Tackling Climate Change in the U.S.: The Potential Contribution from Wind Power

American Solar Energy Society
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National Renewable Energy Laboratory
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Thanks to

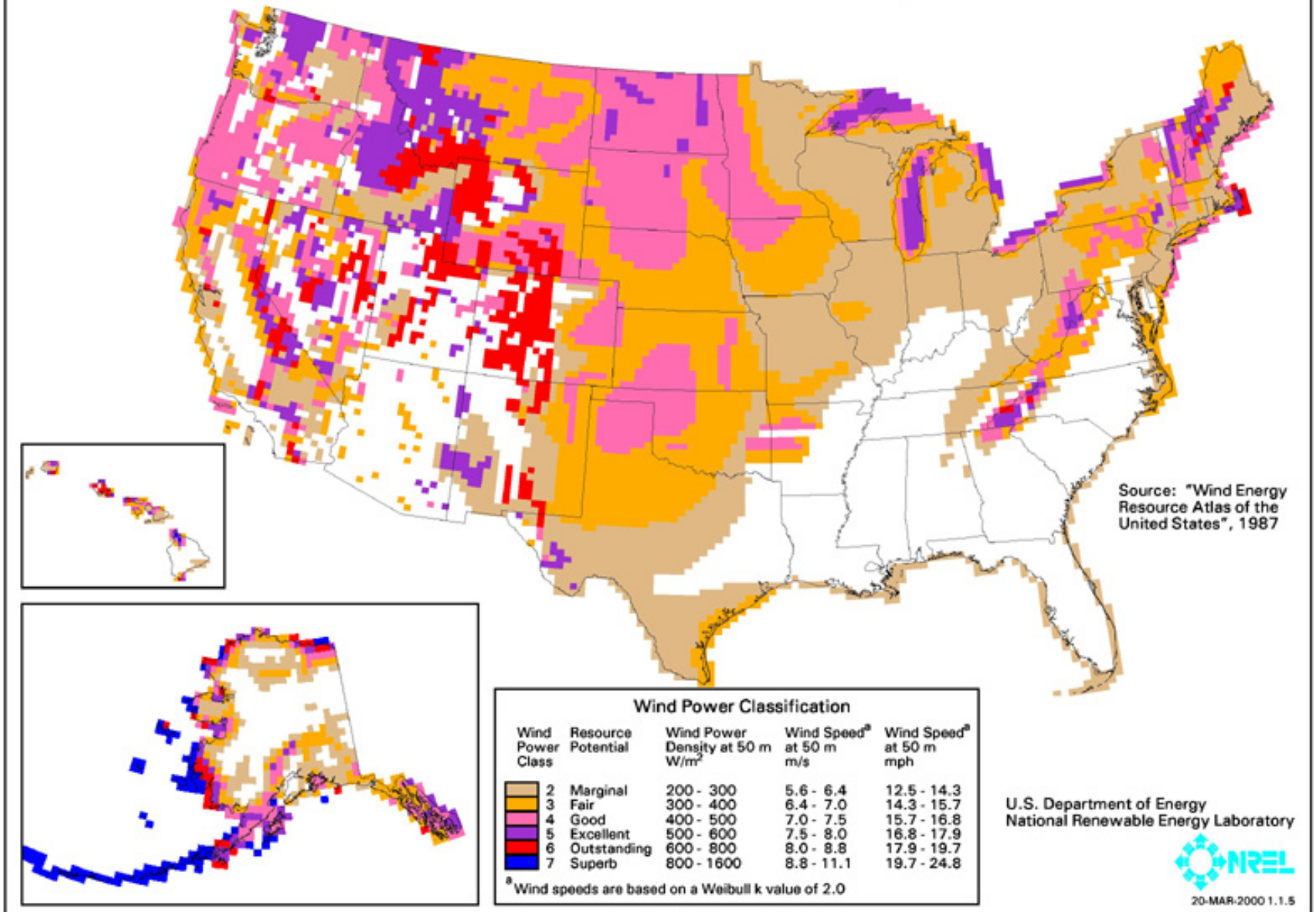
- Nate Blair
- Donna Heimiller
- Brian Parsons
- George Scott
- Walter Short
- Wind Task Force, WGA/CDEAC

Presentation Topics

- Introduction and resource overview
- Clean and Diverse Energy Plan
- Cost of energy from wind
- Wind Deployment System Modeling results
- Carbon reduction potential from wind
- Summary

Note: All costs in constant 2005 dollars unless otherwise stated

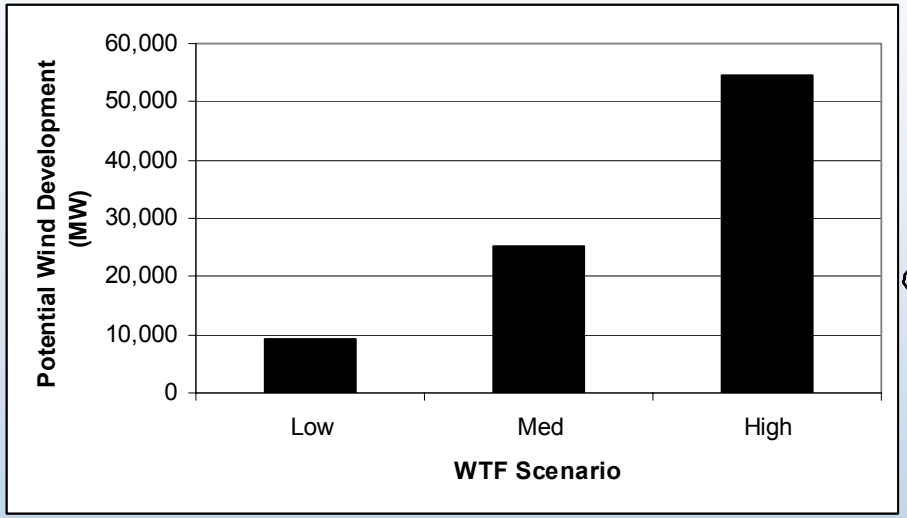
United States - Wind Resource Map

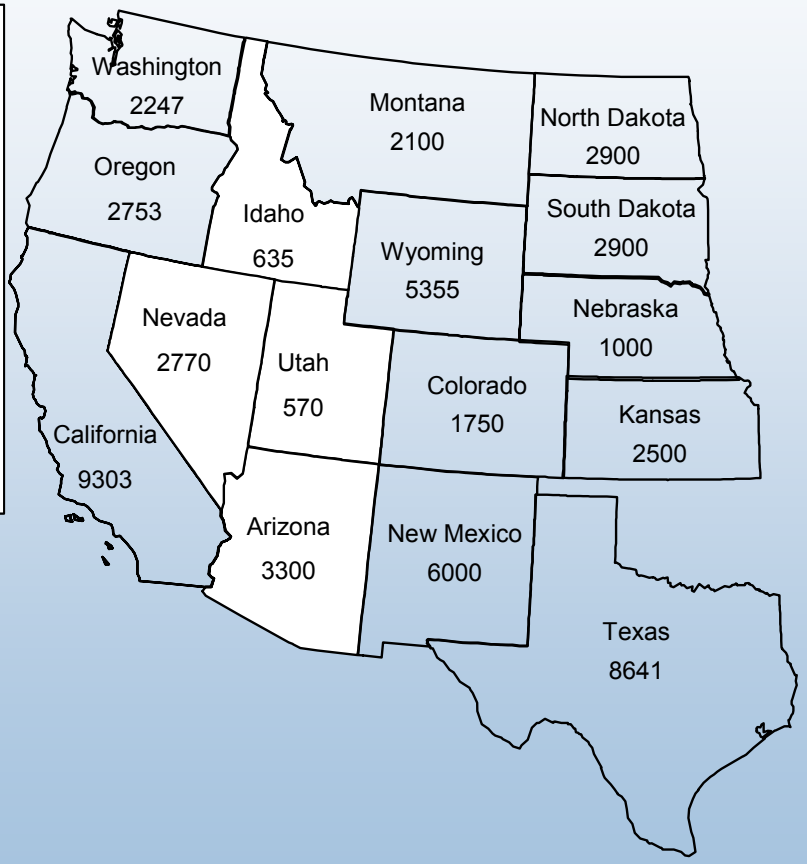


Western Governors' Association

- Clean and Diverse Energy Plan
- Supply curve development
- Evidence of wind development
  - Regional and sub-regional transmission planning in the West and Midwest
  - Development driven by RPS, IRP
  - May not follow supply curve predictions
- Wind task force scenarios

