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ARTICLES

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Future cost-competitive electricity systems and their impact on US CO_2 emissions

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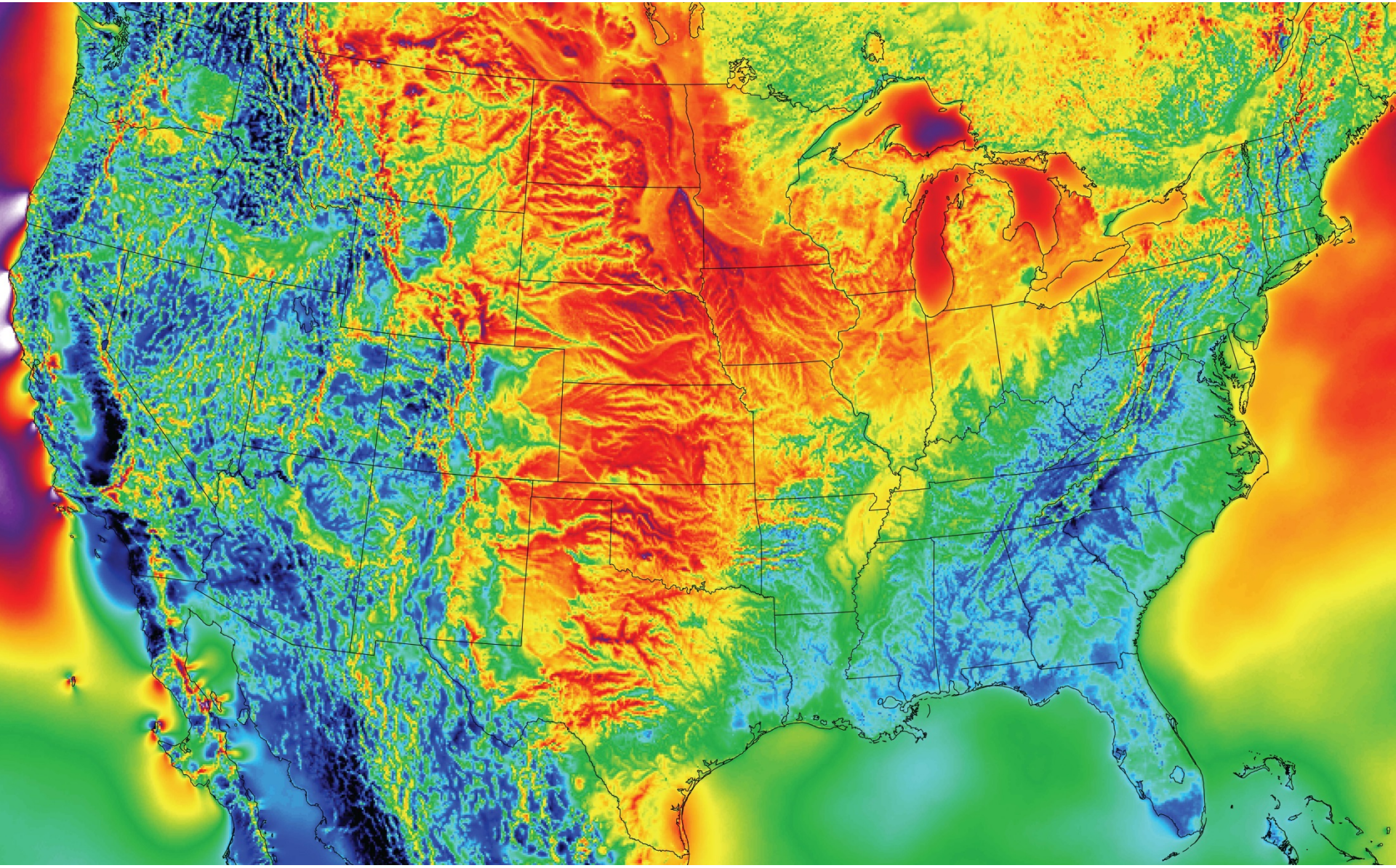
In the present study, we calculate the cost-optimized configuration of variable electrical power generators using weather data with high spatial (13-km) and temporal (60-min) resolution over the contiguous US. Our results show that **carbon dioxide emissions** from the US electricity sector **can be reduced by up to 80% relative to 1990 levels**, **without an increase in the levelized cost of electricity.**

