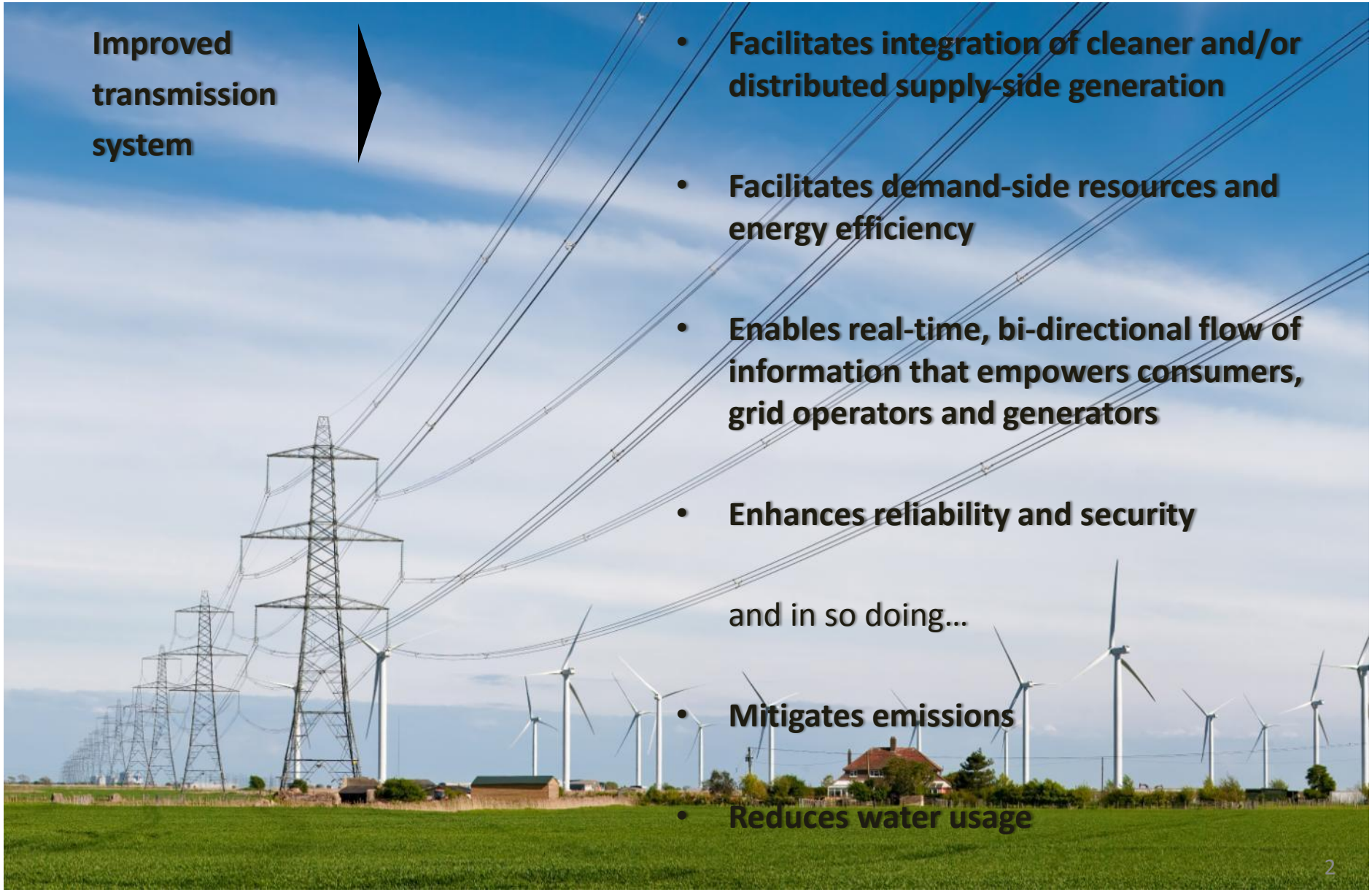
Improved Transmission: Its Benefits and Importance

Americans for a Clean Energy Grid

November 14th – Nashville, TN

An improved transmission system affords multiple benefits



Improved transmission system

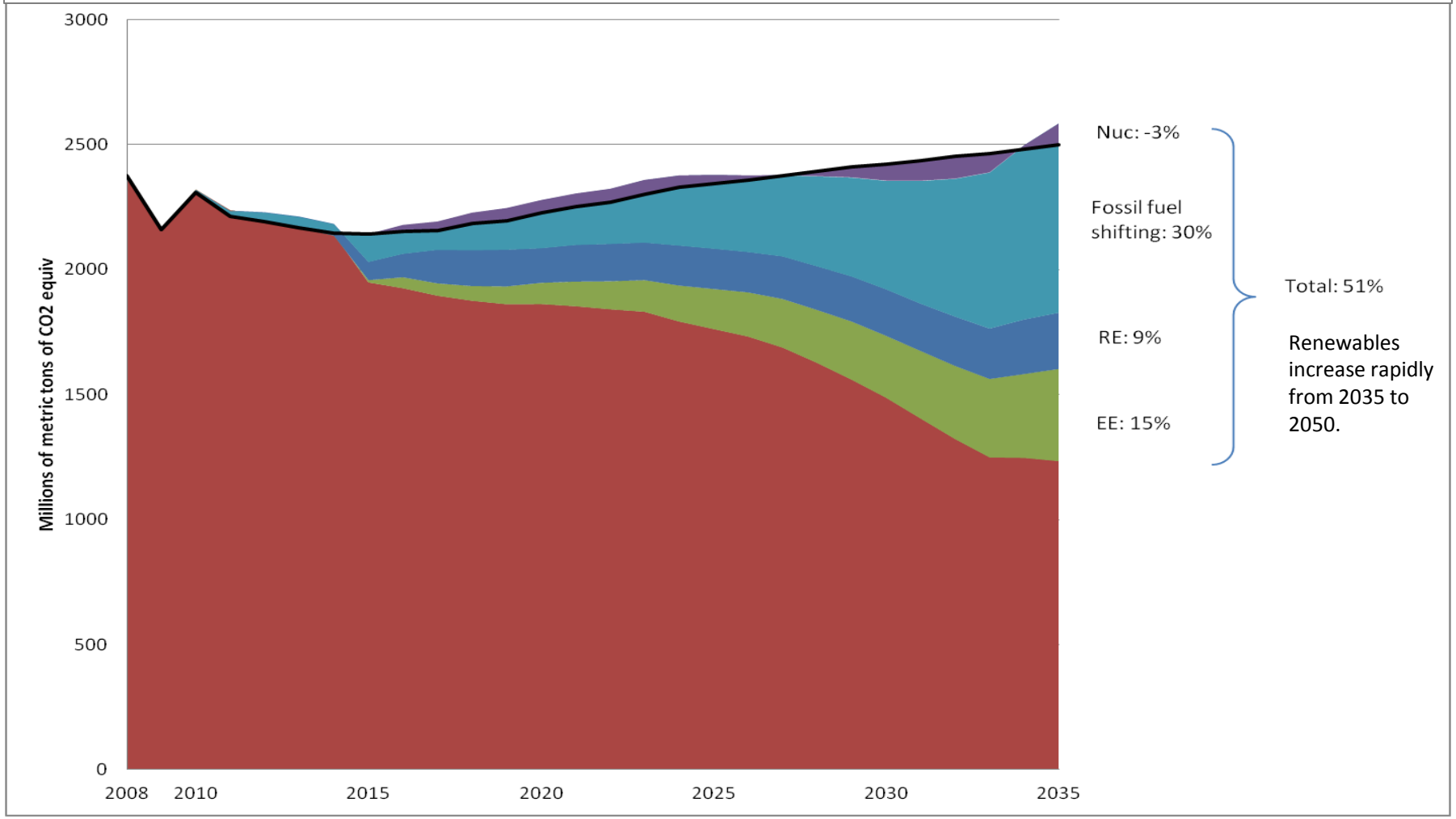
- **Facilitates integration of cleaner and/or distributed supply-side generation**
- **Facilitates demand-side resources and energy efficiency**
- **Enables real-time, bi-directional flow of information that empowers consumers, grid operators and generators**
- **Enhances reliability and security**

