Tools for 111(d) Compliance Planning

Technical Summit on EPA's Carbon Pollution Standards

Atlanta, Georgia

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# Agenda

1. Spreadsheet Tools
   a. Coal Asset Valuation Tool or CAVT (Synapse)
   b. 111(d) Cost Estimate Tool (Synapse)
   c. Excel based tools (various)

2. AVERT (EPA)

3. Utility System Models
   a. Strategist (Ventyx)
   b. EGEAS (EPRI)

4. Regional Electric System Models
   a. PROMOD (Ventyx)
   b. PROSYM (Ventyx)
   c. GEMAPS (General Electric)
   d. PLEXOS (Energy Exemplar)

5. National Electric System Models
   a. NEMS (EIA)
   b. IPM (ICF)
   c. REEDS (NREL)
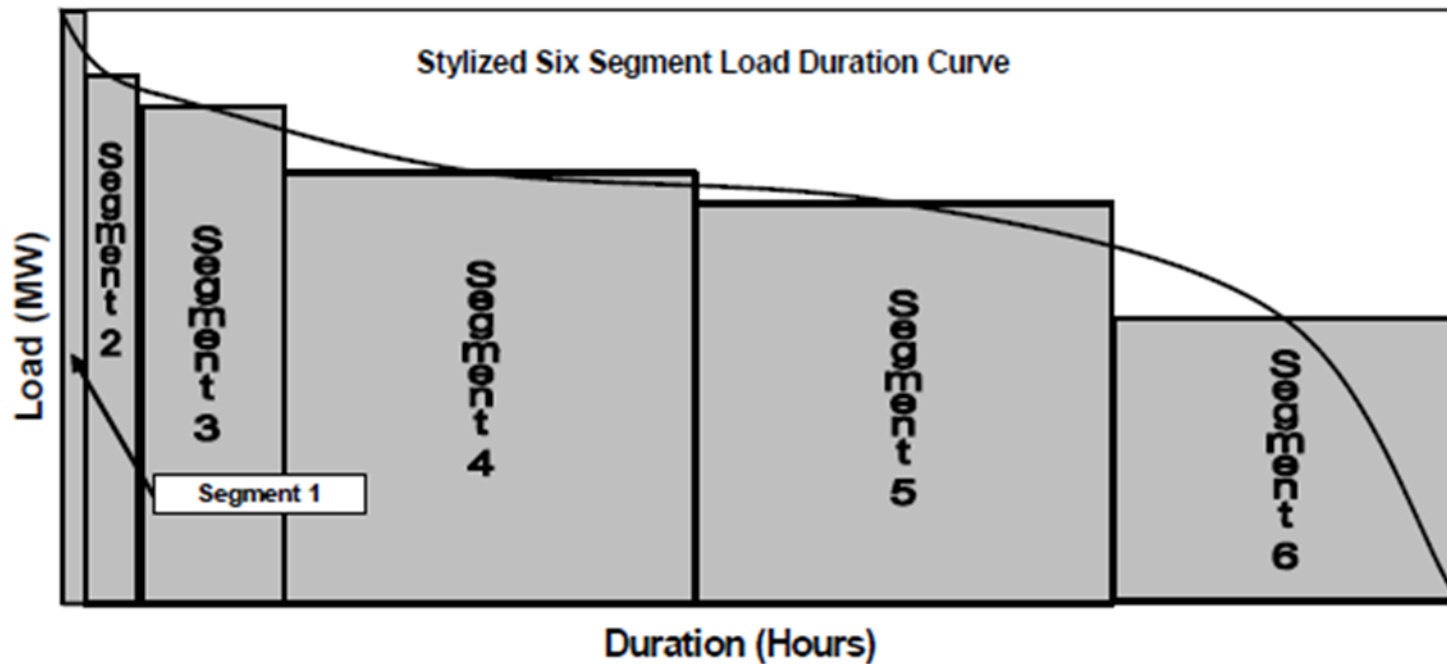
Temporal Resolution – Production Cost Model
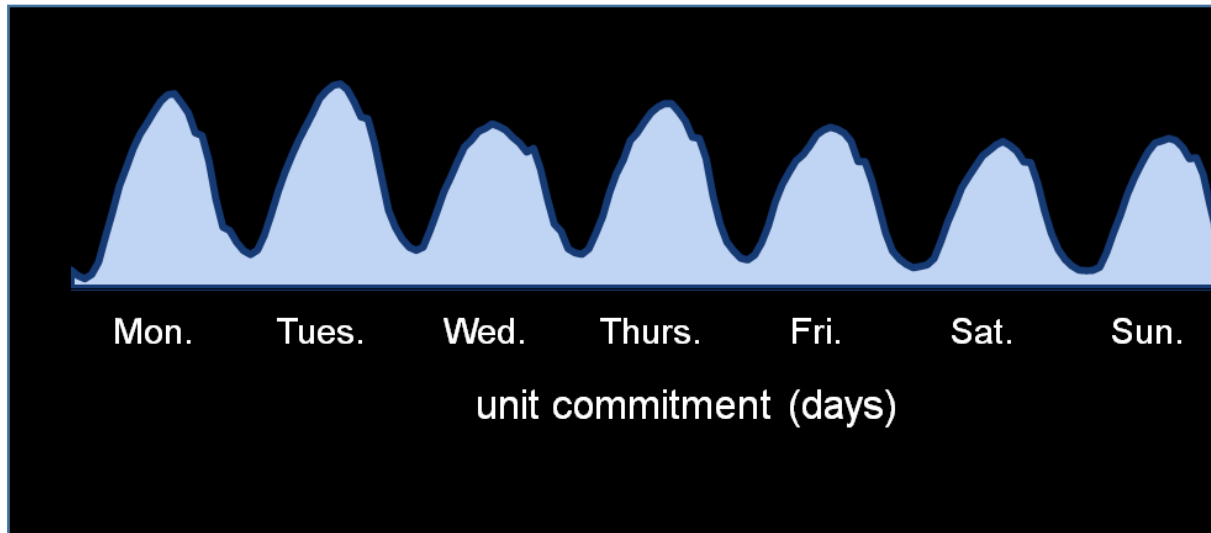
Temporal Resolution – One Approximation

Load Duration Curve
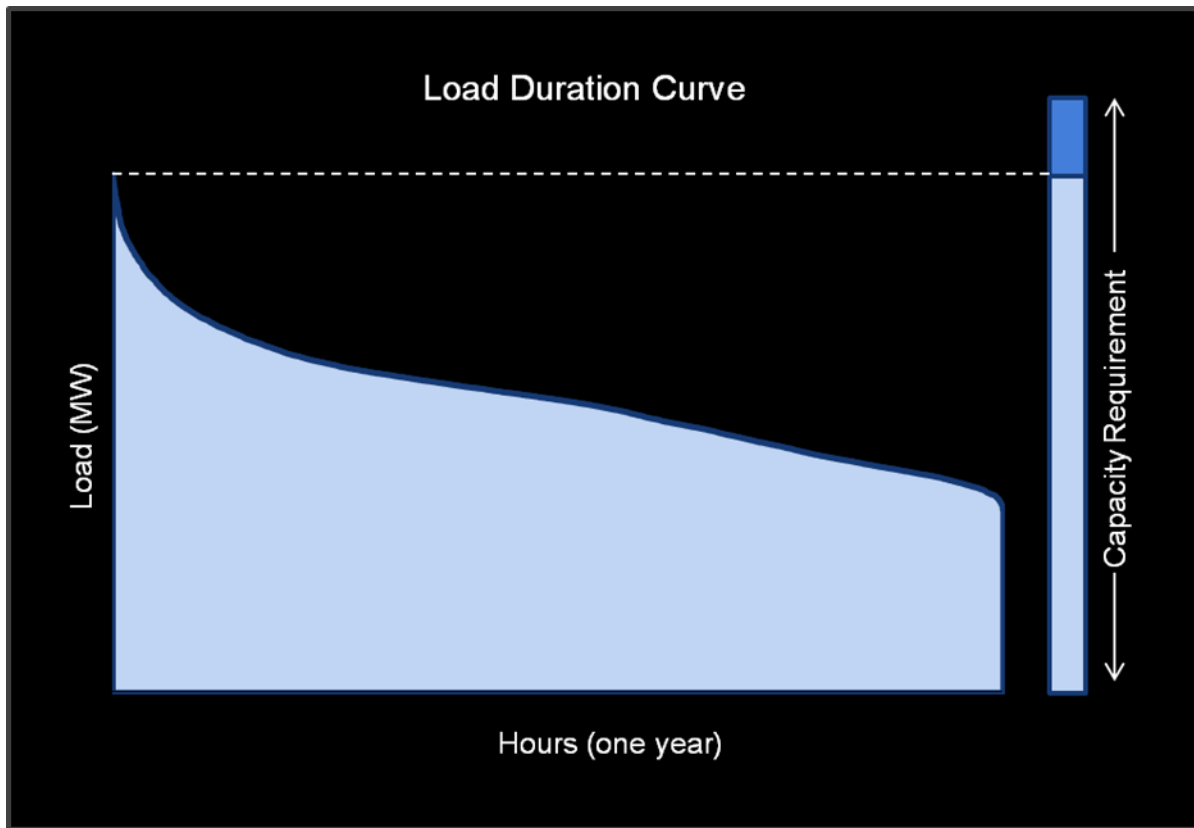
Temporal Resolution – Another Approximation

