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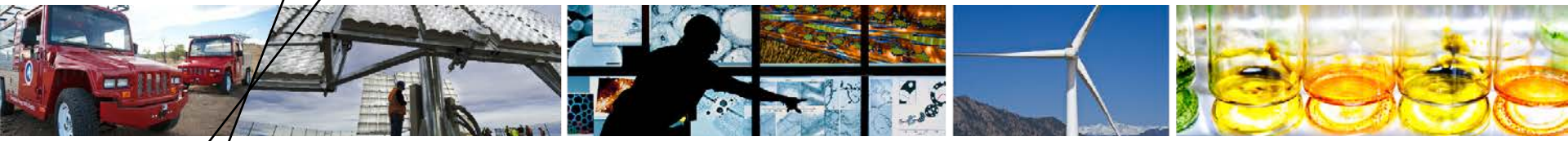
Wind Technology Advancements and Impacts on Western Wind Resources



Bureau of Land Management WWOCM Project Public Meeting

Robi Robichaud, Senior Engineer

Denver, Colorado

September 16, 2014

NREL/PR-5000-62858

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Wind Technology Advancements

- Wind is a dynamic industry.
- Land-based technology continues to evolve.

- Technology innovation increases the potential areas where economically feasible wind projects can be developed.

Evolving Turbine Technologies

- **Tower Height**
  - Taller towers often increase capacity factor.
  - The average tower height in United States in 2013 was 80m.**
    - This is a 45% increase since 1998-1999.
- **Blade Length**
  - Longer blades increase capacity factor.
  - Segmented blades are possible.
  - The average rotor diameter in 2013 was 97m.**
    - 103% increase since 1998-1999
    - 310% increase in rotor-swept area since 1998-1999.

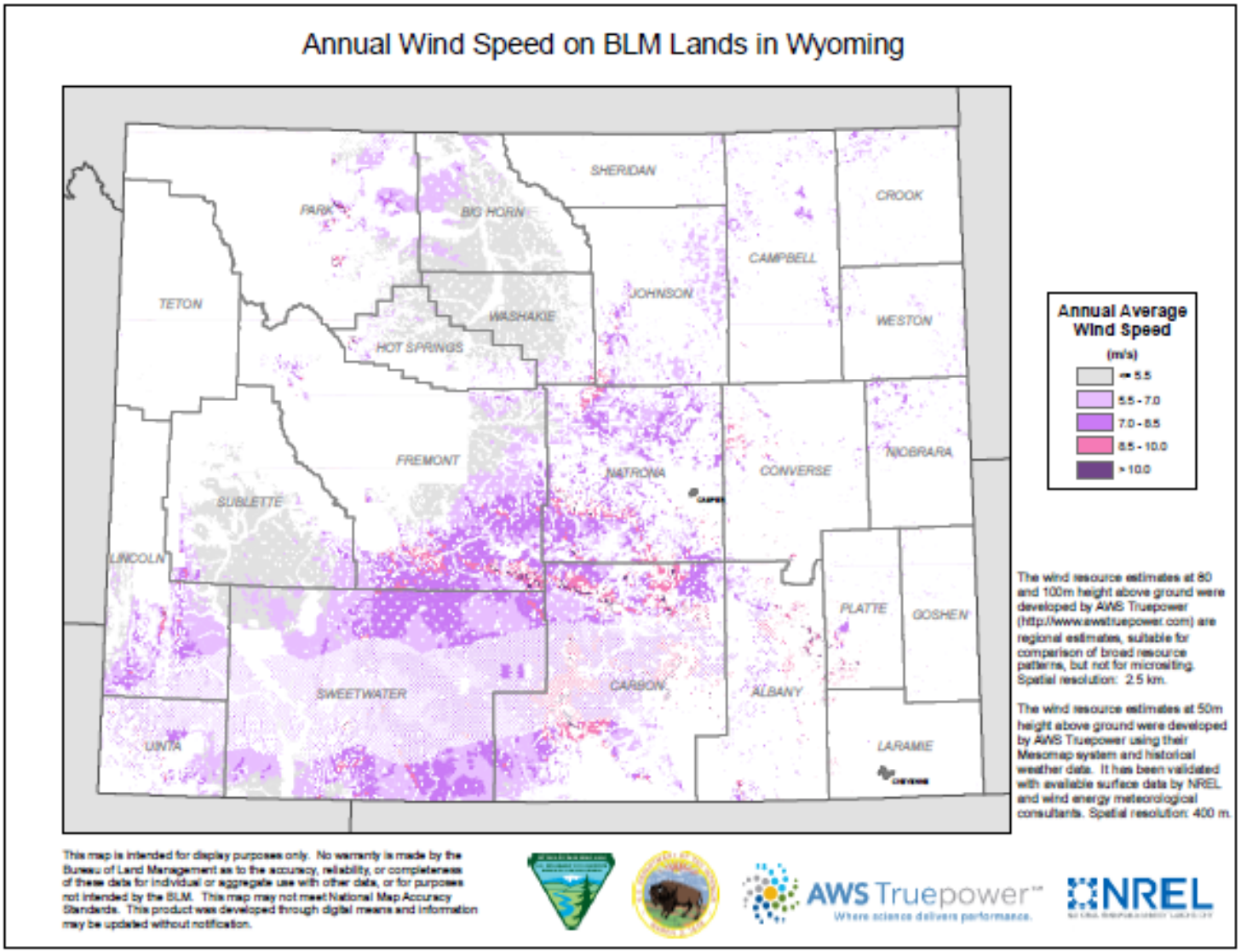
**Source: (Wiser, R.; Bolinger, M. 2013 Wind Technologies Market Report, LBNL, EERE-DOE, August 2014