and in so doing…

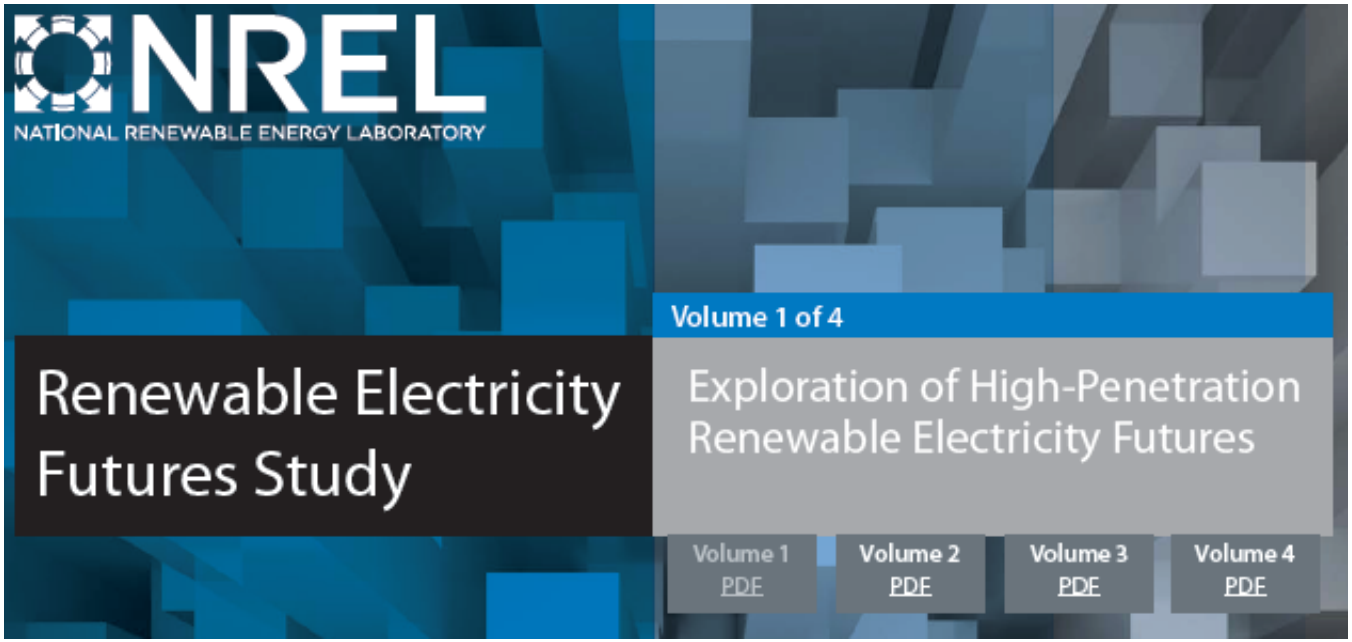
- **Mitigates emissions**
- **Reduces water usage**

NRDC believes that power sector emissions could be cut in half by 2035 – we see a future with high renewables and energy efficiency

Changes in power sector GHG emissions under a CES with standards and codes



NREL concludes that renewable energy could supply 80 percent of US electricity demand



"Renewable energy resources, accessed with commercially available generation technologies, could adequately supply 80% of total U.S. electricity generation in 2050 while balancing supply and demand at the hourly level."

Utility scale renewables will require expanding and upgrading the T&D system

If you love renewables you have to at least learn to like transmission (& other technologies)

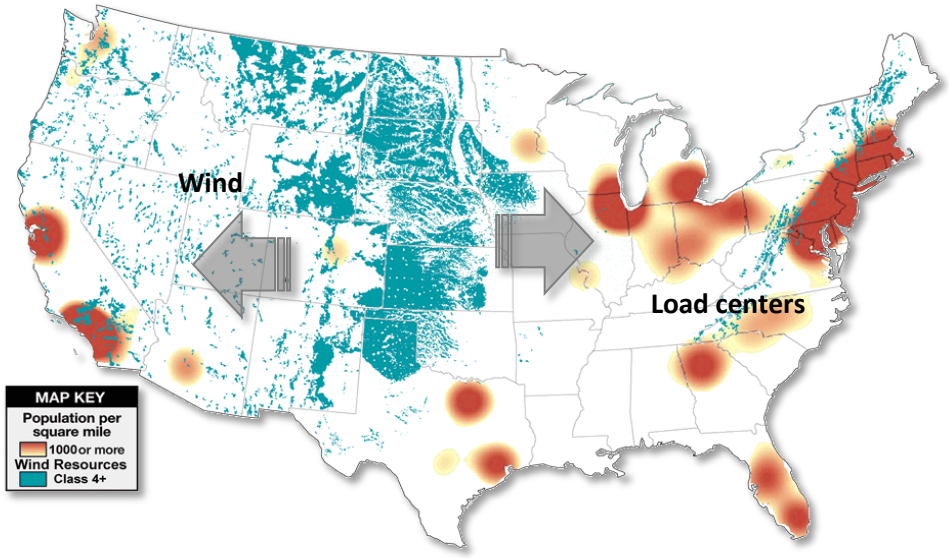
NRDC
THE EARTH'S BEST DEFENSE

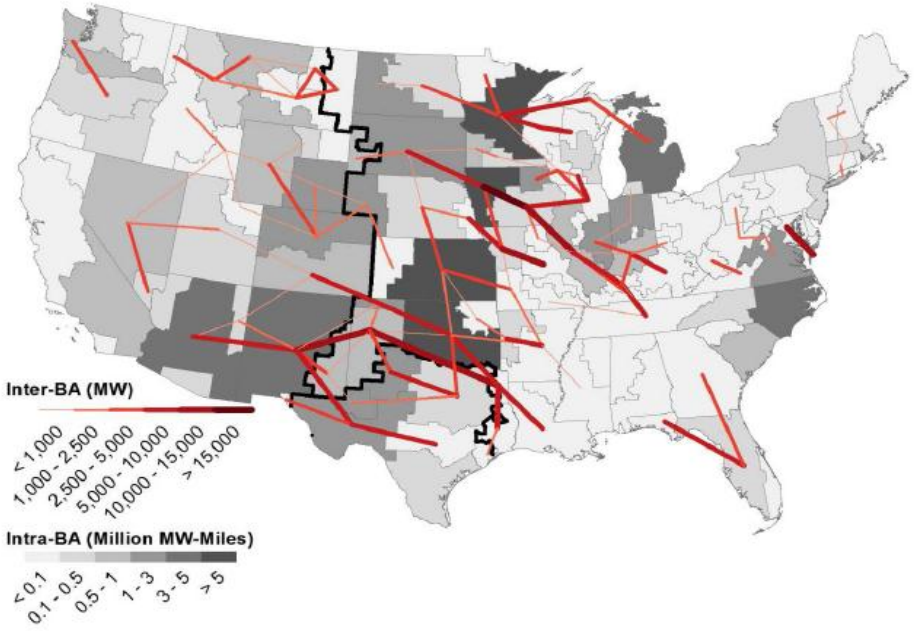
Location of best renewable resources may not be proximal to demand

