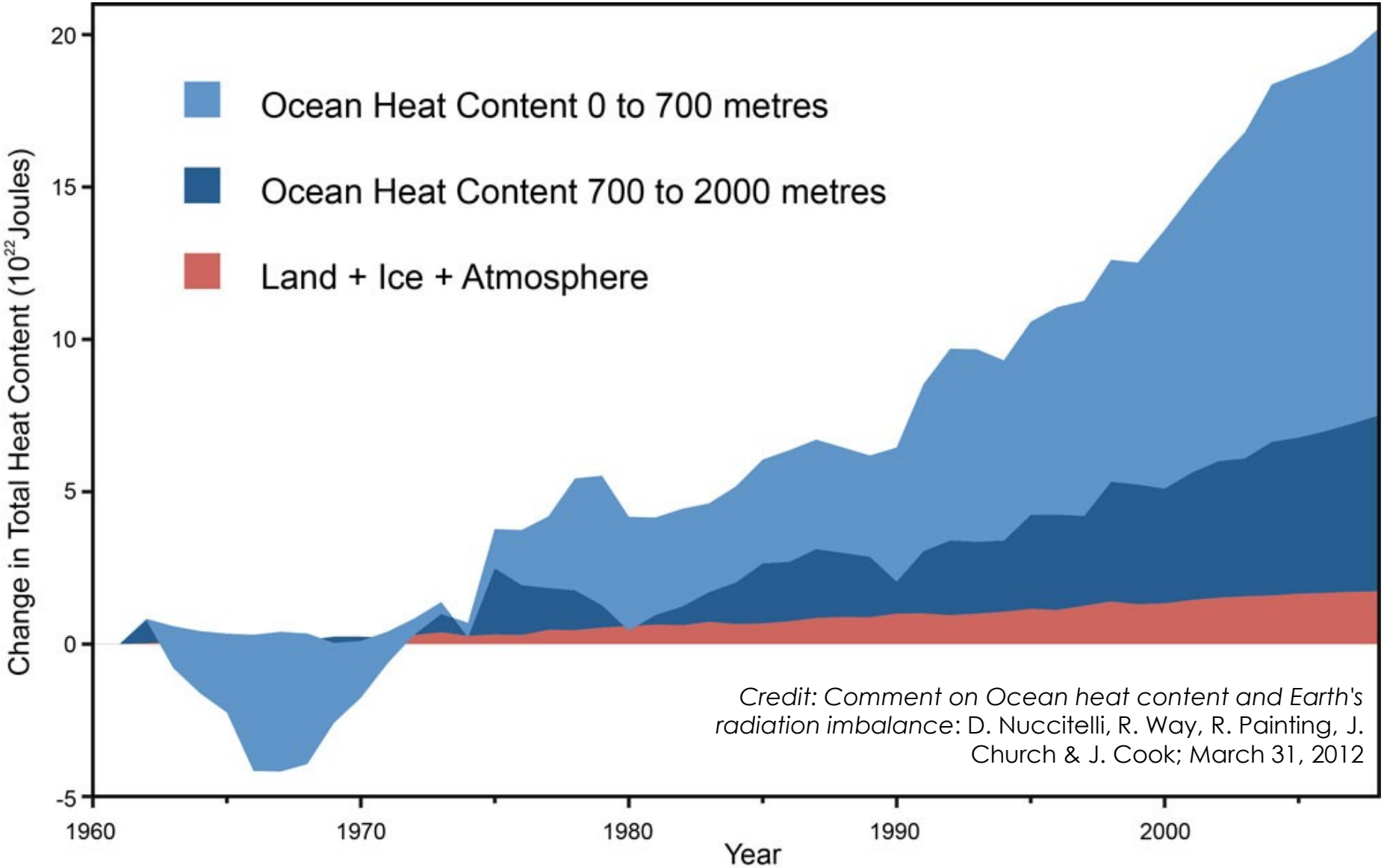
Energy Sector Decarbonization Impacts

Dr Christopher T M Clack
Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado

SWRR Sustainable Water Resources Roundtable, Tuesday July 19th 2016

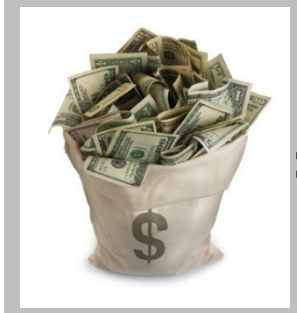
What is the problem?

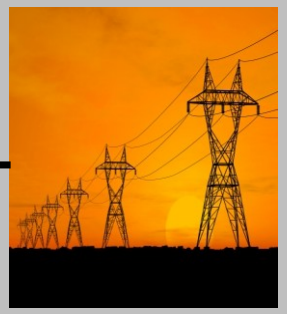


- The greenhouse gases are causing the planet to heat up, beyond normal climate variations.

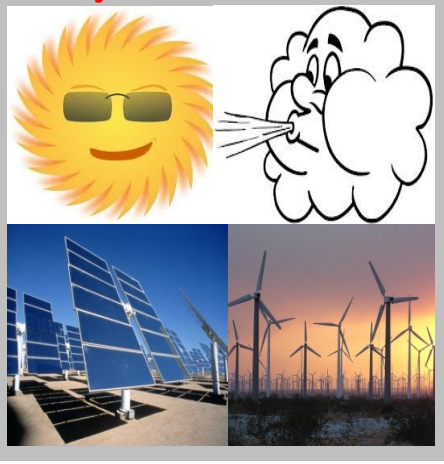
NEWS Solves To Find The "Best" System

Minimize:



= + + + + 

Subject to:

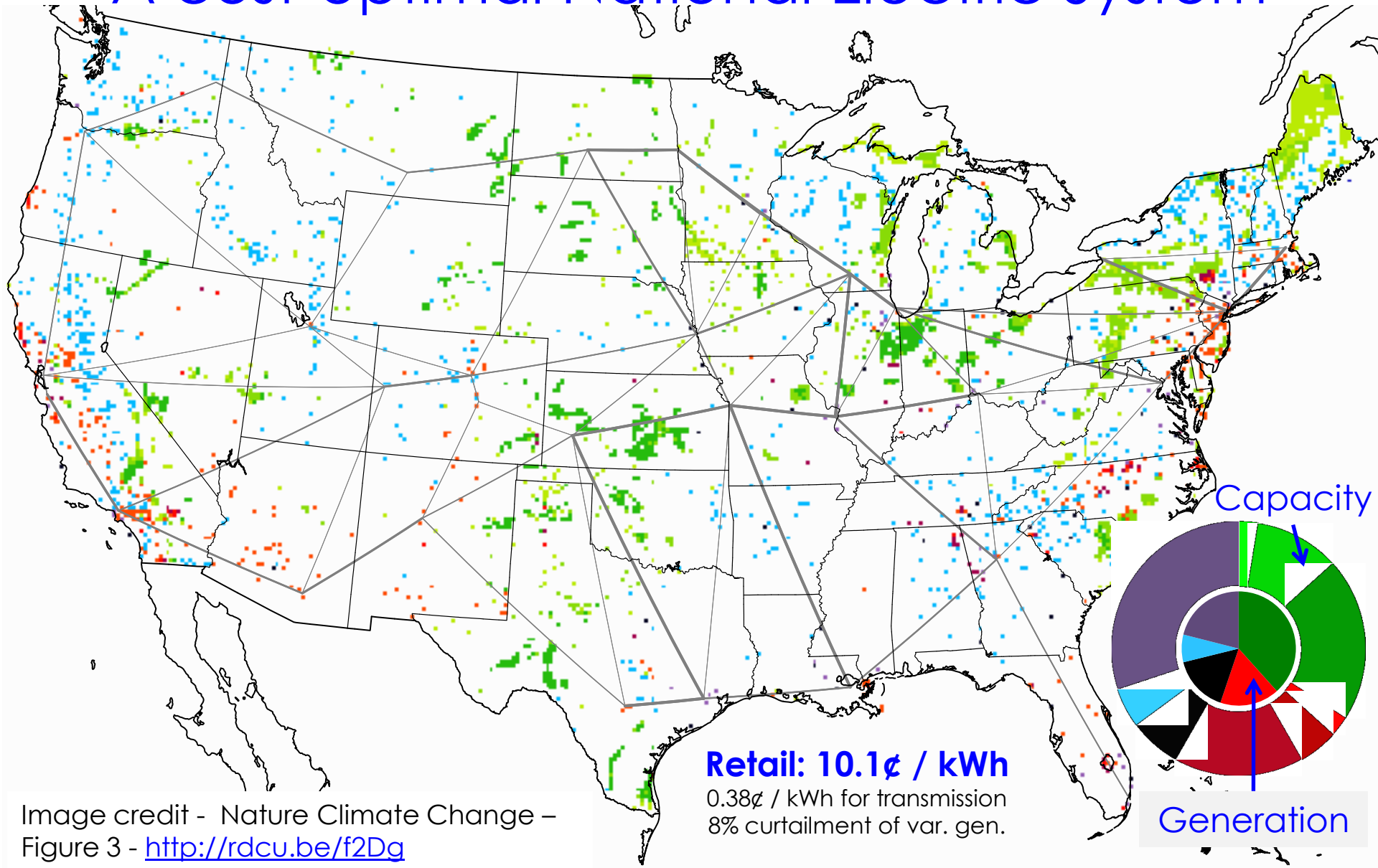


+ - ≥

ALL OTHER EQUATIONS CONSTRAIN THE MAGNITUDE OF ANY OF THE TERMS

See, e.g. C. T. M. Clack, Y. Xie, and A. MacDonald: Linear Programming Techniques for Developing an Optimal Electrical System including High-Voltage Direct Current Transmission and Storage, International Journal of Electric Power and Energy Systems, 68, 103-114, (2015).

A cost-optimal National Electric System



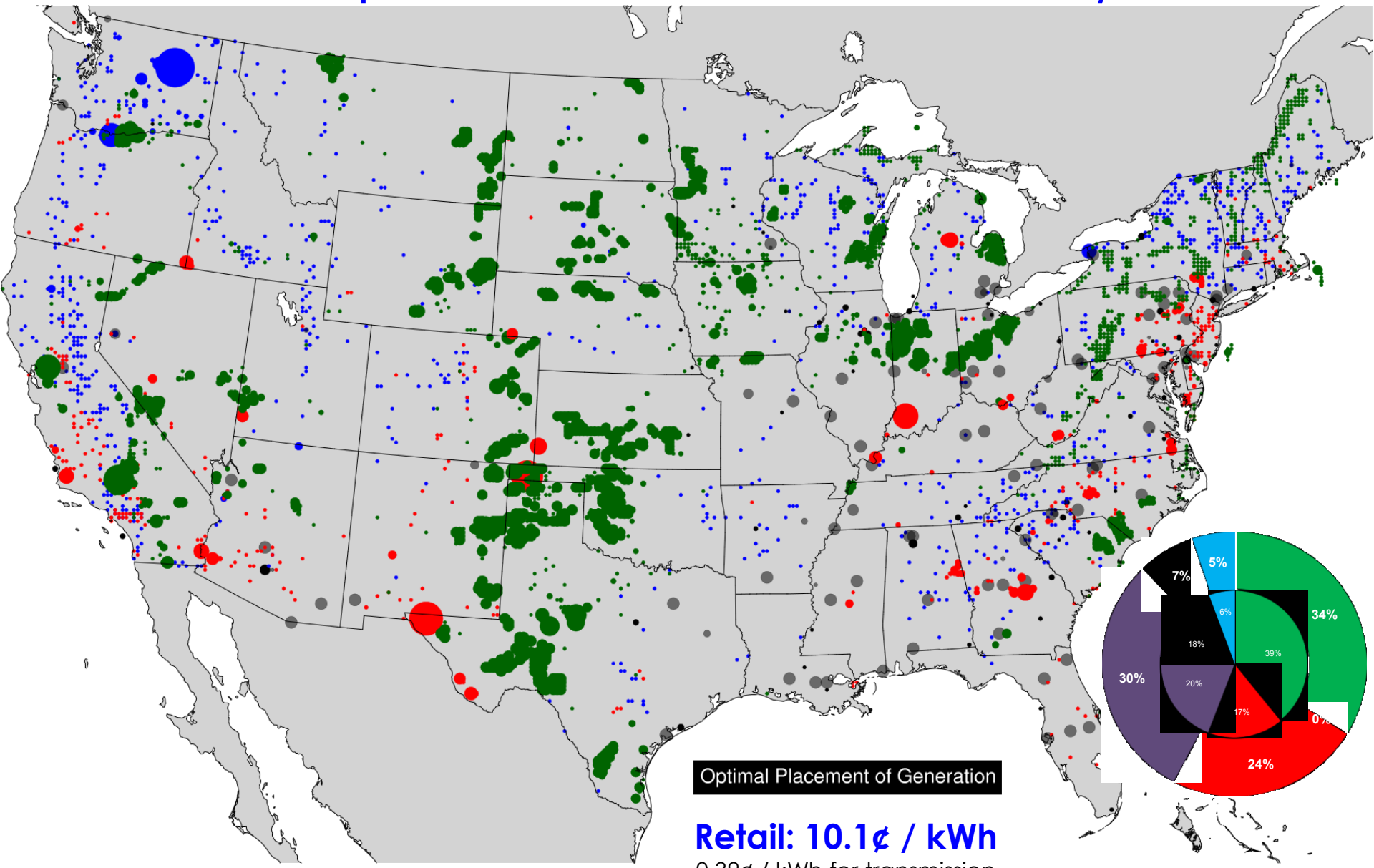
Retail: 10.1¢ / kWh

0.38¢ / kWh for transmission
8% curtailment of var. gen.

Image credit - Nature Climate Change – Figure 3 - http://rdcu.be/f2Dg

Onshore Wind
Hydroelectric
Offshore Wind
Natural Gas
Solar PV
Nuclear
3 GW Transmission

