Clean Energy Advocates Bootcamp

Understanding Supply and Demand in New England

February 12, 2015

Synapse Staff

Introduction

Synapse Energy Economics

- Founded in 1996 by CEO Bruce Biewald
- Leader for public interest and government clients in providing rigorous analysis of the electric power sector
- Staff of 30 includes experts in energy and environmental economics and environmental compliance

Agenda

Time Slot	Presenter	Topic Name
9:00 – 9:30		Check-in and coffee
9:30 – 9:45	Bruce Biewald	Introduction
9:45 – 10:30	Bruce Biewald	The history and future of New England's electric sector; supply and demand in New England
10:30 – 11:15	Doug Hurley	The ISO and energy markets
11:15 – 12:00	Paul Peterson	How electric planning is currently done in New England
12:00 – 1:00		Lunch and Networking
1:00 – 1:45	Tommy Vitolo	Multiple resource choices
1:45 – 2:30	Liz Stanton	Planning for greenhouse gas compliance and preparing for unknowns
2:30 – 3:30		Group discussion

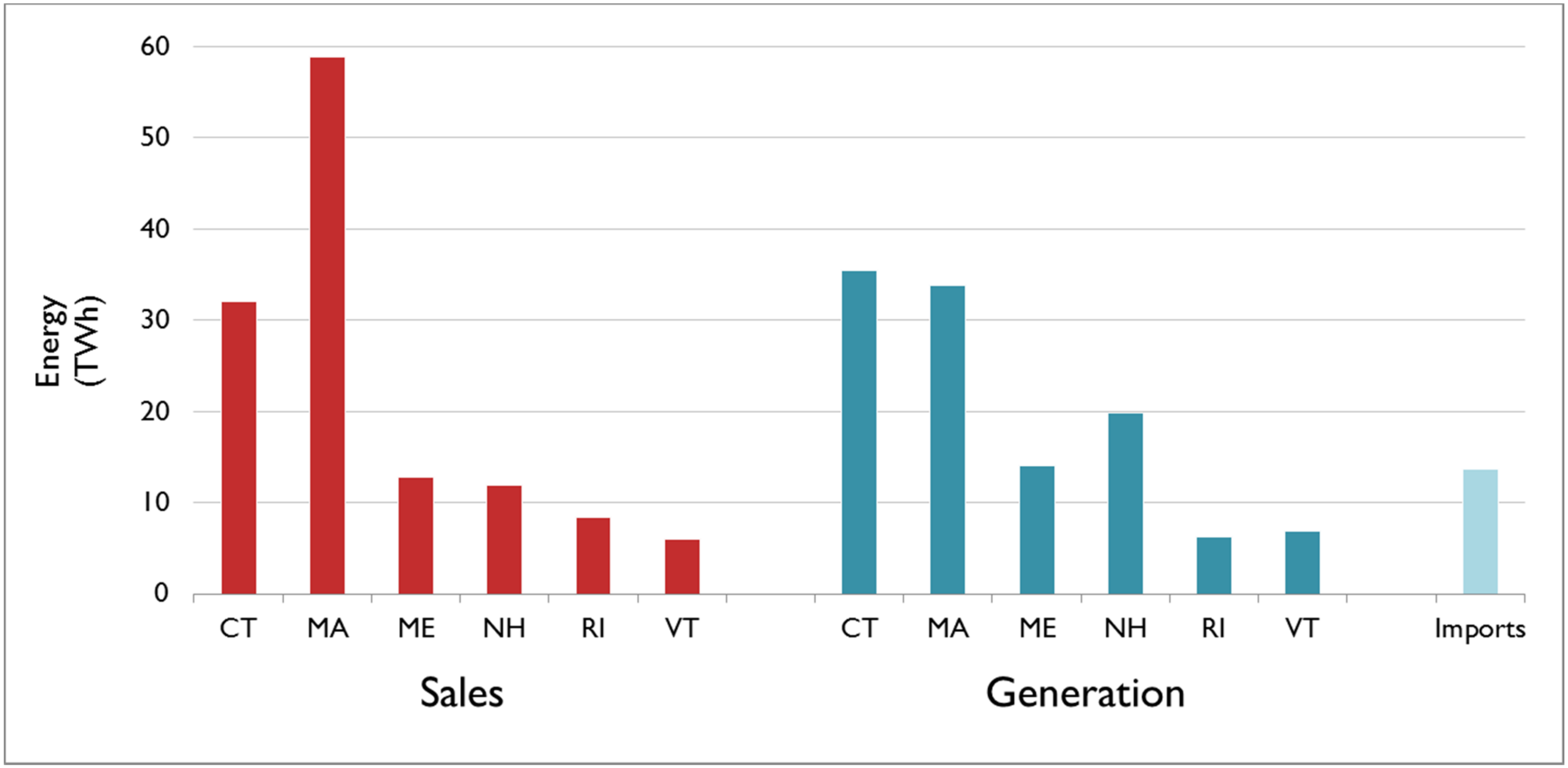
Energy Supply and Demand in New England

Major Concepts

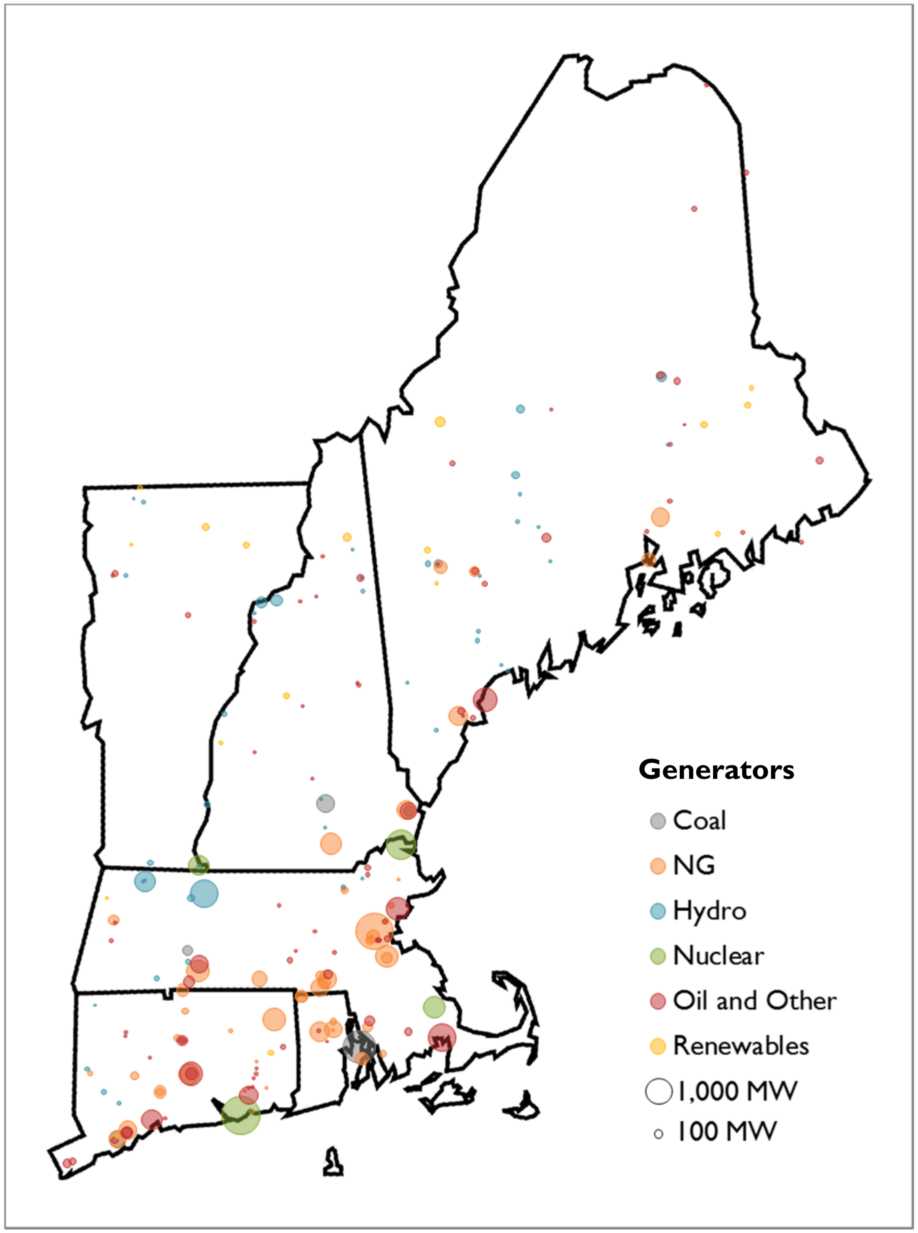
- Energy use by sector
  - Electricity vs. heating
- Drawing borders
- Energy market implications
- Electricity trends: Historical
- Electricity trends: Potential futures