Stylized Six Segment Load Duration Curve

1. Spreadsheet Tools

What is CAVT?

- CAVT is a spreadsheet-based database and model.

- It aggregates publicly available data (such as capacity, generated power, and heat rate) on ~1,000
non-cogenerating coal units

- CAVT combines this with publicly available cost methodologies to calculate the cost of complying with environmental regulations

- It adds in environmental retrofit capital and O&M costs for the year the control is expected to come into effect. The net present value of each unit's lifetime cost is then calculated for 2013 through 2042.

- CAVT then compares these economics with proxy values for energy market prices.

What is CAVT For?

- **Preliminary assessment of coal asset value**. Providing publicly available estimates, triggering public and commission scrutiny where otherwise obscured, compelling utility planning where otherwise absent

- **Starting point for detailed, unit-specific cash flow analysis**. Generic publicly available data can be replaced with unit-specific (and possibly confidential) data incrementally, as such data are obtained

- **Prioritization and screening**. Identifying candidates for retirement and focusing advocacy efforts

- **National and regional analyses**. Developing and costing out broadly defined coal fleet retrofit/retirement scenarios

Limitations and caveats:

- *Where possible, users should review CAVT assumptions for specific cases, particularly with regard to individual units*

- *CAVT uses numerous simplifying assumptions (e.g., capacity factors are fixed over time)*

CAVT Results: Mid-cases and Sensitivities

## Uneconomic Coal Capacity Compared to Energy-Only Purchases (GW)

	Environmental Retrofit		
	Lenient	Mid	Strict
High	192 (62%)		292 (94%)
Natural Gas Price — **Mid**		295 (95%)	
Low	254 (82%)		306 (98%)

Uneconomic Coal Capacity Compared to All-In Purchases (GW)

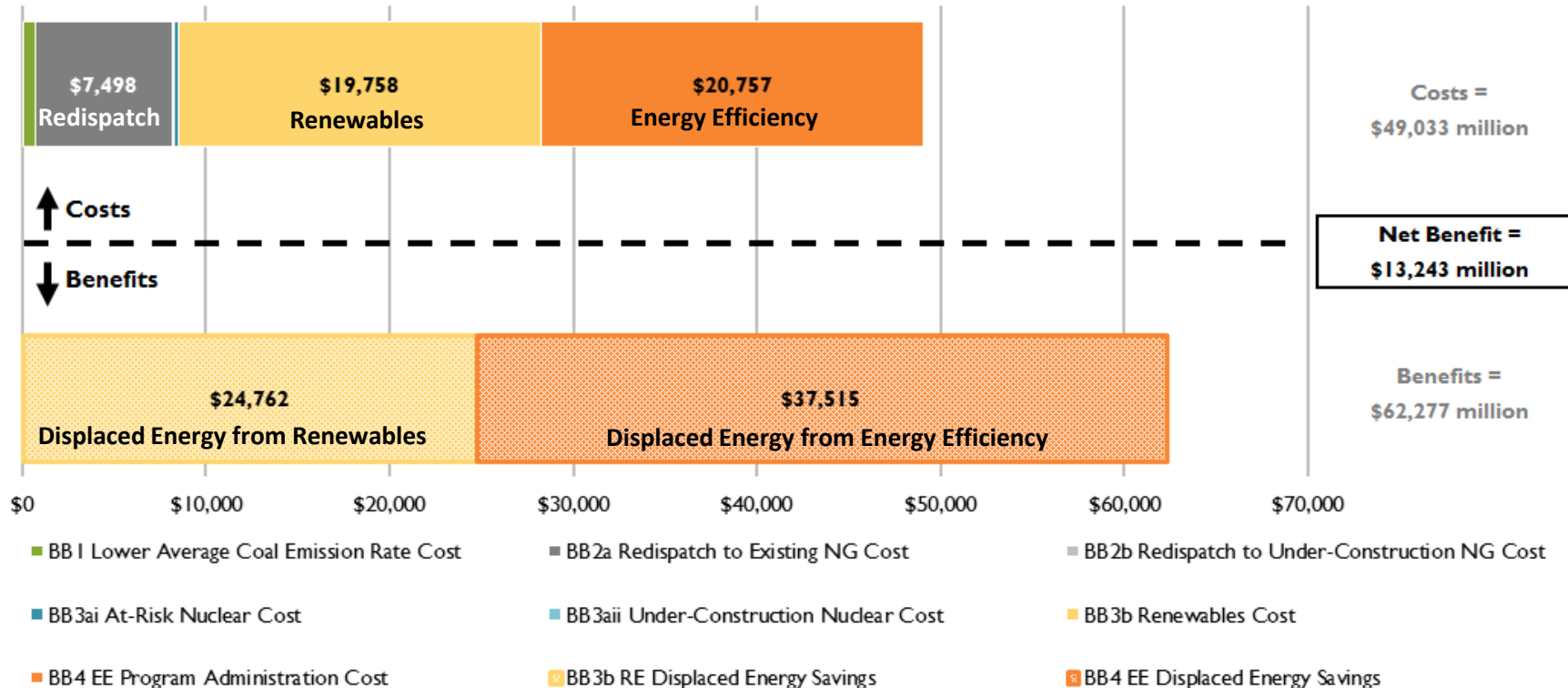|	Environmental Retrofit		
	Lenient	Mid	Strict
High	63 (20%)		230 (74%)
Natural Gas Price — **Mid**		228 (73%)	
Low	101 (33%)		274 (88%)

Source: Knight, P., E. A. Stanton, J. Fisher, B. Biewald. 2013. *Forecasting Coal Unit Competitiveness: Coal Retirement Assessment Using Synapse's Coal Asset Valuation Tool (CAVT).* Synapse Energy Economics.