Western Governors' Association Wind Additions: Scenario 3





Three WGA Scenarios

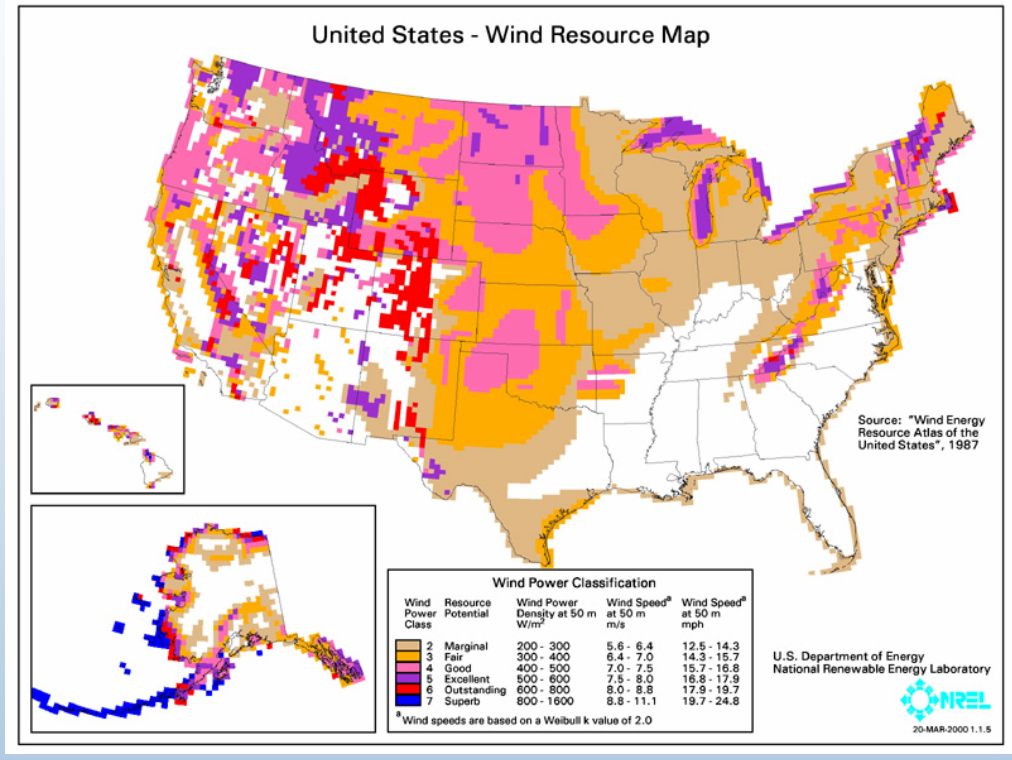
Total: 54,724 MW

A First Quick Look at Wind Supply and Transmission in the U.S.

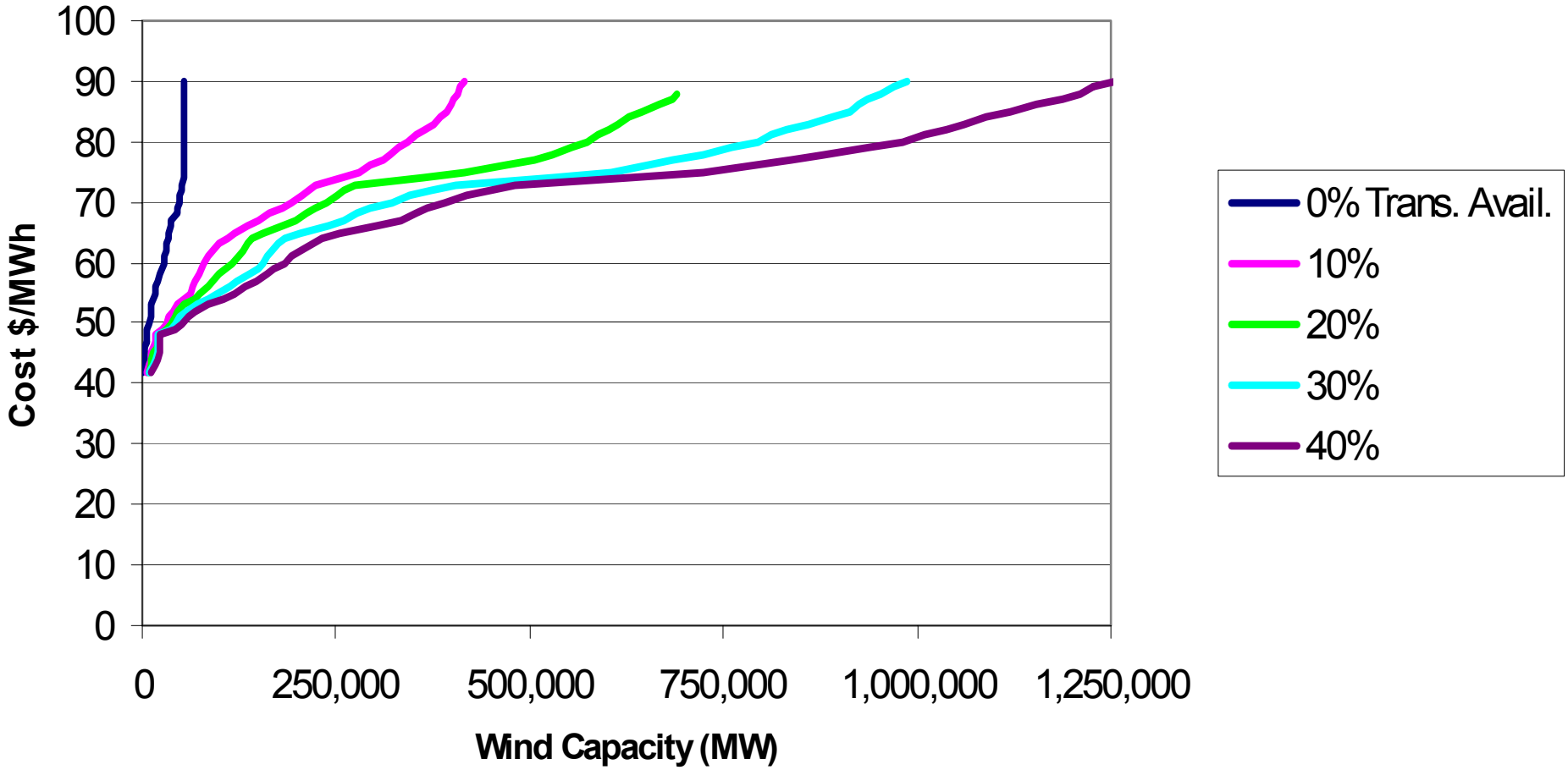
- Based on work for Western Governors' Association
- Expanded for nation
- Assumes no change in cost of energy
  - Technology is constant
  - Manufacturing: no learning
- 50m map data extrapolated to hub height
- Supply curves do NOT include PTC, integration cost, fuel risk benefit of wind, etc.