- Additional transmission infrastructure likely required to bring remote wind energy to market
- Other resources (distributed generation, offshore wind) don't obviate the need for new lines

A new, holistic paradigm is needed to plan, site and build transmission

- Transmission planning needs to account for a variety of resources, from different regions. It needs to serve three important roles:
  - Deliver generation from cost-effective remote renewable resources to load centers
  - Smooth output profiles of variable resources by enabling greater geospatial diversity
  - Enable reserve sharing over greater distances

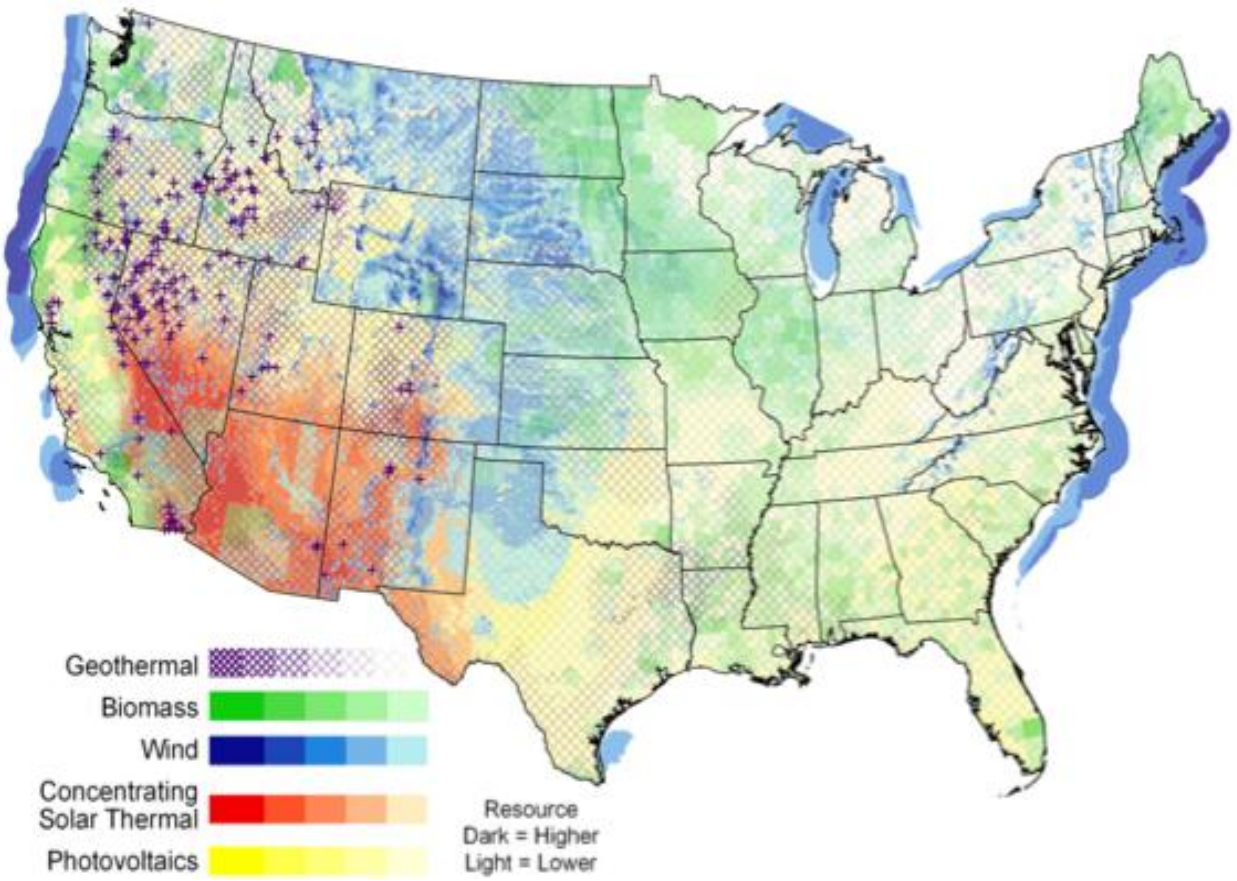




The US has a variety of renewable energy resources…

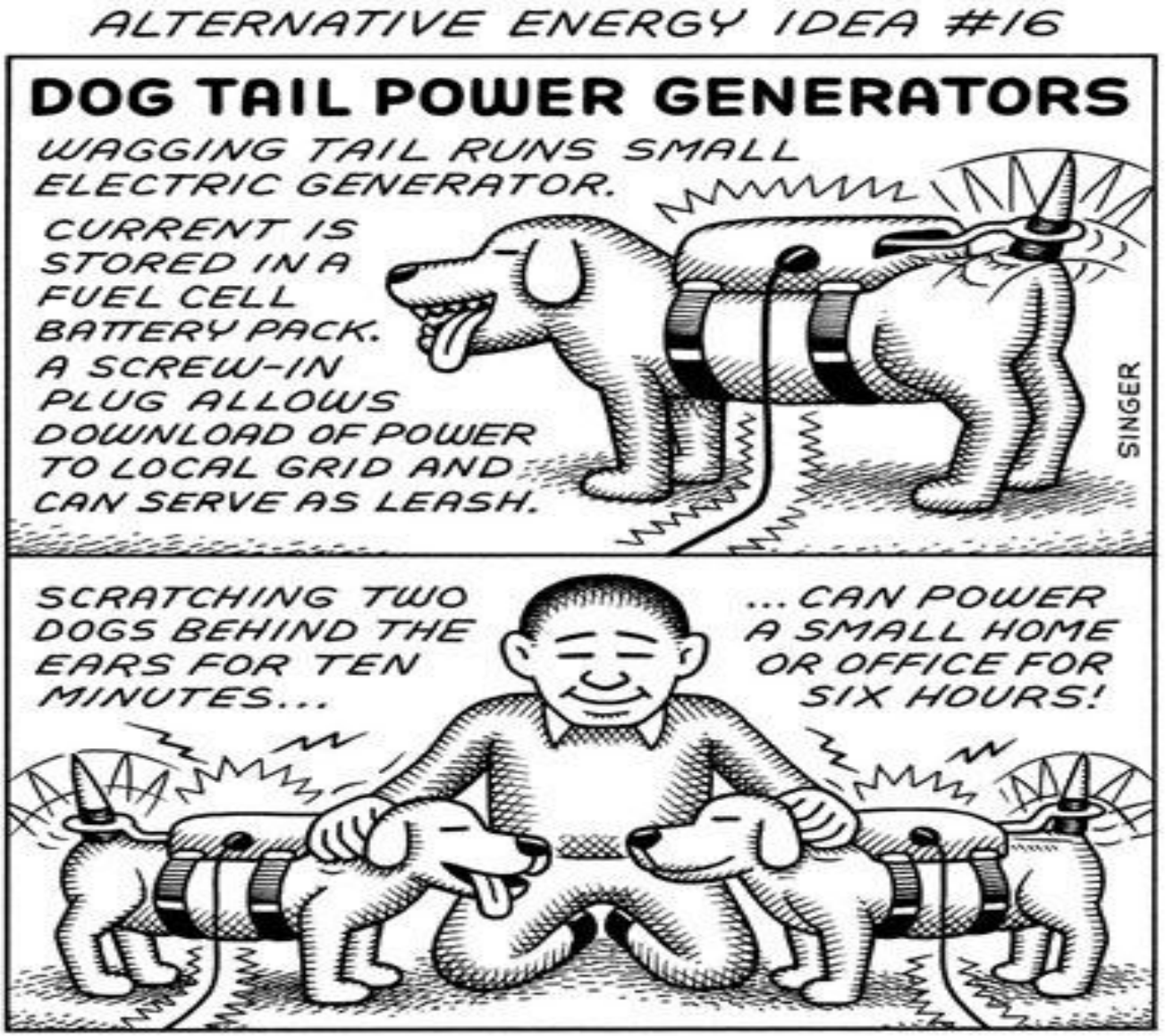
"All regions of the United States could contribute substantial renewable electricity supply in 2050, consistent with their local renewable resource base.

