Market Structure and Design and Wind Energy

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Theme

You cannot believe in markets,
reliability, or renewable energy
and remain agnostic about market structure

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Outline

- Market Context
- Wind integration Lessons Learned
- Transmission Infrastructure Policies

Market Context

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Wind Growing Worldwide

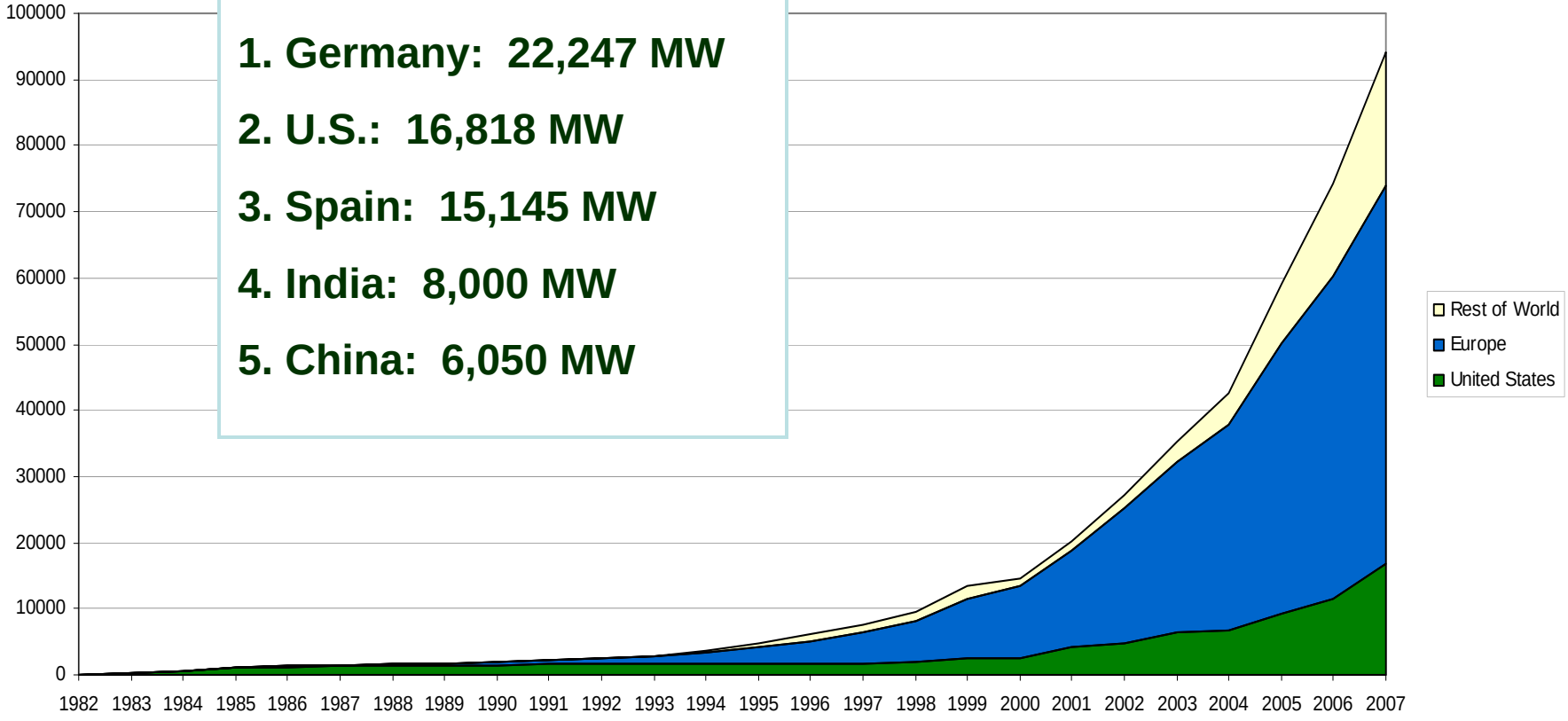
1. Germany: 22,247 MW

2. U.S.: 16,818 MW

3. Spain: 15,145 MW

4. India: 8,000 MW

5. China: 6,050 MW



Source: GWEC Global Market Report

As of December 31, 2007

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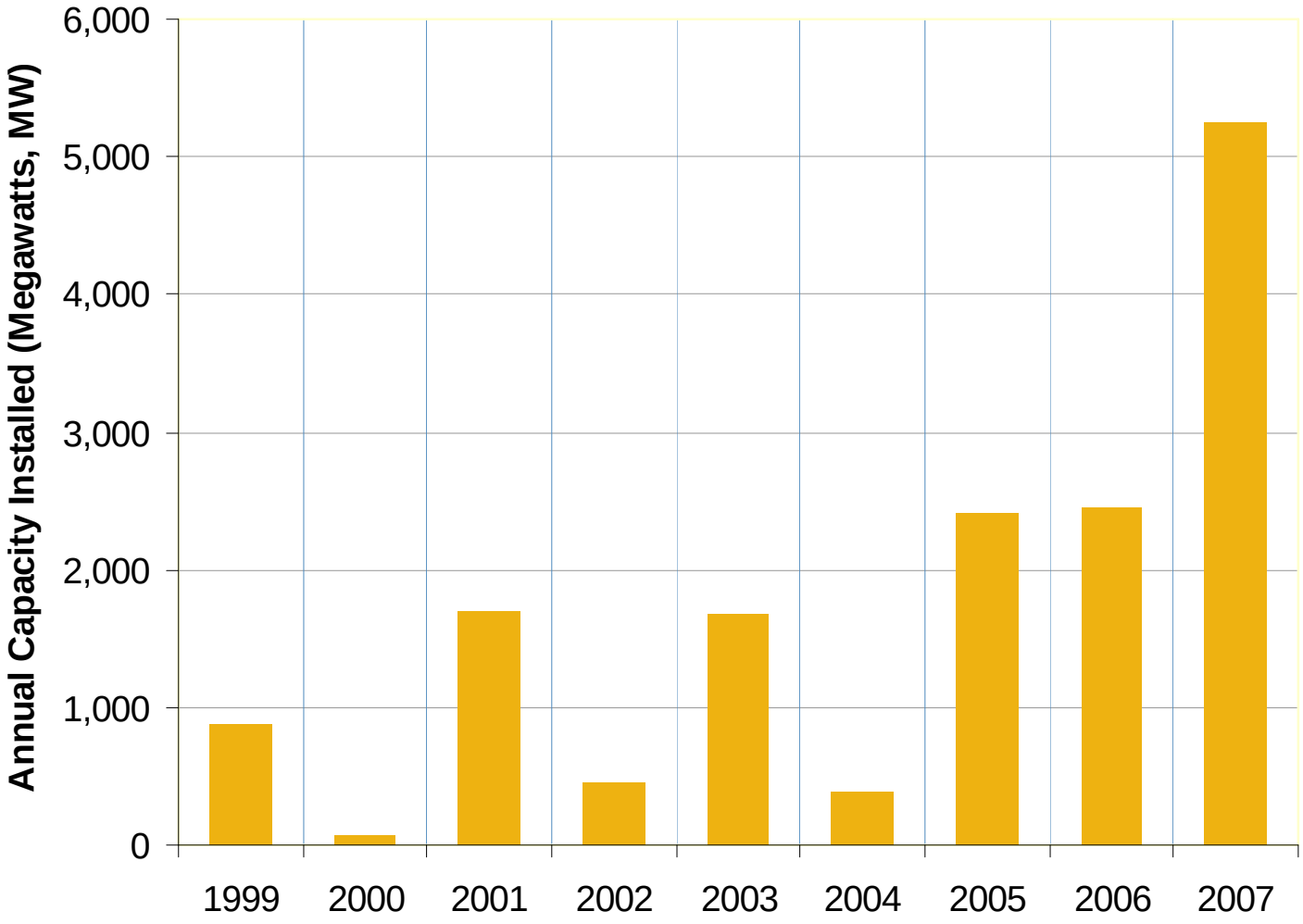
Annual U.S. Wind Capacity Installation