Challenges

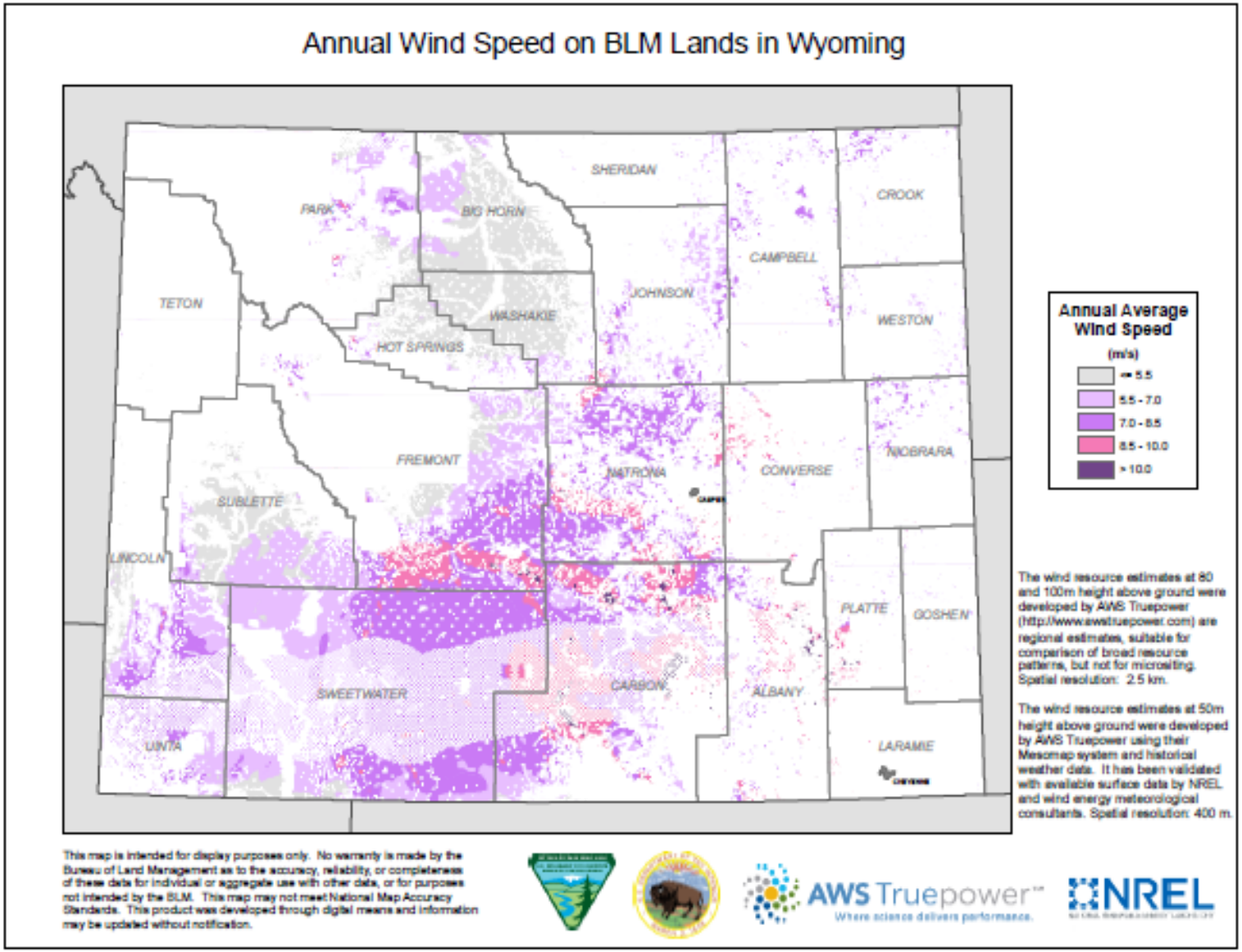
- **Logistics**
  - Blade transportation
  - Logistics and cost of turbine tower transportation.

- **Transmission**
  - Historical planning process – needs have changed
  - Identifying markets for power offtake.