A cost-optimal National Electric System



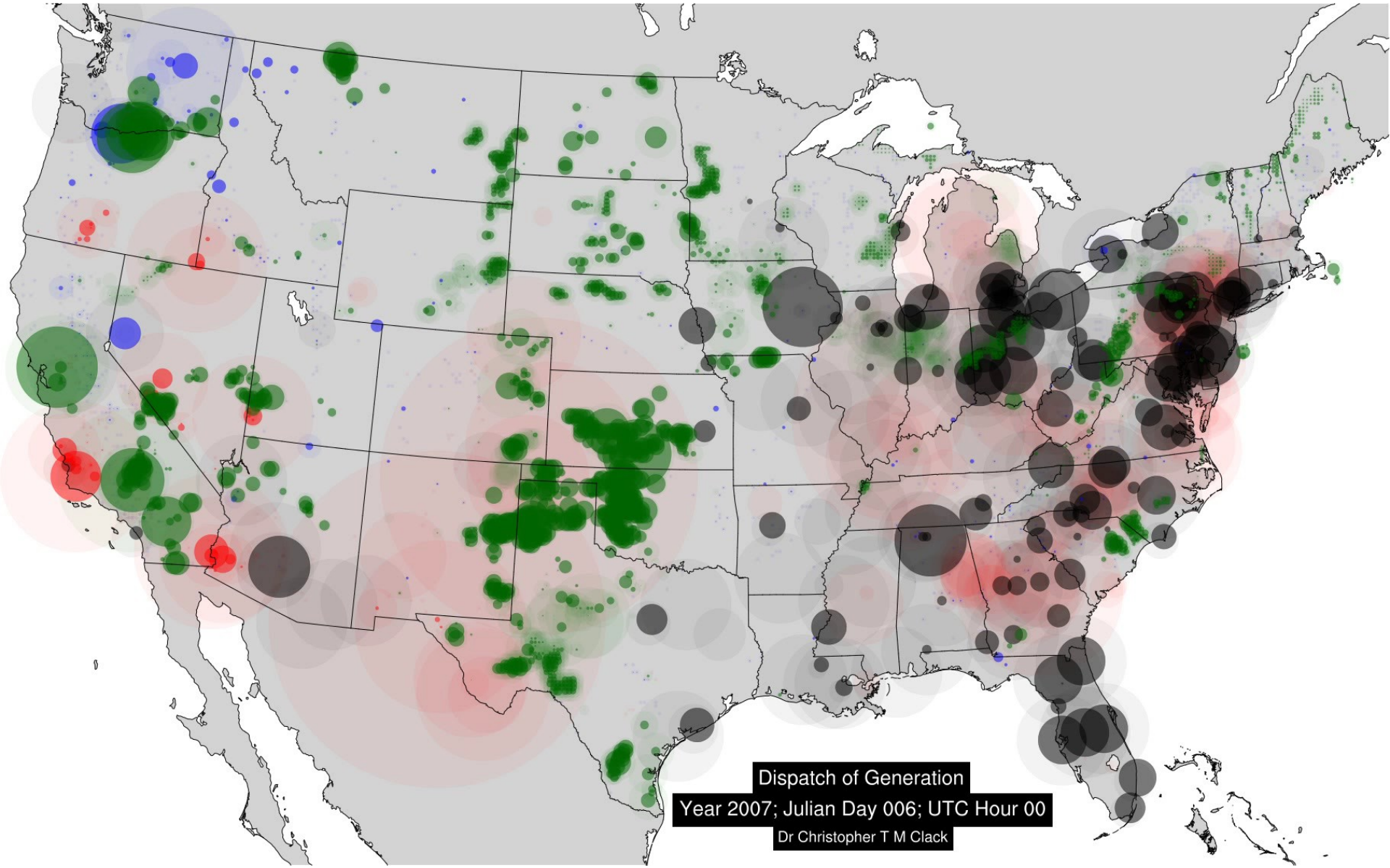
Optimal Placement of Generation

Retail: 10.1¢ / kWh

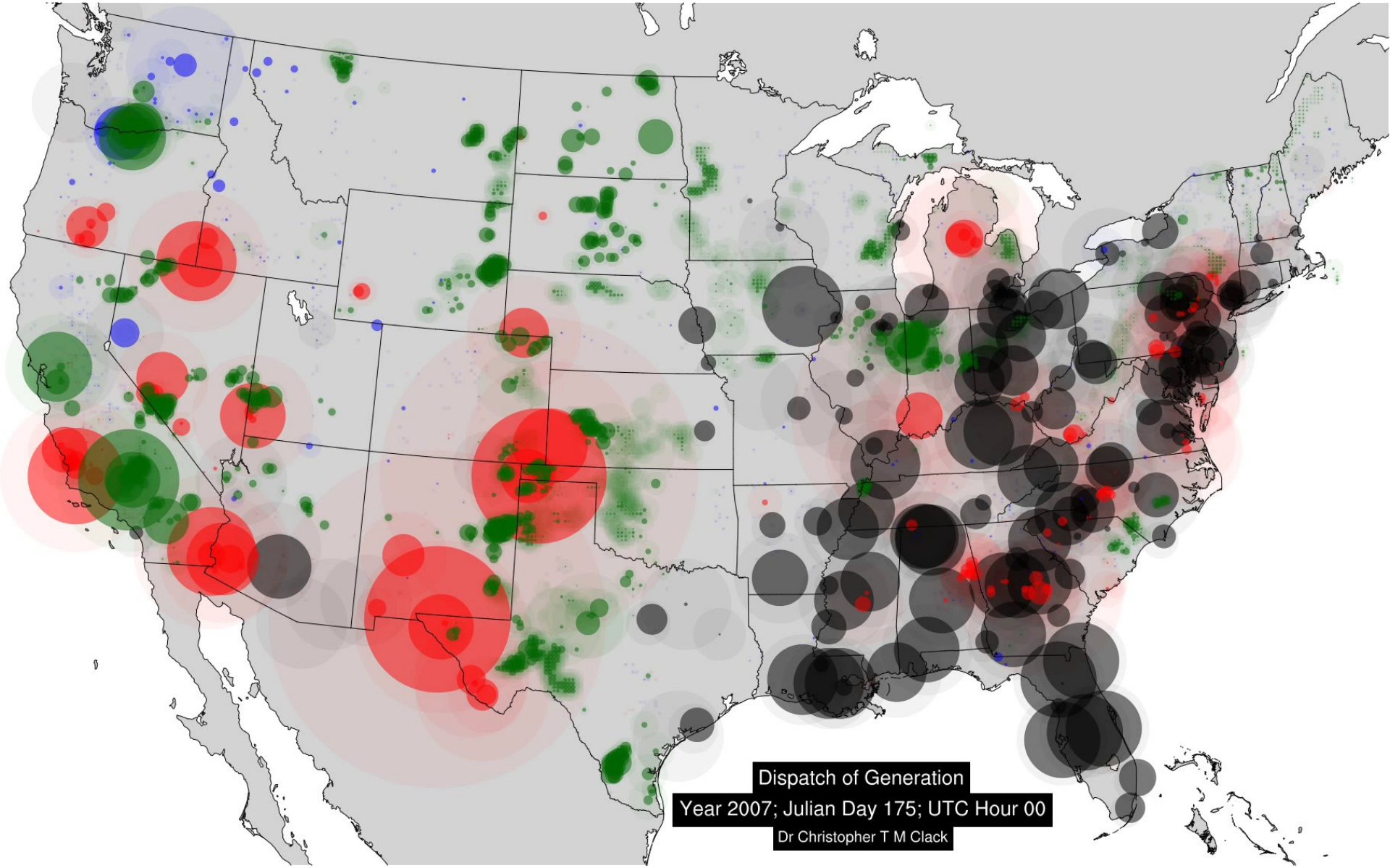
0.39¢ / kWh for transmission

8% curtailment of var. gen.