- U.S is more than 25% of global market
- Annual Installation in 2007: 20,000 MW

- U.S.: 5,200 MW
- Spain: 3,400 MW
- China: 3,400 MW
- India: 1,800 MW

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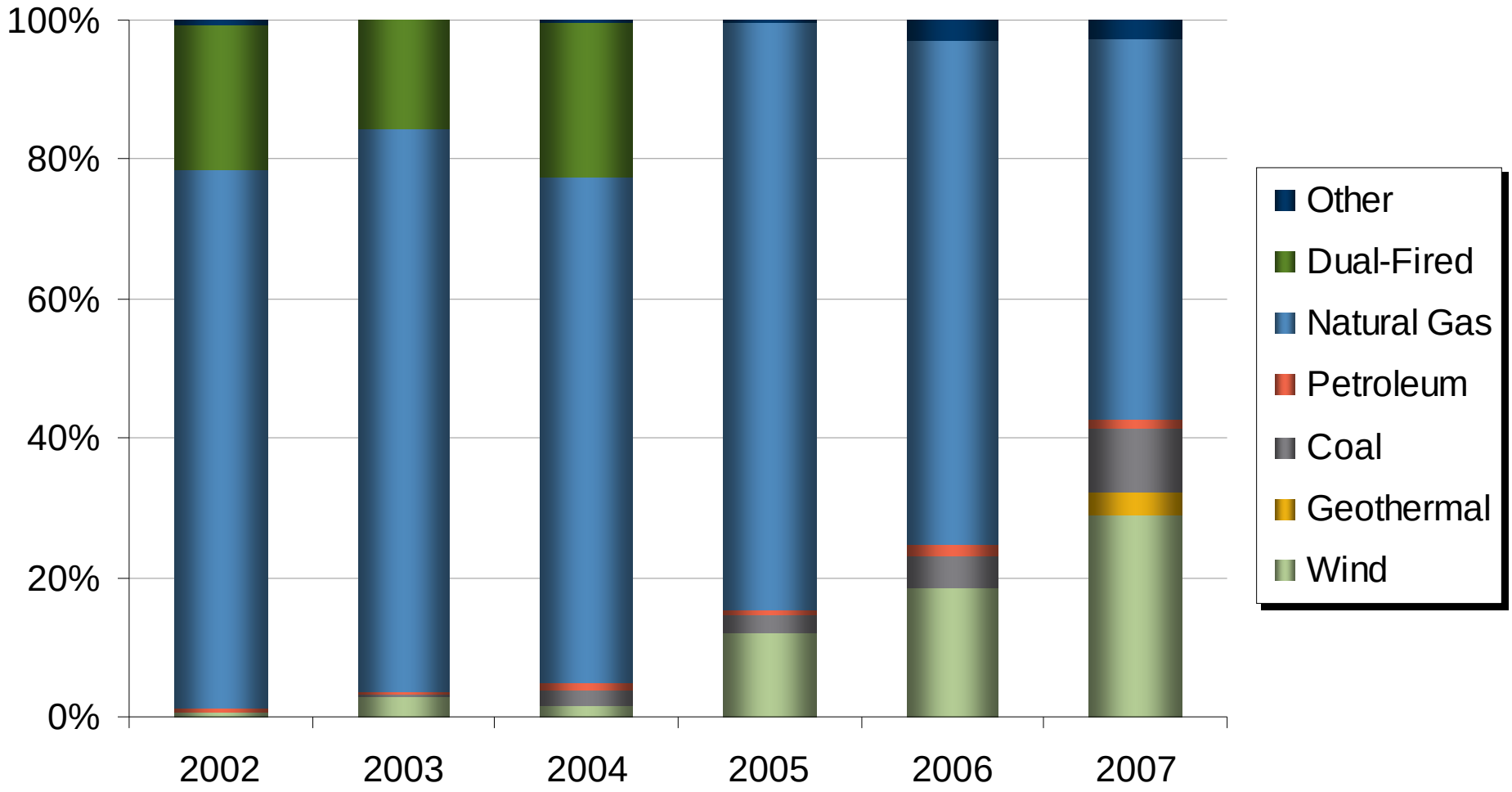
New Capacity by Source