Multiple pathways exist to achieve a high renewable electricity future."



Source: NREL

…and we need them all



The Eastern Interconnection is currently concluding initial steps to plan for tomorrow's grid, in support of a low-carbon future

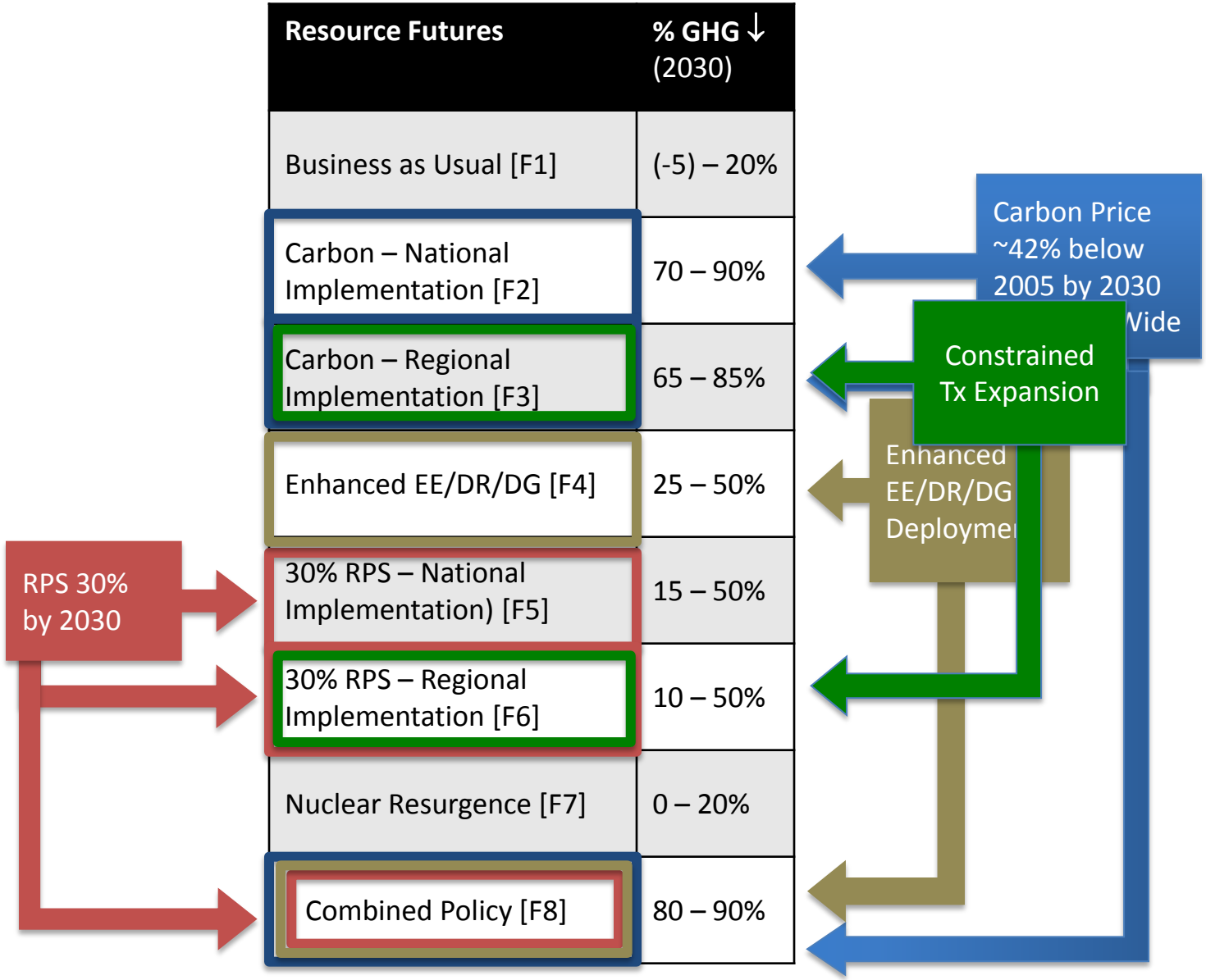
Resource Futures	% GHG ↓ (2030)
Business as Usual [F1]	(-5) – 20%
Carbon – National Implementation [F2]	70 – 90%
Carbon – Regional Implementation [F3]	65 – 85%
Enhanced EE/DR/DG [F4]	25 – 50%
30% RPS – National Implementation) [F5]	15 – 50%
30% RPS – Regional Implementation [F6]	10 – 50%
Nuclear Resurgence [F7]	0 – 20%
Combined Policy [F8]	80 – 90%