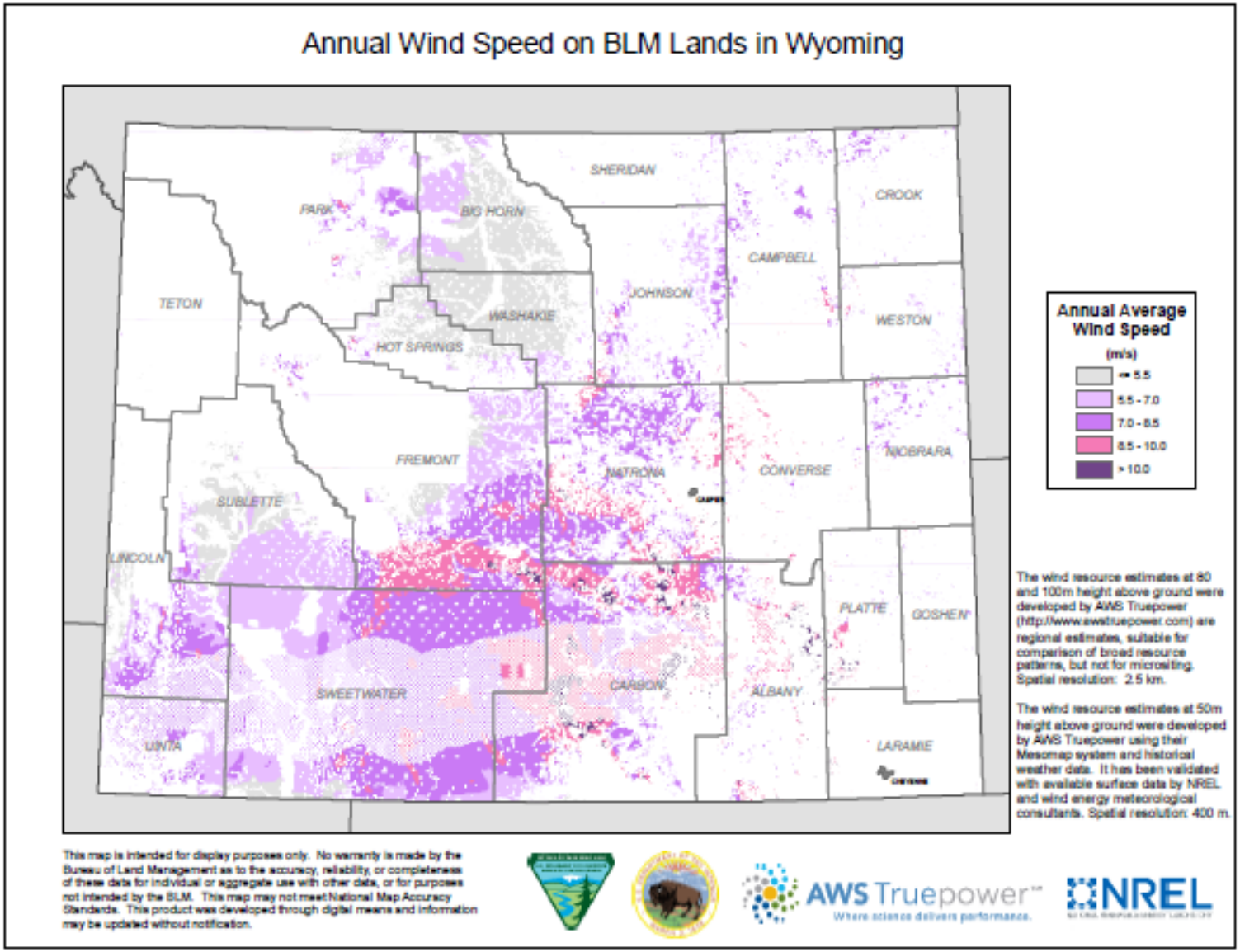
BLM Land, WY - Mean Wind Speed at 50m



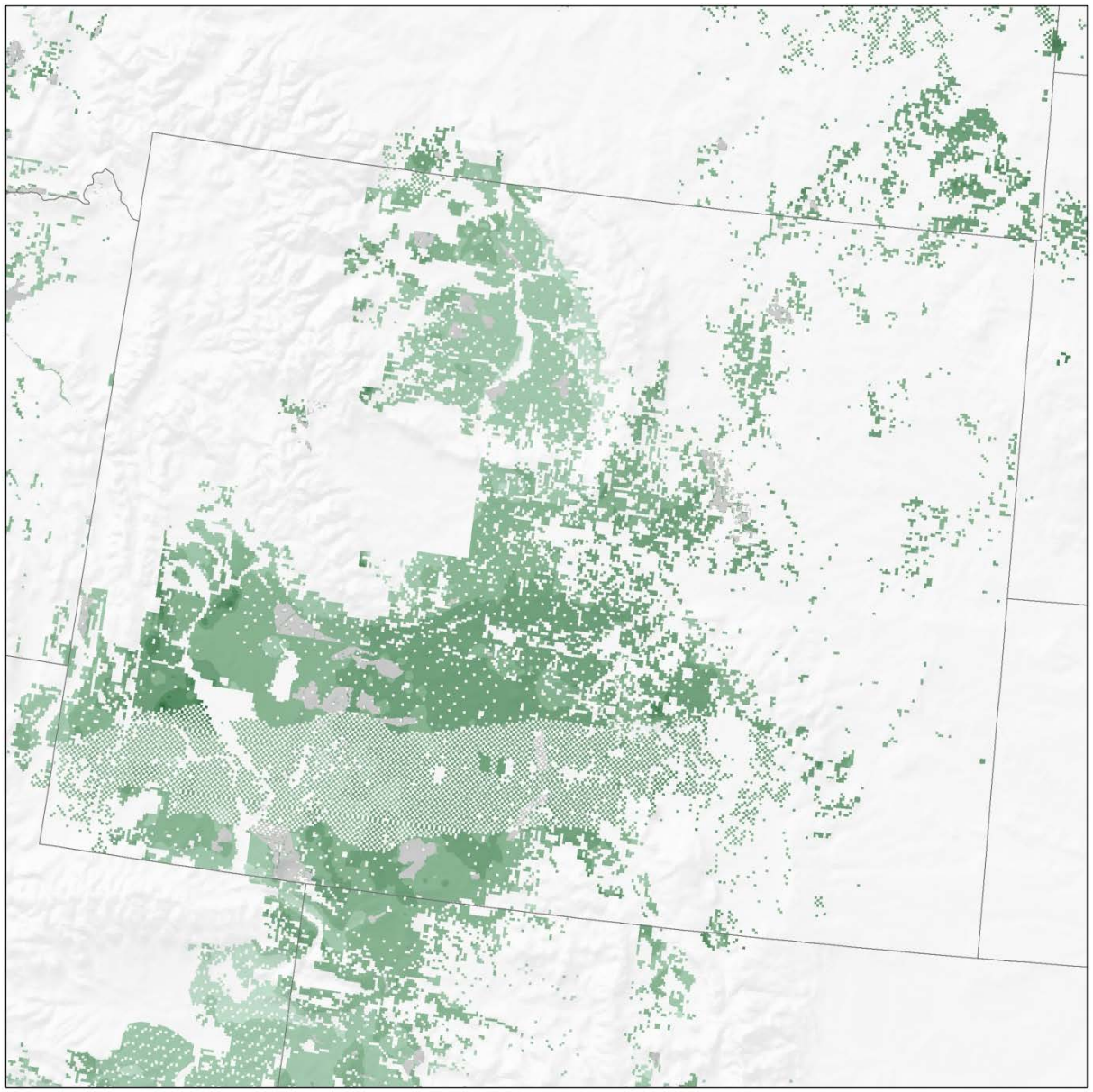
BLM Land, WY - Mean Wind Speed at 80m



BLM Land, WY - Mean Wind Speed at 100m



Difference in Mean Wind Speed from 100m to 80m - WY



Average Wind Speed Difference
100m - 80 m
Bureau of Land Management
Wyoming

Difference in Speed (m/s)

- > 0.6
- 0.5 - 0.6
- 0.4 - 0.5
- 0.3 - 0.4
- 0.2 - 0.3
- 0.1 - 0.2
- 0.0 - 0.1
- < 0.0
- Excluded BLM land

Data sources: AWS Truepower, Bureau of Land Management, and Natural Earth.

This map was produced by the National Renewable Energy Laboratory for the Department of Energy. September 2014