Supply Curve Development

- Uses high-resolution maps (when available) from national GIS database
- Converts wind speed to power and energy
- Wind cost of energy calculated based on annual average wind speed and distance to transmission



Impact of Transmission Availability on Wind Supply



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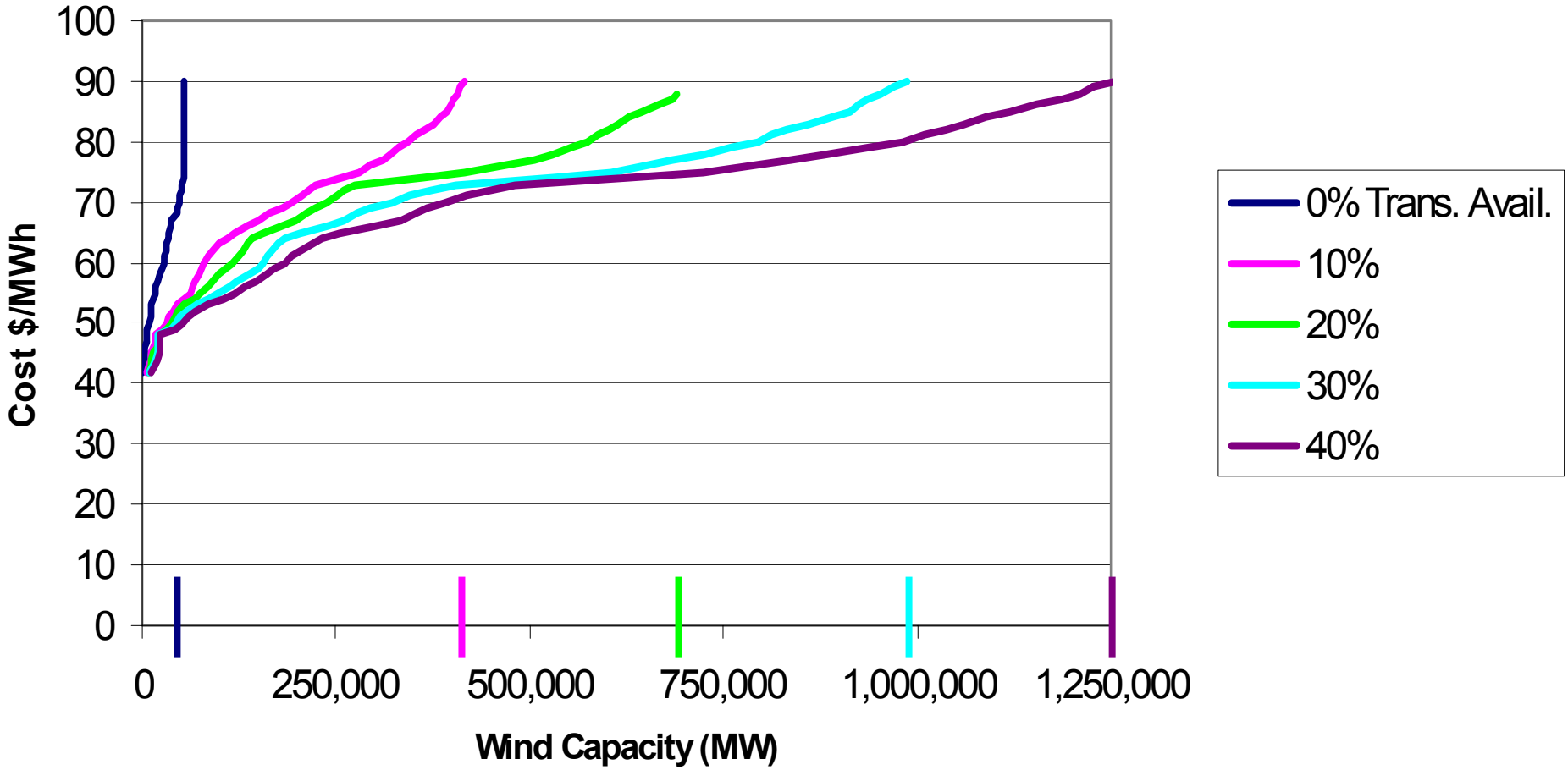

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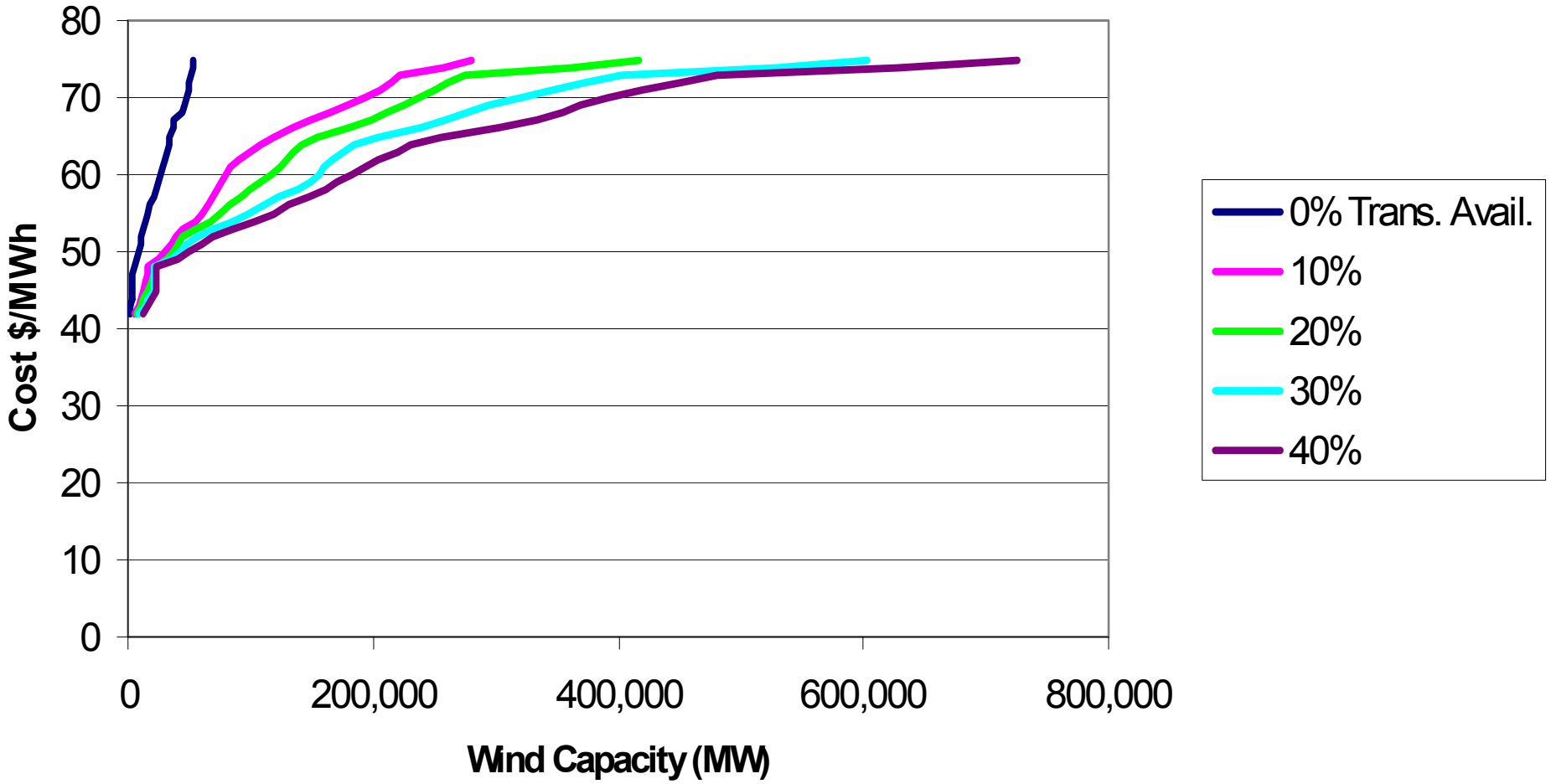

