Impact of Renewable Electricity Mandates on Nuclear Generation

George Taylor, Ph.D.
Director, Palmetto Energy Institute
Los Altos, California

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Can We Avoid Freezing to Death in the Dark …

… When Fossil Fuels Run Short?

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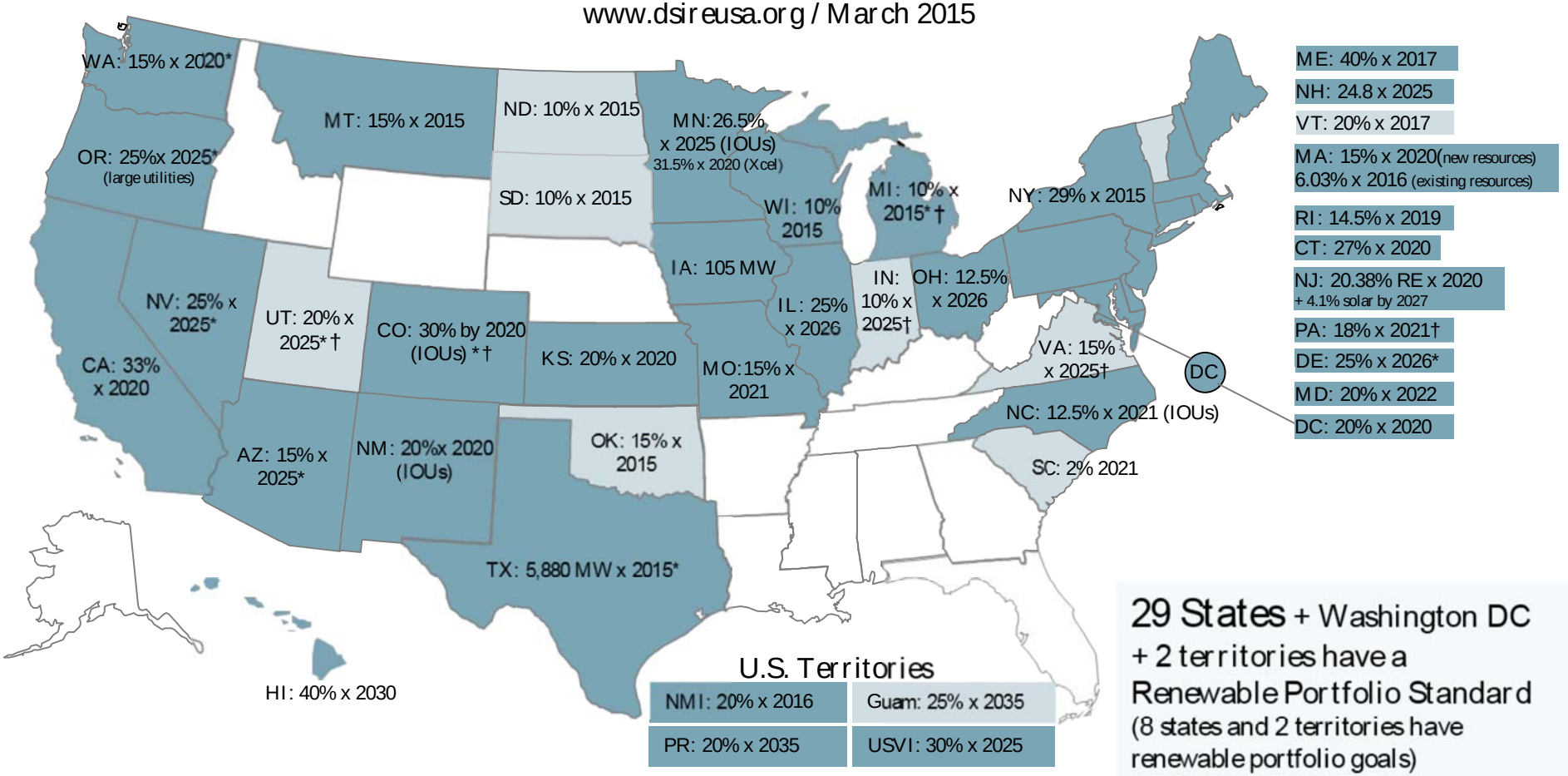
Renewable Portfolio Standard Policies

www.dsireusa.org / March 2015



ME: 40% x 2017
NH: 24.8 x 2025
VT: 20% x 2017
MA: 15% x 2020(new resources) 6.03% x 2016 (existing resources)
RI: 14.5% x 2019
CT: 27% x 2020
NJ: 20.38% RE x 2020 + 4.1% solar by 2027
PA: 18% x 2021†
DE: 25% x 2026*
MD: 20% x 2022
DC: 20% x 2020