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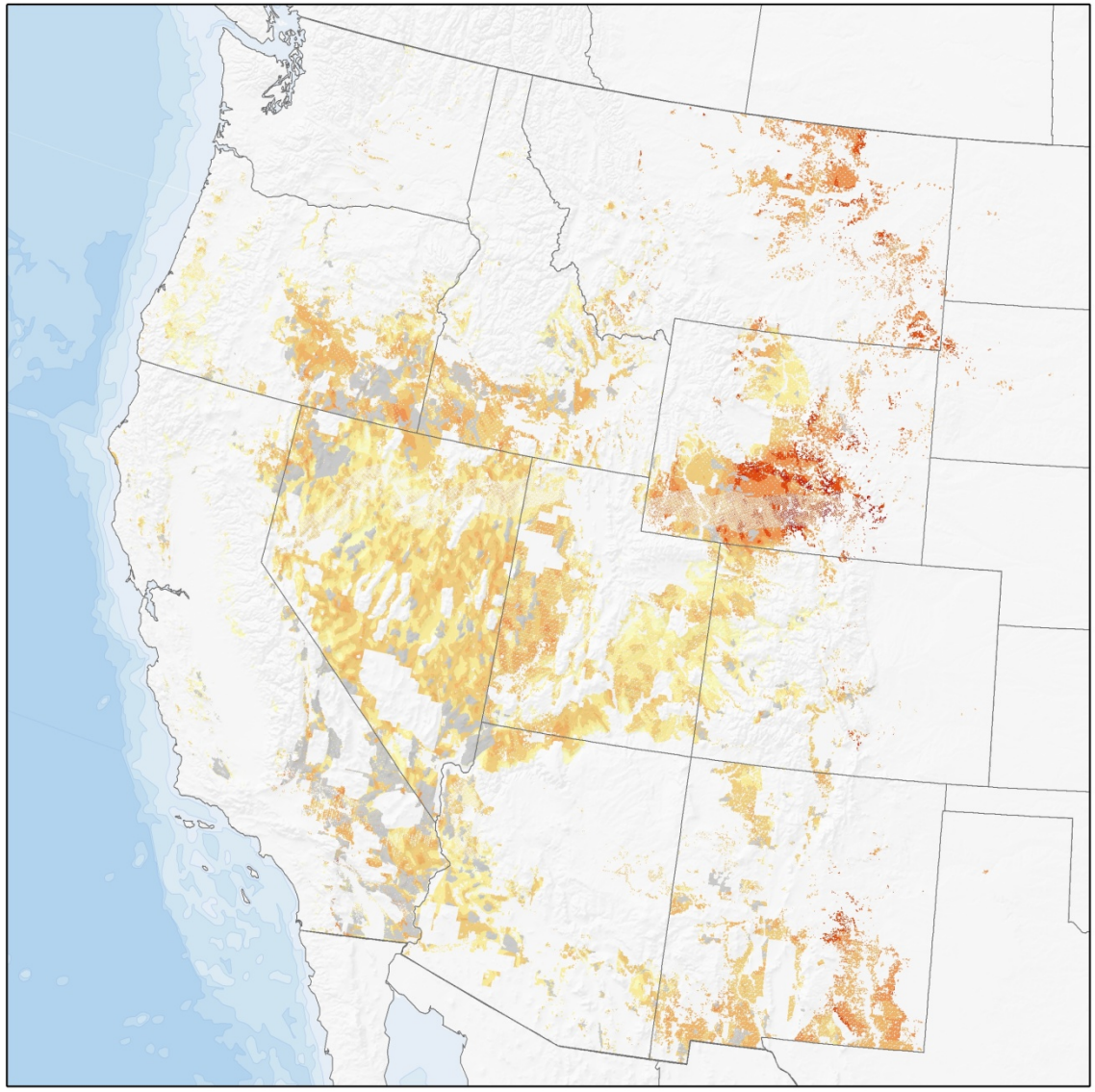
Mean Wind Speed at 80m on BLM Land



Average Wind Speed at 80 m
Bureau of Land Management

Speed (m/s)

- > 10
- 9.1 - 10
- 8.1 - 9.0
- 7.1 - 8.0
- 6.1 - 7.0
- 5.1 - 6.0
- 4.1 - 5.0
- < 4.1
- Excluded BLM land

Data sources: AWS Truepower, Bureau of Land Management, and Natural Earth.

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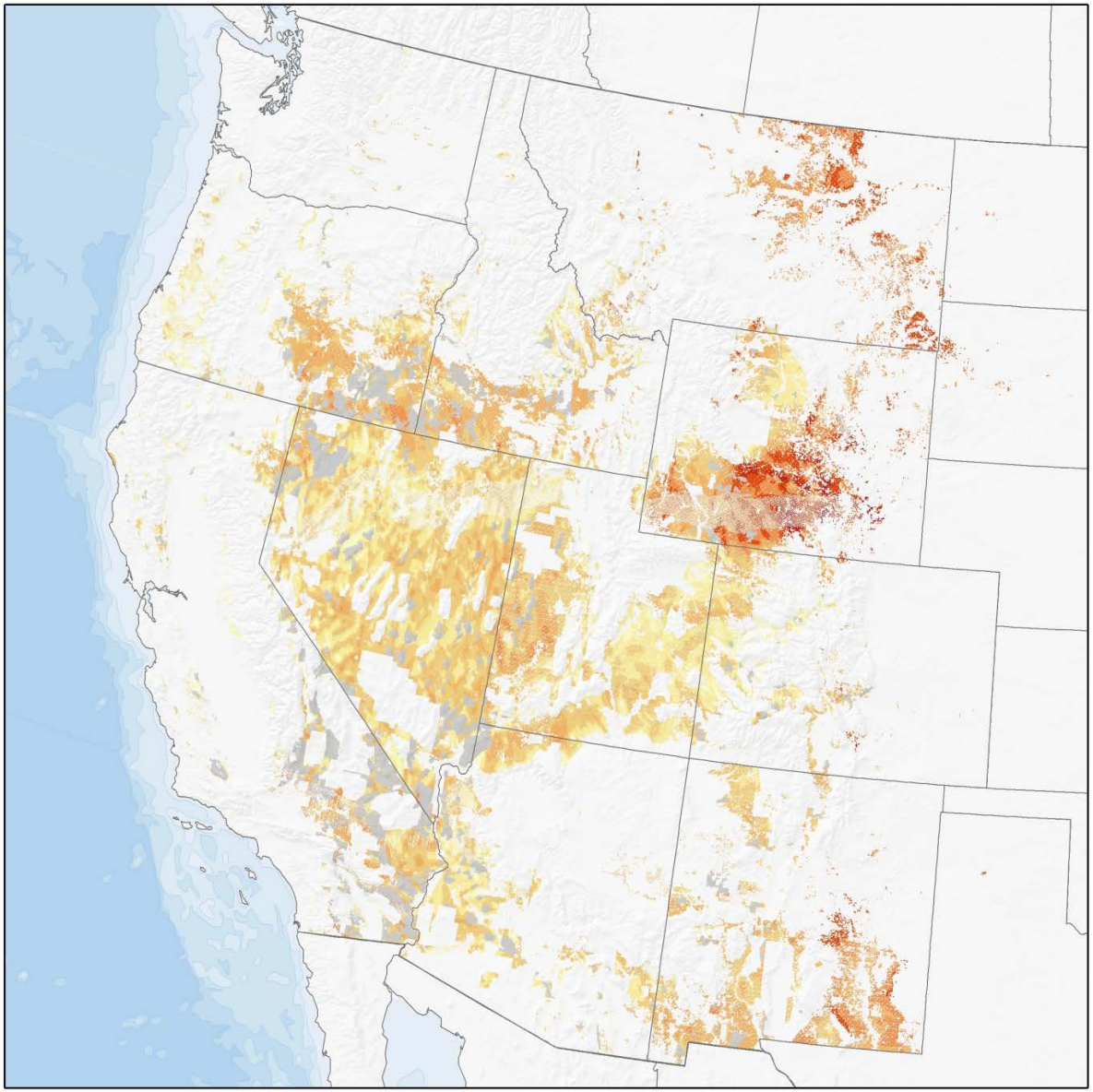
Mean Wind Speed at 100m on BLM Land



Average Wind Speed at 100 m
Bureau of Land Management

Speed (m/s)

- > 10
- 9.1 - 10
- 8.1 - 9.0
- 7.1 - 8.0
- 6.1 - 7.0
- 5.1 - 6.0
- 4.1 - 5.0
- < 4.1
- Excluded BLM land

Data sources: AWS Truepower, Bureau of Land Management, and Natural Earth.