TVA's Colbert Fossil Plant in Alabama: A Case Study in Uneconomic Coal
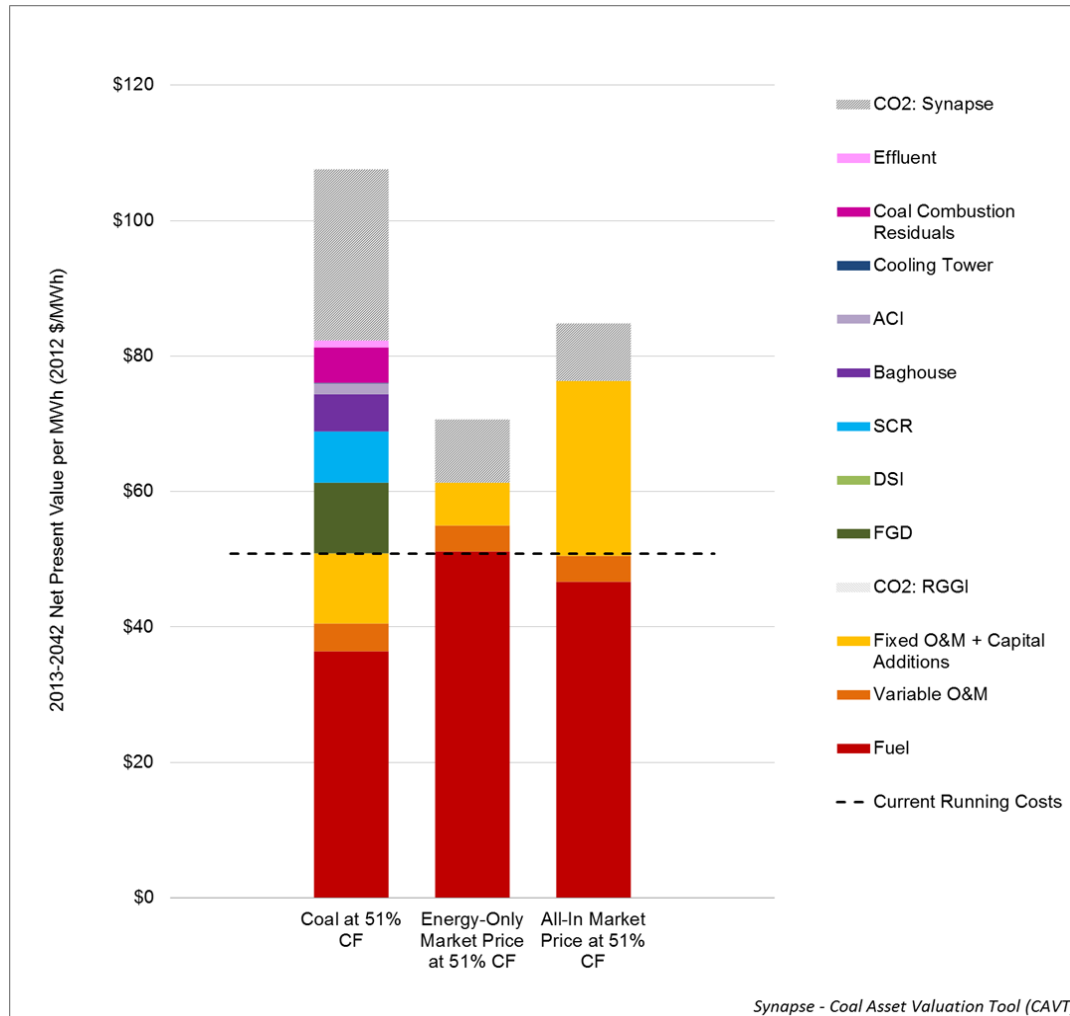
111(d) Cost Estimate Tool: 2030 U.S. Electric-Sector Costs and Benefits

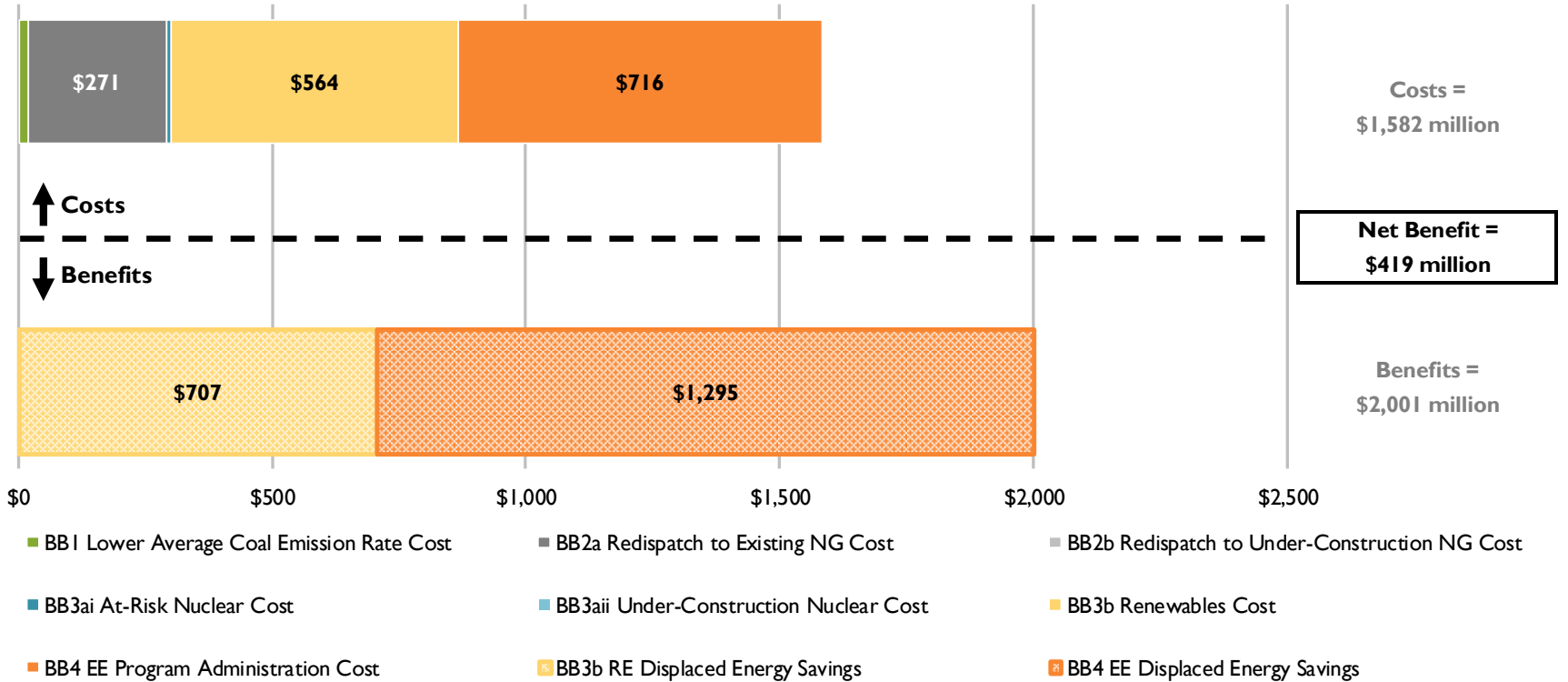## 2030 U.S. Total Electric Sector Costs and Benefits of 111(d) Compliance (millions of 2011 $)

	BBI	BB2a	BB2b	BB3ai	BB3aii	BB3b	BB4	BB3b	BB4	Net
(Costs) and Savings	($684)	($7,498)	($69)	($267)	$0	($19,758)	($20,757)	$24,762	$37,515	$13,243
Percent of Net Savings	1%	15%	0%	1%	0%	40%	42%	-51%	-77%	

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111(d) Cost Estimate Tool: 2030 Georgia Electric-Sector Costs and Benefits

2030 Georgia Electric Sector Costs and Benefits of 111(d) Compliance (millions of 2011 $)

- ■ BB1 Lower Average Coal Emission Rate Cost
- ■ BB2a Redispatch to Existing NG Cost
- ■ BB2b Redispatch to Under-Construction NG Cost
- ■ BB3ai At-Risk Nuclear Cost
- ■ BB3aii Under-Construction Nuclear Cost
- ■ BB3b Renewables Cost
- ■ BB4 EE Program Administration Cost
- ▨ BB3b RE Displaced Energy Savings
- ▨ BB4 EE Displaced Energy Savings

Note: Values estimated by Synapse. Does not include energy efficiency participant costs or climate and health benefits.