Dispatching the optimal system in the 2030s



Dispatching the optimal system in the 2030s



Levelized Cost of Electricity for a National System

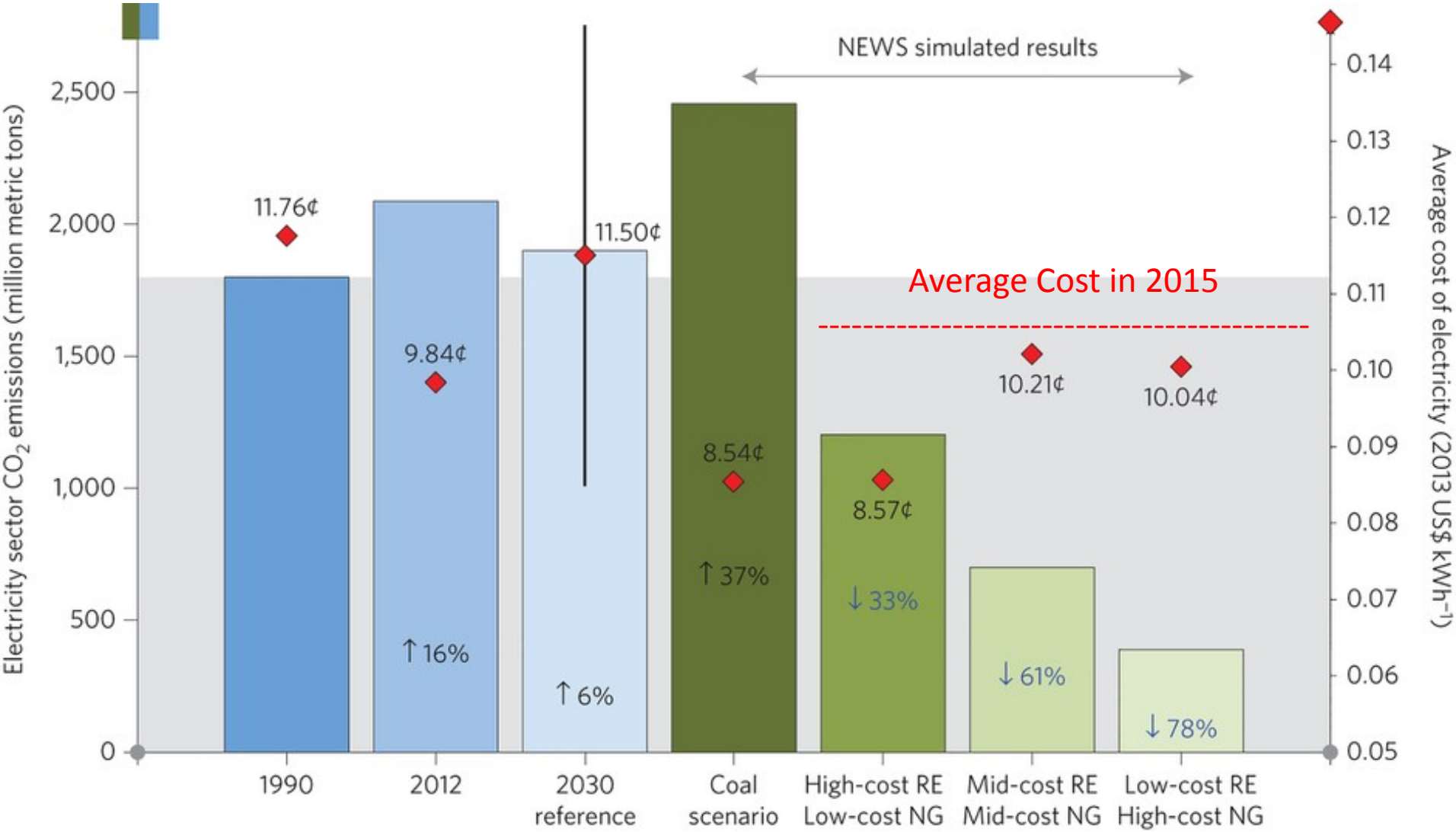
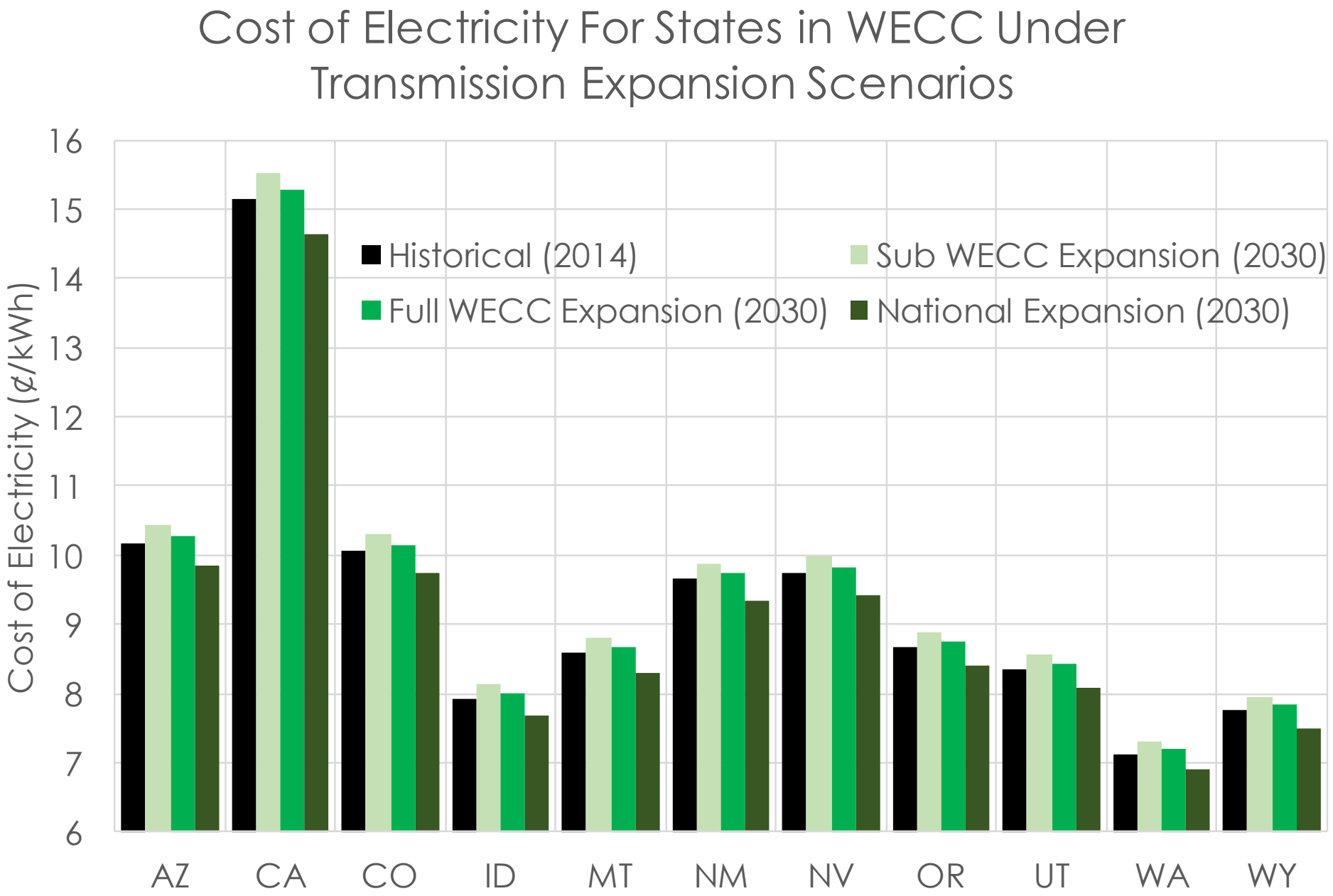
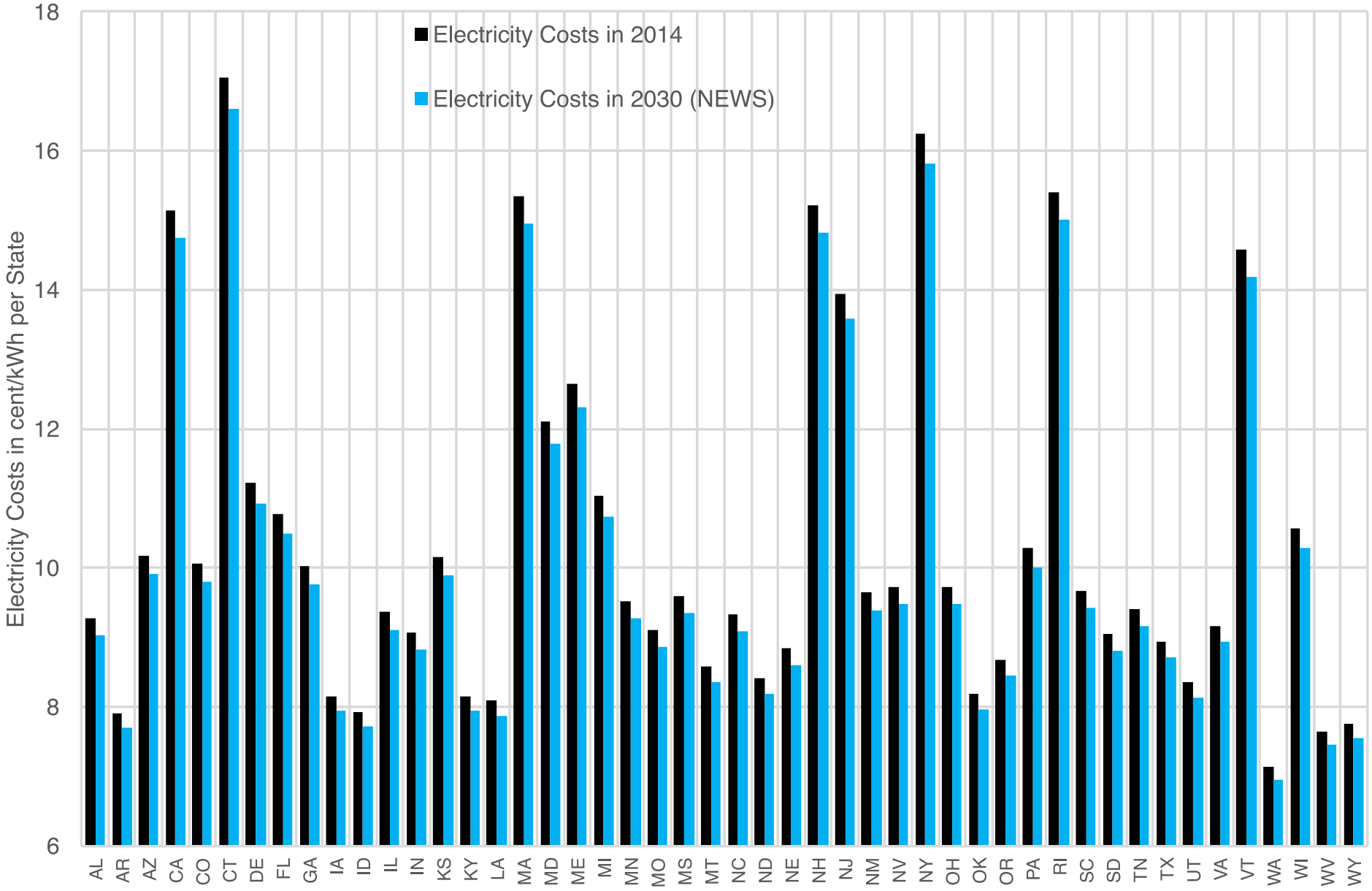


Image credit - Nature Climate Change – Figure 2 - http://rdcu.be/f2Dg

Transmission Expansion Impacts On My State?