U.S. Territories

NMI: 20% x 2016	Guam: 25% x 2035
PR: 20% x 2035	USVI: 30% x 2025

29 States + Washington DC + 2 territories have a Renewable Portfolio Standard (8 states and 2 territories have renewable portfolio goals)

Renewable portfolio standard

Renewable portfolio goal

* Extra credit for solar or customer-sited renewables

† Includes non-renewable alternative resources

Overview

- 35 states have adopted non-nuclear Renewable Electricity mandates or goals
- In practice, most RE mandates = wind mandates
- But there is no such thing as wind by itself
- There is only fossil + wind + transmission,
  hydro + wind + transmission, or
  wind + storage + transmission
- Nuclear + wind would save neither money nor CO_2

Overview (continued)

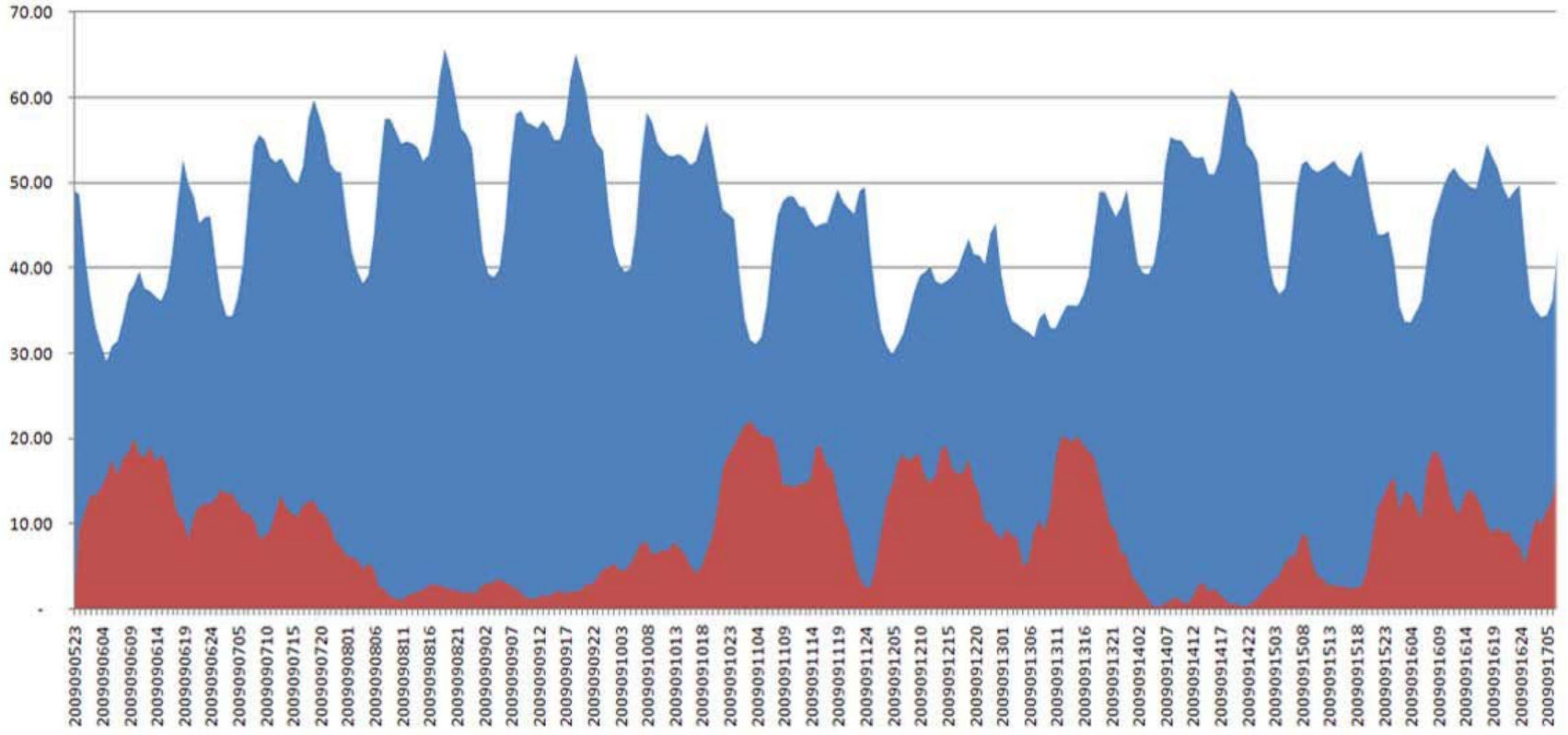
- In the absence of massive storage (which no one is advocating)