Carbon Price ~42% below 2005 by 2030 Economy-Wide

Enhanced EE/DR/DG Deployment

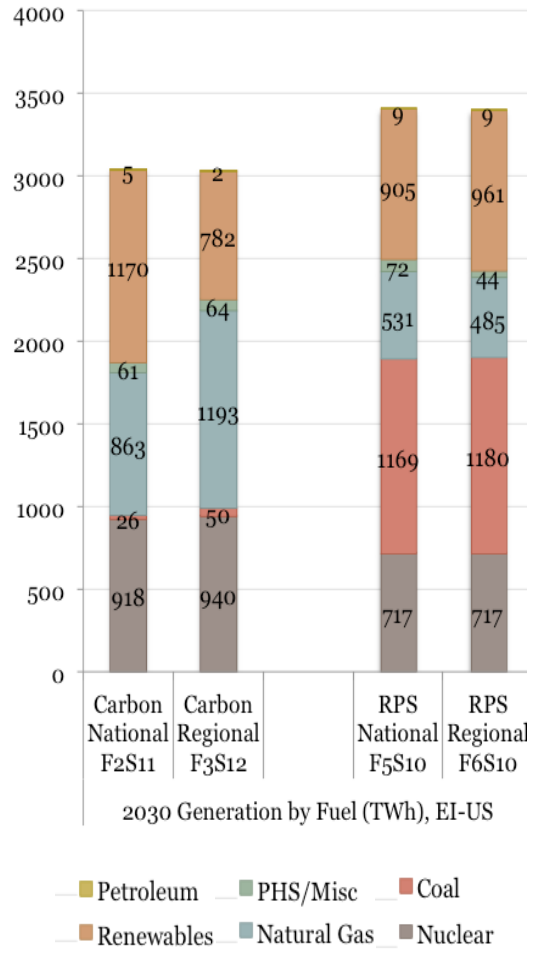
RPS 30% by 2030

… and a couple of "futures" study the consequences of constrained transmission

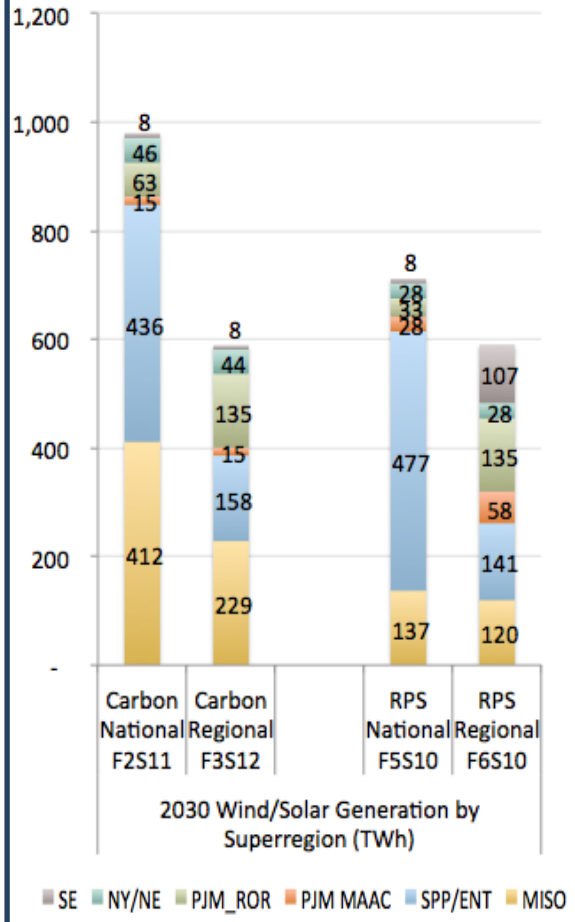


Transmission constraints hindered optimization around fuel mix, renewable resource use and cost

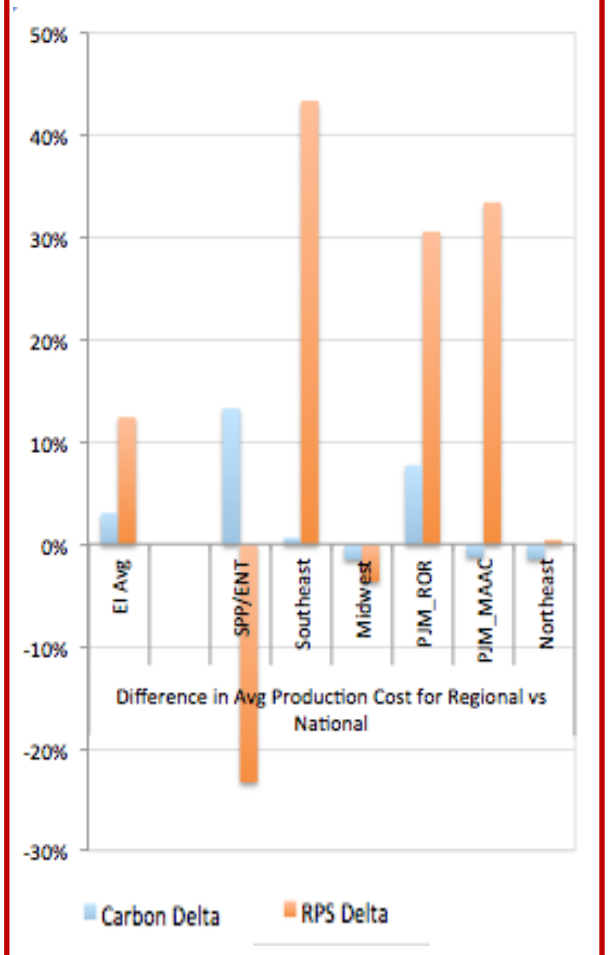
Fuel mix: Smaller share of renewables w/ constrained transmission; or under RPS, targets achieved with higher cost options.



Resource use: Naturally available renewable resources cannot be fully tapped w/ constrained transmission.



Cost: Higher cost of implementation w/ constrained transmission (3 – 12 percent higher).



Five key ingredients are needed to achieve an improved transmission system

Policy trends, research and operational experience are moving in a favorable direction

An improved transmission system is needed to capitalize on renewables, distributed generation, energy efficiency and demand response, to progress towards a low-carbon future, **via:**

- Coordinated transmission planning (including states and federal)
  - FERC Order 1000, EIPC process are assisting
- Greater transmission buildout in strategic locations / regions, to increase overall connectivity
  - Greater flow within interconnections
  - Greater flow between interconnections (Eastern, Western, ERCOT)
- Greater operational flexibility and processes (in addition to transmission infrastructure)
  - Enhanced balancing authority cooperation, coordination and consolidation (e.g., Texas, MISO, PJM)
  - New ancillary service markets and more efficient markets
- Progressive oversight of transmission systems to promote low-carbon energy sources
- New technologies
  - Truly smart grids for demand/supply management
  - Storage technologies (including electric vehicles)
  - Improved renewable energy forecasting

"Most people who don't see this high renewables future possible are thinking about the current grid and adding in a small amount of renewables. But the grid we want is one where we deploy energy efficiency first, then renewables, and then back them up with storage and back that up with natural gas."

-- Dan Kammen, UC Berkeley

APPENDIX

It could make economic sense for the Southeast to make use of Midwest wind

Wind siting strategy

As an increasing number of states in the MISO footprint began to enact renewable energy mandates or goals, a strategy for siting wind generation was required to minimize the cost of delivered energy to consumers. To determine the low cost solution, encompassing generation and transmission capital cost, MISO developed a set of potential energy zones or locations where wind generation could feasibly be located, on a state by state basis[29]. In conjunction with state regulators and other stakeholders, MISO used these zones to explore a number of long term transmission and generation strategies to meet the state RPS requirements. These analyses focused on the tradeoffs between local wind generation, which typically requires less transmission expansion but a larger amount of wind turbines to deliver a given amount of wind energy; versus regional wind generation, which requires fewer wind turbines at the cost of higher levels of transmission expansion.