How the national system impacts my state?



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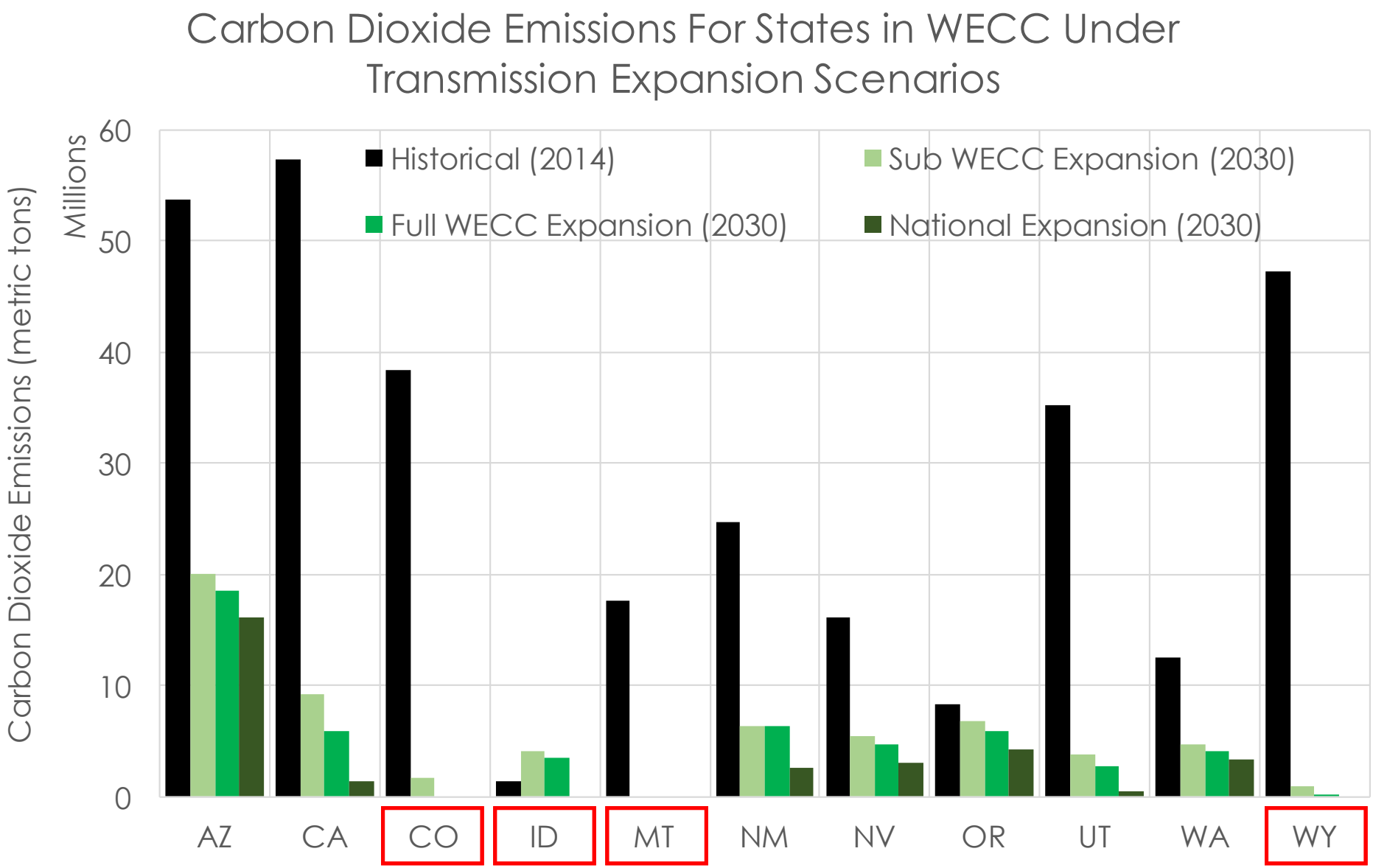

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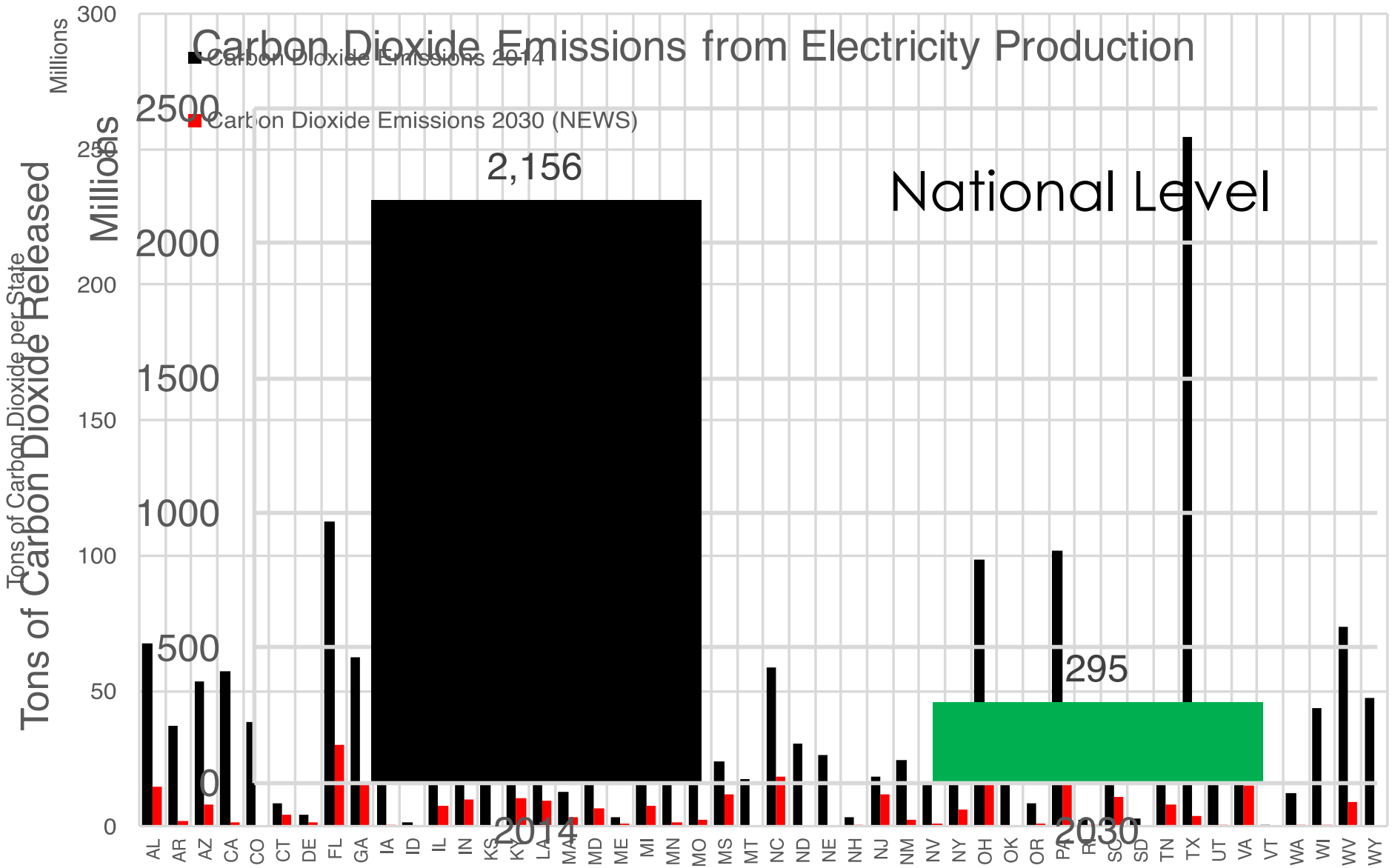

