Simulation of NY CES and RGGI Options

Dan Shawhan
RFF/Cornell

May 6, 2016

The Current Team

Daniel L. Shawhan[1,2,4], Ray D. Zimmerman[2],
Carlos Murillo-Sanchez[2,5], Biao Mao[*,4],
Daniel Tylavsky[3], Yujia Zhu[*,3],
and William D. Schulze[2]

[1]Resources for the Future, Washington, DC
[2]Cornell University, Ithaca, New York
[3]Arizona State University, Tempe, Arizona
[4]Rensselaer Polytechnic Institute, Troy, New York
[5]Universidad Nacional de Colombia, Bogota, Colombia
*Student (doctoral)

Key Acknowledgements

- DOE CERTS R&M program
- NYISO
- PSERC
- Energy Visuals, Inc.
- Dick Schuler, Bob Thomas, Joe Eto, Phil Overholt, Rana Mukerji, Steve Whitley, Mike Swider, Dejan Sobajic, collaborators, and past team members

1. THE SIMULATION TOOL

ENGINEERING, ECONOMIC, AND ENVIRONMENTAL ELECTRICITY SIMULATION TOOL

E4ST

Uses of E4 Simulation Tool

Project effects of

- Policies (various types)
- Investments
- Fuel prices
- Technology costs
- Demand changes
- Etc.

Optimize

- Investments
- Policies

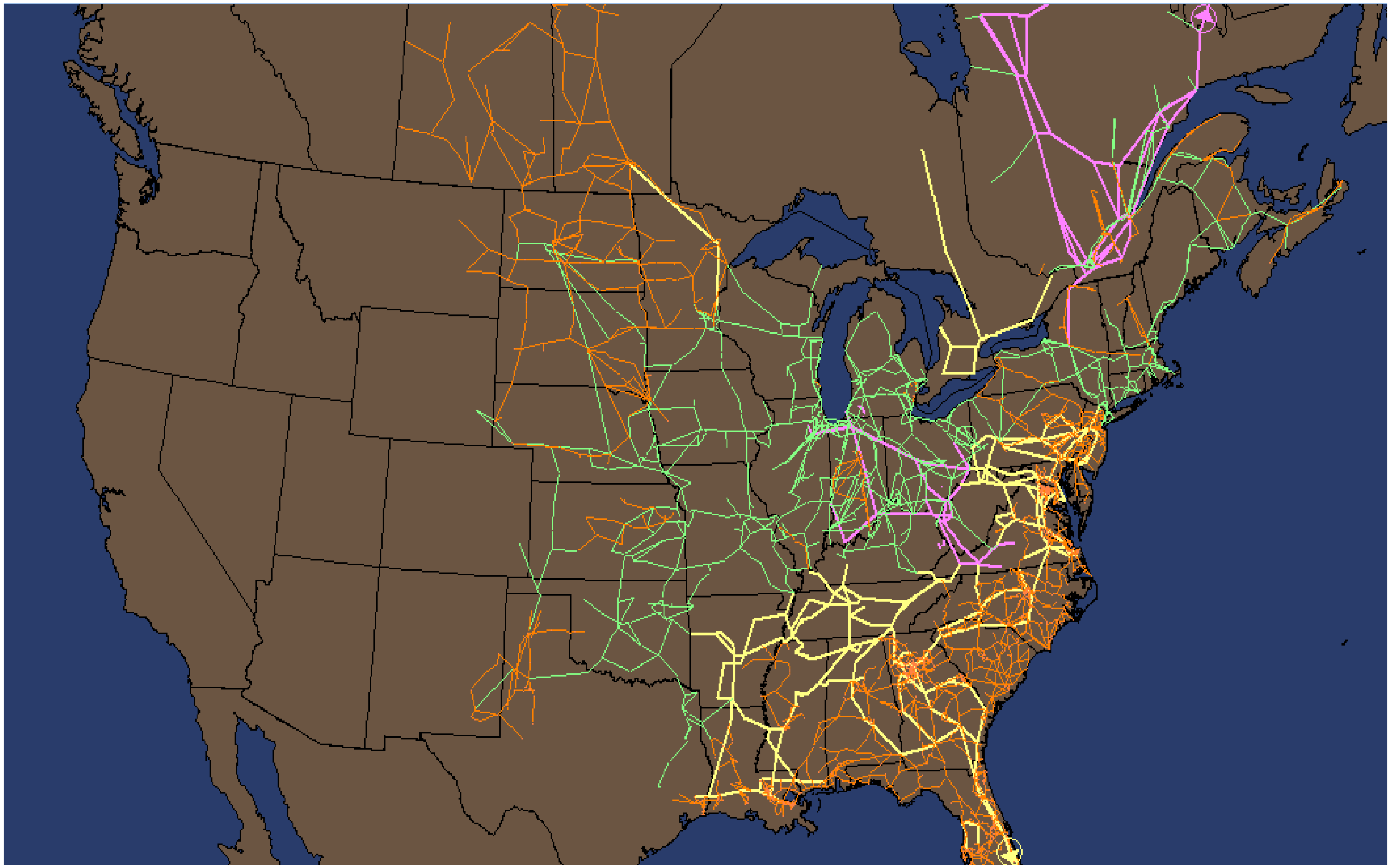
Why the E4 Simulation Tool?

