

Challenges to the Integration of Renewables

Wind Integration in the Western Interconnection

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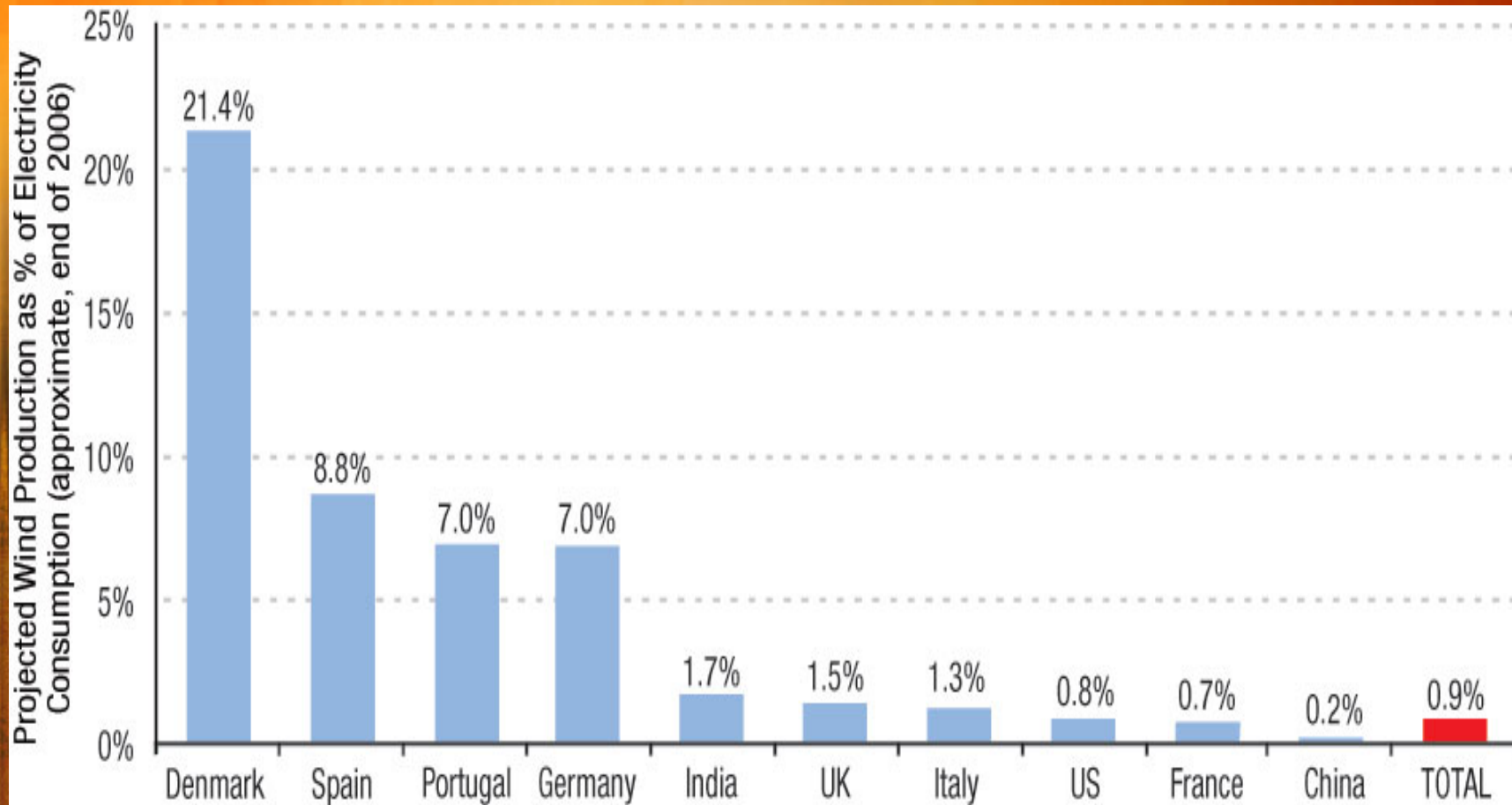
Key points

- Climate change is a big deal
- Utility industry must act regionally
- Planning must change
- Markets matter
- Reliability is still essential
- More transmission is needed
- Is the current Tx paradigm up the challenge?

Climate Change is a big deal

- It's not about **whether** to add renewables
- It's about **how**
- Attitude is important
 - Load serving entities
 - Regulators

U.S. lags



Source: Berkeley Lab estimates based on data from BTM and elsewhere.