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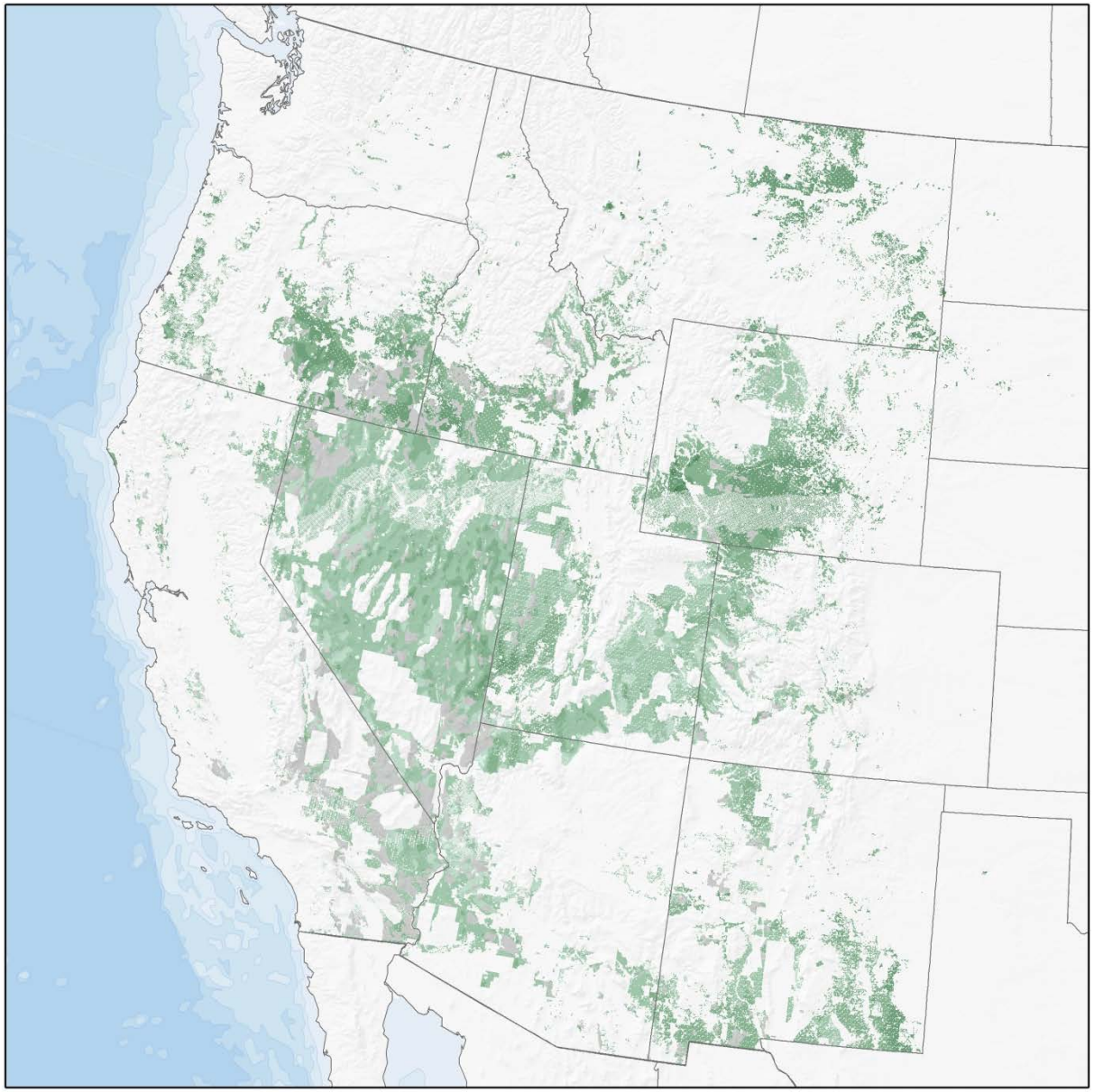
Tall Tower Difference - Mean Wind Speed from 100m to 80m



Average Wind Speed Difference
100m - 80 m
Bureau of Land Management

Difference in Speed (m/s)

- > 0.6
- 0.5 - 0.6
- 0.4 - 0.5
- 0.3 - 0.4
- 0.2 - 0.3
- 0.1 - 0.2
- 0.0 - 0.1
- < 0.0
- Excluded BLM land

Data sources: AWS Truepower, Bureau of Land Management, and Natural Earth.