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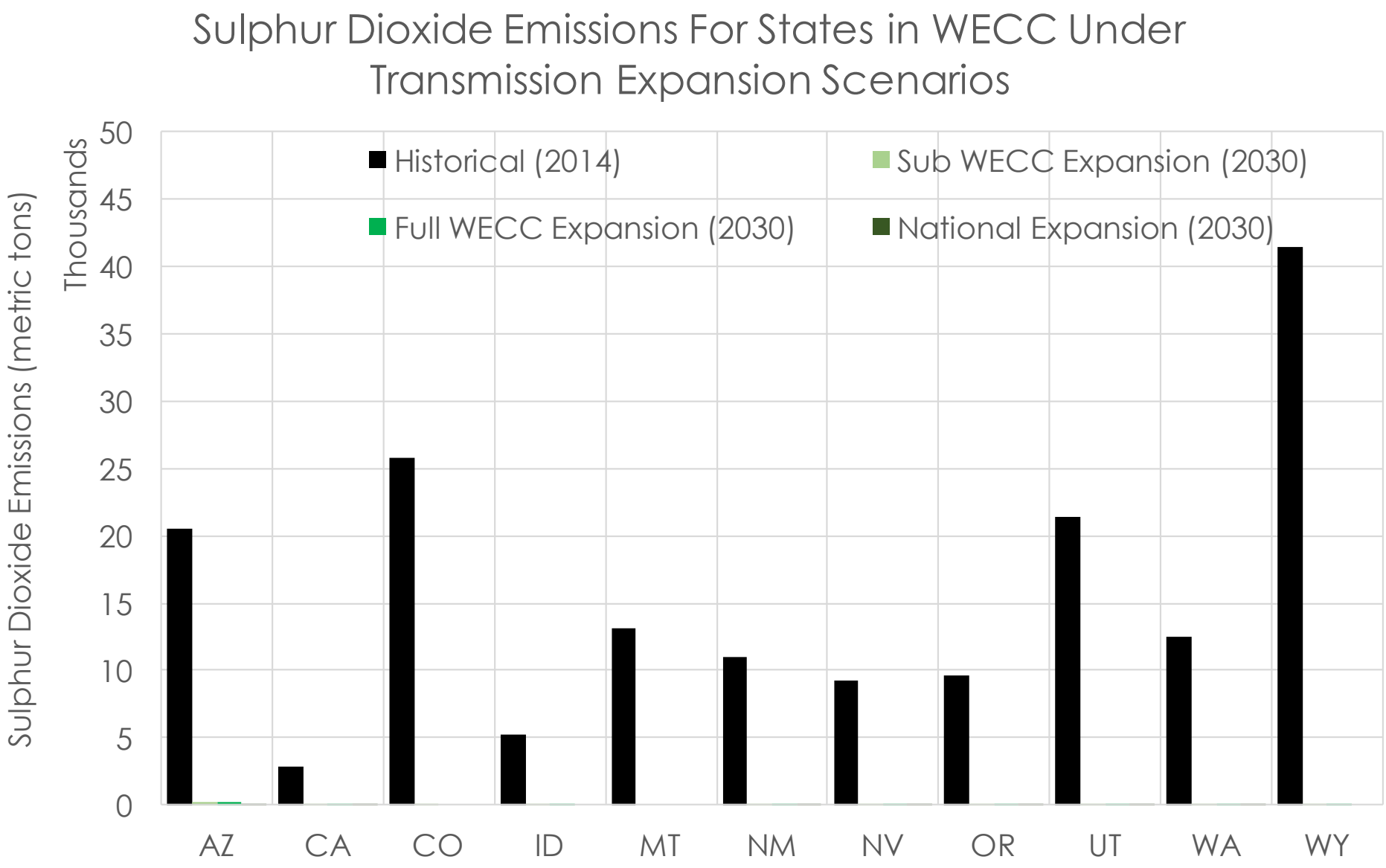

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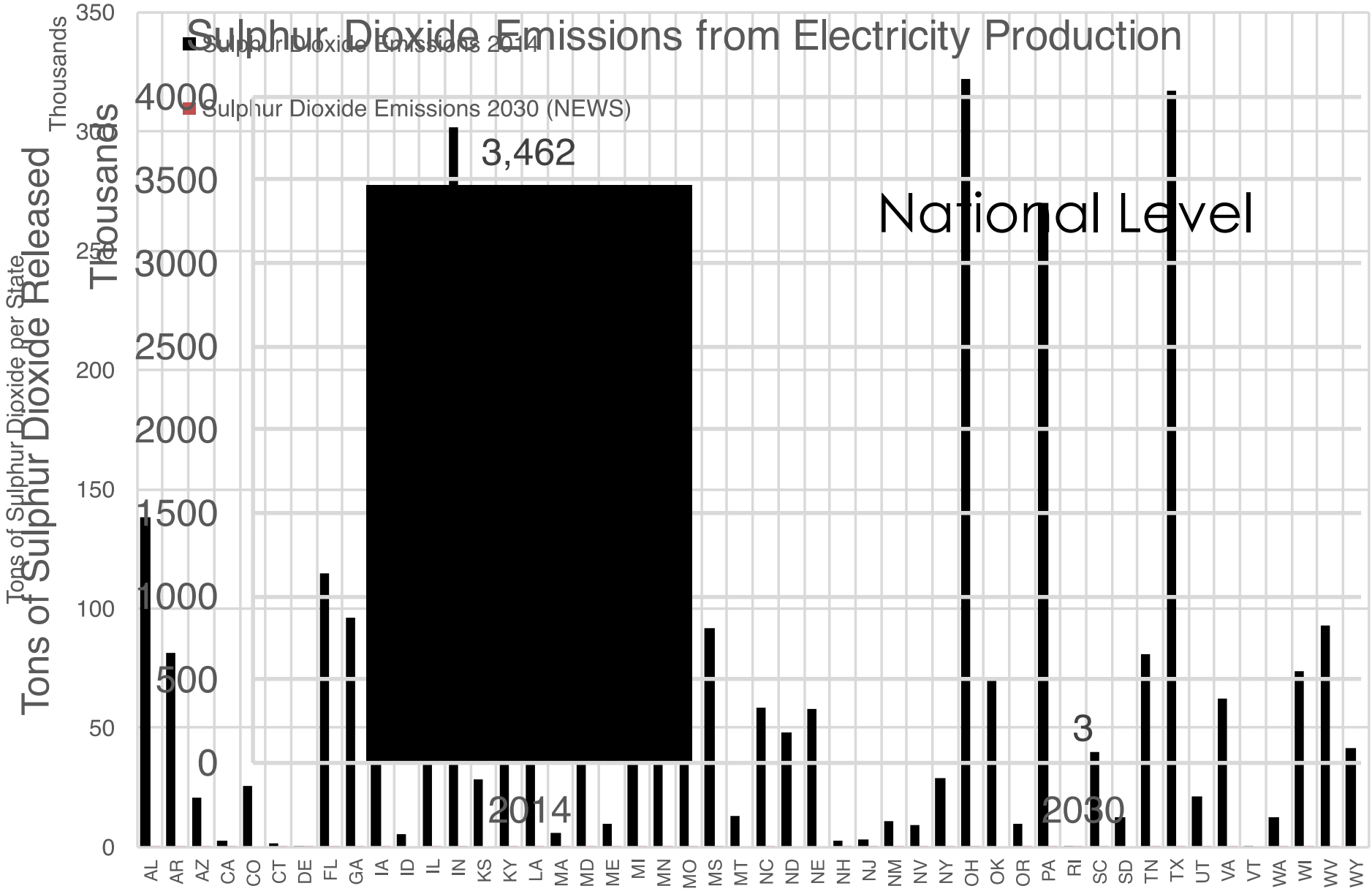