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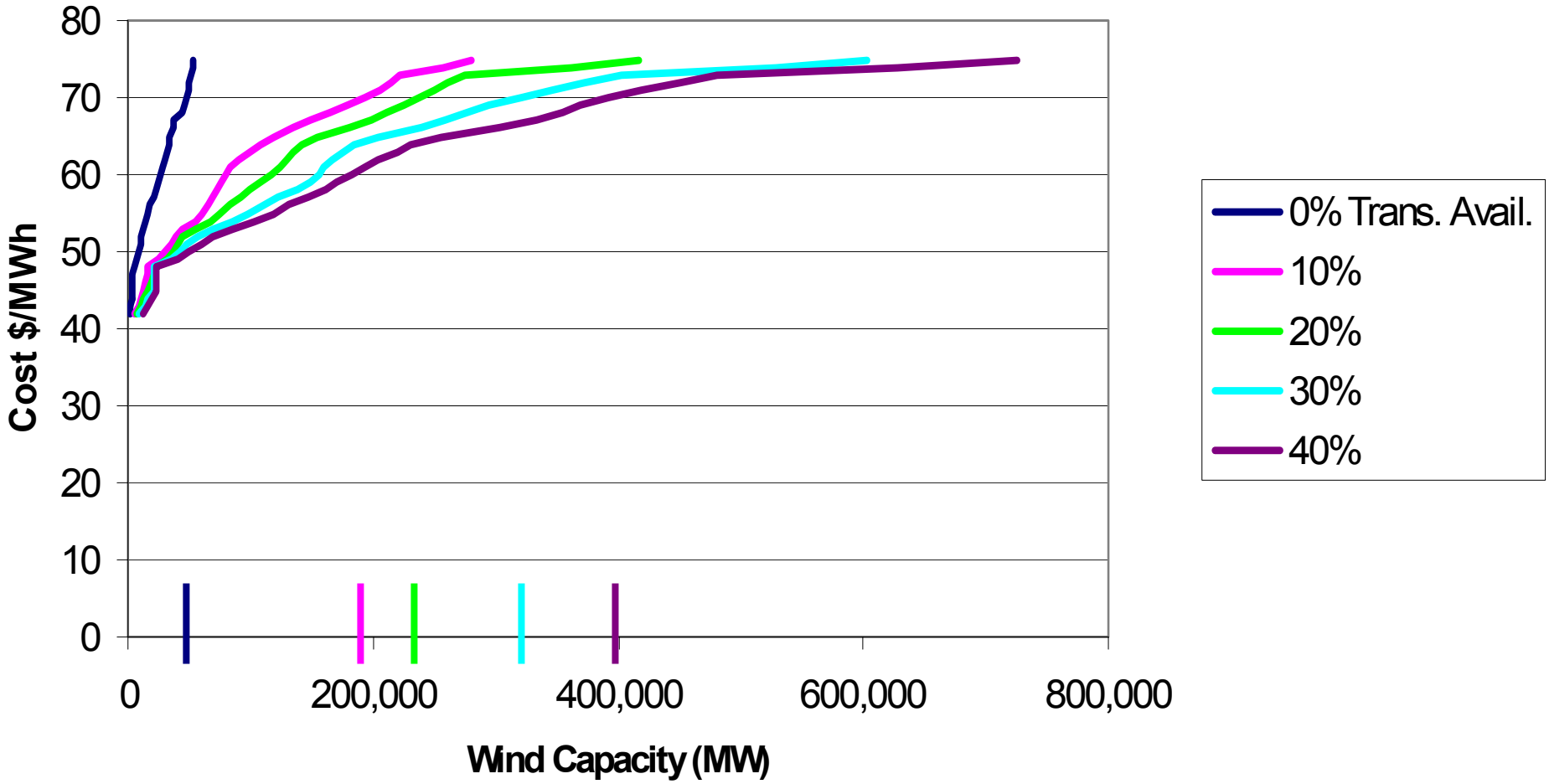

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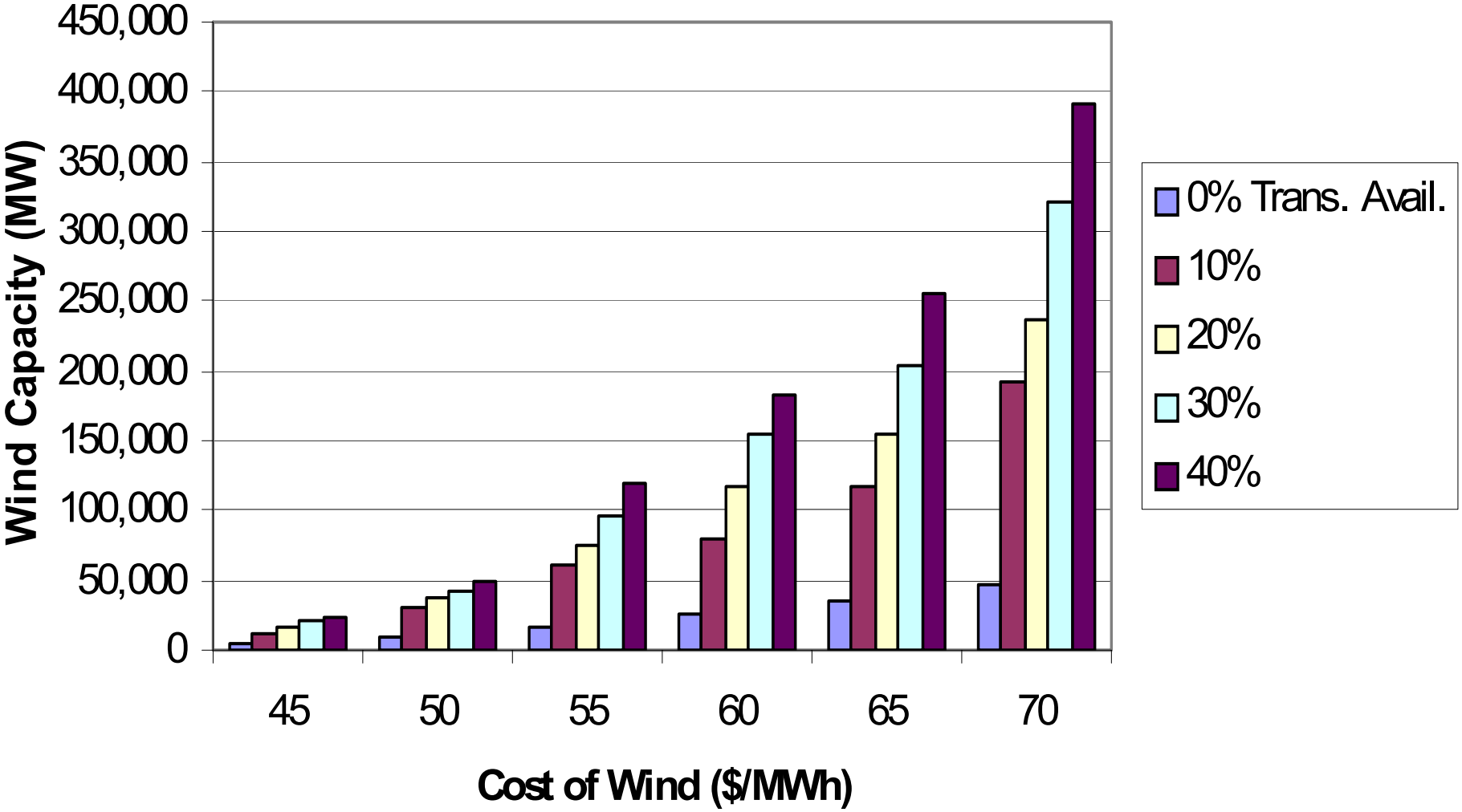

