

Getting Ready for Low-Carbon Resources

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Increasing Renewable Energy in the Western Grid
Summit, September 2007

Outline

- Climate, energy security goals
- Renewables supply
- Organizing to use renewables
- Aligning electric, climate goals
 - Renewables-first transmission
 - Energy-first planning

GHG Reduction Goals

Western Climate Initiative

2040-2050

Arizona

50% below 2000

British Columbia

not established

California

80% below 1990

Manitoba

not established

New Mexico

75% below 2000

Oregon

> 75% below 2000

Utah

to be set by 6/08

Washington

50% below 1990

GHG Reduction - Renewables

California 33% renewable energy, 2020

- Cuts electric CO₂ 25%, to 1990 levels

California CO₂ law: 80% below 1990 by 2050

Electric sector contribution?

Commercial Potential, 2025

Renewables Industry Consensus:

Wind	225 GW
Solar (PV, CSP)	164 GW
Geothermal	20 GW
Biomass	100 GW
Water	23 GW

=>40%-50% US electric supply, 2025

Organizing To Use Renewables

Next 10 years, meet state RPS 15% - 25% goals

- Integrate generation-transmission planning
- Renewables-first transmission; mega-projects
- Regional markets, coordinated procurement
- Combine control areas, facilitate integration
- Improve forecasts, gain confidence with variable-output resources

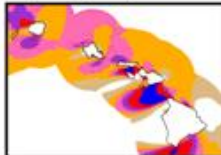
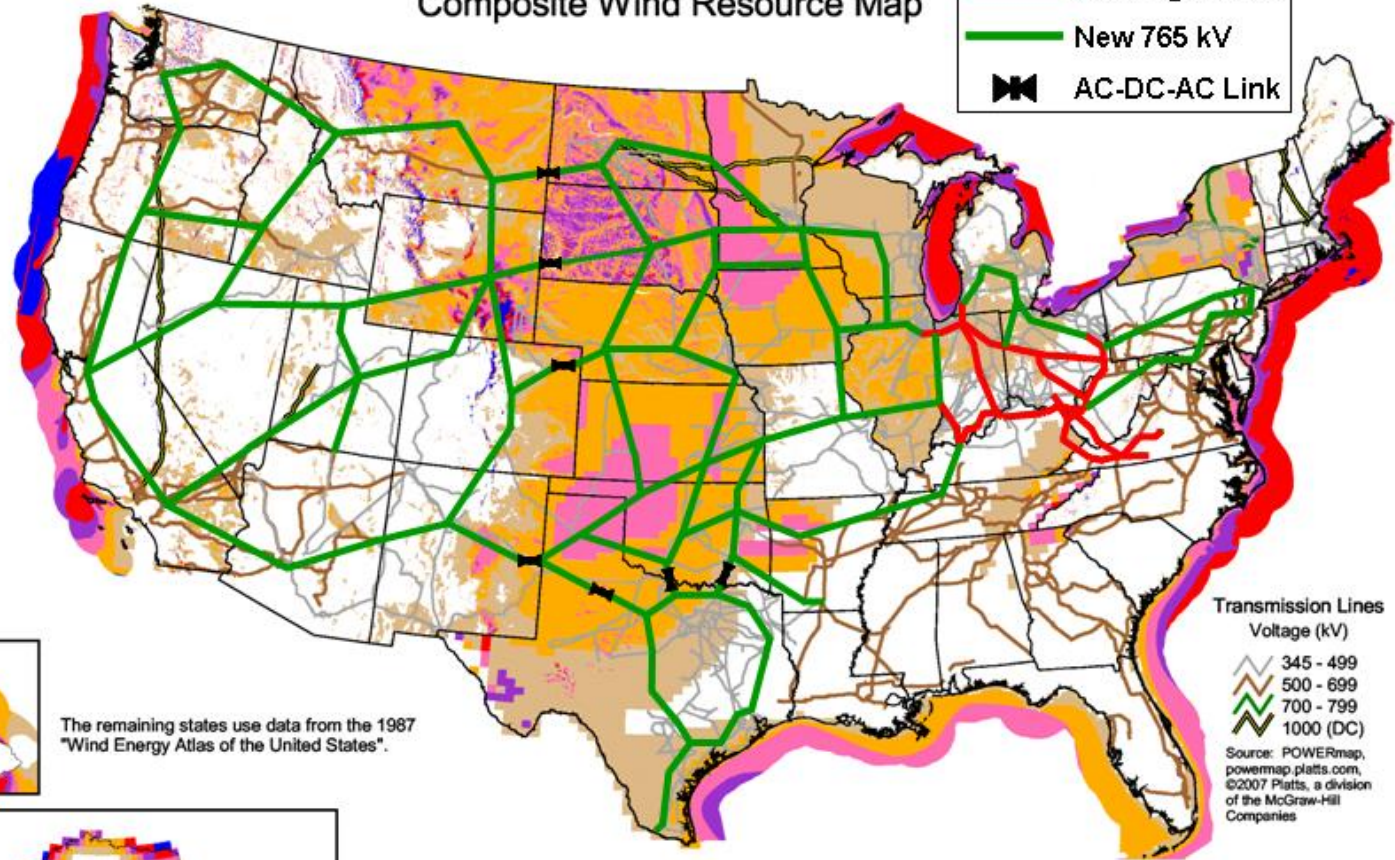
Renewables-First Transmission

- 3,000 MW+ projects in active development
- Mega-projects need, can afford dedicated tx
- Wind-only lines economic when regional power cost differentials are large
- No apparent conflict with OATT
- Most western tx can be planned, approved to supply renewables for next 20 years
- Coal with CCS can use lines later

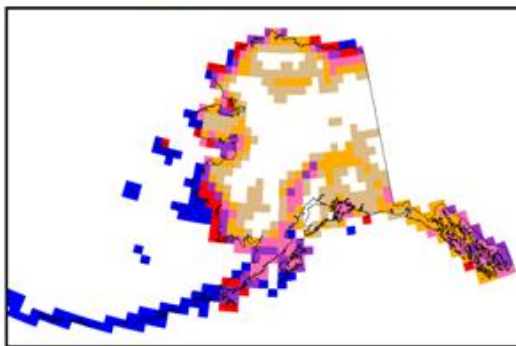
NREL Updated Maps:
 Arizona (2003)
 California (2002)
 Colorado (2004)
 Connecticut (2001)
 Delaware (2002)
 Hawaii (2004)
 Idaho (2002)
 Illinois (2001)
 Indiana (2004)
 Maine (2001)
 Maryland (2002)
 Massachusetts (2001)
 Michigan (2004)
 Missouri (2005)
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 Ohio (2004)
 Oregon (2002)
 Pennsylvania (2002)
 Rhode Island (2001)
 South Dakota (2001)
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 Utah (2003)
 Vermont (2001)
 Virginia (2002)
 Washington (2002)
 West Virginia (2002)
 Wyoming (2002)

Composite Wind Resource Map

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



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

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



Energy-First Planning

- Organize planning, system operations to maximize use of low carbon energy
- Wind, solar displace more expensive energy
- Don't expect capacity to supply most energy
- Build capacity strategically, to support low-carbon energy resources
- Improve reliability, reduce total cost

Aligning Electric, Climate Goals

- Energy efficiency meets all load growth
- CHP heats, cools, powers urban centers
- Low carbon resources supply most energy
- Smart Grid interoperability supplies capacity
- Fossil resources with CCS supply capacity, incremental energy
 - Plan today for 2015-2065