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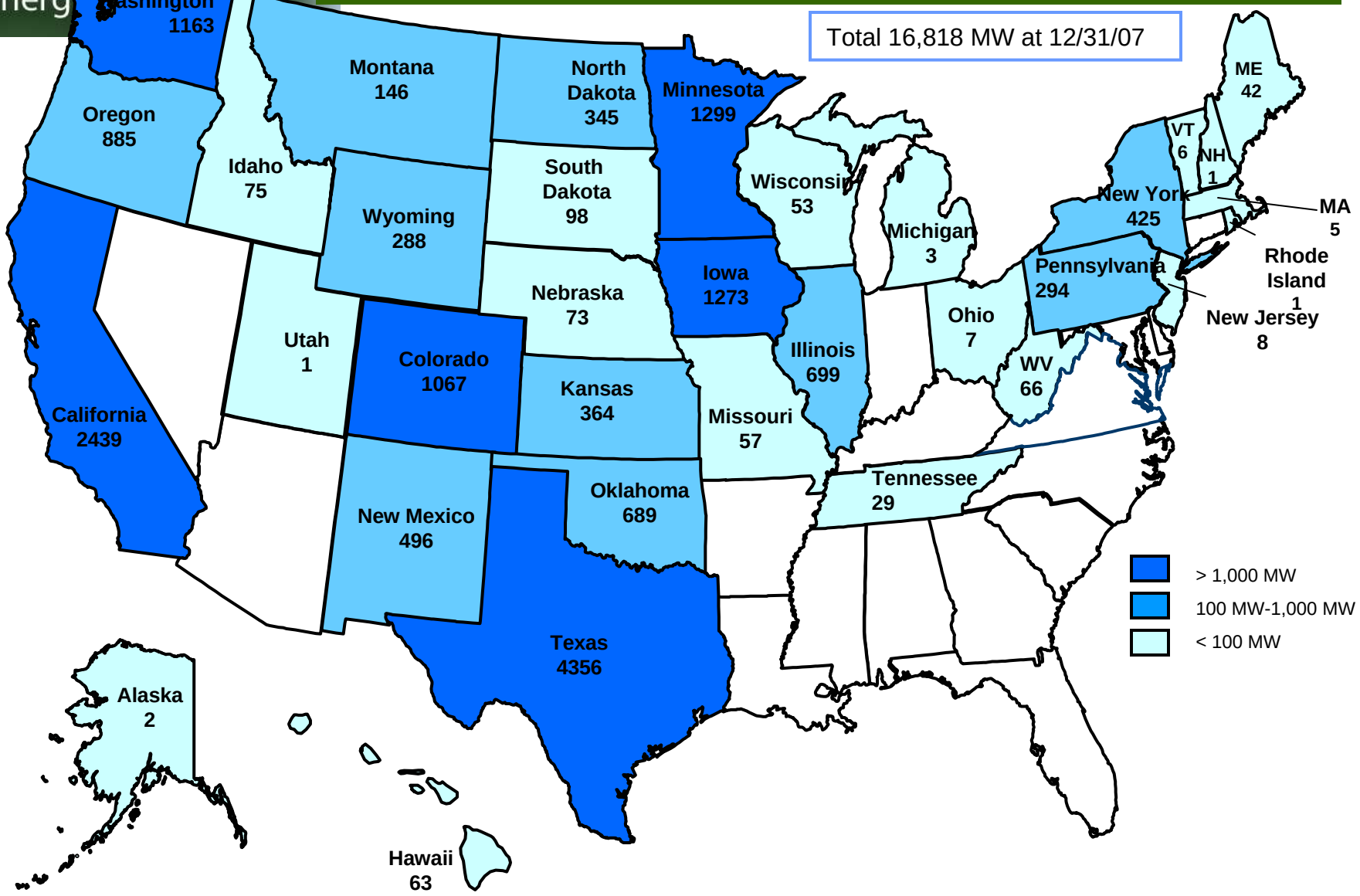
Installed Utility-Scale Wind Power

as of December 31, 2007



Wind Integration Lessons Learned

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IEA on Wind Integration

- “Larger balancing area size and wind aggregation: both load and generation benefit from the statistics of large numbers as they are aggregated over larger geographical areas. Larger balancing areas make wind plant aggregation possible. The forecasting accuracy improves as the geographic scope of the forecast increases; due to the decrease in correlation of wind plant output with distance, the variability of the output decreases as more plants are aggregated. On a shorter time scale, this translates into a reduction in reserve requirements; on a longer time scale, it produces some smoothing effect on the capacity value. Larger balancing areas also give access to more balancing units.” (p 107).