	BB1	BB2a	BB2b	BB3ai	BB3aii	BB3b	BB4	BB3b	BB4	Net
(Costs) and Savings	($20)	($271)	$0	($11)	$0	($564)	($716)	$707	$1,295	$419
Percent of Costs	1%	17%	0%	1%	0%	36%	45%	-45%	-82%	

Where Can I Get Synapse's CAVT and 111(d) Cost Estimate Tool?

- **CAVT (Coal Asset Valuation Tool):** Free, open-source tool used for calculating the costs of complying with upcoming environmental regulations for coal plants (contact pknight@synapse-energy.com for more information)

- **EPA 111(d) Cost Estimate Tool:** Excel workbook breaking down each state's 111(d) building blocks and accompany cost estimates (available at http://www.synapse-energy.com/Downloads/SynapseReport.2014-07.0.111(d)-Cost-Estimate-Tool.14-026.xlsm)

2. AVERT

What is AVERT?

- AVERT – "Avoided Emissions and Generation Tool"

- AVERT began development in 2012 as EPA began to search for a tool that could provide users the capability to estimate the changes in generation and emissions at particular generating units due to new renewable energy (RE) and energy efficiency (EE) projects

- AVERT is now an EPA-approved tool used to translate the energy impacts of EE/RE policies and programs into emission reductions (NO_X, SO_2, CO_2)

What is AVERT?

- AVERT aims to fill the gap between expensive and work-intensive tools (like dispatch models) and the use of generic state-by-state marginal emission rates

Basic Method eGRID region non-baseload emission rates	**Intermediate Method** Historical hourly emission rates	**Sophisticated Method** Energy Modeling

Economic parameters

End use demand

User defined constraints

Emission factors

Energy Model

Technology data

Fuel data

Environmental regulations

What is AVERT?

- AVERT was built to be:
  - user friendly
  - transparent
  - credible
- AVERT has been thoroughly reviewed, well-documented and tested. EPA has:
  - Conducted external and internal peer reviews
  - Benchmarked AVERT against industry-standard electric power sector model (PROSYM)
  - Worked with states to beta-tested tool for functionality, appropriate uses, and clarity of user manual
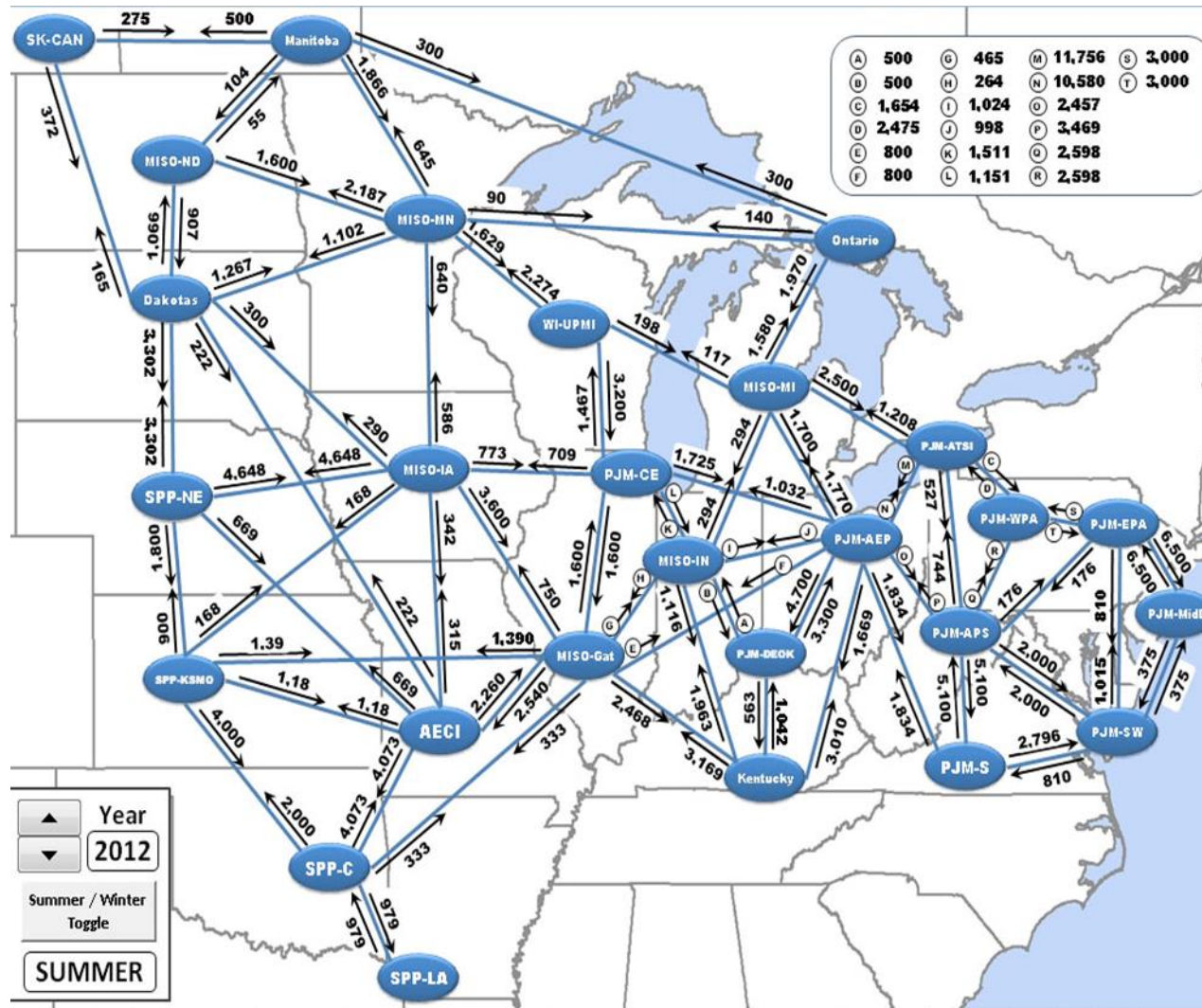
Where Can I Get AVERT?

On the EPA website: epa.gov/avert/

Soon, on the new Synapse website: www.synapse-energy.com

3. Utility System Models

Geographic Coverage Production Cost Model

Resource Expansion Models

Strategist, System Optimizer

- 20-year capacity expansion plan

- Minimization of System Costs

- Choice from a bundle of future technologies

- Dispatches based on some form of aggregated time (i.e., typical week)