  Every 1X wind mandate = 2-4X gas + wind mandate
  or an even larger coal + wind mandate

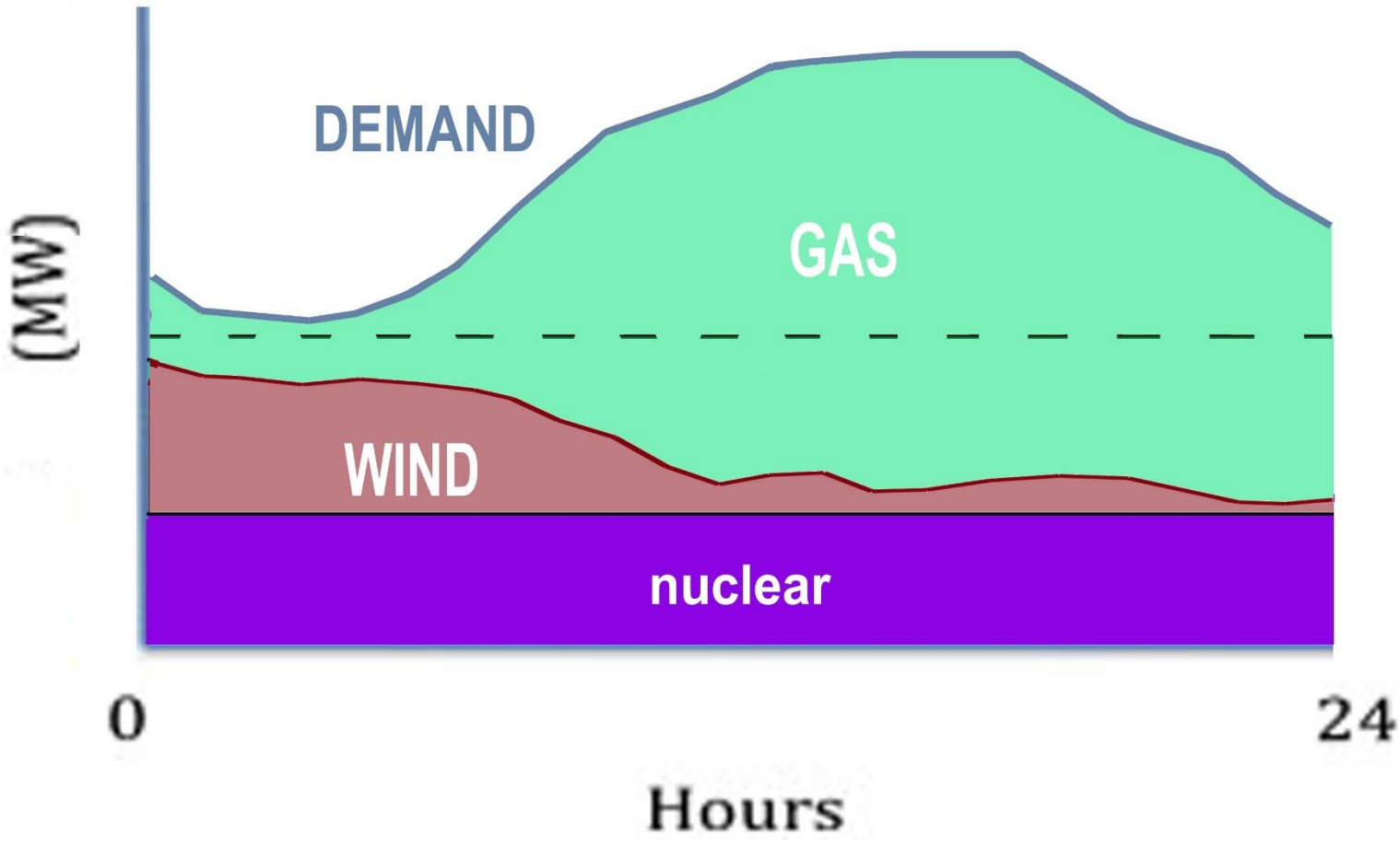
- Fossil + wind competes with nuclear to supply baseload