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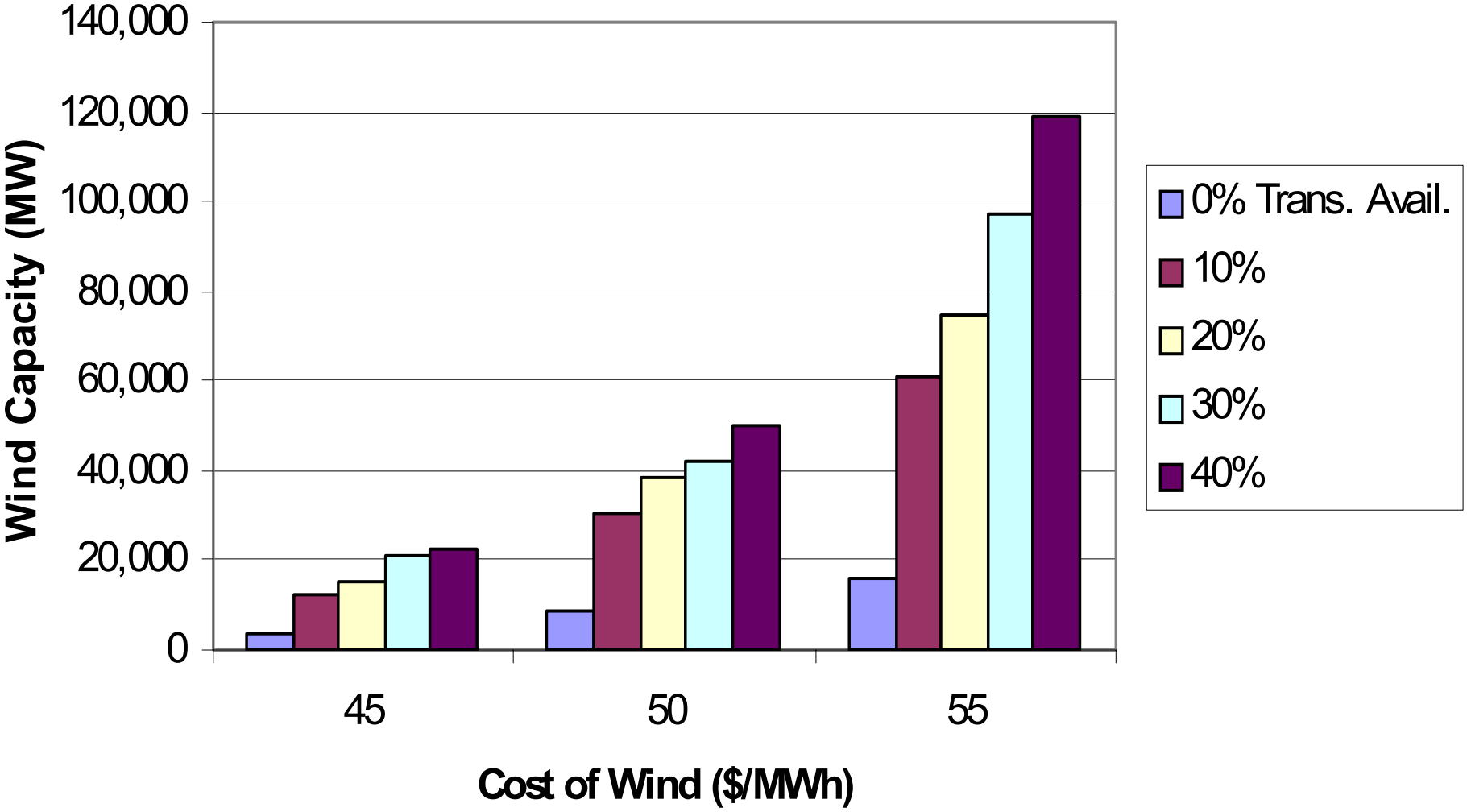

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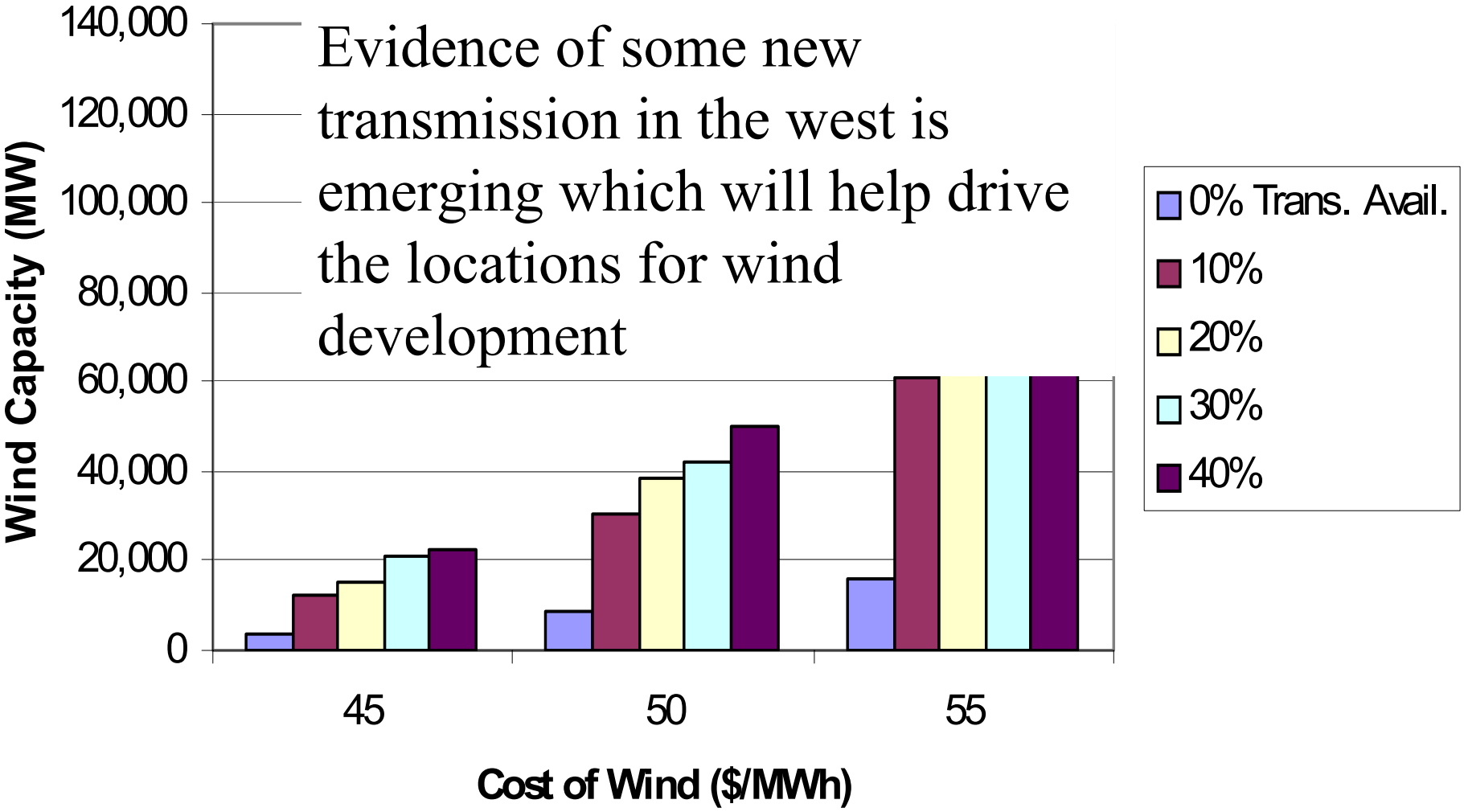