Energy in New England

2013 consumption vs. generation



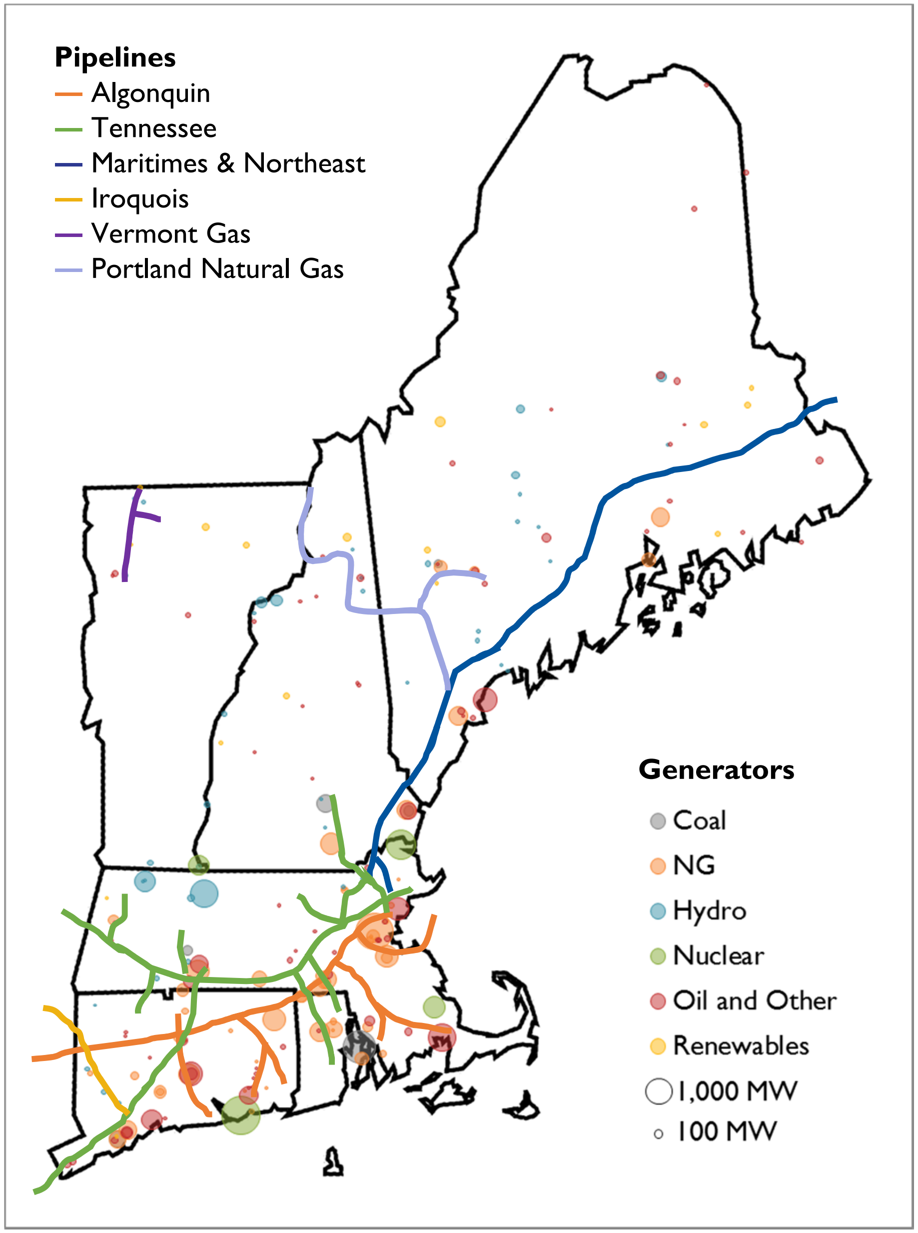
Note: Sales grossed up by 8 percent to account for transmission losses
Sources: EIA 923 2013, EIA 826 2013



NE Electric System

	Number of Units	Capacity (GW)	Generation (TWh)	Capacity Factor
Natural Gas	202	14	52	42%
Nuclear	5	5	37	92%
Oil and Other	337	9	11	14%
Hydro	584	4	8	25%
Coal	14	3	6	28%
Renewables	74	1	2	26%
Total	1,216	35	116	

Sources: EIA 860 2012-2013, EIA 923, http://www.necma.com/tek/New%20England%20small.gif, http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2013/nov2020 13/icf_upstream_gen_impacts_white_paper_11-18-2013.pdf, http://www.iso-ne.com/static-assets/documents/nwsiss/grid_mkts/key_facts/iso_geo_diagram_sept2013_final_nonceii_revised.pdf



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Major pipelines: Algonquin, Tennessee, Maritimes