- Holttinen H., et al 2007, *Design and Operation of Power Systems With Large Amounts of Wind Power: State of the Art Report*, VTT Working Paper 82, IEA Wind

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U.S. Wind Integration Studies Costs <10% of Total

Date	Study	ISO/RTO	Wind Capacity Penetration	Integration Cost: $/MWh of Wind Output	Energy Market Interval
3/05	NYISO	ISO/RTO	10%	Very Low	5 minute
12/06	Minnesota/MISO	ISO/RTO	31%	$4.41	5 minute
2/07	GE/Pier/CAIAP[(a)]	ISO/RTO	33%	$0-$0.69	10 minute
3/07	Avista	No	30%	$8.84	1 hour
3/07	Idaho Power[(b)]	No	30%	$7.92	1 hour

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MN DOC study

- "The MISO [Midwest Independent System Operator] energy market also played a large role in reducing wind generation integration costs. Since all generating resources over the market footprint are committed and dispatched in an optimal fashion, the size of the effective system into which the wind generation for the study is integrated grows to almost 1200 individual generating units. The aggregate flexibility of the units on line during any hour is adequate for compensating most of the changes in wind generation." (See www.puc.state.mn.us/docs/windrpt_vol%201.pdf.) (Zavadil 2006)

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Letter from 22 Orgs to FERC

"Independently run regional grid operations can foster renewable energy and demand response development by:

- Eliminating "pancaked" transmission rates that are assessed across every utility area;
- Providing energy markets where variable or intermittent resources can sell excess energy or purchase shortages at a transparent and fair price;
- Minimizing operational impacts of variable resources by netting out aggregate load and generation over a wide region;
- Facilitating regional transmission planning to access generating resources as well as address reliability, congestion, and load growth in the most efficient overall manner;
- Providing a mechanism to pursue regional cost allocation policies; and
- Providing for flexible transmission tariffs that allow rates to be paid on an as-used basis as opposed to a capacity reservation basis."

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Northwest Wind Integration

- **"There are steps we can take to increase integration capability and to lower integration costs.**
  The cost of wind integration services can be reduced through generally four types of actions: **(1) developing more cooperation between regional utilities to spread the variability of wind more broadly; (2) developing markets that will reward entities who choose to market their surplus flexibility;** (3) making more low-cost flexibility such as that provided by hydroelectric resources available; and (4) development and application of new flexibility technologies.