Proper projection or optimization often requires prediction of *system-wide*, *society-wide*, and *long-term* effects.

System-wide	Society-wide	Long-term
• Determines flows according to laws of physics	• Emissions, their transport, and health effects	• Simultaneously predicts operation, investment, and retirement

2. INPUTS

We Have Built Detailed Models of the West, Texas, and the East (some lines shown here)



Our model of the East: 5222 nodes, 14225 branches, 8190 generators

Have models of the 3 US (& Canadian) grids, plan to build for Mexico, can build for elsewhere.

Generator, Network, & Demand Data

- Pre-existing generators: Capacities, marginal costs, fixed costs, locations, emission rates, smokestack specs, more. From combining 12 sources provided by EIA, EPA, & Energy Visuals. Also from Canadian utilities.
- Transmission grids: Reduced from ~10x as many nodes using methods we developed keep generators whole and minimize accuracy loss.
- Representative hours (currently ~40) represent joint frequency distribution of demand, generator availability, wind, and solar.
- Renewable generation data: Hourly generation of *each current and potential wind farm and PV site*.
- Demand magnitude at each node from Energy Visuals, modified with data from EIA and utilities.

Other Key Inputs & Assumptions of Simulations in this Presentation

- 2011 grid and generators
- Price responsiveness of load
- No nuclear retirements
- EIA base case NG prices

3. VALIDATION

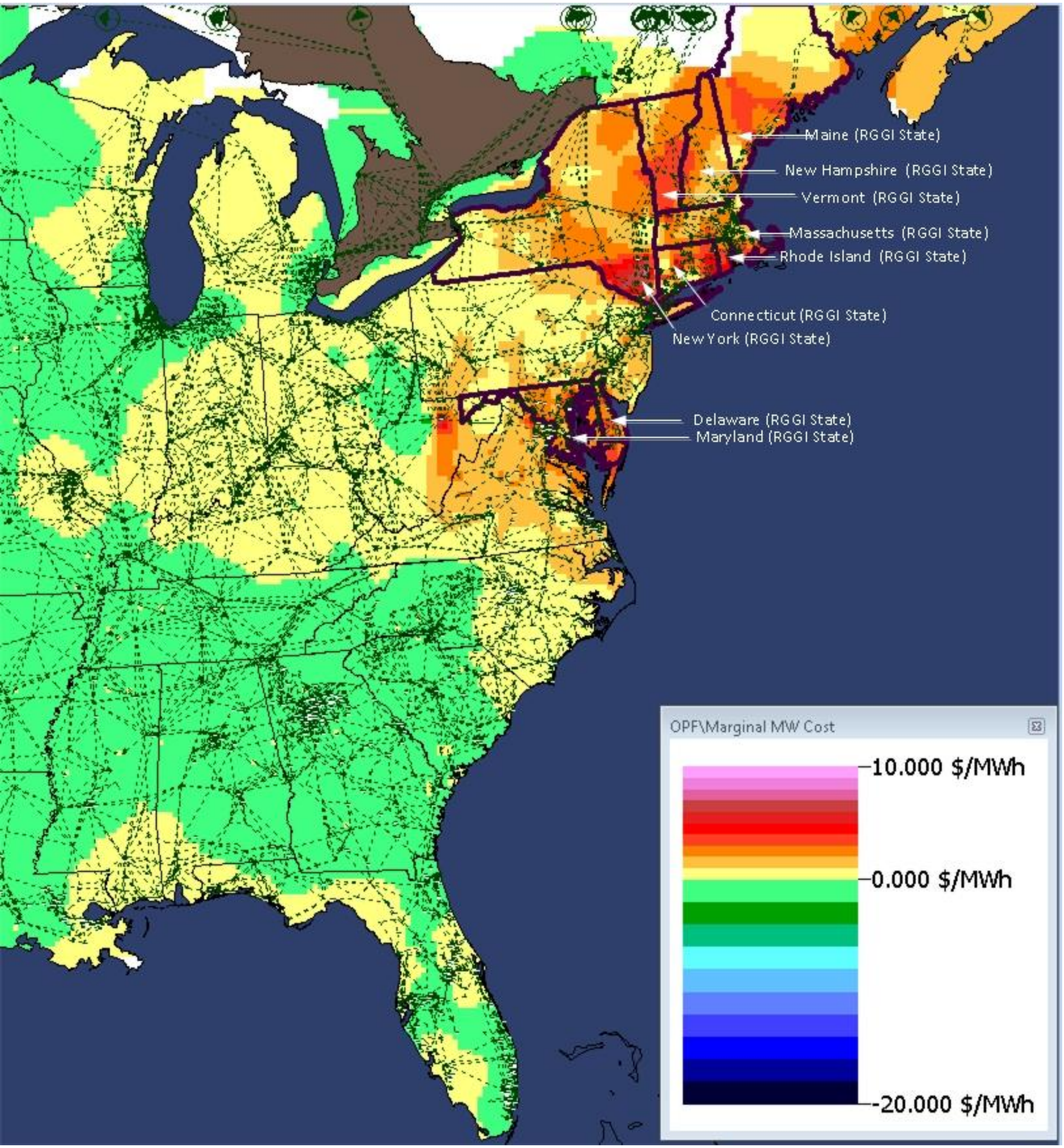
Model Validation: 2013 average electricity prices in simulation output and in reality