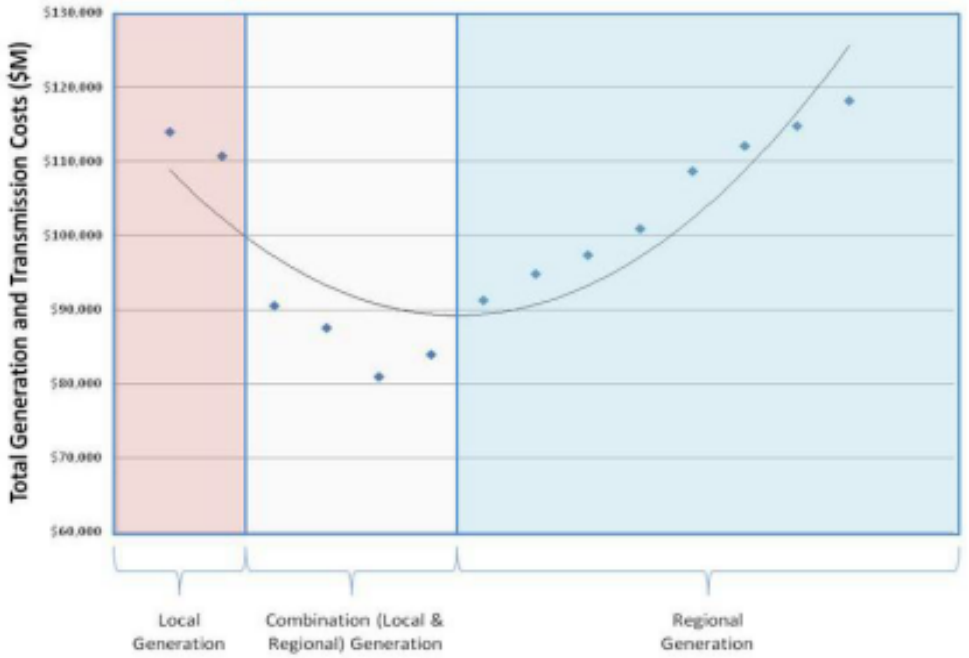
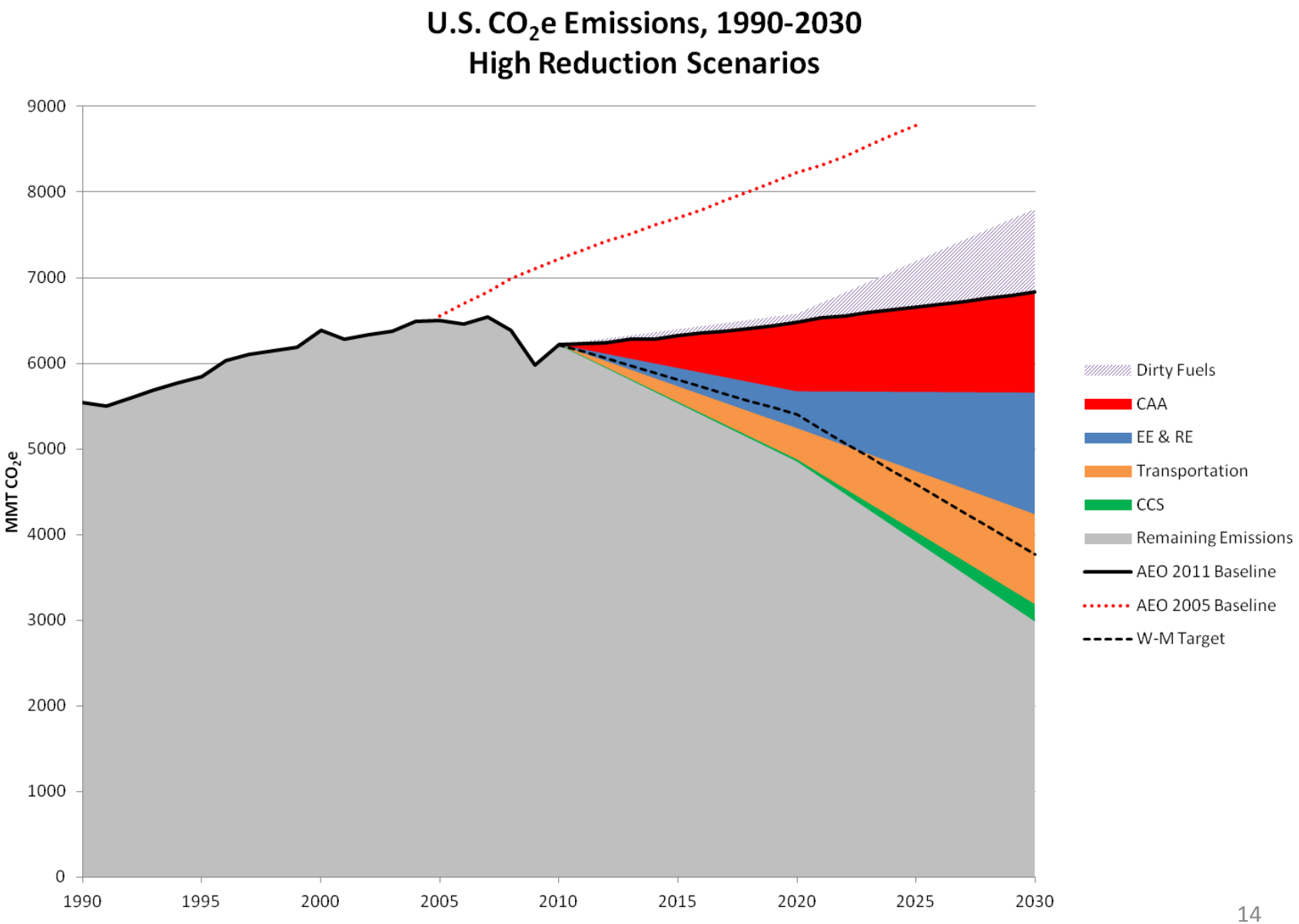


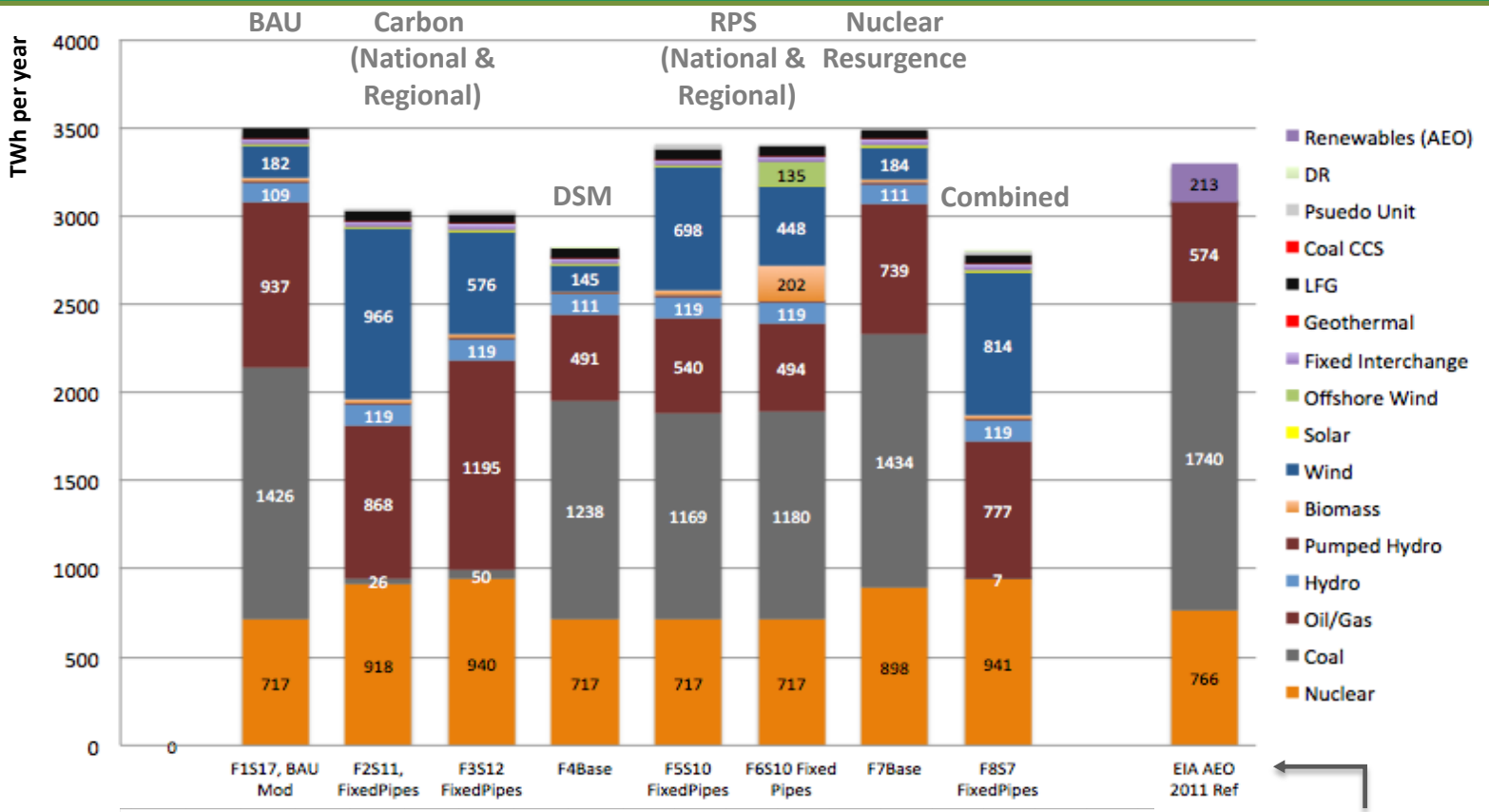
Figure 4.1-9: Capital costs of transmission and generation