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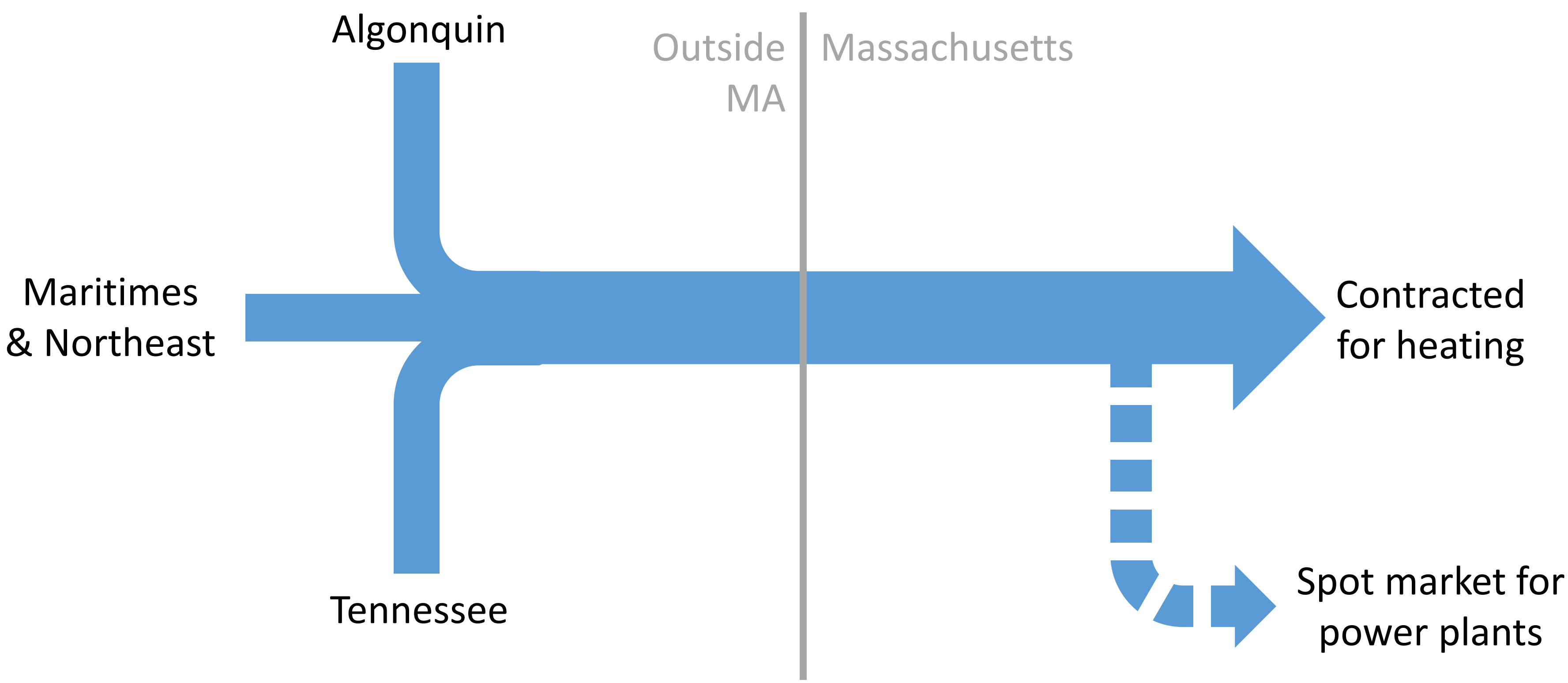