$/MWh	Wind Supply as Function of Existing Transmission Availability (Percent)				
	0%	**10%**	**20%**	**30%**	**40%**
45	3,604	12,449	15,502	20,808	22,654
50	8,989	30,824	38,094	41,984	49,846
55	15,818	61,079	74,778	96,995	119,225
60	26,938	80,156	116,734	155,711	182,636
65	34,559	118,325	154,416	203,739	255,795
70	47,159	192,893	237,811	321,042	391,437

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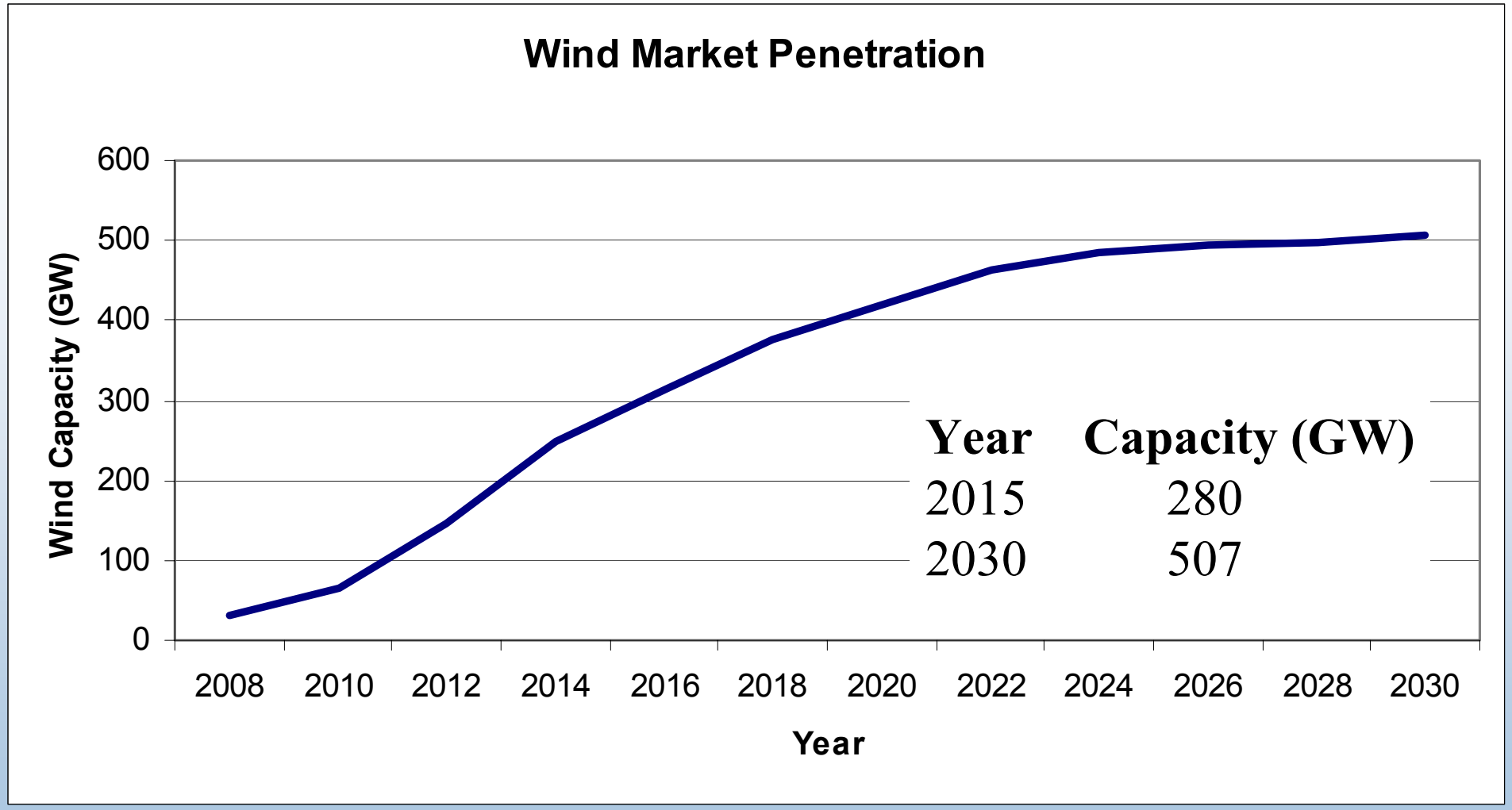
Assumes no change in technology, PTC not included