- Run for a moderate sized region, typically a utility service territory

- Resources can be "picked" by the programmer or the model

Strategist Sample Output - Processed
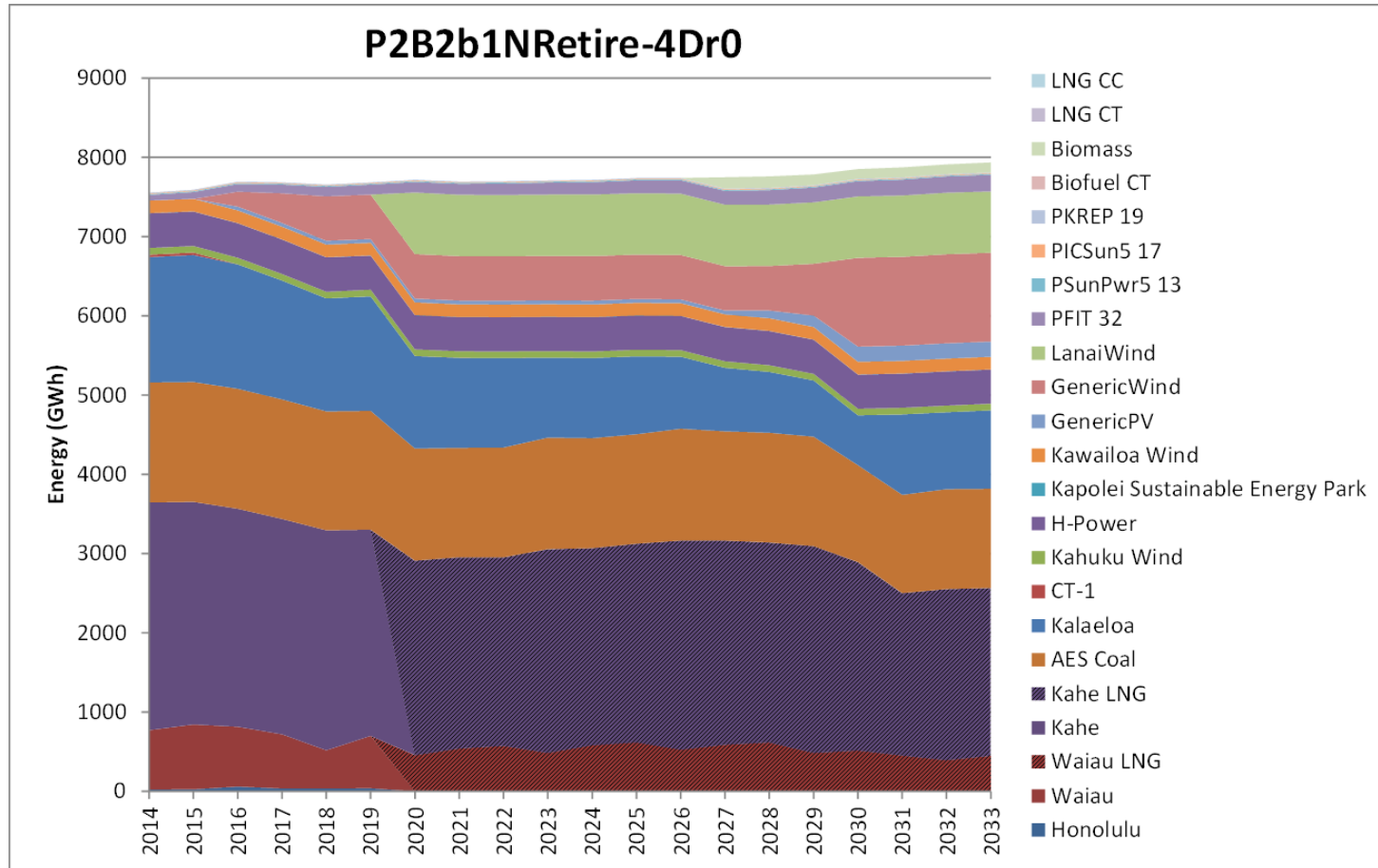
4. Regional Electric System Models

PROSYM Outputs

- Load and capacity reserves

- Transmission loadings

- Loss of Load expectation

- Fuel use

- Ancillary services

- Air emissions

- Market Prices

- Revenues

EIPC – Combining National Capacity Expansion & Production Cost Models

Carbon emissions profile, 2015-2040, Scenarios 1 and 3
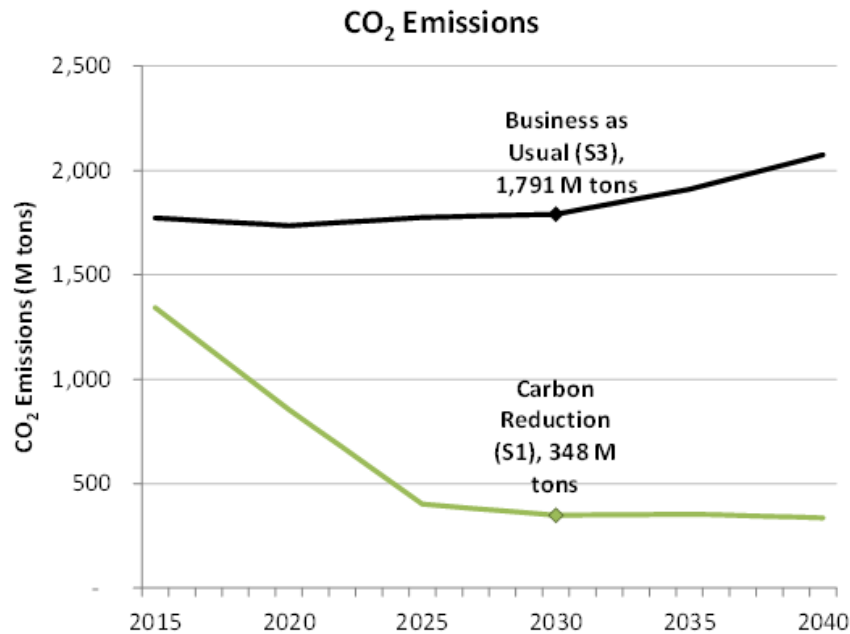
Source: Fagan, B., J. Fisher, B. Biewald. 2013. *An Expanded Analysis of the Costs and Benefits of Base Case and Carbon Reduction Scenarios in the EIPC Process.* Synapse Energy Economics for The Sustainable FERC Project.