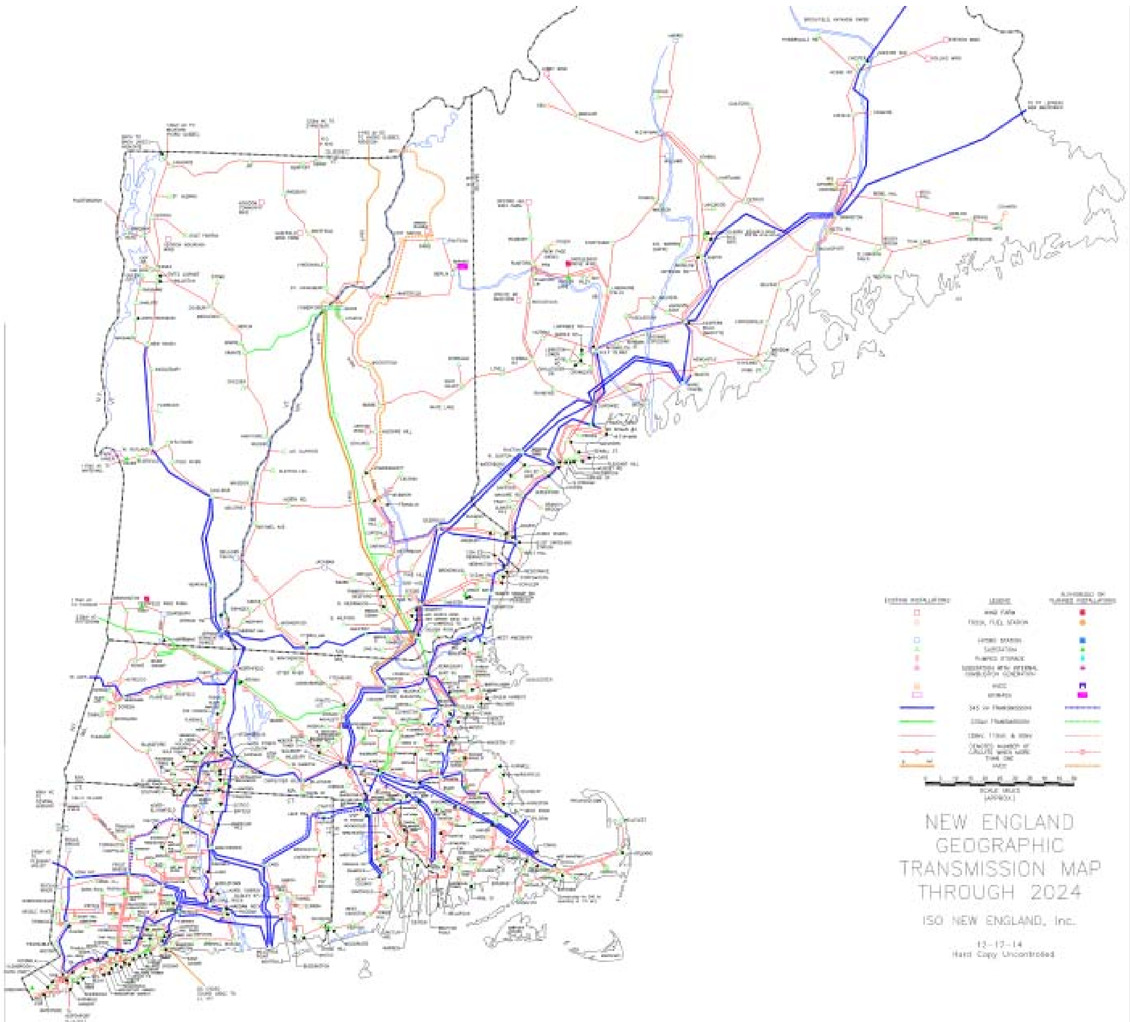
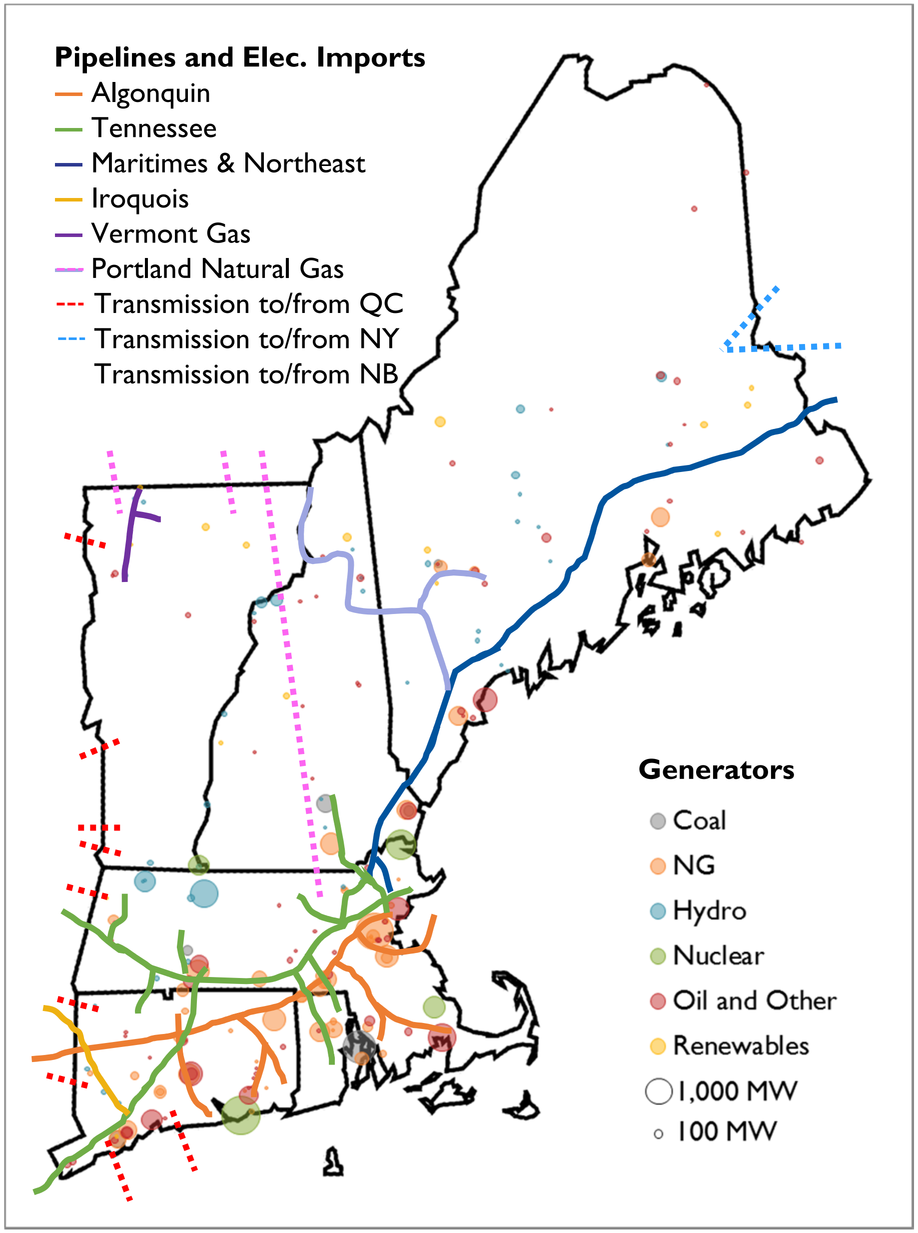
Pipeline supply