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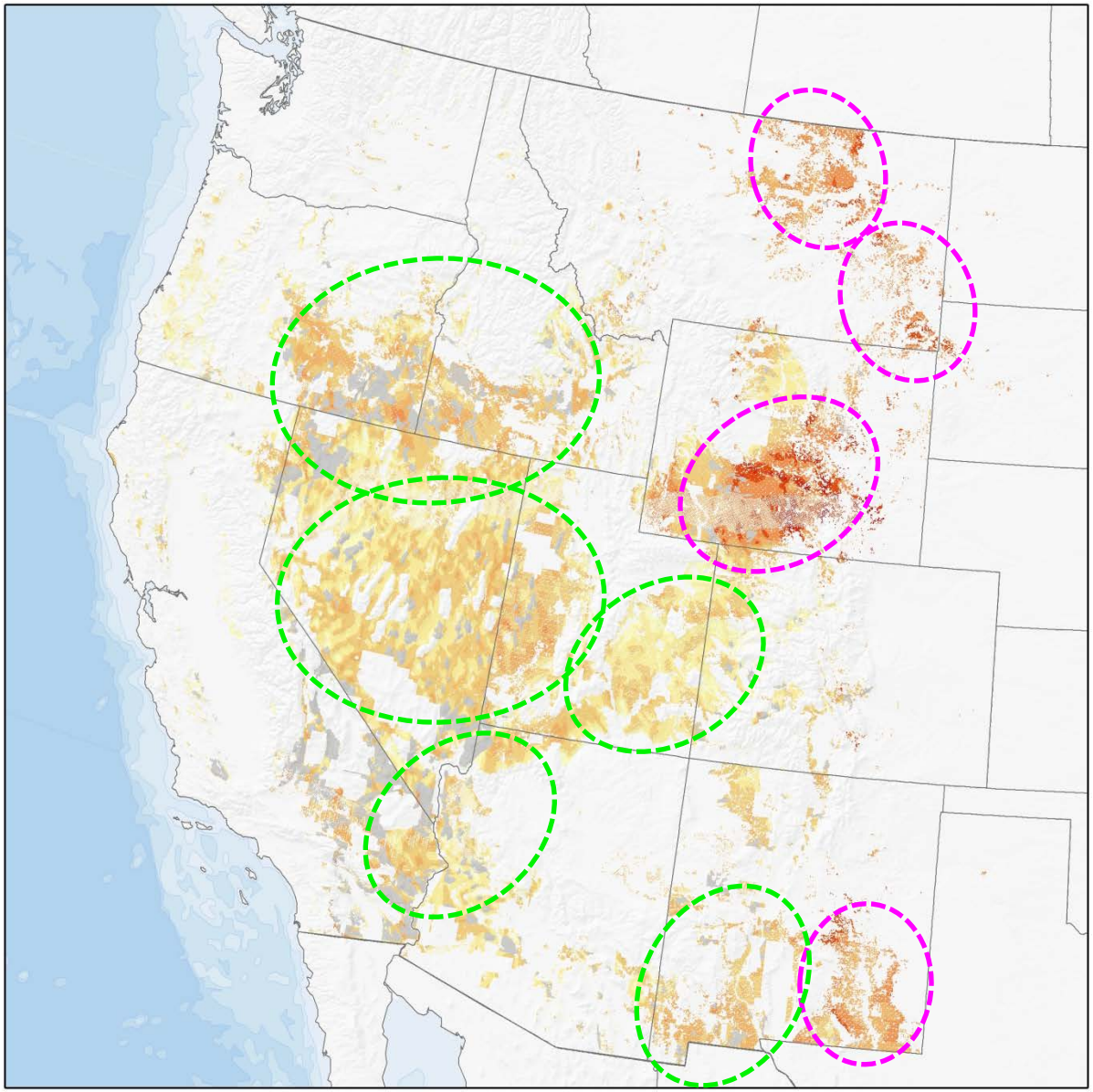
Low-Wind-Speed Turbines - Mean Wind Speed at 80m



Average Wind Speed at 80 m
Bureau of Land Management

Speed (m/s)
- > 10
- 9.1 - 10
- 8.1 - 9.0
- 7.1 - 8.0
- 6.1 - 7.0
- 5.1 - 6.0
- 4.1 - 5.0
- < 4.1
- Excluded BLM land

Data sources: AWS Truepower, Bureau of Land Management, and Natural Earth.

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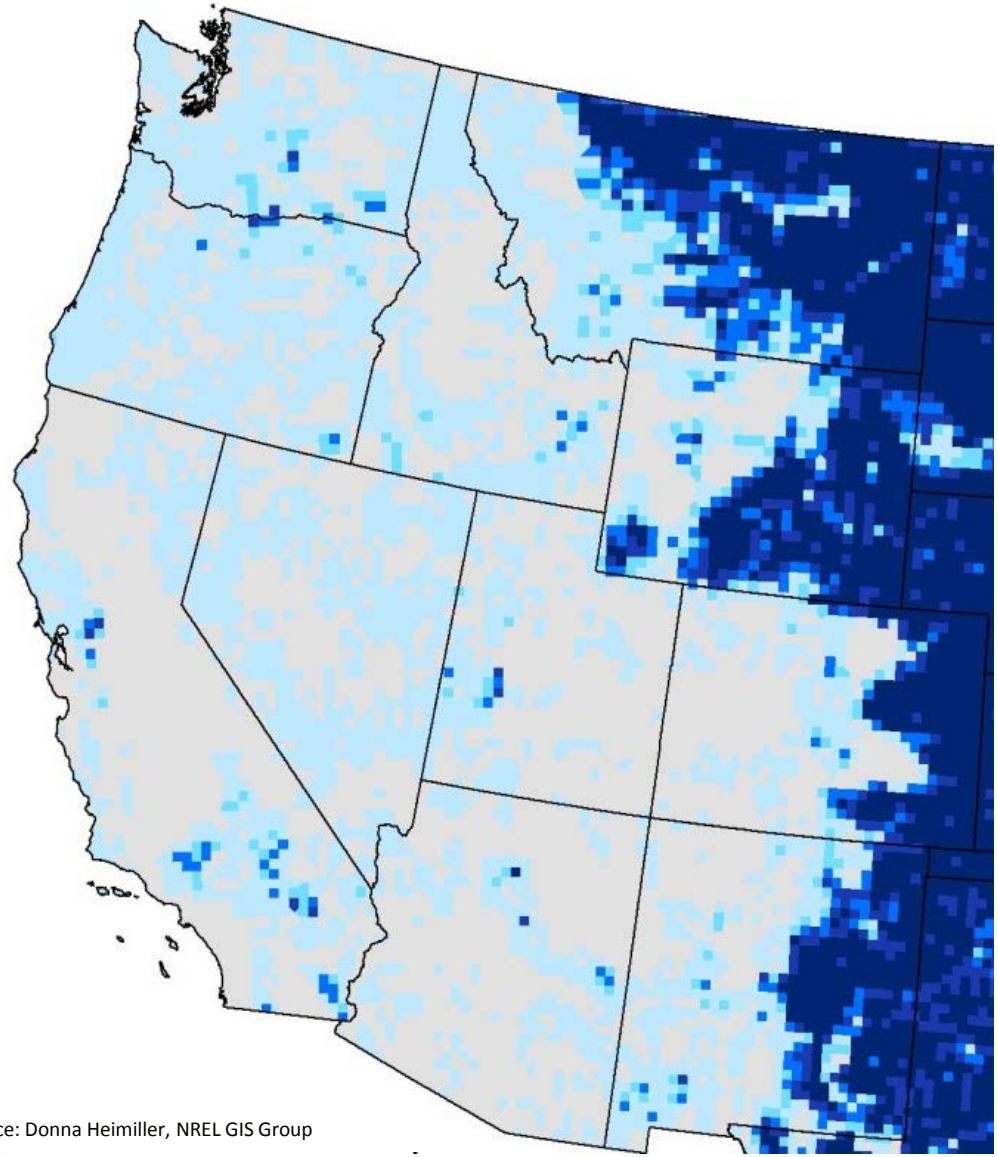
Past Estimates – Gross CF>30% IEC Class 2 80-m Hub Height

- Wind data: AWS Truepower 200-m resolution binned at 20-km resolution, long-term adjusted hourly wind speed

- Adjusted for altitude and appropriate International Electrotechnical Commission (IEC) class turbine

- Exclusions include: all urban areas, bodies of water, national parks, and half of U.S. Forest Service lands

- Shading is raw area available land (darker blue is the more available area).