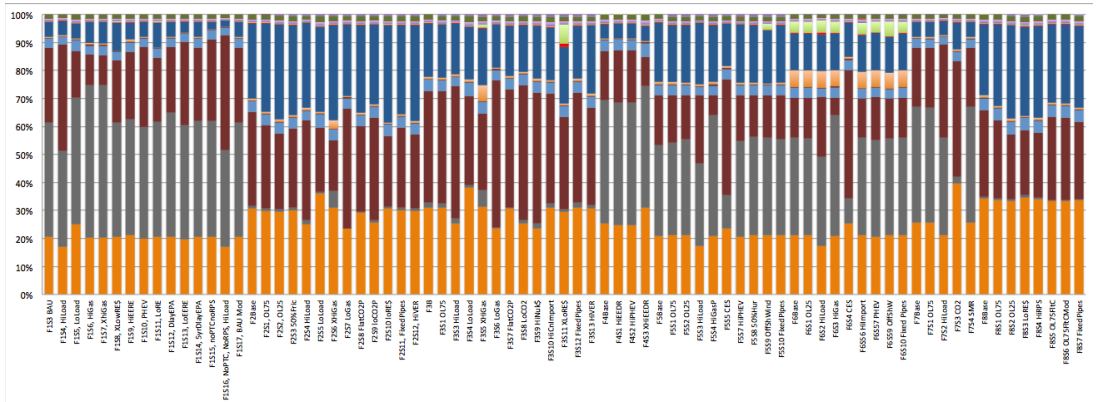
MISO Transmission Expansion Plan, pages 56-57.
Available at: https://www.midwestiso.org/Library/Repository/Study/MTEP/MTEP11/MTEP11%20Report.pdf

Progress is being made on climate



EIPC Phase I results: Combined policy shows greatest emissions reductions





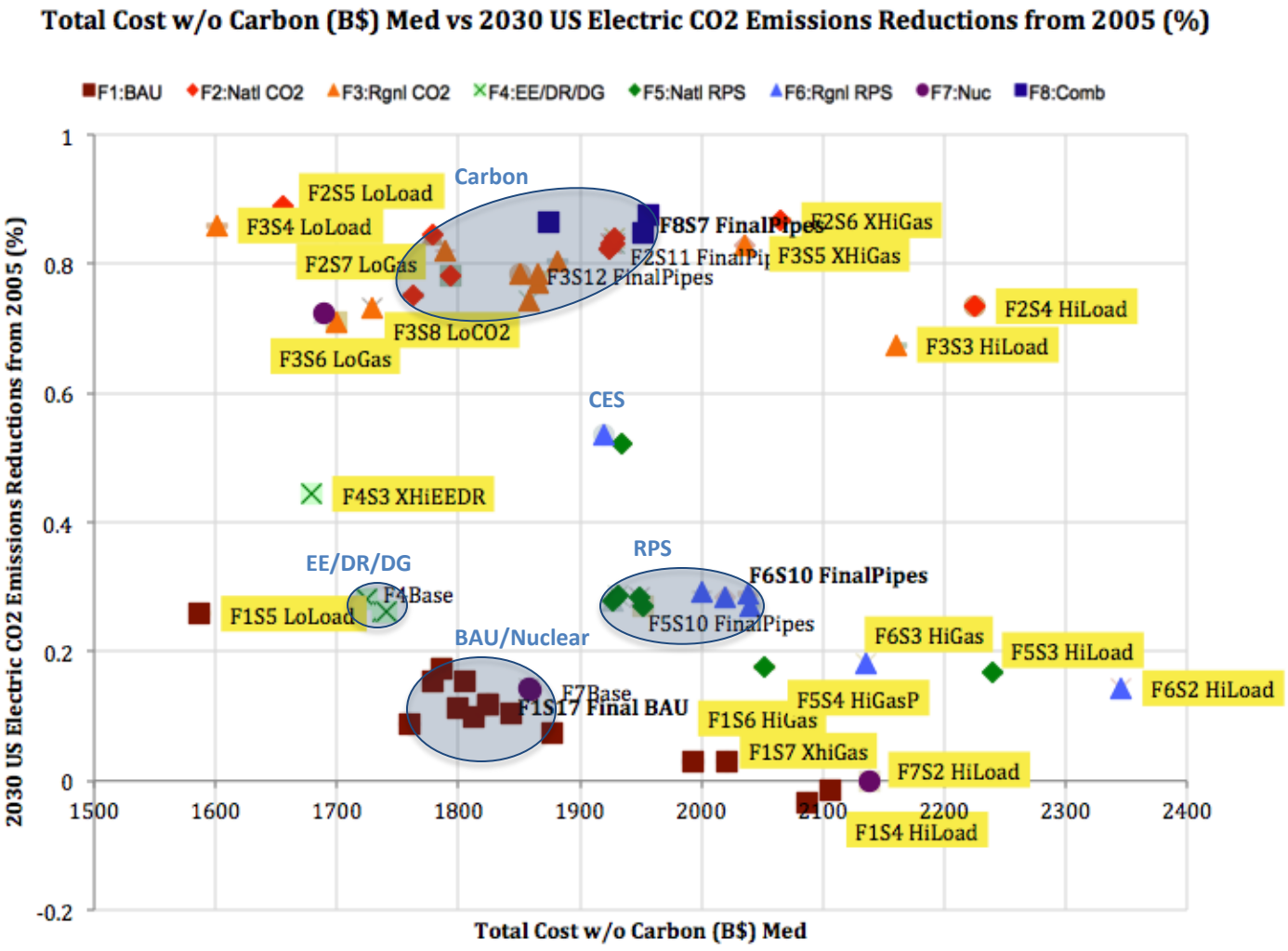
2030 generation by fuel for the central modeling run of each of the 8 resource futures

2030 generation shares as a fraction of total annual TWh for all 80 modeling runs

Note: AEO 2011 reference case is provided for comparison and shows significant increase in natural gas use in the EIPC BAU despite identical cost inputs in the two models