New England Transmission, Internal



Source: *http://www.iso-ne.com/static-assets/documents/nwsiss/grid_mkts/key_facts/iso_geo_diagram_sept2013_final_nonceii_revised.pdf*



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Major pipelines: Algonquin, Tennessee, Maritimes

New England is a net importer from: NY, NB, QC

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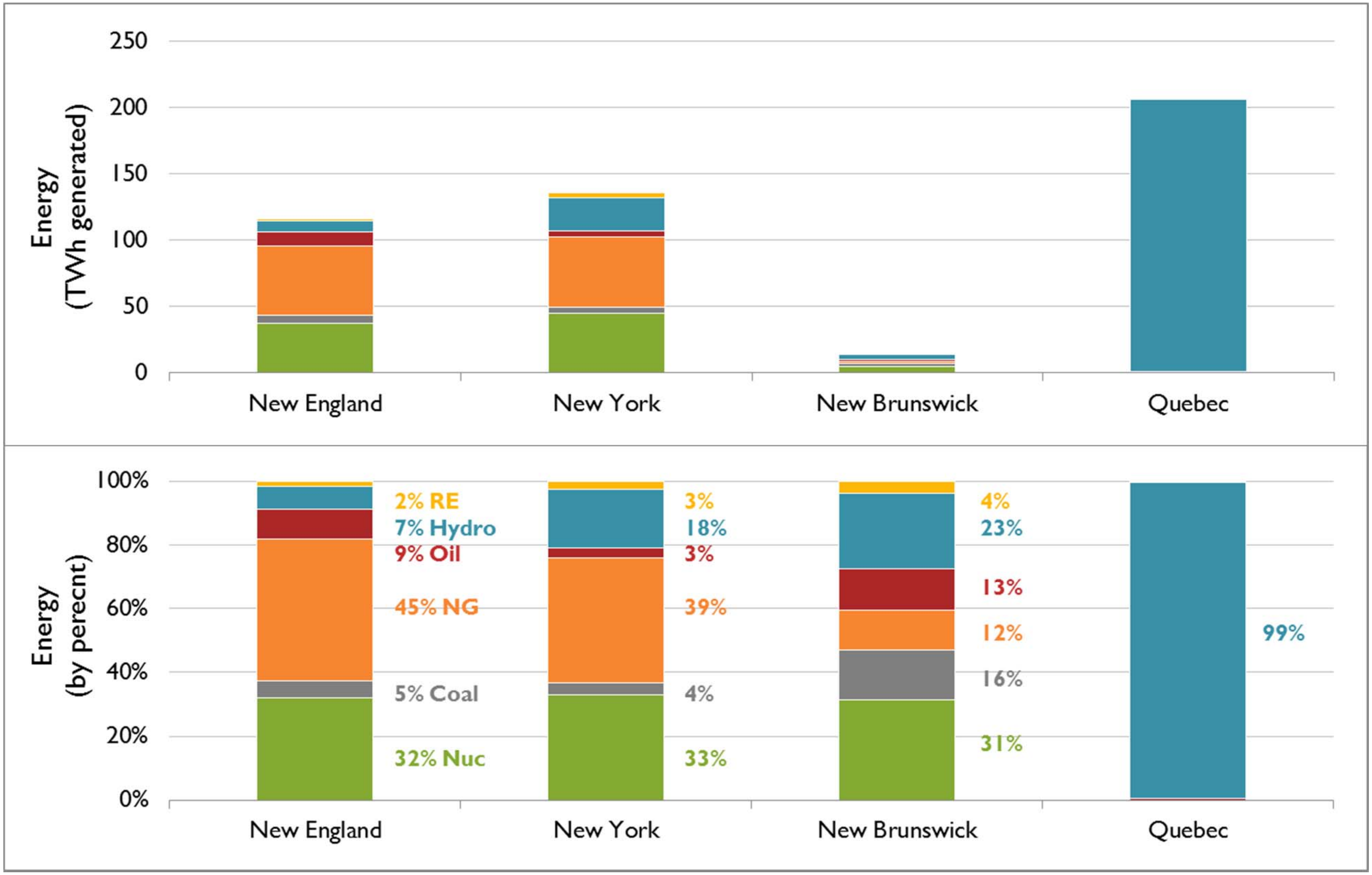
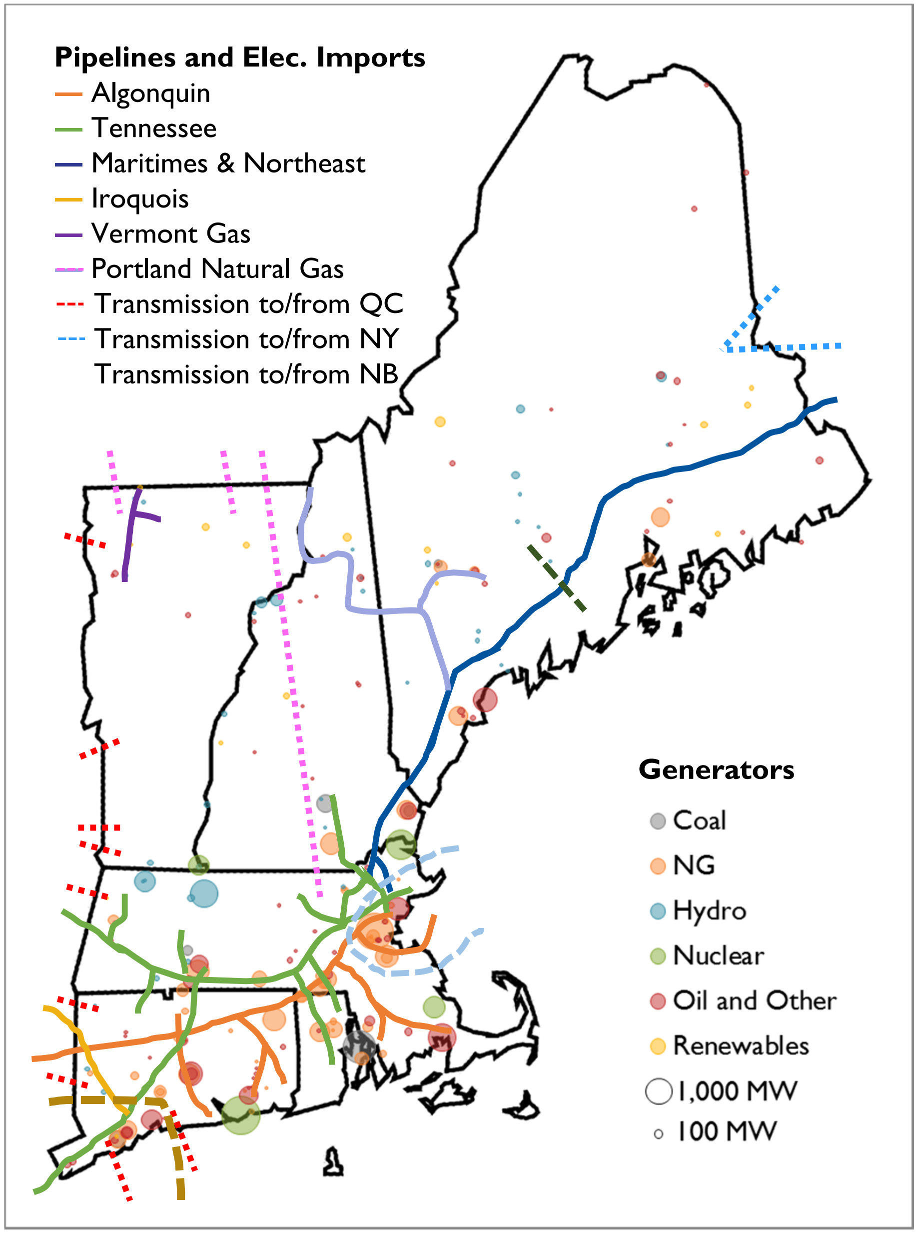
Comparisons of 2013 Energy Mixes