- Fossil + solar does not supply baseload, but interferes with baseload generation

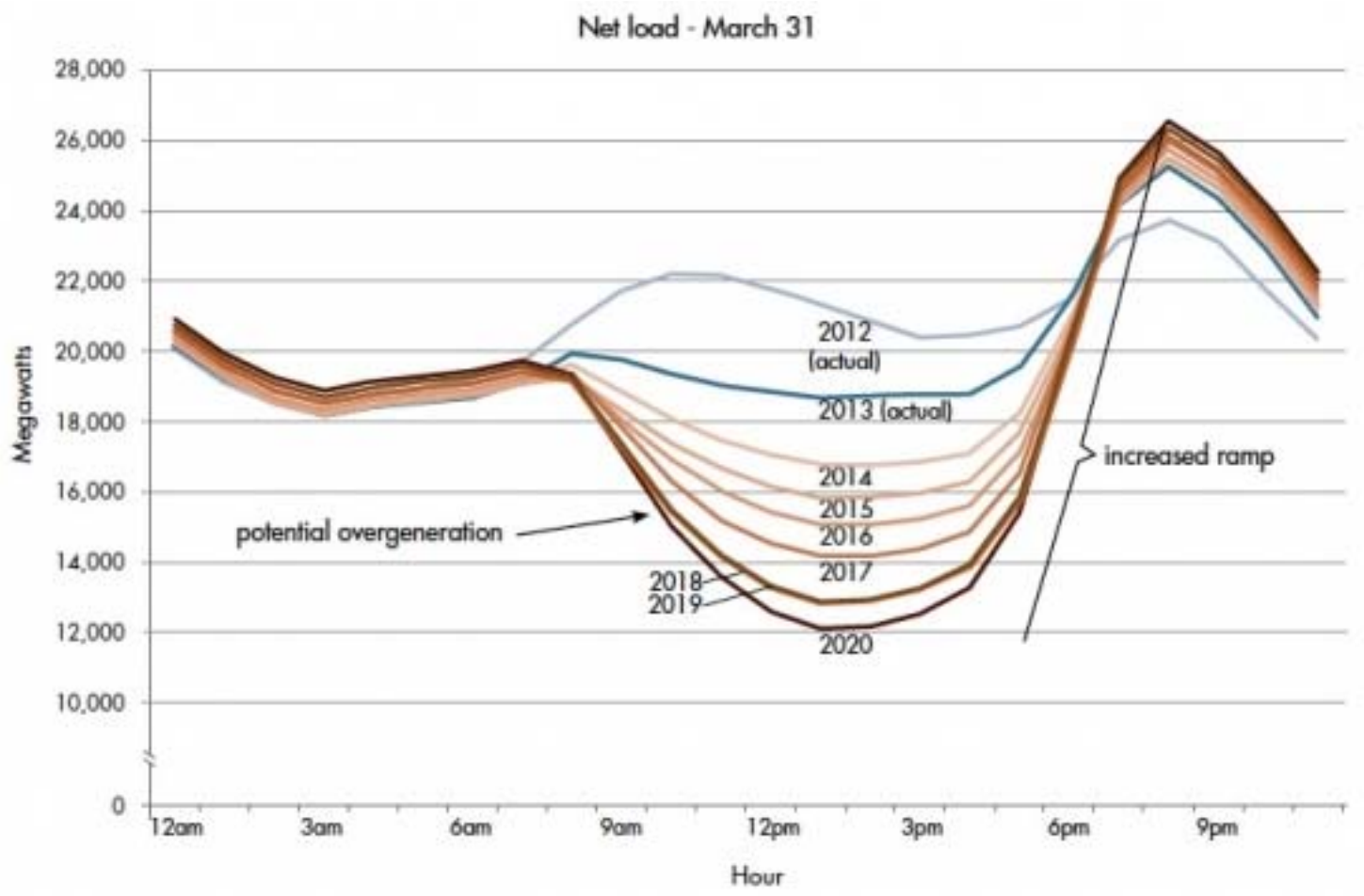
Hourly Demand and Wind, SE Australia



How Wind Blocks Nuclear



Duck Curve – California PUC



Summary of RES Impact on Nuclear

- 15 states with 30 reactors have no restrictions
  - Idaho has maxed out with hydro
- 19 states with 32 reactors have low RE restrictions
  - Could maintain 20% to 50% nuclear generation
- CA, MD and MA (5 reactors) could keep them, but not increase