It takes a region

- Synchronized machine
- Markets
- Regional coordination
 - Economies of scale, geography
 - LSE coordination
 - Transmission developer economies

Planning

- (low carbon) Energy first
 - Resource procurement
 - Transmission
- Weak Tx planning authority in the West

Markets

- RECs
- Ancillary services
- Capacity

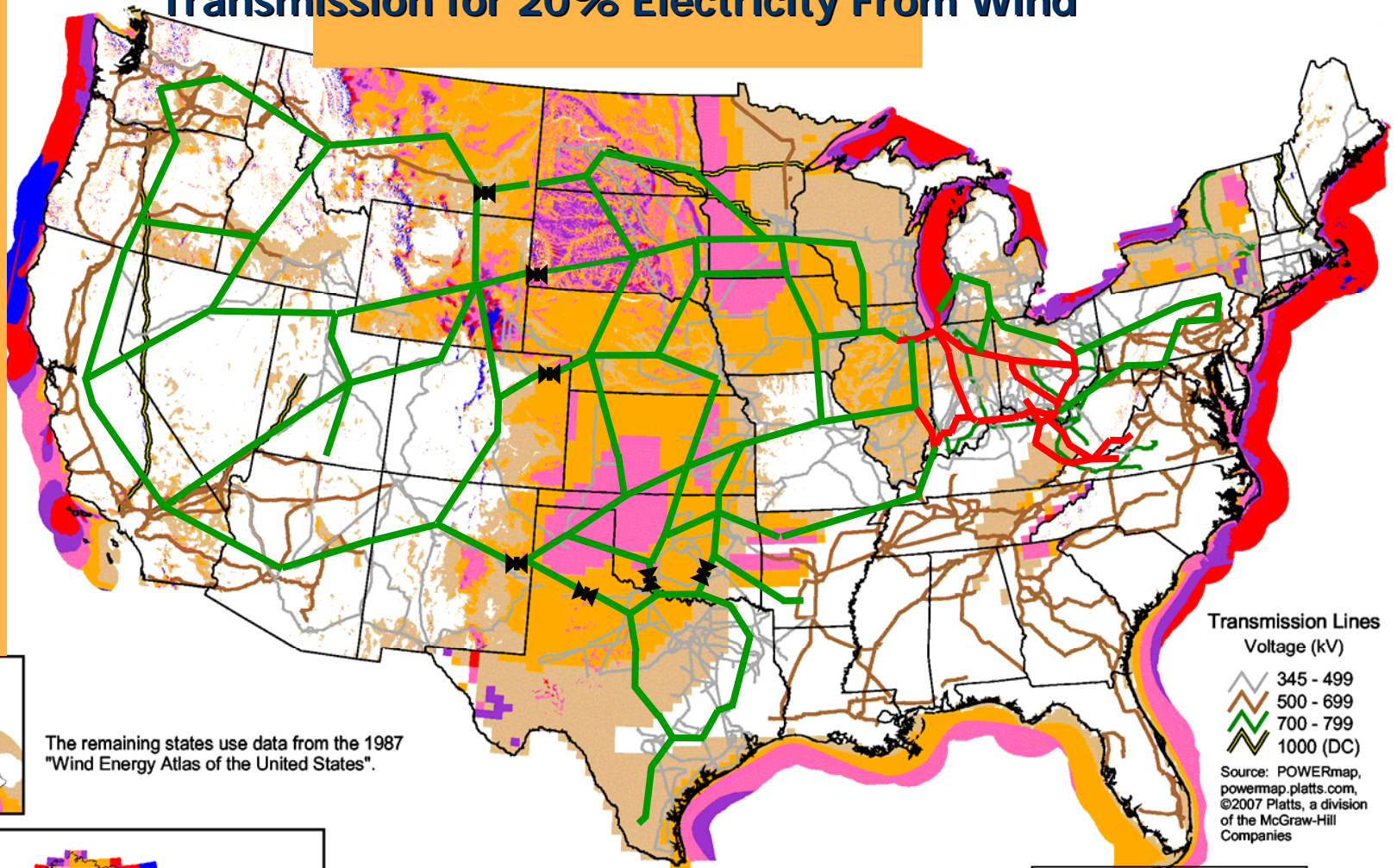
Reliability

- Still essential
- Capacity resources complement energy resources

Transmission--more is needed

- Optimize existing system
 - Better use of existing capacity
- Reliability
- Commerce in renewables
- Oversizing
 - How to pay for it?
- Confront public's paradox
 - Love renewables
 - Hate (new) transmission

Transmission for 20% Electricity From Wind



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

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

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



Is the current Tx paradigm up to the challenge?

- Ownership
 - Private, customer, government
- Regulation
 - State, federal, regional
- RTOs
 - Second coming?
- Functions
 - Balancing, integration
 - Market making
 - Planning, with obligations

Key points--again

- **Climate** change is a big deal
- Act **regionally**
 - Think globally
- Change planning--**energy first**
- **Markets** matter
- **Reliability** is still essential
- **More transmission** is needed
- Current **paradigm** up the challenge?



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