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Major pipelines: Algonquin, Tennessee, Maritimes

New England is a net importer from: NY, NB, QC

Import constrained areas: Boston, SW CT
Export constrained areas: Orrington ME

Sources: EIA 860 2012-2013, EIA 923, http://www.necma.com/tek/New%20England%20small.gif, http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2013/nov2020 13/icf_upstream_gen_impacts_white_paper_11-18-2013.pdf, http://www.iso-ne.com/static-assets/documents/nwsiss/grid_mkts/key_facts/iso_geo_diagram_sept2013_final_nonceii_revised.pdf

Hourly Energy Market – Example

Hour	1	
Load (MW)		
	Capacity Amount (MW)	**Bid ($/MWH)**
Unit 1	500	$0
Unit 2	500	$0
Unit 3	100	$5
Unit 4	100	$5
Unit 5	100	$10
Unit 6	200	$15
Unit 7	250	$16
Unit 8	250	$16
Unit 9	100	$20
Unit 10	250	$30
Unit 11	250	$31
Unit 12	400	$50
Unit 13	50	$56
Unit 14	25	$70
Unit 15	50	$75
Marginal Price		

Hourly Energy Market – Example

Hour	1	
Load (MW)	**3000**	

	Capacity Amount (MW)	Bid ($/MWH)
Unit 1	500	$0
Unit 2	500	$0
Unit 3	100	$5
Unit 4	100	$5
Unit 5	100	$10
Unit 6	200	$15
Unit 7	250	$16
Unit 8	250	$16
Unit 9	100	$20
Unit 10	250	$30
Unit 11	250	$31
Unit 12	400	$50
Unit 13	50	$56
Unit 14	25	$70
Unit 15	50	$75
Marginal Price		**$50**