5. National Electric System Models

NEMS Geographic Coverage – National Resource Expansion Model

Figure 6. Electricity Market Model Supply Regions

IPM Model Region Mappings

Legend:
- Interconnect
- PCA
- Wind/CSP Region
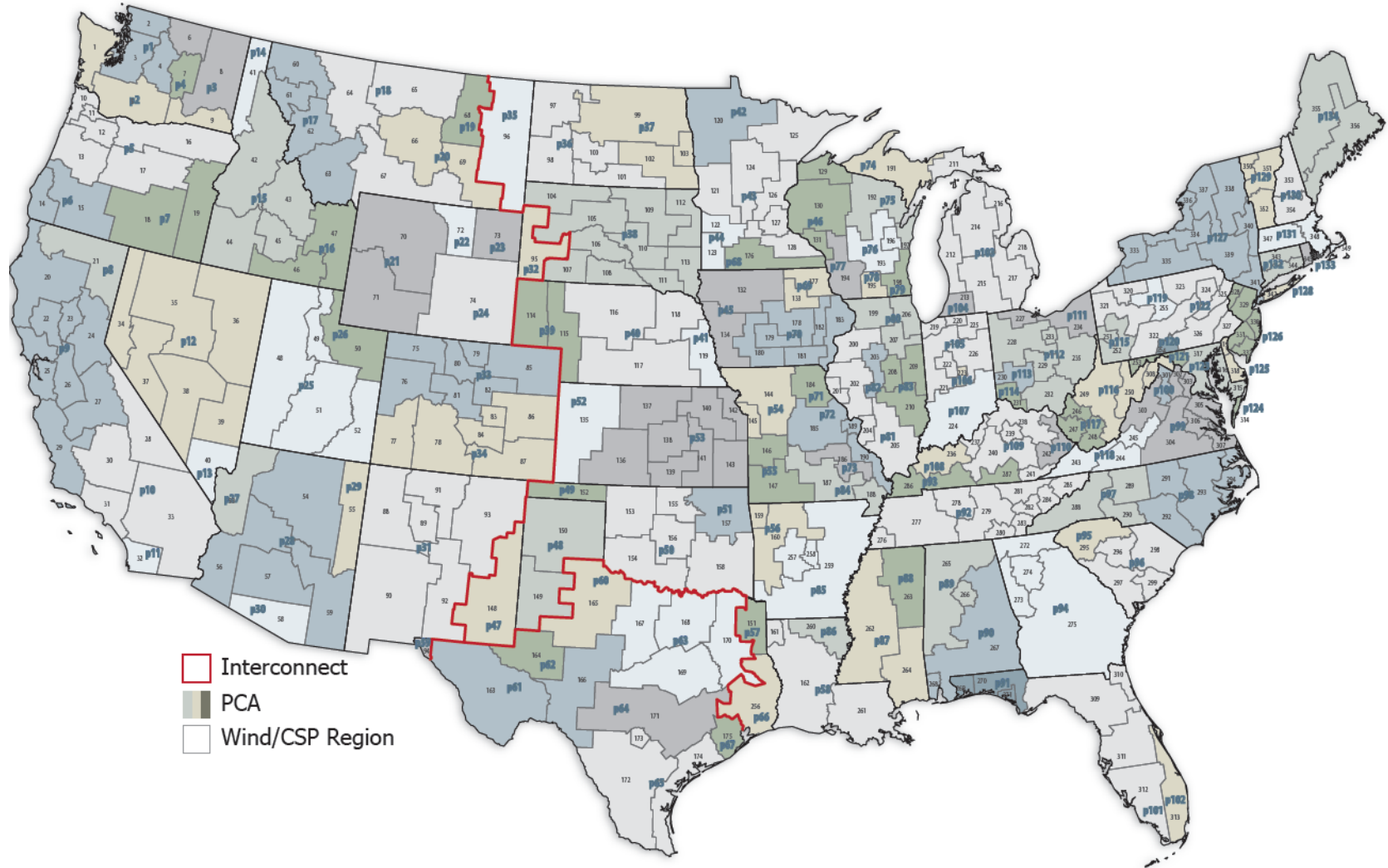
National Capacity Expansion Models – Representative Studies
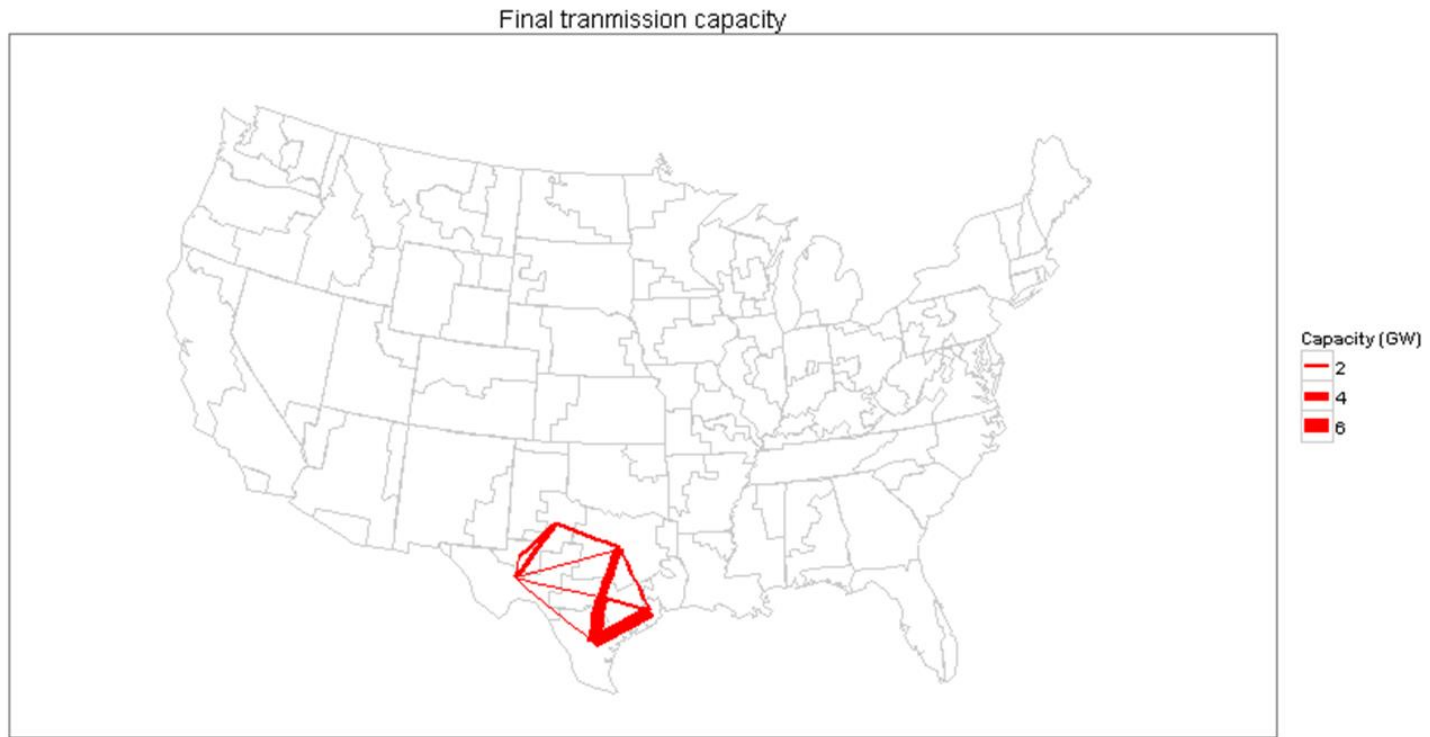
NEMS, IPM, ReEDS

- EIA Annual Energy Outlook

- EIA Analysis of Clean Energy Standard Act of 2012

- IPM Analysis of 111(d) (EPA and NRDC)

- NREL Renewable Electricity Futures

- 20% Wind by 2030

- Synapse ReEDS Analyses for Civil Society Institute, REMI, and the Energy Foundation