The reductions are possible with current technologies and without electrical storage. Wind and solar power increase their share of electricity production as the system grows to encompass large-scale weather patterns. This reduction in carbon emissions is **achieved by moving away from a regionally divided electricity sector to a national system** enabled by high-voltage direct-current transmission.

US Average Capacity Factor from 3 km **Weather Assimilation Model** - 2013

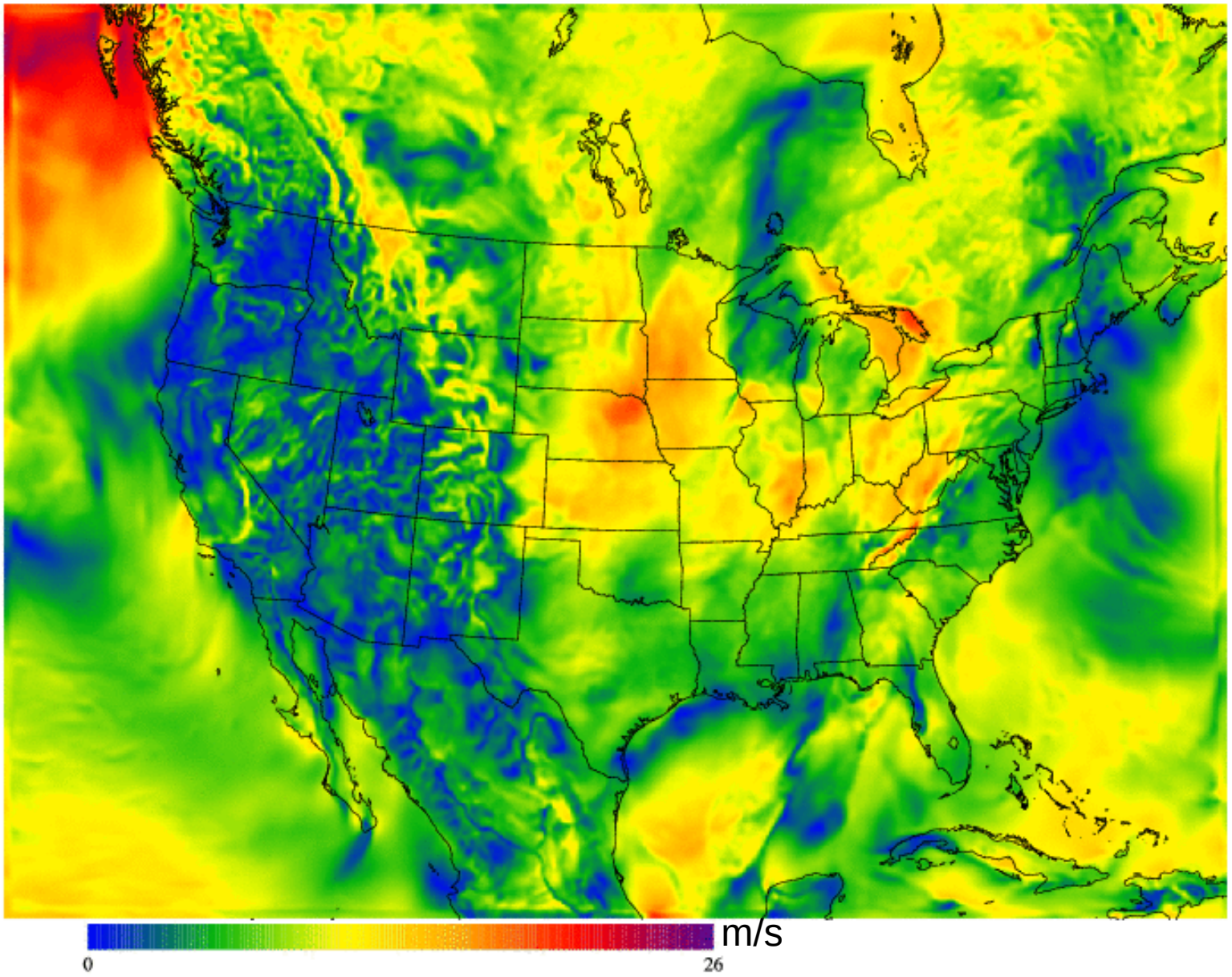


Purple > 50%

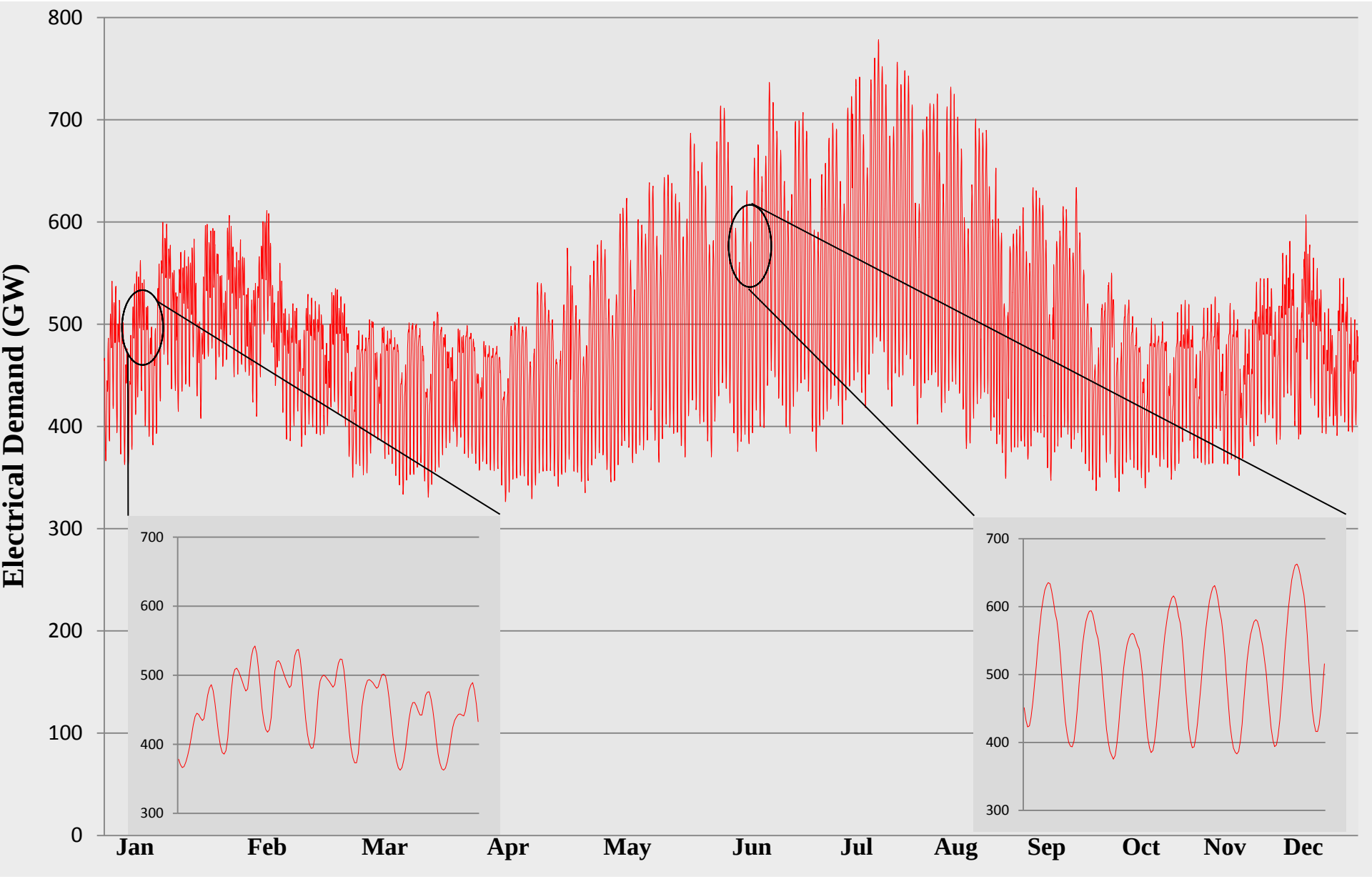
Red> 40%

Deep blue < 10 %

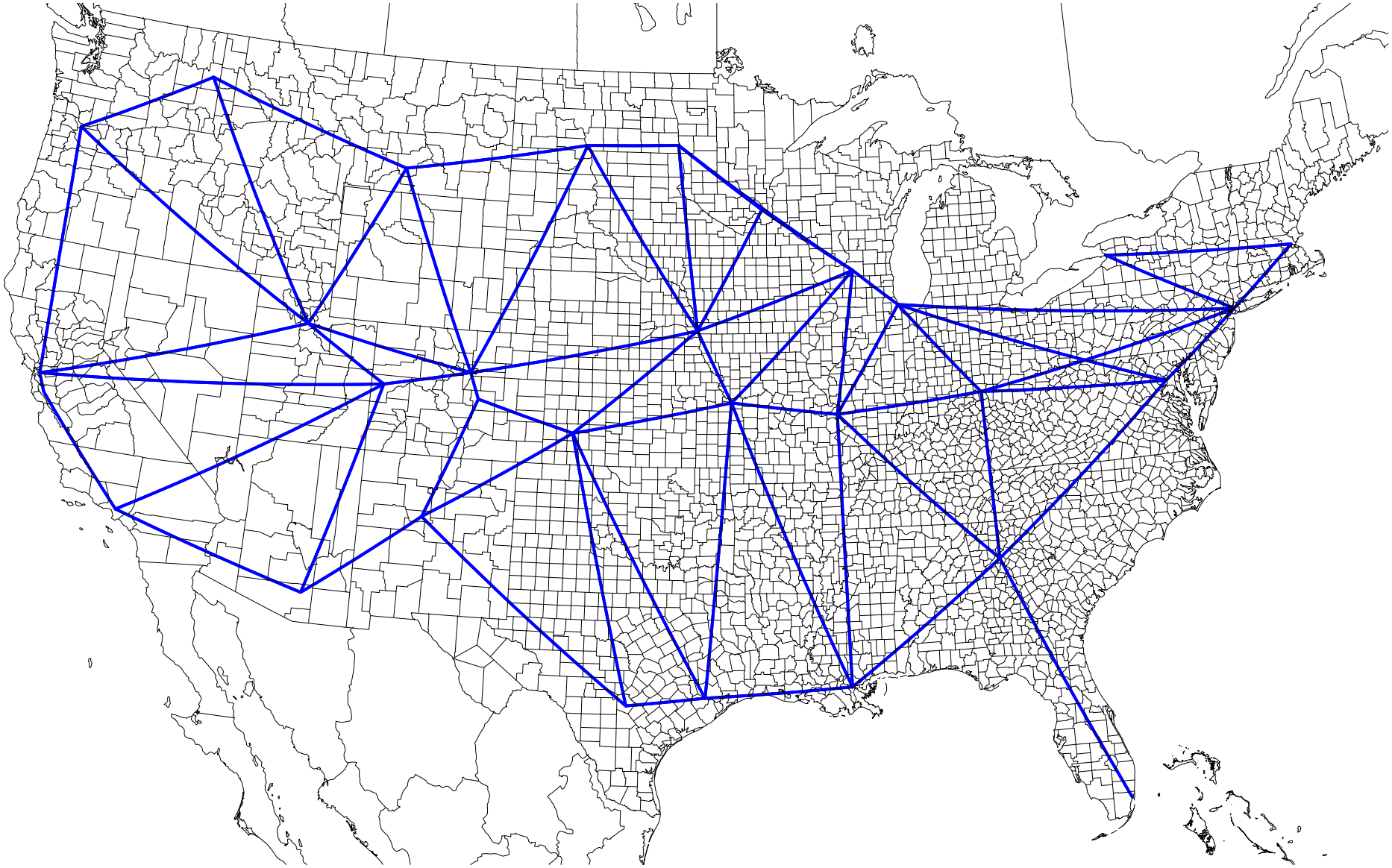
Wind Speed Video



Electric Demand/Load