- http://www.nwcouncil.org/energy/Wind/library/2007-1.htm

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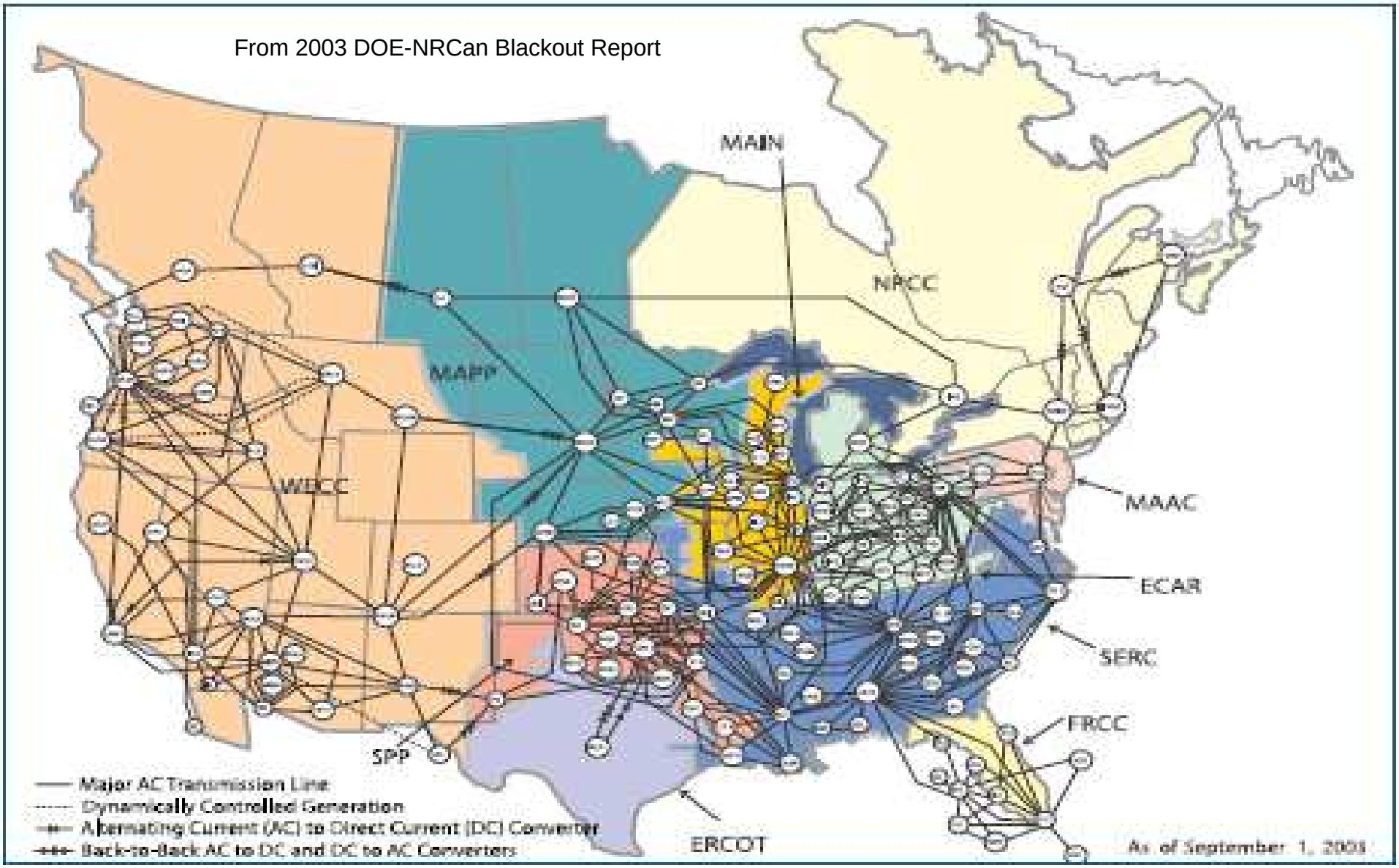
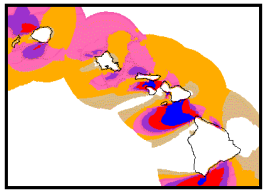
140 Control Areas Today

From 2003 DOE-NRCan Blackout Report

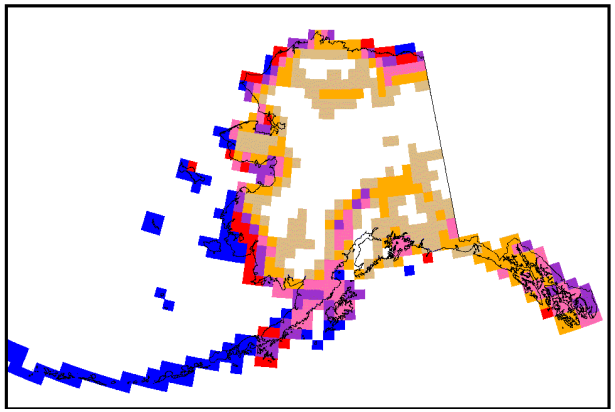


Transmission Infrastructure Policies

Transmission for 20% Electricity From Wind



The remaining states use data from the 1987 "Wind Energy Atlas of the United States".



Transmission Lines
Voltage (kV)

- 345 - 499
- 500 - 699
- 700 - 799
- 1000 (DC)

Source: POWERmap, powermap.platts.com, ©2007 Platts, a division of the McGraw-Hill Companies

- Existing 765 kV
- New 765 kV
- AC-DC-AC Link

Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed [a] at 50 m m/s	Wind Speed [a] at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

[a] Wind speeds are based on a Weibull k value of 2.0

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

19-APR-2007 1.5.9

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Chicken and egg

- Which comes first? Transmission !!
- Need pro-active transmission
  - MN, CA, TX, CO policies bearing fruit
  - FERC: CAISO tariff
  - Sen. Harry Reid National Renewable Energy Zone bill