Total cost generally lower under carbon price and under combined policy scenario

Strong correlation between cost and GHG emissions reduction is not clear

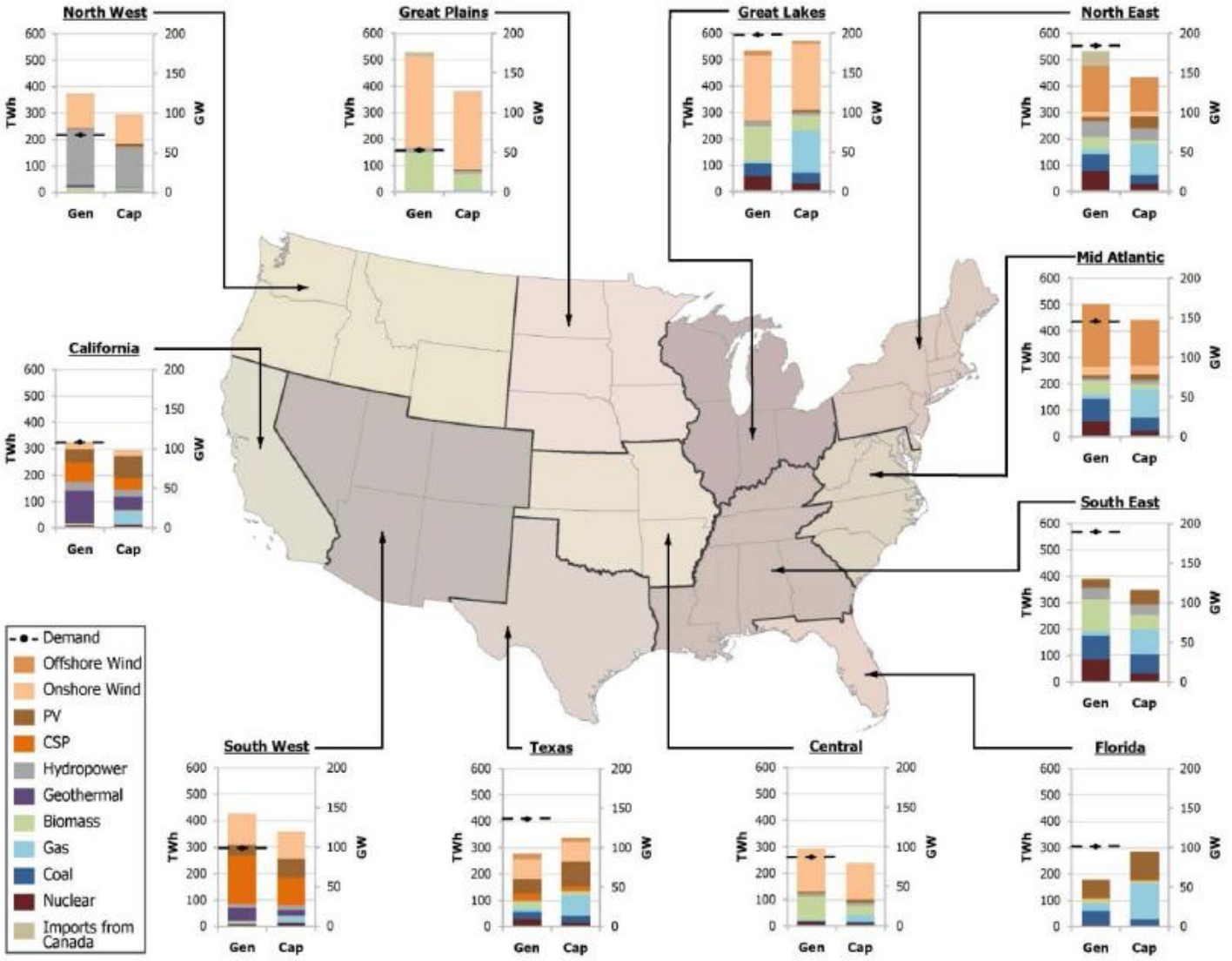


A 2D plot of all 80 modeling runs mapped in terms of GHG reeductions in the power sector relative to 2005 versus total cost

Note:
The uncertainty in natural gas price and load growth produces a much larger dispersion in total cost than large scale GHG abatement measures and energy policy driver.

Total cost shows no decernible correlation with GHG emission reduction fraction.

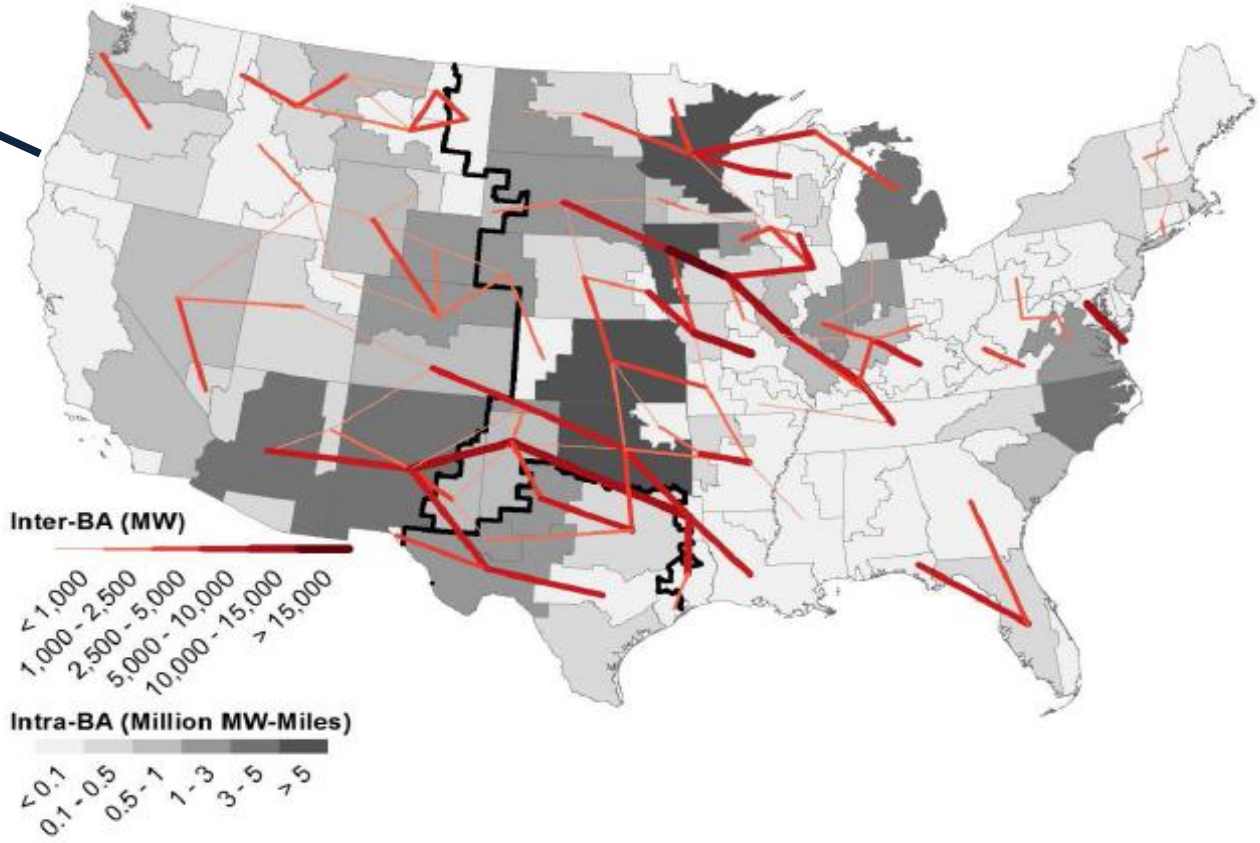
Important (renewable) energy sources by region



An improved transmission system is essential for a low-carbon future

"As renewable electricity generation increases, additional transmission infrastructure is required to:

- *deliver generation from cost-effective remote renewable resources to load centers,*
- *smooth output profiles of variable resources by enabling greater geospatial diversity,*
- *enable reserve sharing over greater distances."*



NREL Renewable Electricity Futures. Emphases added.

Regional, as opposed to national, implementation futures constrained transmission to study the consequences

- Transmission modeled in the Eastern Interconnection using a “bubble and pipe” model
  - Used to evaluate the evolution of the bulk power system through 2030
  - Transmission expansion is modeled by evaluating economic drivers such as the differences in power prices between adjacent regions
- Transmission expansion was constrained in two of the futures, by <u>not</u> allowing certain power lines to expand as needed