Source: Donna Heimiller, NREL GIS Group

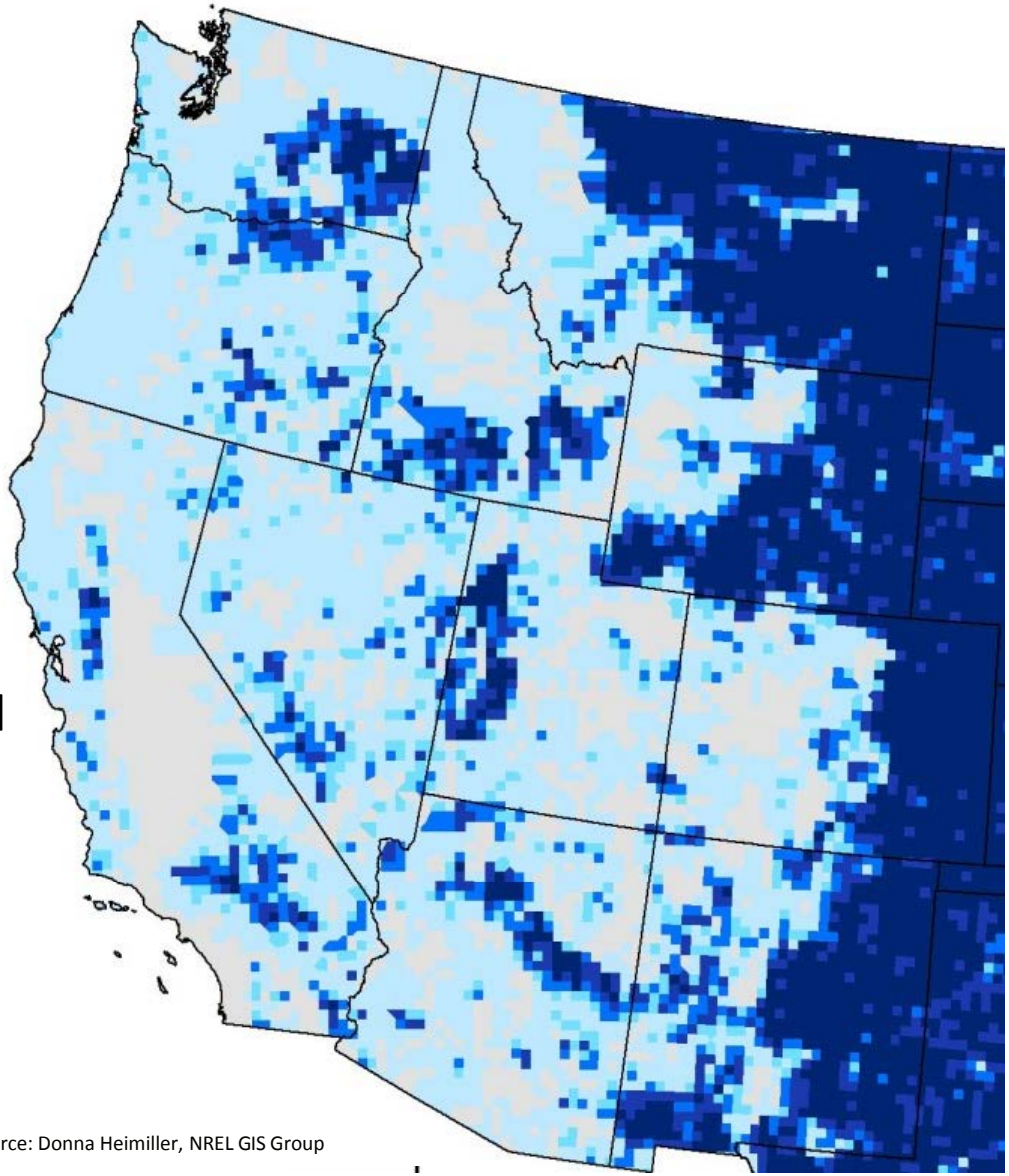
New Estimates – Gross CF>30% GE 1.62-100 80-m Hub Height

- Wind data: AWS Truepower 200-m resolution binned at 20-km resolution, long-term adjusted hourly wind speed

- Adjusted for altitude and appropriate International Electrotechnical Commission (IEC) class turbine

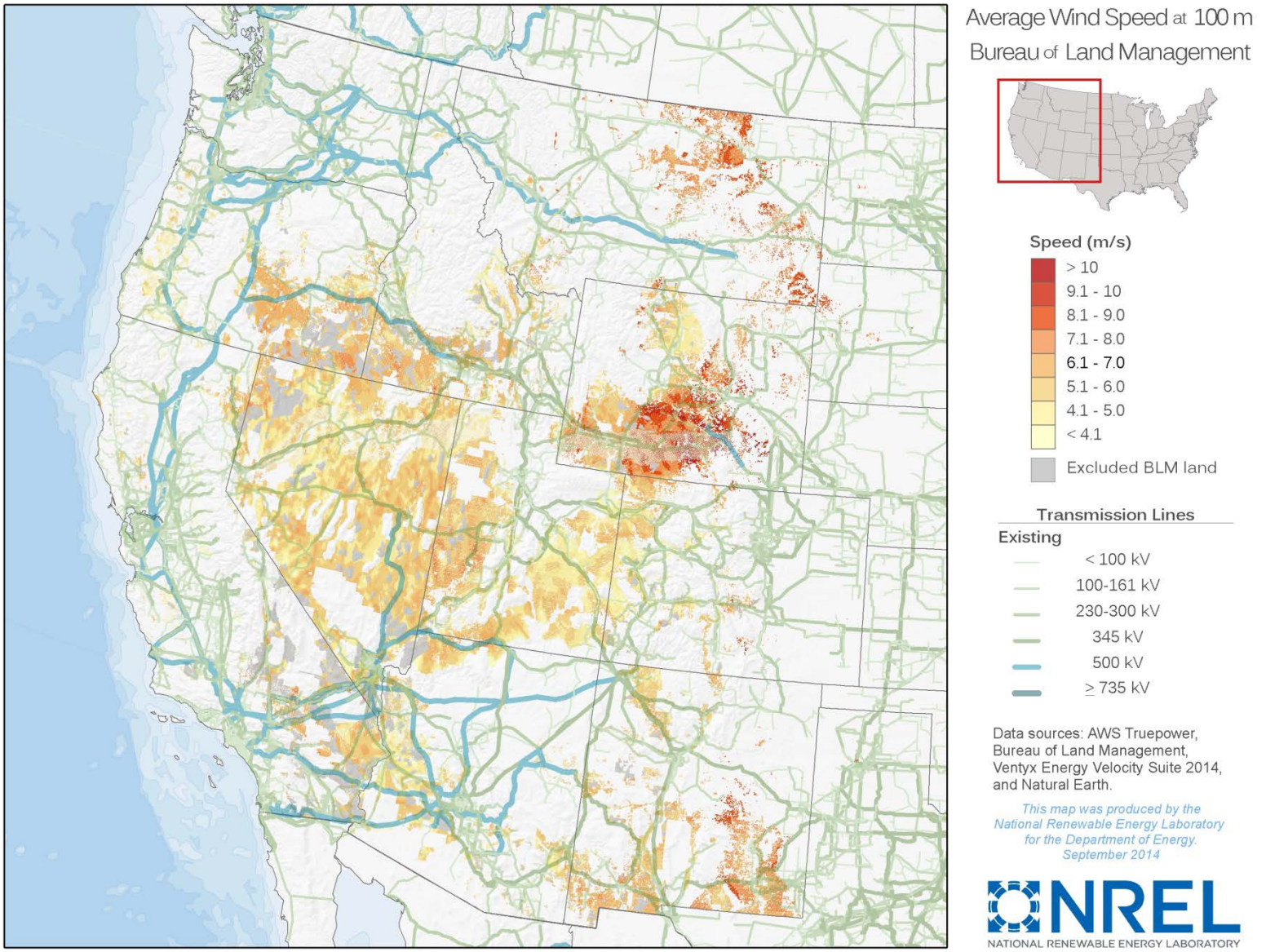
- Exclusions include: all urban areas, bodies of water, national parks, and half of U.S. Forest Service lands