- VT (had 1 reactor) could have kept it
- 8 states with 32 reactors will likely have to reduce nuclear to meet RES, but nuclear plants are licensed beyond mandate deadlines
- CO, DE, HI, OR and UT have effectively prohibited nuclear

RES Could Reduce Existing Nuclear in 8 States

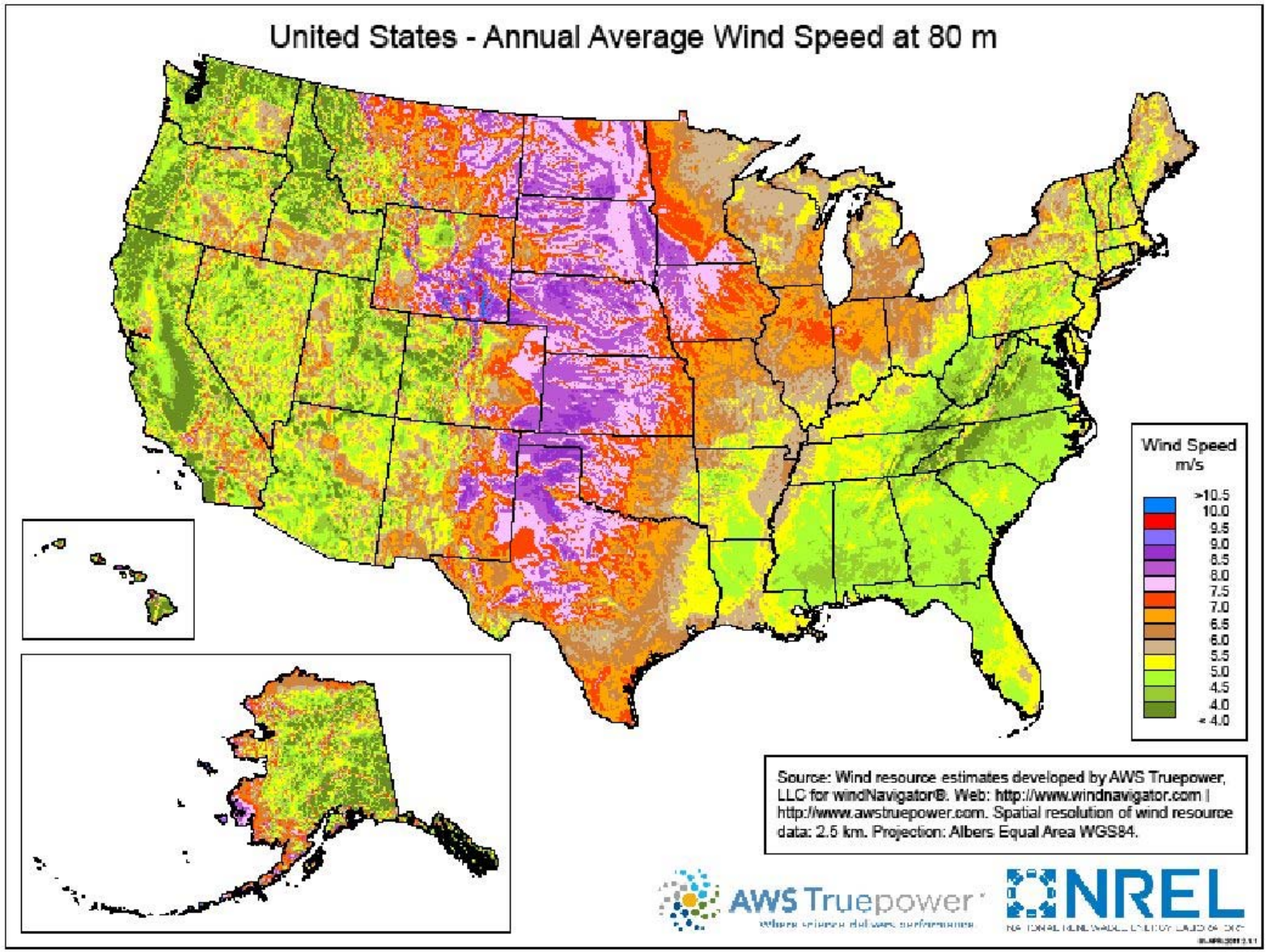
- Connecticut 27% / 15% RES, low CF won't allow 47% N
- Illinois 25% / 19% RES won't allow 48% N
- Minnesota 25% / 19% RES won't allow 22% N
- New Hampshire 24% / 10% RES won't allow 42% N