IPM Results for Coal in the Southeast

Capacity - Coal

Generation - Coal
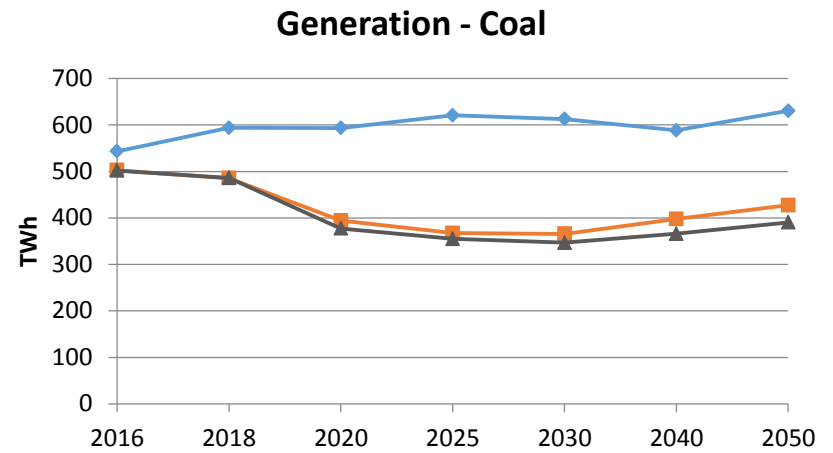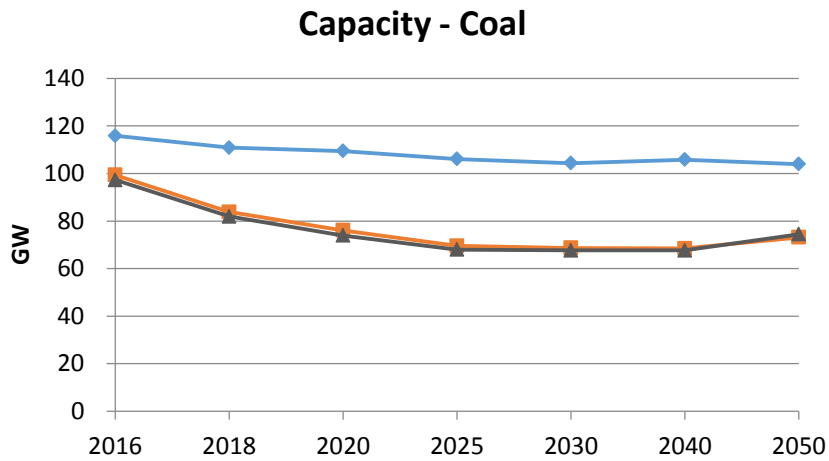
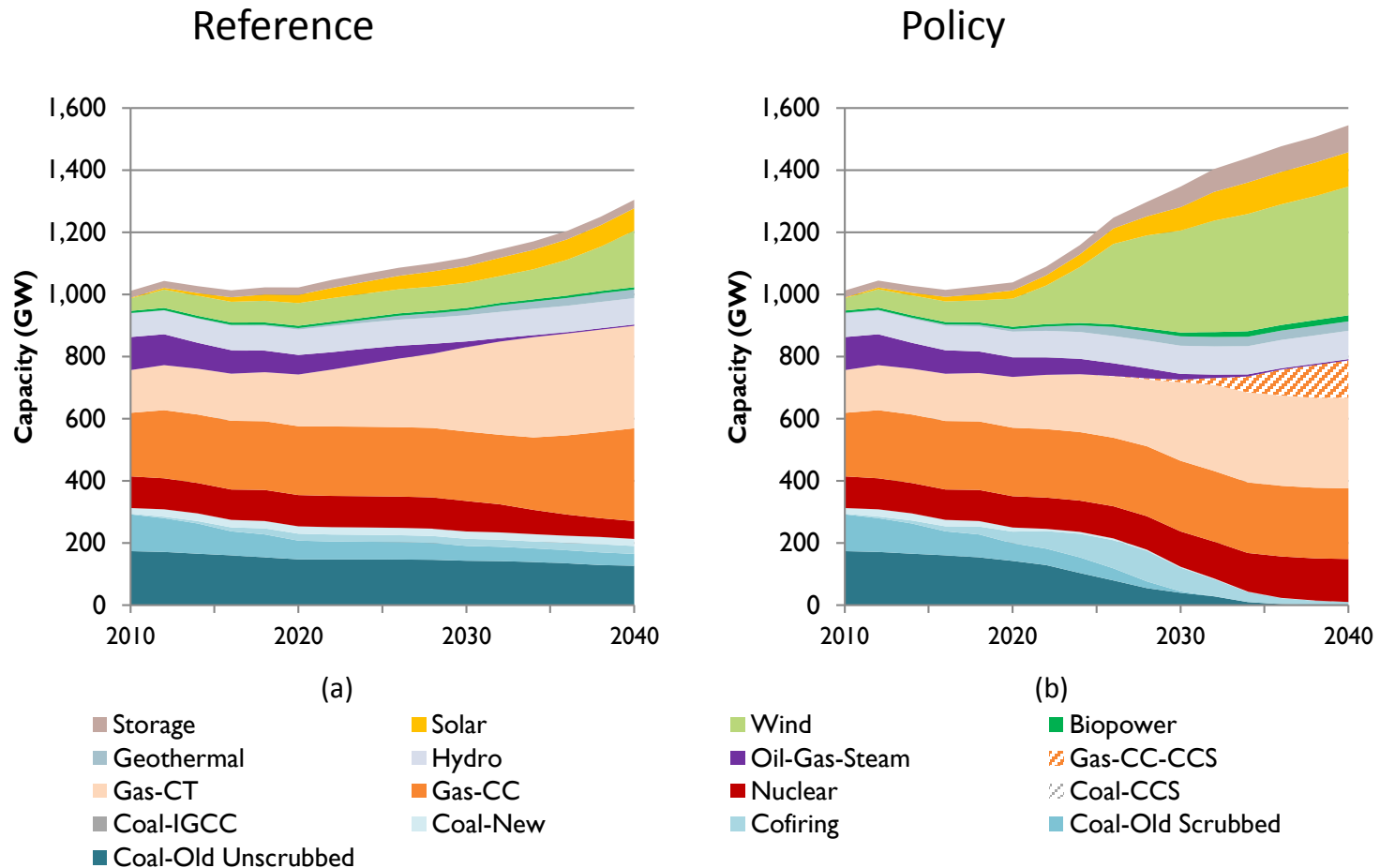
Source: White, D. 2014. *Southern States IPM Modeling Summary*. From "Southern" worksheets of analysis workbook "IPM Case Analysis 2014-08-08.xlsx."
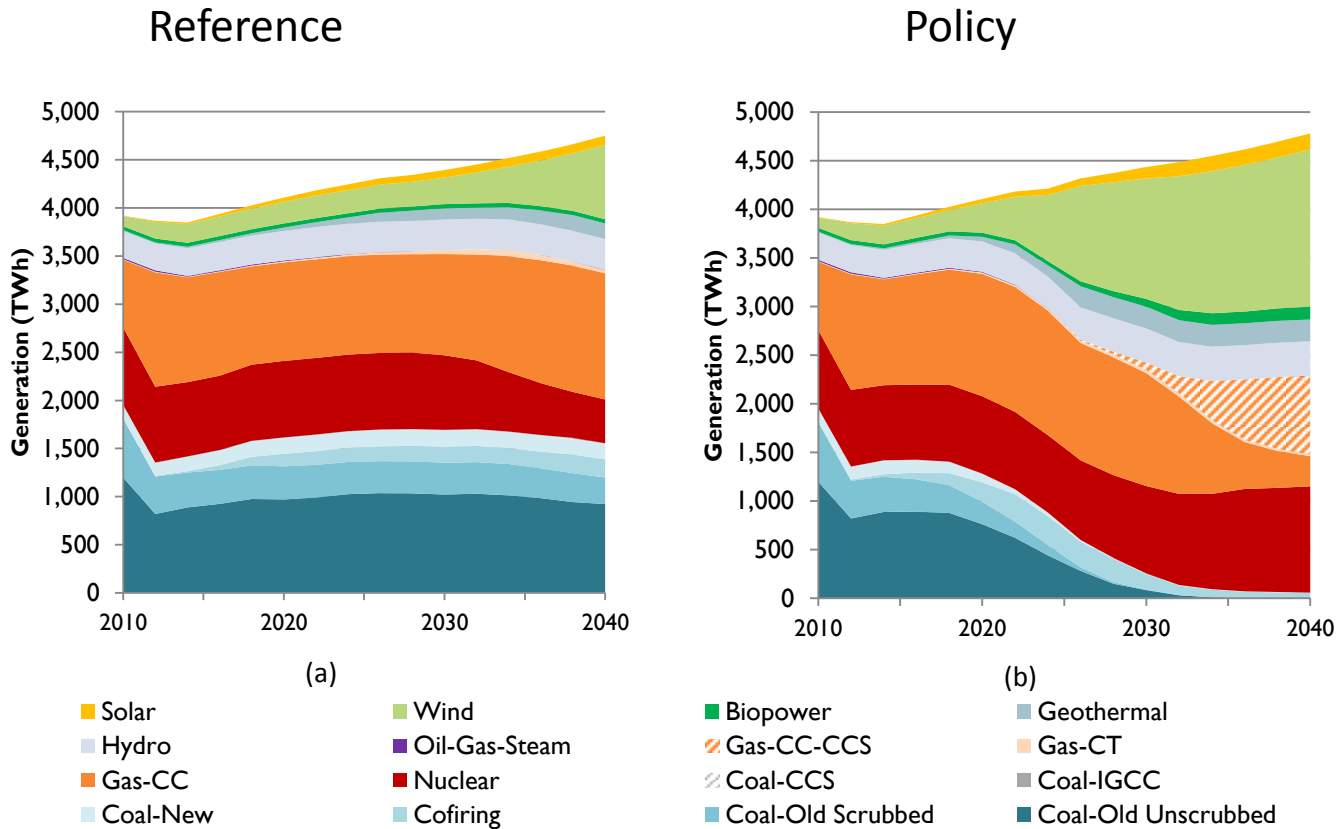
ReEDS Outputs

Final tranmission capacity

Capacity (GW)
— 2
— 4
— 6

ReEDS Capacity (GW)

Reference

Policy

(a)

(b)

Legend:
- Storage
- Solar
- Wind
- Biopower
- Geothermal
- Hydro
- Oil-Gas-Steam
- Gas-CC-CCS
- Gas-CT
- Gas-CC
- Nuclear
- Coal-CCS
- Coal-IGCC
- Coal-New
- Cofiring
- Coal-Old Scrubbed
- Coal-Old Unscrubbed

Source: Nystrom, S., P. Luckow. 2014. *The Economic, Climate, Fiscal, Power, and Demographic Impact of a National Fee-and-Dividend Carbon Tax.* Regional Economic Models, Inc. and Synapse Energy Economics for Citizens' Climate Lobby.