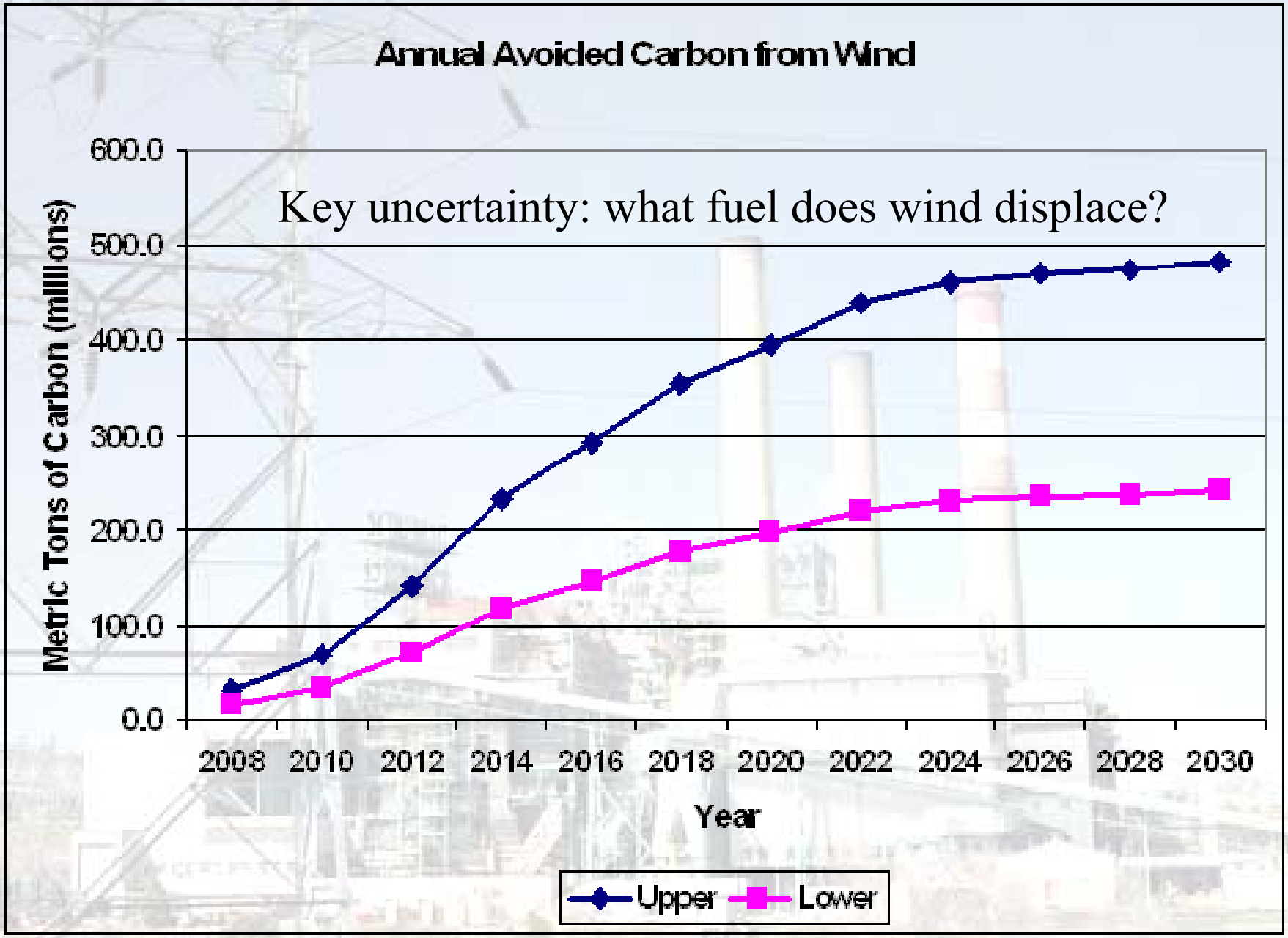
Wind Cost Decline in Future

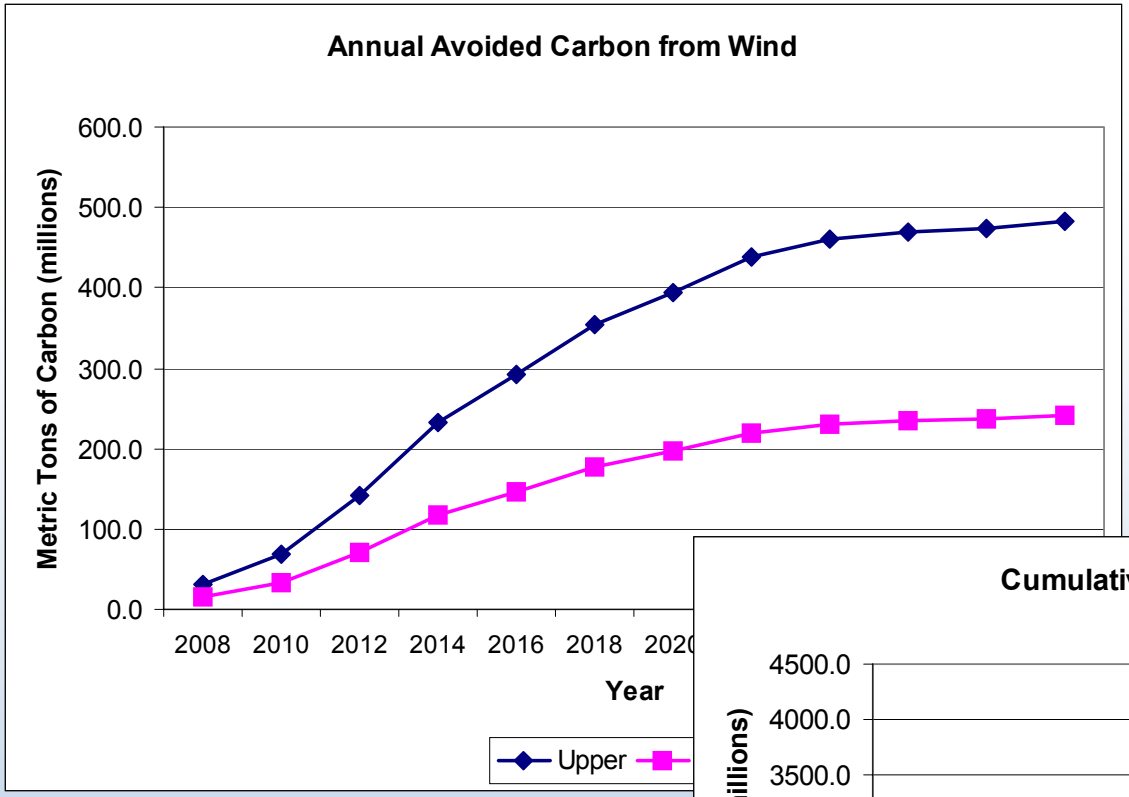
- Current “spike” not considered
  - Permanent or temporary?
  - Causes
    - Steel price increase
    - Foreign exchange (weak dollar)
    - Pent-up demand from PTC re-instatement and slow adjustment in supply