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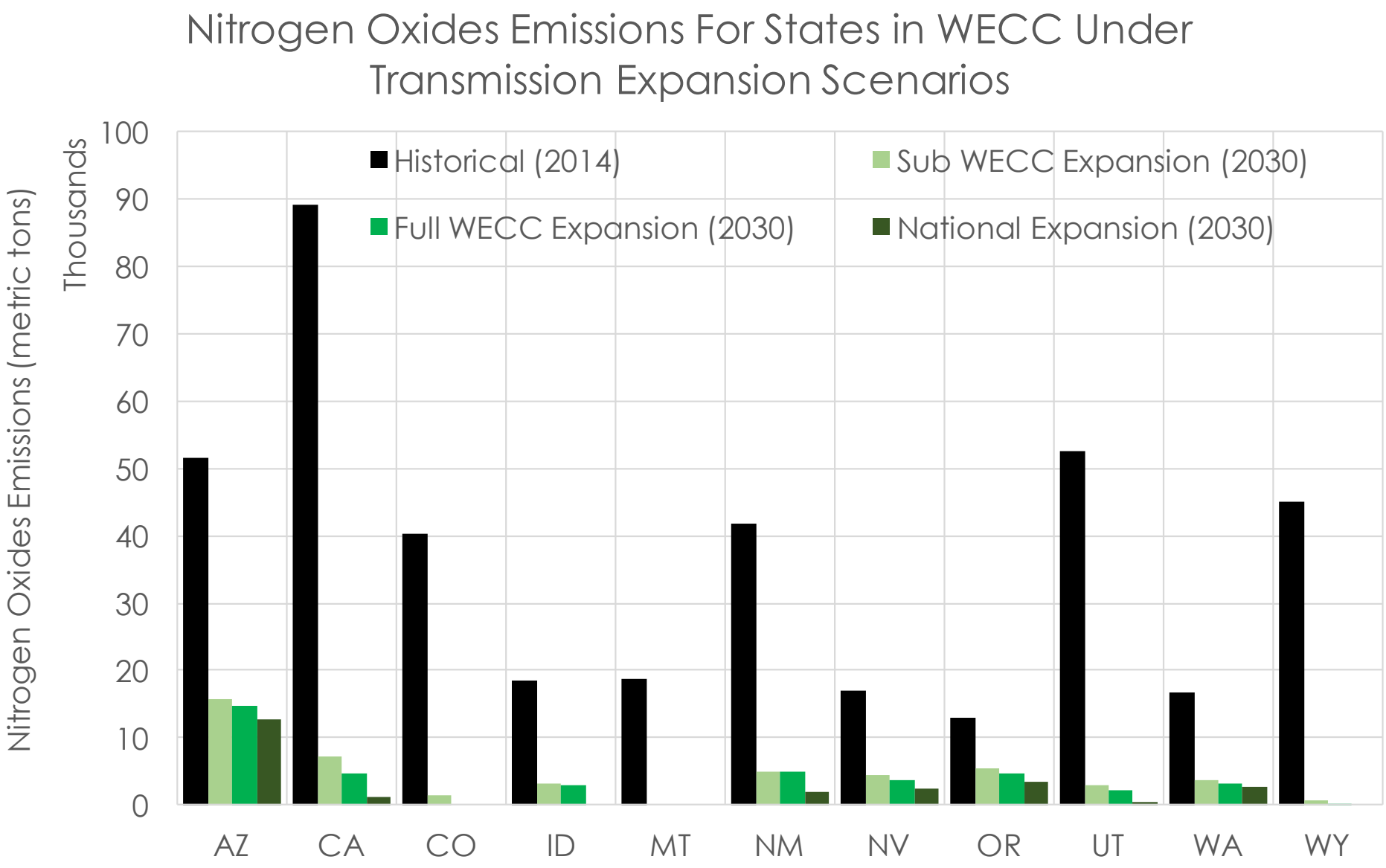

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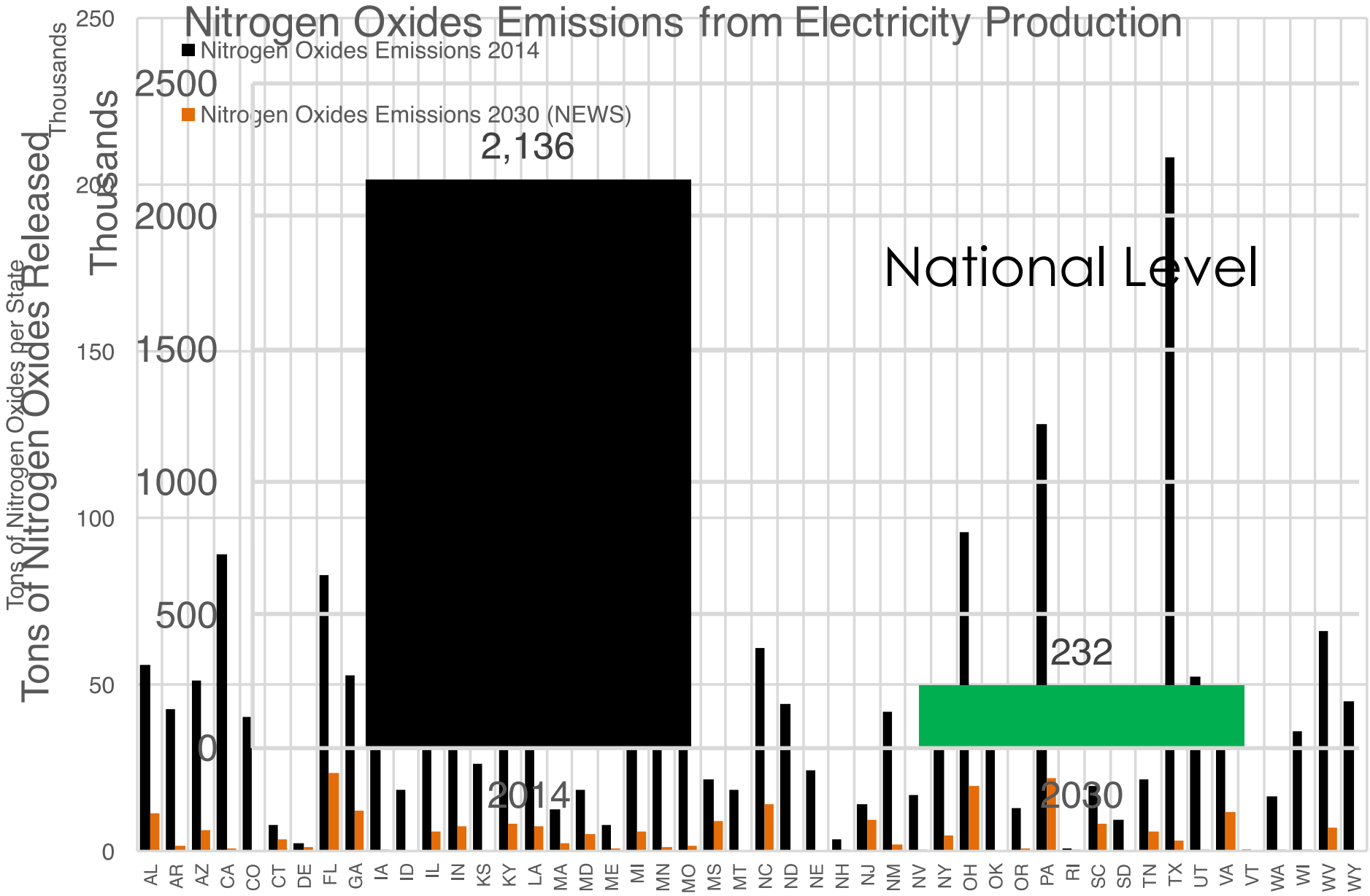

