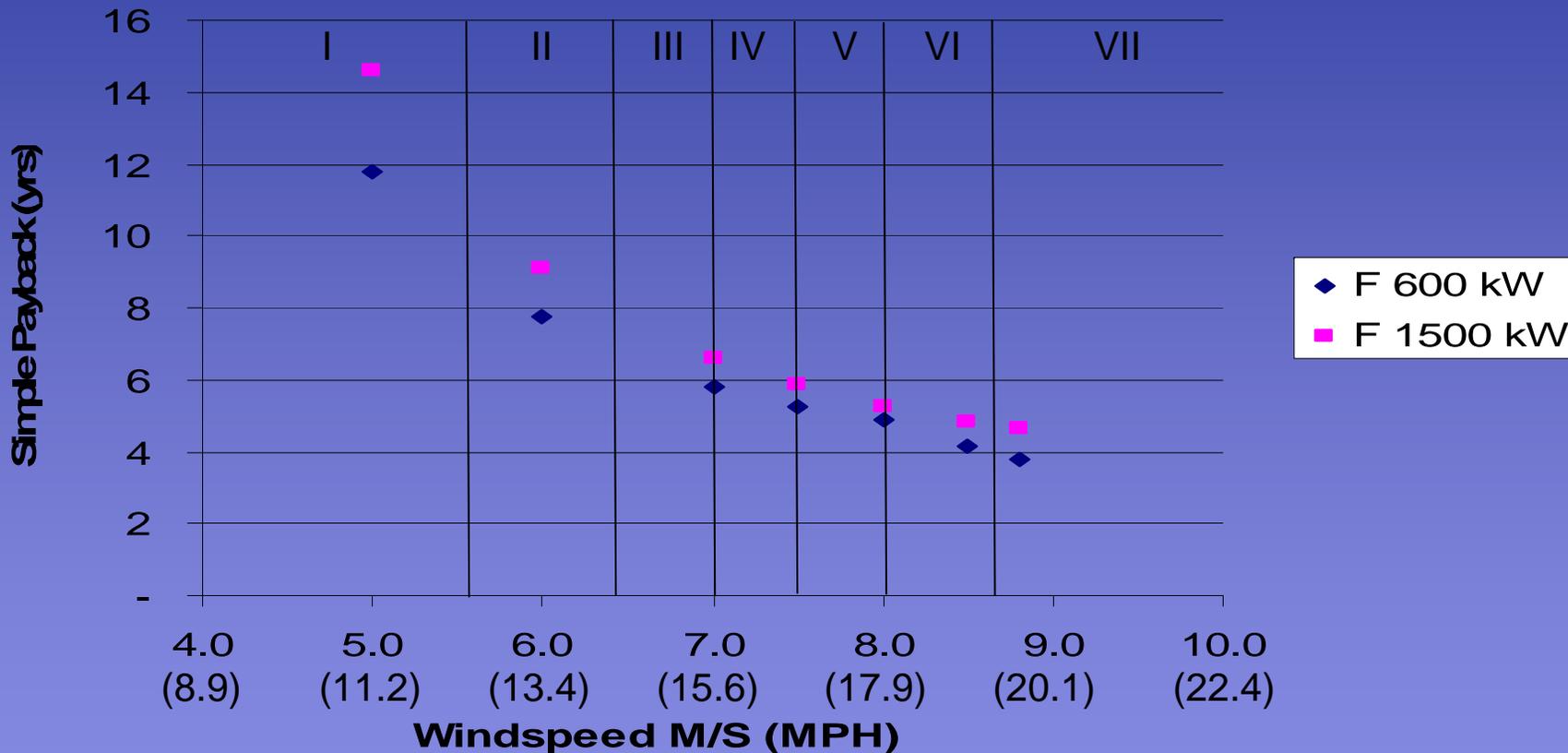
Assumptions

1. Current Rate \$0.10 per kwh, no demand charges
2. Installed Wind turbine project cost \$2000 / kW, cost to install 600 kW: \$1,200,000, cost to install 1500 kW: \$3,000,000
3. Used 600 kW and 1500kW wind Turbine power curves and energy production estimates from Fuhrlander website: www.fuhrlander.de
4. No Federal / State Incentives nor any finance charges included.
5. SCI Simple Payback = 6.4 years, GTMO Bay Simple payback = 10 years