ReEDS Generation (TWh)

Reference

Policy

(a)

(b)

Legend: Solar, Wind, Biopower, Geothermal, Hydro, Oil-Gas-Steam, Gas-CC-CCS, Gas-CT, Gas-CC, Nuclear, Coal-CCS, Coal-IGCC, Coal-New, Cofiring, Coal-Old Scrubbed, Coal-Old Unscrubbed

Source: Nystrom, S., P. Luckow. 2014. *The Economic, Climate, Fiscal, Power, and Demographic Impact of a National Fee-and-Dividend Carbon Tax.* Regional Economic Models, Inc. and Synapse Energy Economics for Citizens' Climate Lobby.
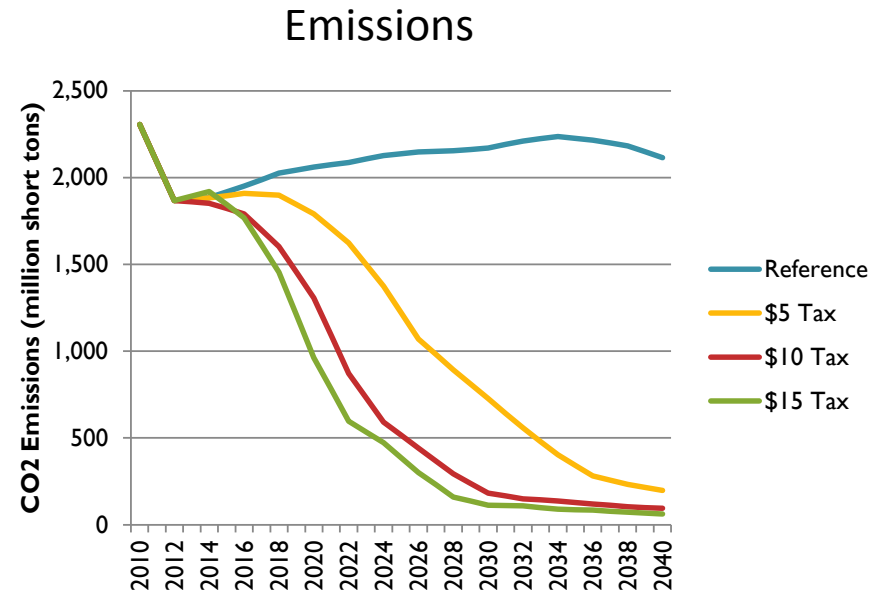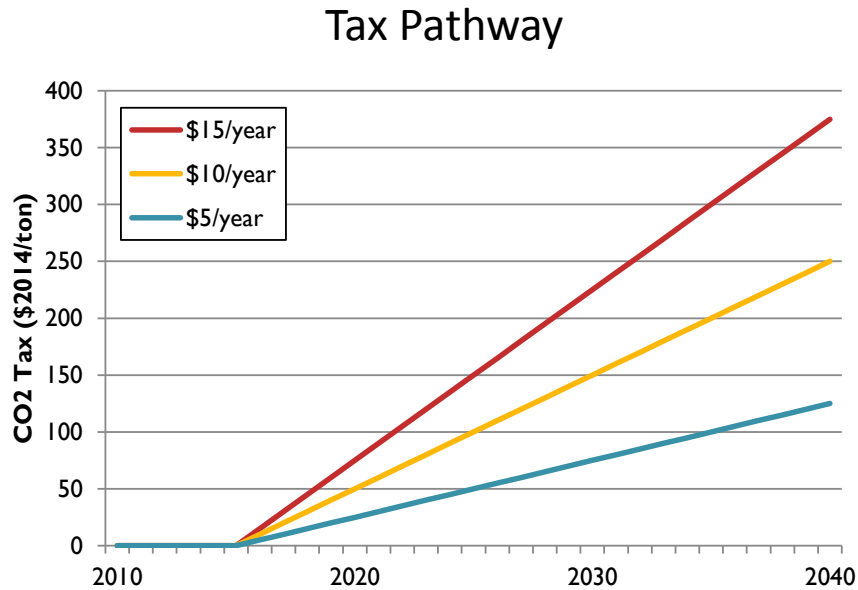
ReEDS Regional Results

2040 regional generation share by technology
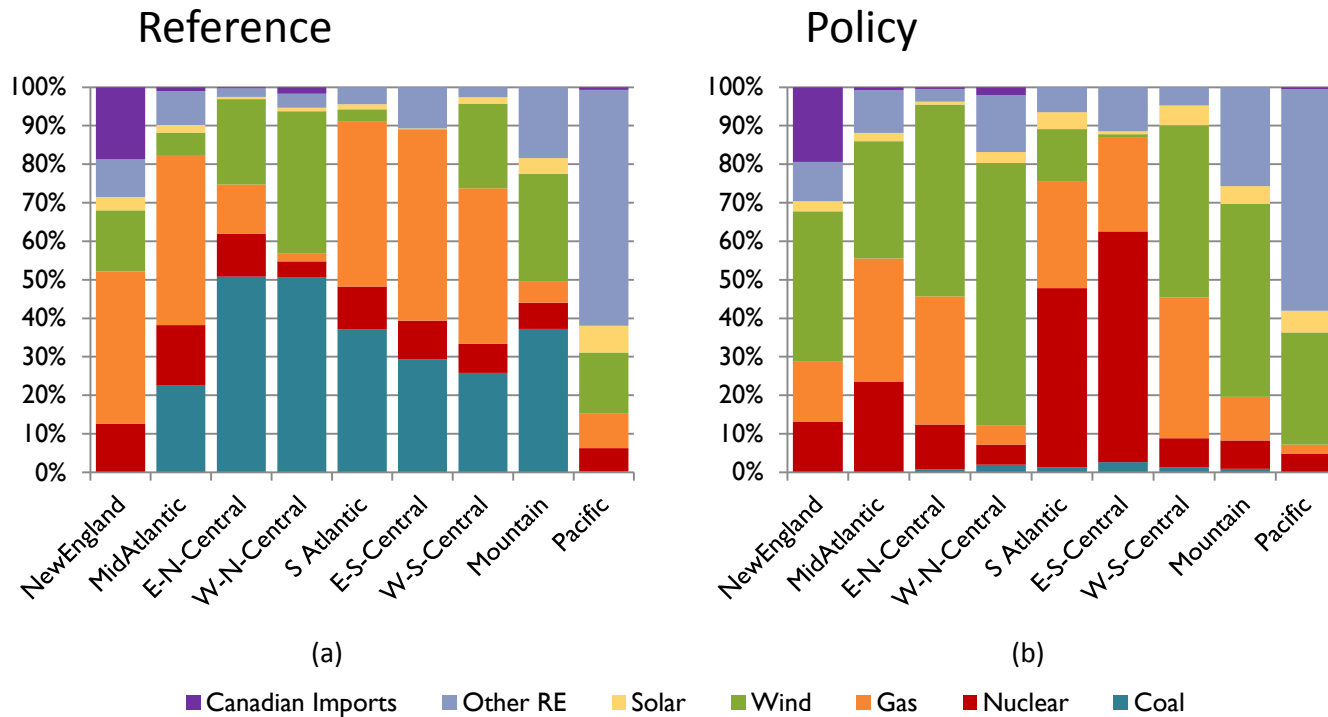
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ReEDS National CO$_2$ Emissions

Tax Pathway

Emissions

Models Have Strengths and Weaknesses

- **PLEXOS/PROSYM** good for hourly market prices, handle hourly conv gen dispatch in response to RE reasonably well

  - Require an assumed capacity build out

- **Strategist** optimizes new capacity based on assumed market conditions, but has limited hourly resolution for RE

  - Optimization only good if you let it optimize

- **ReEDS** good for regional/national response to policies as well as transmission optimization

  - Very limited representation of hourly conventional generation operation

Review of Tools for Compliance

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