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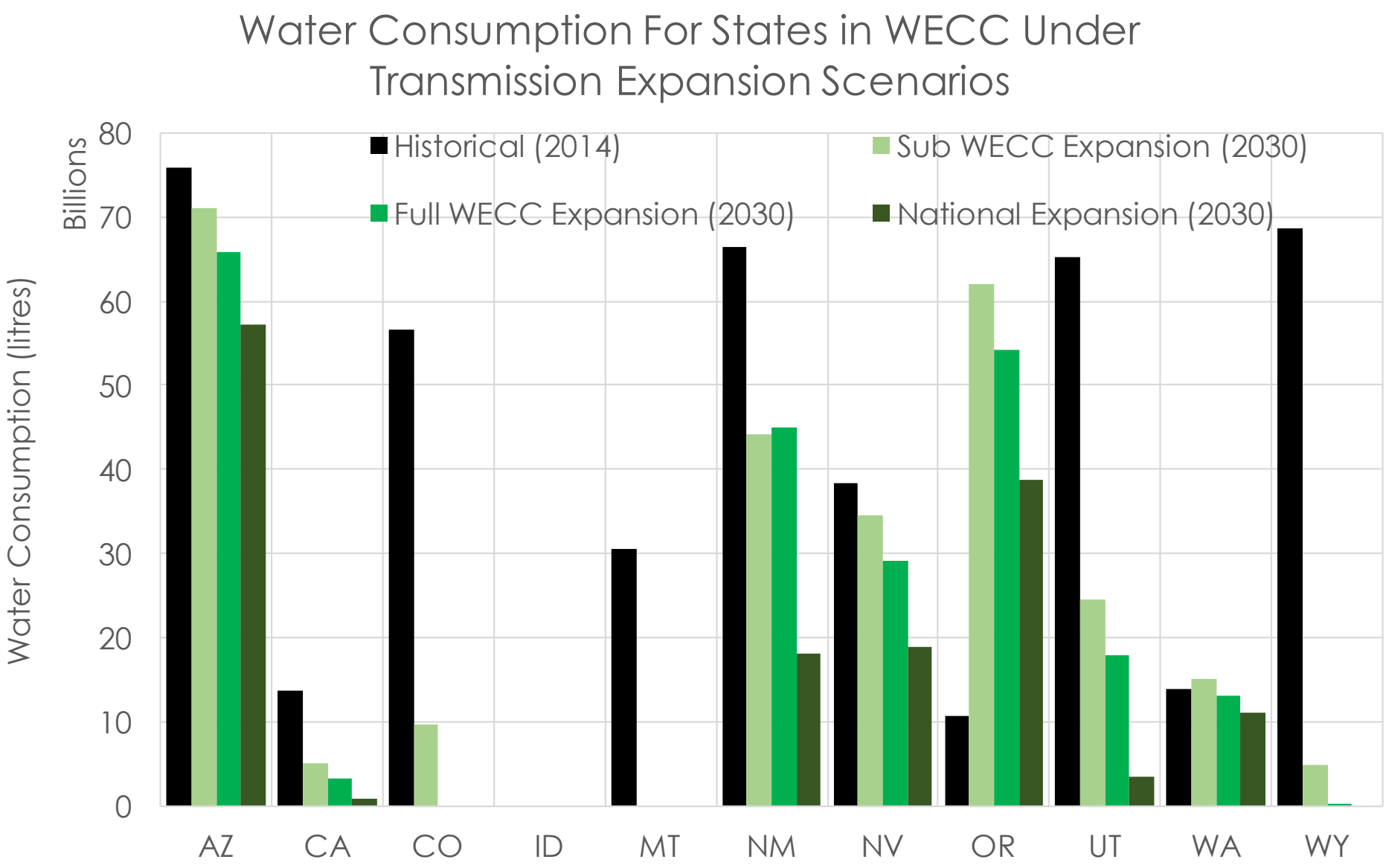

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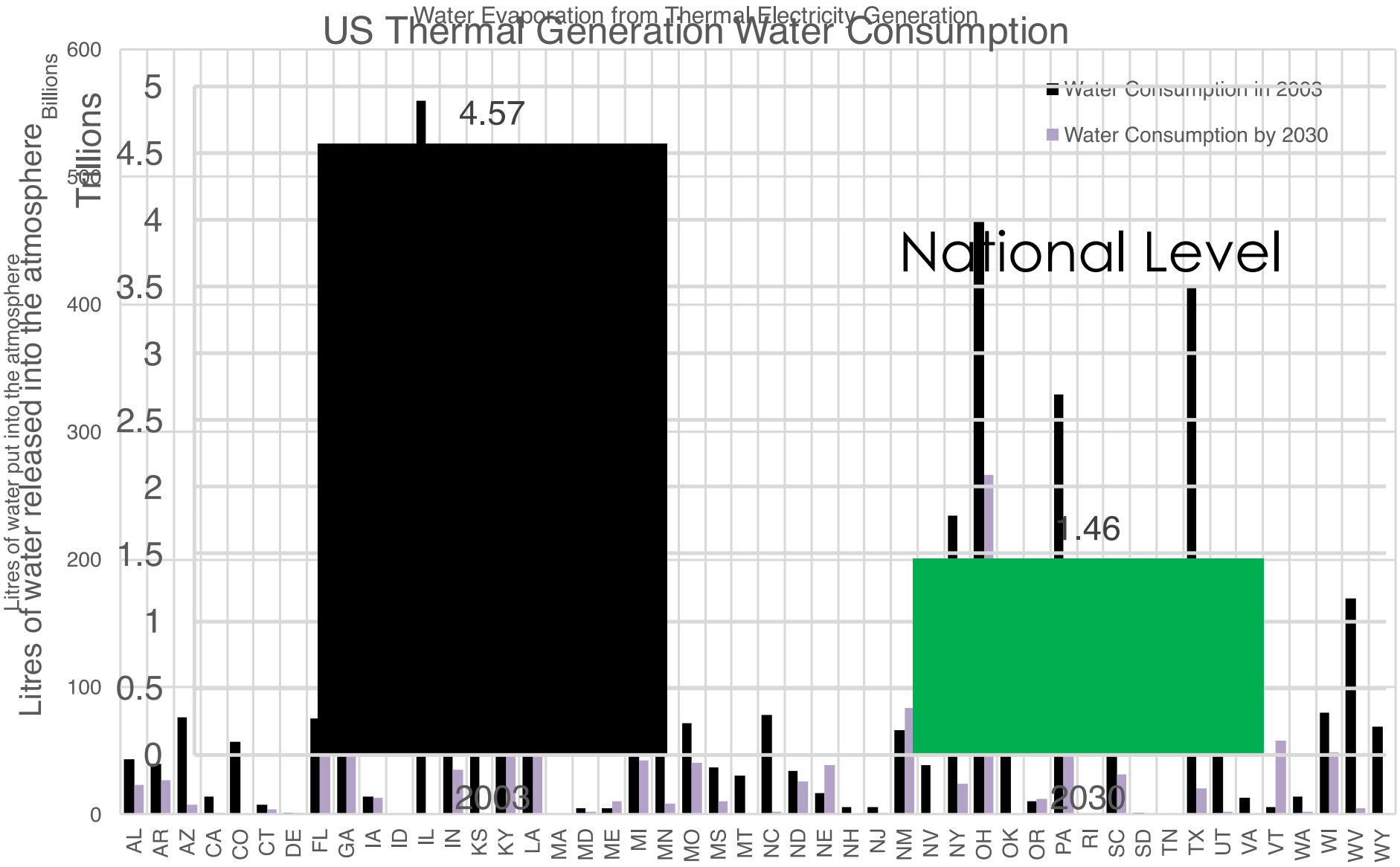

Critical Key Findings My Studies

- It is ***not*** always best practice to place variable generators ***where the most power*** potential is.

- **A large area system** is beneficial for numerous reasons, but particularly to find ***more valuable*** sites for variable generation.

- Co-optimizing **allows benefits** from multiple different features; such as **water**, jobs, effluents and carbon dioxide.

- Each component can be **tracked and optimized** upon for each time step within the model.

Questions?

NEWS Webpage:
esrl.noaa.gov/gsd/renewable/news-simulator.html

NEWS Results Webpage:
esrl.noaa.gov/gsd/renewable/news-results/#usstudy-2007-lrhg-1

NEWS Results Data:
esrl.noaa.gov/gsd/renewable/news-results/usstudy/

Free Copy of the Nature Climate Change Paper:
http://rdcu.be/f2Dg

Dr Christopher T M Clack
Christopher.Clack-1@colorado.edu
chrisclack@hotmail.com

colorado.academia.edu/ChristopherClack
researchgate.net/profile/Christopher_Clack2
linkedin.com/in/clacky007
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