Wind Energy Economics

Theoretical Wind Speed Vs. Simple Payback





Navy Wind Energy Projects

- San Clemente Island
 - 3, 225 kW NEG-Micon turbines, 675 kW total
 - 700 – 1000 MWhs annual wind energy produced
 - 10-13% Total energy from Wind
 - 11.8-16.9% Turbine Capacity Factor
 - Saves \$213,160 in energy costs annually
 - 6.4 year project simple payback (due to high fuel cost)
 - 15% pollutant emission reduction



San Clemente Island



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San Clemente Island



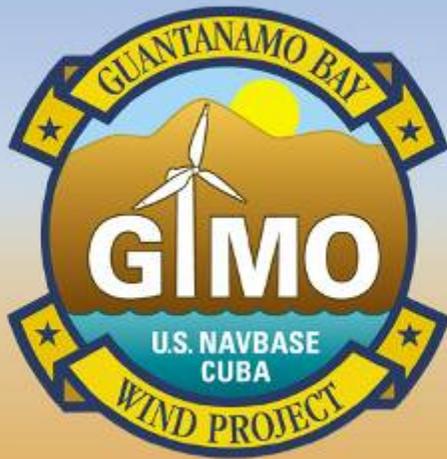


Navy Wind Energy Projects

- Guantanamo Bay (GTMO)
 - 4, 950 kW Vestas turbines, 3.8 MW total
 - \$12.1 M Capitol cost, 9.8 yr simple payback
 - Installed and operating since 2005
 - Reduces Diesel fuel use by 650,000 GPY
 - Prevents production of 13M lbs. of air pollutants annually
 - Produces up to 25% of electrical peak demand
 - 5-7% of total power consumed from wind turbines



Guantanamo Bay



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Guantanamo Bay





Other Navy Potential Wind Projects

- San Nicolas Island, CA
- Naval Base Ventura County, CA Laguna Peak
- Barstow, CA
- Key West, FL
- Newport, RI
- Cutler, Maine
- NAVFAC-Marianas, Guam



Wind Energy Challenges for the Navy

- Environmental Concerns
 - Noise / Visual
- Radar Concerns
- Transmission and Tying into power grid-
“wind integration” issues
- Specific Mission Conflicts



Environmental Concerns

- Birds / Bats
- Endangered Species
- Noise
- Visual
- NIMBY





Radar Concerns

- Main concerns include:
 - DOD Long Range Radar
 - FAA flight path / communication restrictions
 - Other regional / local flight / comm restrictions



Radar Concerns

- Mitigation Techniques
 - Site wind turbines outside of LOS of long range radar
 - Potential for “software” fixes in radar computers, such as filtering



Radars Concerns

- Where to go for further information:
 - <http://www.eere.energy.gov/windandhydro/federalwindsiting/>
 - <http://www.nationalwind.org/events/business/37/default.htm>
 - <https://oeaaa.faa.gov/oeaaa/external/portal.jsp>
 - UK Studies linked on eere website



Radar Concerns

- Federal Govt. POC's:

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Wind Energy Grid Integration

- Navy Remote locations can improve local grid
 - Both GTMO and SCI has increased power quality of local grids
- Tie into utility grid, so far no Navy Wind projects
- Potential issues
 - Local power company interconnection agreements
 - Building new transmission lines to remote areas



Specific Mission Conflicts

- Navy/MC flight patterns
- Bombing / firing ranges
- Navy wildlife refuges
- Navy Clean up sites, safe to build
- Classified areas of Navy installations



Navy / NREL Efforts

- 2+ year long partnership with NREL
- Develop Navy Renewable Energy Plan
 - Main Deliverable, GIS tool for N/MC Energy Managers to use
 - Will include adjustable parameters: COE, COEq, Fed/State Incentives
- Re-evaluation of N/MC wind resources on a number of facilities
 - Focus on Distributed Generation wind
 - Have funding up to 6 N/MC sites, looking for bases interested in cost sharing of studies to stretch funds, please contact US!
- NREL to study Navy “Renewable Community” concept at SNI



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Where to go for further info

- DON Energy Website:
 - <https://energy.navy.mil>
- Tri-Service Renewable Energy Committee (TREC)
- DOE FEMP Assistance
- DOE Labs





References and Acknowledgements

- Dale R. Foster, CEM, Tetra Tech EM, Inc.
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- AWEA 07 Conference, pictures
- GE picture



Would you like to know more about this session?

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QUESTIONS??



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