- New Jersey 20% RES, low CF won't allow 52% N
- New York 29% / 8% RES won't allow 31% N
- Virginia 15% / 9% RES, low CF won't allow 38% N
- Washington 15% RES + 70% hydro meets all baseload

- California 33% RES, but only 8% nuclear after San Onofre
- Vermont 20% RES met by hydro, 72% N was OK

Conclusion

- Gas makes sense. Nuclear makes sense. Gas + wind does not.
- If you believe gas will be abundant, wind is unnecessary.
- If you believe the opposite, wind won't make enough difference.
- 20% wind is impossible unless (a) storage or (b) close all nuclear and hydro, and force all states to import wind, regardless of distance.
- 20% wind would lock in 50-60% natural gas and lock out any increases in nuclear, hydro or geothermal
- For nuclear to increase market share, it must beat coal, gas and geothermal in the marketplace and gas + wind in government


United States - Annual Average Wind Speed at 80 m
Wind Speed
m/s
>10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
< 4.0
Source: Wind resource estimates developed by AWS Truepower, LLC for windNavigator®. Web: http://www.windnavigator.com | http://www.awstruepower.com. Spatial resolution of wind resource data: 2.5 km. Projection: Albers Equal Area WGS84.
AWS Truepower
NREL

Levelized Cost of New Baseload Generation

	Cap Cost / Capacity Factor $ / W	Levelized Cap Cost c/kWh	Fuel @ $5 NG c/kWh	O&M c/kWh	Total @ $5 NG c/kWh	Total @ $15 NG c/kWh
COAL	3.4	4	2.5	1	7.5	7.5
CC GAS	1.1	1.3	3.3	0.5	5	11.5
CT GAS / WIND						
CC GAS / WIND	4.4	5.3	2.5	>1	9	14
NUCLEAR	7	8.4	0.6	1.2	10	10
WIND / STORAGE	21	25		>2	27	27

In the Absence of Storage, Wind Cannot Supply More Than 16% of U.S. Electricity

- Unless the plan is to close all nuclear and hydro, and force states which have no onshore wind potential to instead build it offshore or import it from the Great Plains

- 10% -- short duration (which wind cannot address)
- 26% -- nuclear and hydro
- 24% -- fossil in states with no wind potential
- 40% -- fossil plus wind in states with wind potential

- 40% of 40% = 16%

- Which means that DOE's "20% Wind By 2030" proposal would not only be incredibly expensive, it would tie nearly all remaining generation to fossil fuels, forever.

Cost of CO2 Reduction

- Replacing coal with combined-cycle gas (existing plants)
  - Costs $5 / MWh, saves 0.6 tons / MWh $10 / ton of CO2
- Replacing coal with CC gas (new gas plant)
  - Costs $20 / MWh, saves 0.6 tons / MWh $33 / ton of CO2
- Replacing coal with nuclear (new plant)
  - Costs $72 / MWh, saves 1 ton / MWh $72 / ton of CO2
- Adding wind to gas
  - Costs $24 + transmission, saves 0.12 tons $200 / ton of CO2