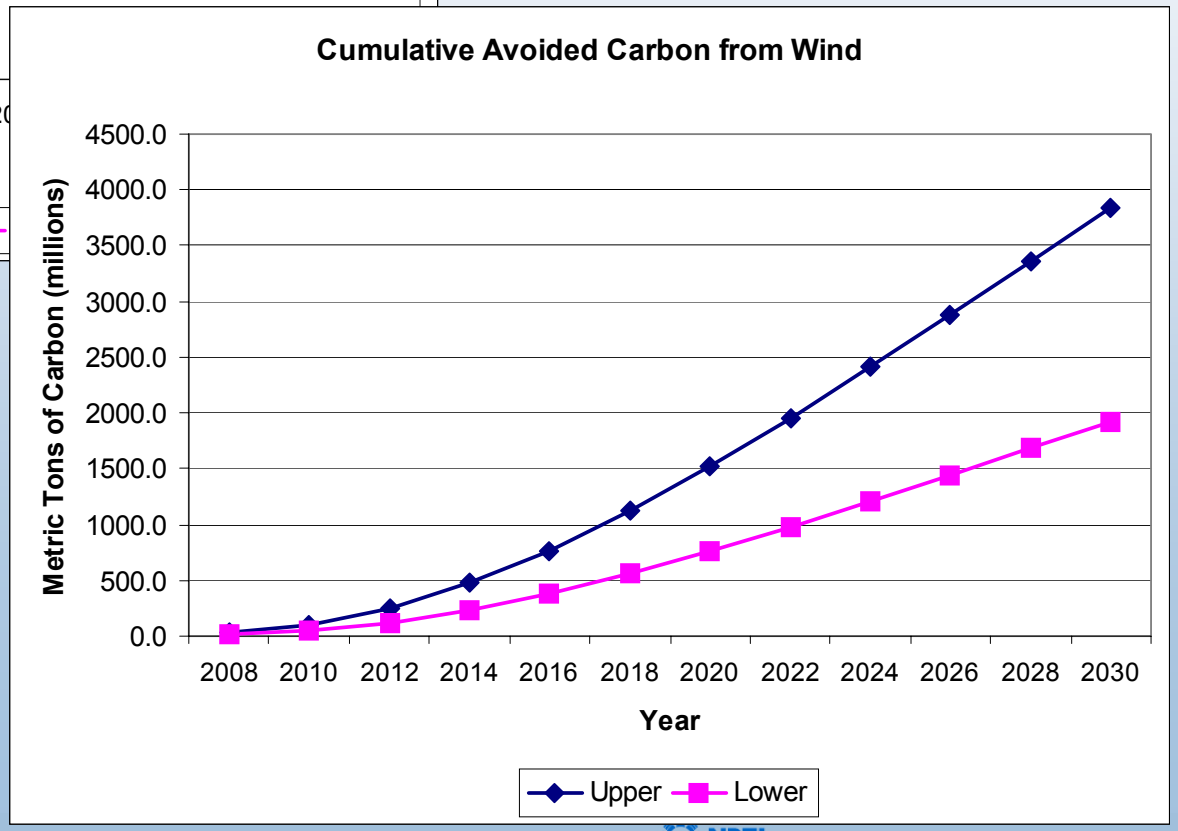
Market Simulation

- Based on Wind Deployment System WinDS (W. Short et. al)
- Wind competes with other resources
- Uses DOE wind cost of energy projection
- Results are preliminary and subject to modeling improvements
- Key assumption: PTC until 2010 with gradual decline until phase-out in 2030 (high wind penetration scenario)


Wind Market Penetration
Wind Capacity (GW)
600
500
400
300
200
100
0
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Year
Year Capacity (GW)
2015 280
2030 507


Annual Avoided Carbon from Wind
Key uncertainty: what fuel does wind displace?
Metric Tons of Carbon (millions)
600.0
500.0
400.0
300.0
200.0
100.0
0.0
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Year
Upper
Lower


Annual Avoided Carbon from Wind
Metric Tons of Carbon (millions)
600.0
500.0
400.0
300.0
200.0
100.0
0.0
2008
2010
2012
2014
2016
2018
Year
Upper


Cumulative Avoided Carbon from Wind
Metric Tons of Carbon (millions)
4500.0
4000.0
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Year
Upper
Lower

Other WinDS Scenarios

- President Bush: 20% of US energy generated by wind
- About 360 GW wind capacity by 2020
- Assumes PTC phase-out from 2010 until 2020 (compared with high potential case with PTC phase-out until 2030)
- Both assume consistent policy framework

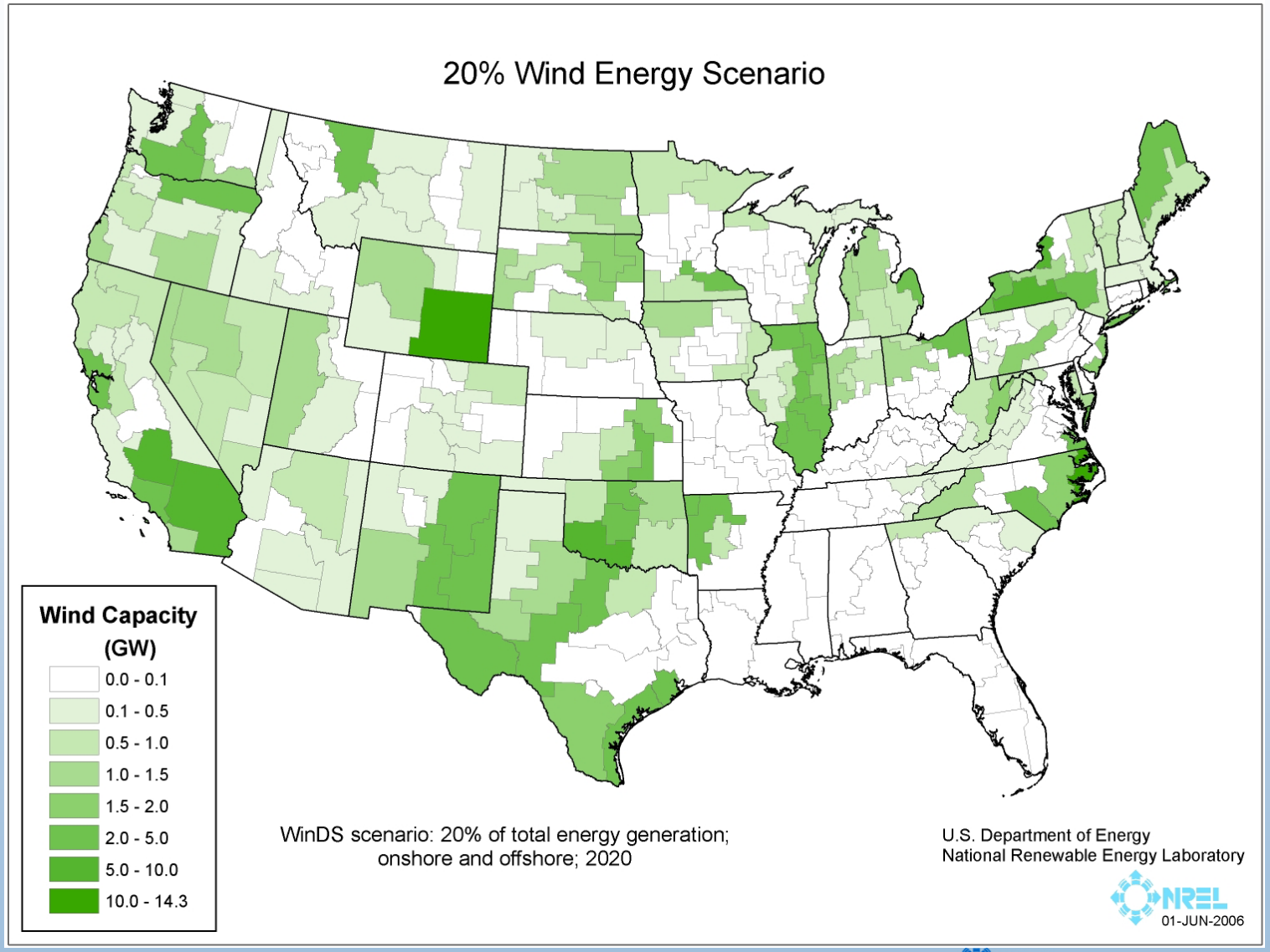
Land Area Impacted by 20% Scenario

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

01-JUN-2006

What does 20% wind look like?



Are These Penetration Rates Achievable?

- Aggressive and depends on
  - Consistent policy framework
  - Continued technical development of wind
  - Continued development of grid operational strategies with large wind
    - Control area consolidation
    - Improved wind forecasting and integrate into control room
    - Deployment of complimentary generation technologies
    - Cost-based transmission tariffs (not penalty-based)
    - Ability to build needed transmission and development of new transmission tariff products, scheduling

Summary

- Current projections indicate potential of more than 500 GW by 2030
- Transmission is critical but is not just a wind problem
- Potential to reduce nearly 4,000 million tons of carbon (high range) by 2030 cumulative