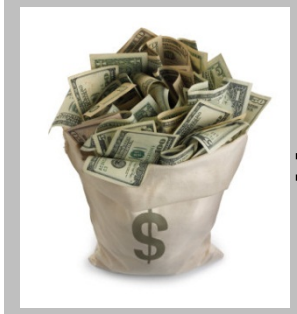


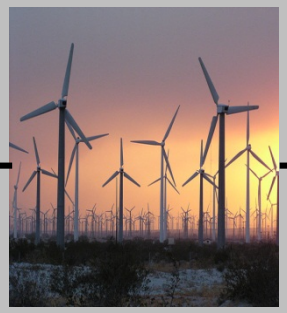
HVDC Transmission Parameterization

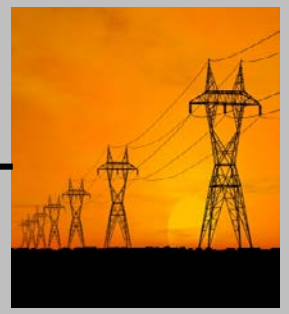


National Energy System Designer

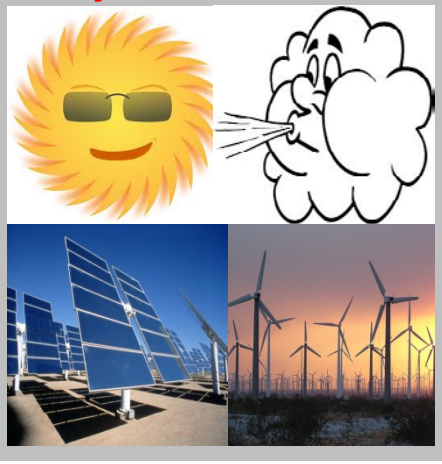
Minimize:





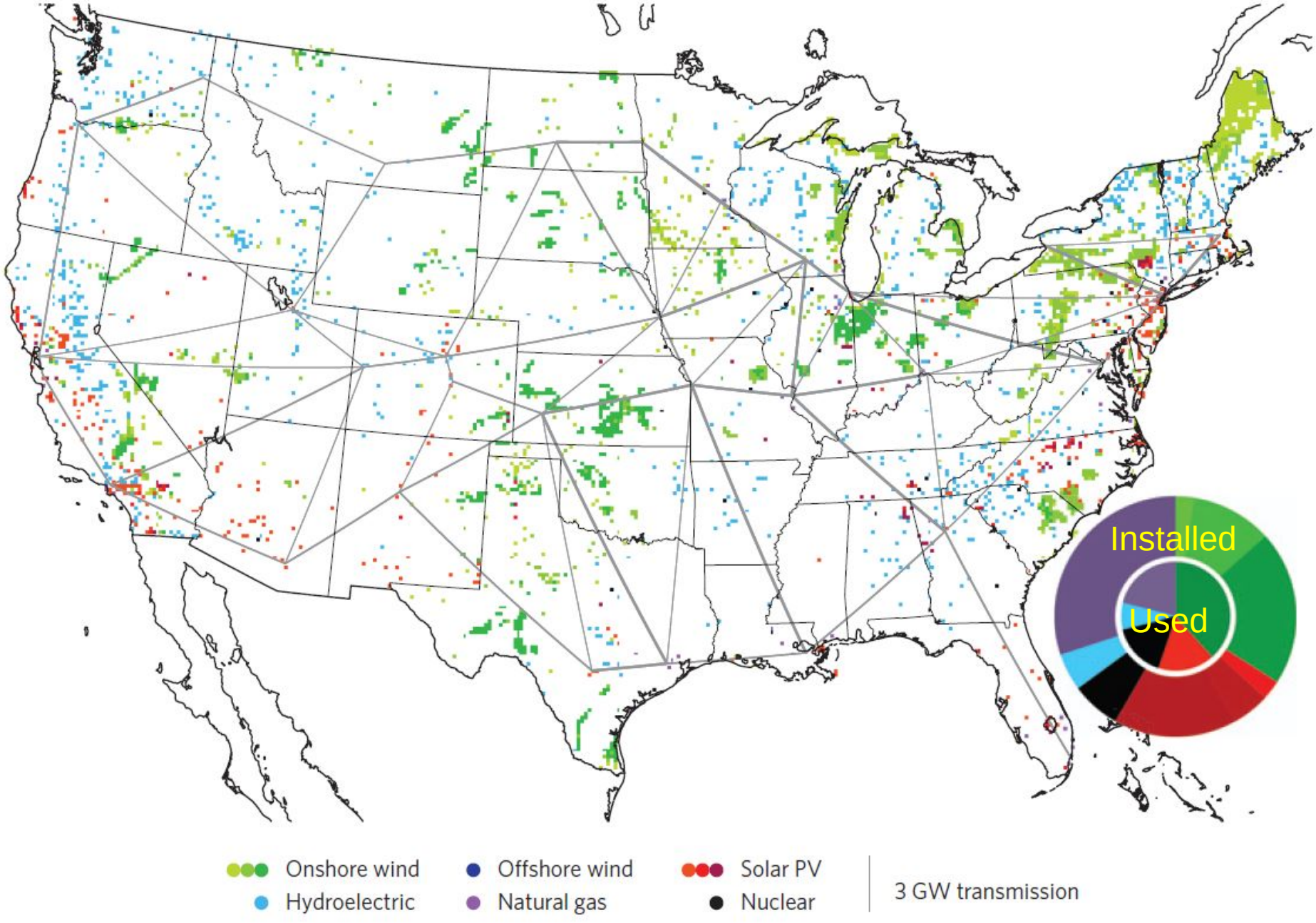
Subject to:



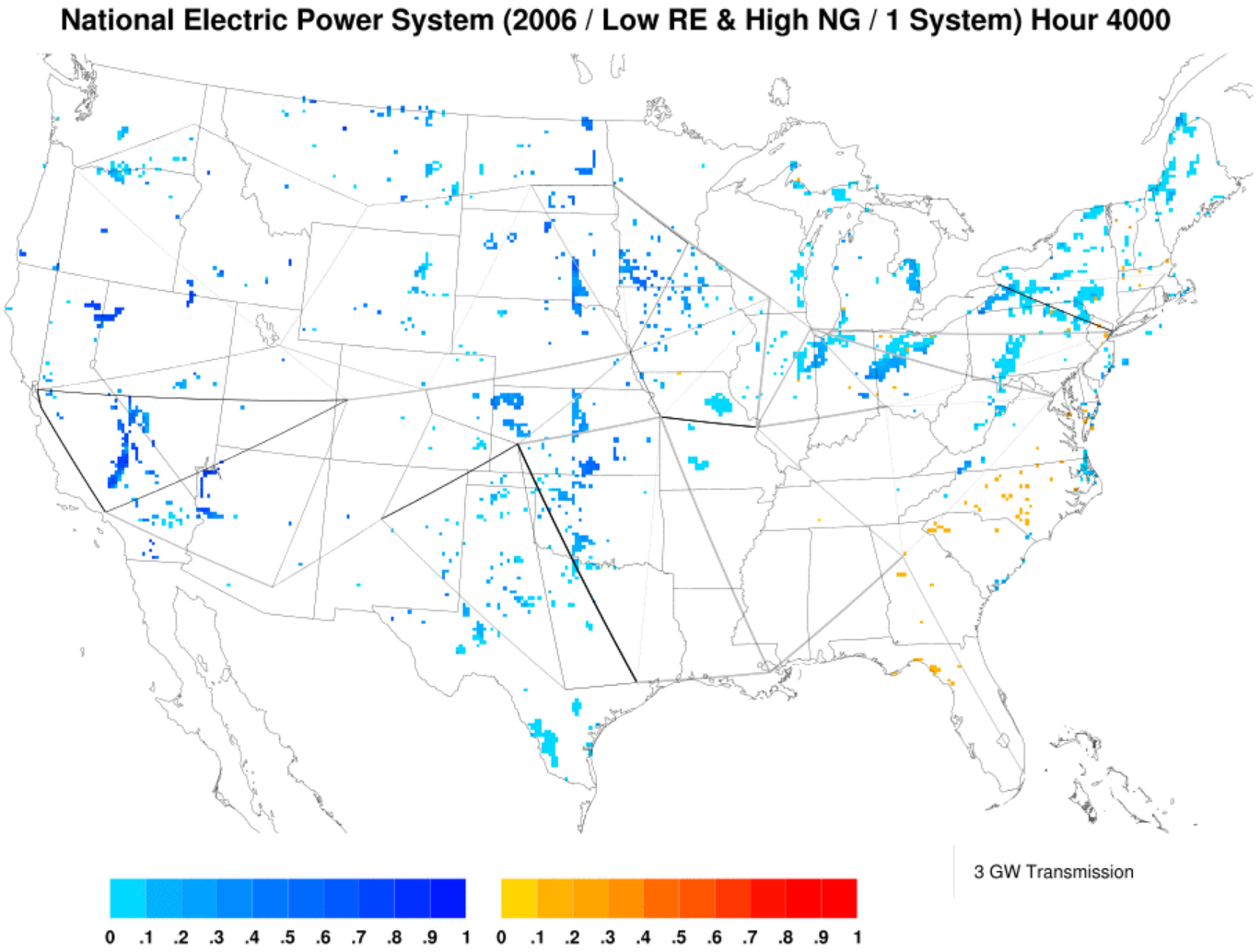

ALL OTHER EQUATIONS CONSTRAIN THE MAGNITUDE OF ANY OF THE TERMS

For details of the NEWS optimization see Clack *et al.*, IJEPES 2015.