We added the voltage-based interface constraint between upstate and downstate NY, which varies in reality, and set its value (very close to estimated real average constraint) to get the NYC-WNY price difference right. Otherwise, no "fudge factors."

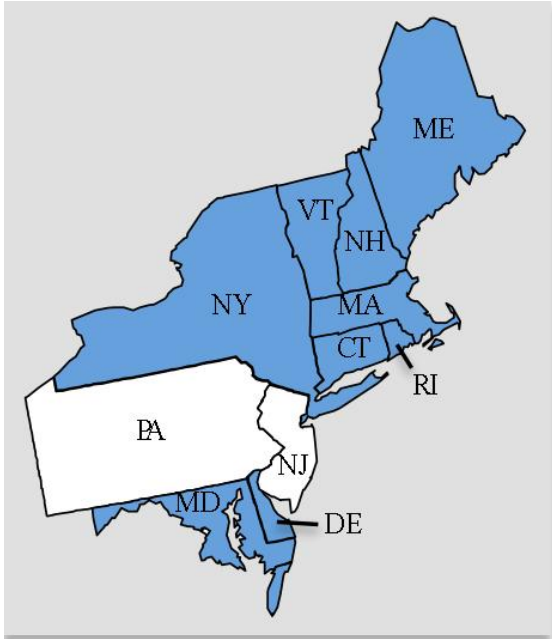
Region	Average LMP from simulation	Actual average LMP	
New England	55.1	56.1	
PJM	37.4	38.0	
State			
west virginia	36.9	35.0	
virginia	40.5	38.6	
pennsylvania	41.9	39.3	
ontario	21.1	26.5	
ohio	34.7	35.1	
north carolina	43.2	38.6	
new jersey	45.4	40.8	
michigan	31.2	35.1	
maryland	42.7	39.6	
kentucky	33.9	35.0	
indiana	33.0	35.1	
illinois	32.0	32.2	
district of columbia	42.3	38.4	
delaware	43.9	40.3	
		Correlation:	**0.97**
NY zone (simple average of LMPs over all hours)			
WNY	37.6	37.8	
NYC	52.6	52.6	
LI	64.1	64.3	
Hudson	53.0	50.1	
Capital	57.5	50.4	
		Correlation:	**0.95**

Sample "Heat" Map: Effect of $10 RGGI Price on Electricity Prices (vs $0 RGGI price)

Ten Years After Policy Goes Into Effect (Simulation Results with 5,000-Node Model)



RGGI states are in blue below



Source of map at left: Simulation using SuperOPF Planning Tool and 5000-node transmission model, reported in Shawhan et al, *Resource and Energy Economics,* January 2014.

One can make a heat map for any result that varies geographically.

4. ANALYSIS

Incremental benefits of more stringent RGGI ($M/yr in EI)

Potential change in RGGI caps (M short tons)-->	From 80 in '25, 80 in '35 to 70 in '25, 60 in '35	From 70 in '25, 60 in '35 to 60 in '25, 40 in '35
to Customers	-2362	-4000
to Congestion revenues	93	322
to Government revenue	1228	1888
to CO2 damage	838	1314
to NOX damage	491	496
to SO2 damage	1508	2461
to Producers	902	1515
Total	2697	3996

Assumes that NY wind+solar requirements are 10% in 2025, 20% in 2035.
If they were 15% in 2025 and 35% in 2035, then benefits would be about 63% of these.

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NY average prices

NY wind&solar requirement

	RGGI stringency (in M short tons in 2025 and 2035)		
	80/80	70/60	60/40
10%/20%	54.73	55.40	56.76
15%/35%	53.43	53.94	55.13

Incremental benefits of more stringent NY wind+solar requirement ($M/yr in EI) (15% in '25, 35% in '35 instead of 10%, 20%)

If RGGI caps (in M short tons/yr) are-->	80 in '25, 80 in '35	70 in '25, 60 in '35	60 in '25, 40 in '35
Then the incremental benefits of the more stringent NY wind+solar requirement are...			
to Customers	2907	3048	3148
to Congestion revenues	229	219	49
to Government revenue	-1298	-1268	-1273
to CO2 damage	221	52	0
to NOX damage	57	-88	-105
to SO2 damage	1137	338	-851
to Producers	-2029	-2151	-2058
Total	1224	150	-1091
Total if weight producer benefit half as much as other benefits	2238	1226	-62

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