- Shading is raw area available land (darker blue is the more available area).

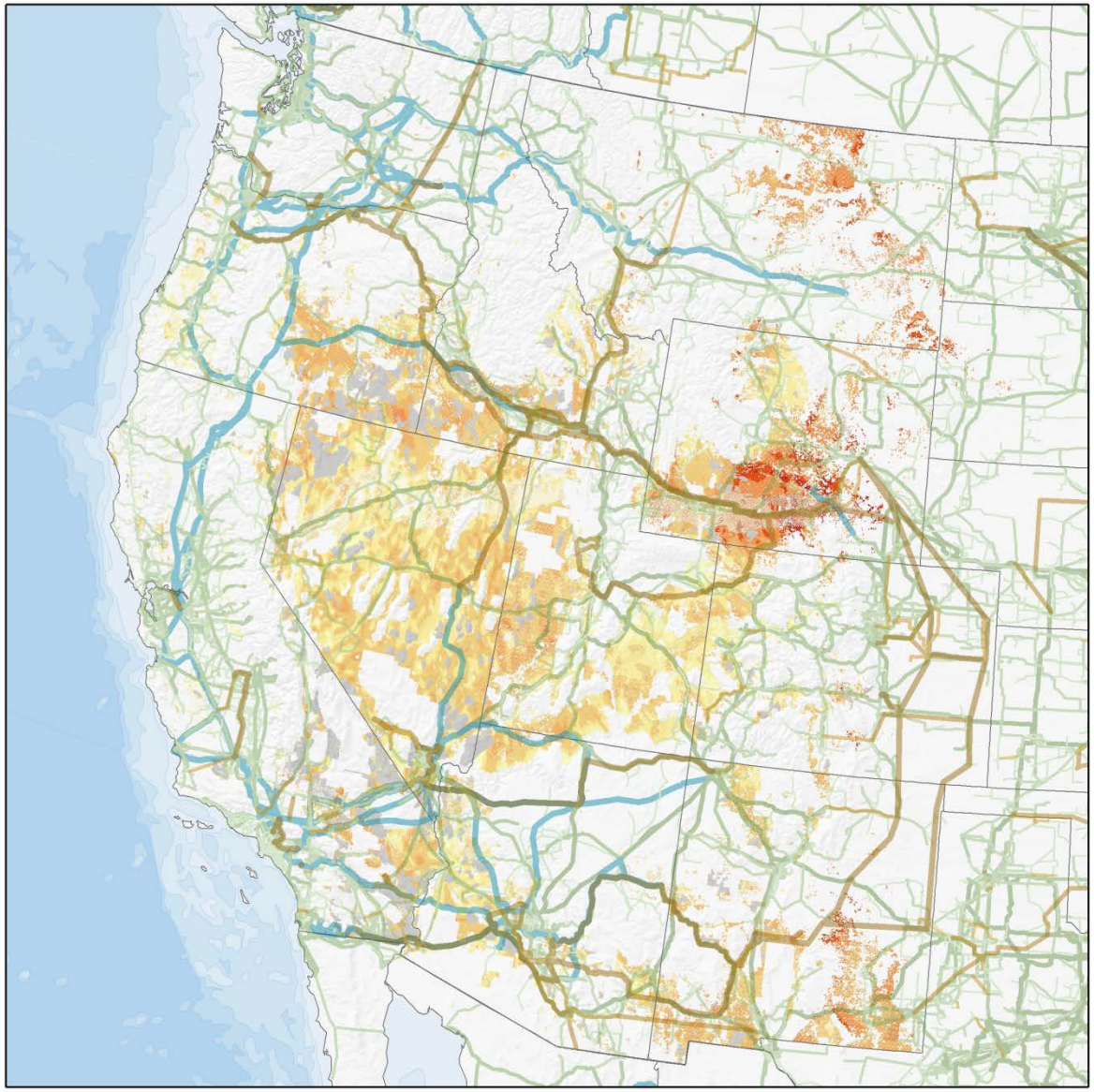


Source: Donna Heimiller, NREL GIS Group

Existing Transmission – 100m Wind Speed



Proposed Transmission – 100m Wind Speed



Average Wind Speed at 80 m
Bureau of Land Management

Speed (m/s)

- > 10
- 9.1 - 10
- 8.1 - 9.0
- 7.1 - 8.0
- 6.1 - 7.0
- 5.1 - 6.0
- 4.1 - 5.0
- < 4.1
- Excluded BLM land

Transmission Lines

Existing		Proposed
	< 100 kV	
	100-161 kV	
	230-300 kV	
	345 kV	
	500 kV	
	≥ 735 kV	

Data sources: AWS Truepower, Bureau of Land Management, Ventyx Energy Velocity Suite 2014, and Natural Earth.

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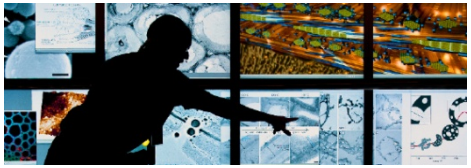
Questions?



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