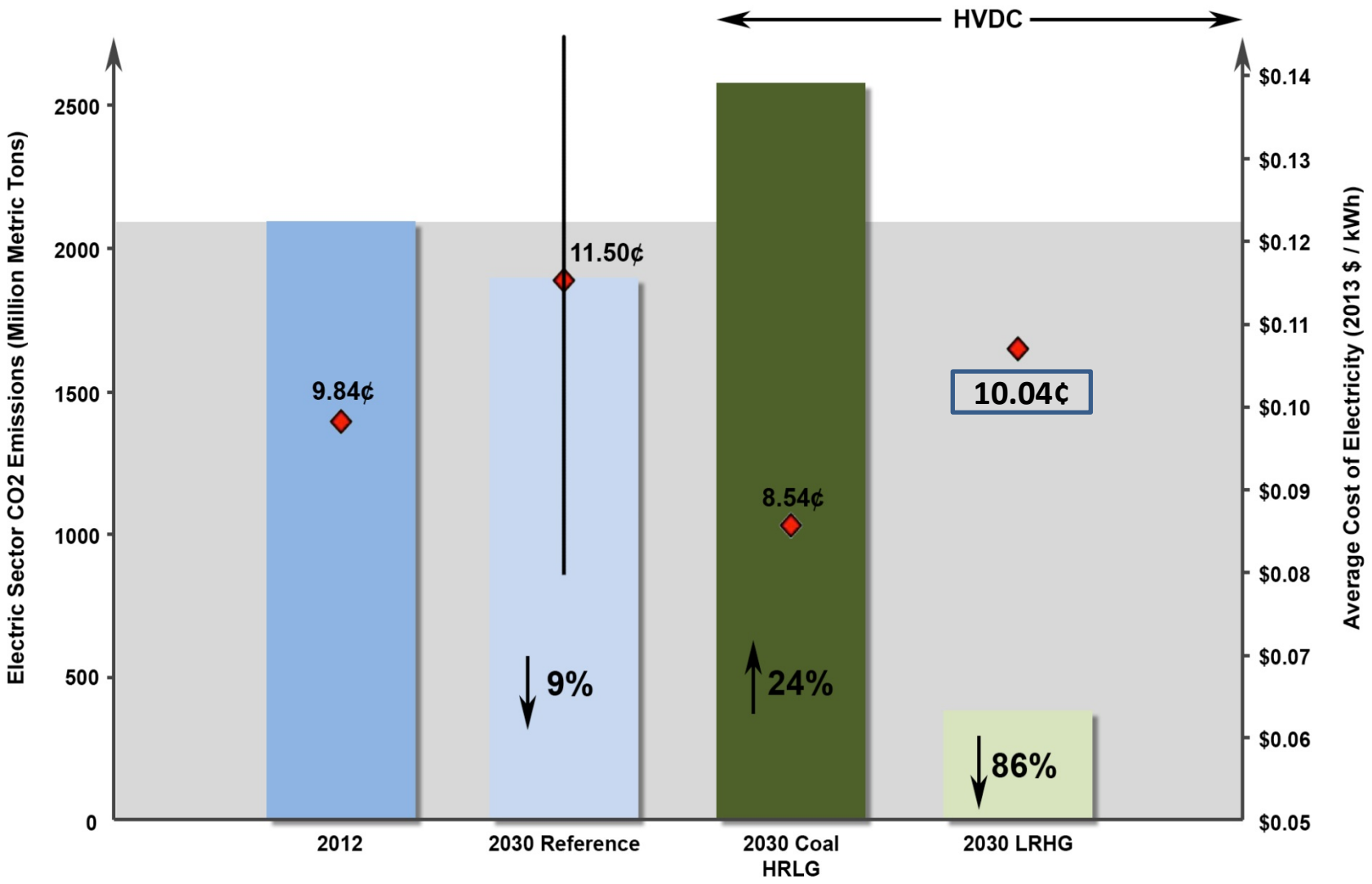
Cost optimized US Electric Power System for 2030



System Realtime Simulation



Cost and Carbon Emission Analysis



$150-$175B for HVDC Transmission and Stations
$3.7-$3.8T for Full System Implementation

Suggested Next Steps

- Learn the details of the model in collaboration with other utility regulators, the regional reliability entities, the independent system operators and regional transmission organizations
- Take a leadership role to implement a national electric system that links geographically optimized renewable generation within a nationwide HVDC transmission network to:
  - Keep electricity prices low
  - Provide reliable, clean, renewable energy
  - Help avert the worst impacts of climate disruption
  - Improve the resilience of the transmission grids
  - Create ~750,000 full-time, permanent jobs