Hourly Energy Market – Example

Hour	1		2	
Load (MW)	**3000**		**3050**	
	Capacity Amount (MW)	**Bid ($/MWH)**	**Capacity Amount (MW)**	**Bid ($/MWH)**
Unit 1	500	$0	500	$0
Unit 2	500	$0	500	$0
Unit 3	100	$5	100	$5
Unit 4	100	$5	100	$5
Unit 5	100	$10	100	$10
Unit 6	200	$15	200	$15
Unit 7	250	$16	250	$16
Unit 8	250	$16	250	$16
Unit 9	100	$20	100	$20
Unit 10	250	$30	250	$30
Unit 11	250	$31	250	$31
Unit 12	400	$50	400	$50
Unit 13	50	$56	50	$56
Unit 14	25	$70	25	$70
Unit 15	50	$75	50	$75
Marginal Price		**$50**		**$56**

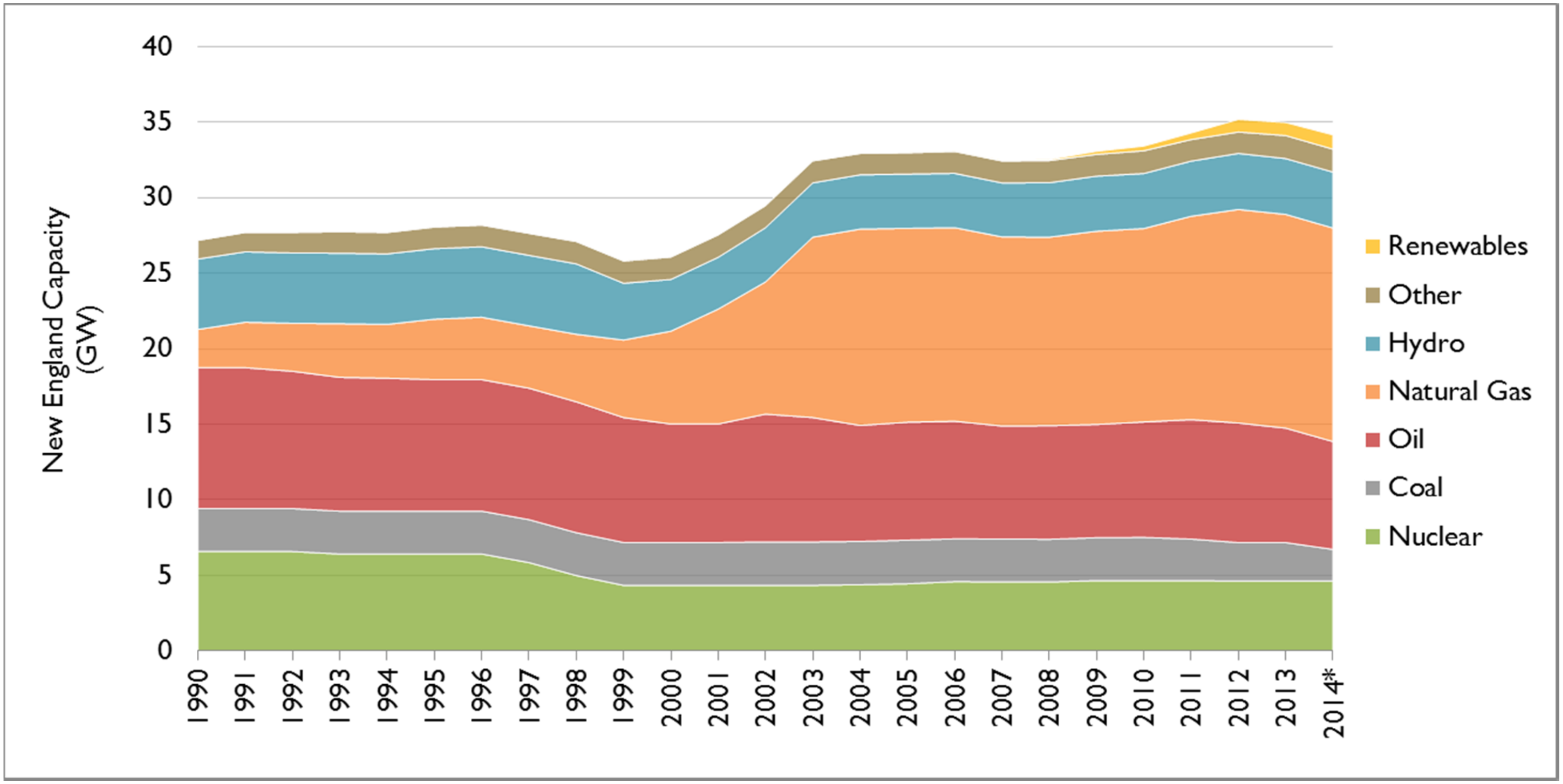
Hourly Energy Market – Example

Hour	1		2		2	
Load (MW)	3000		3050		3125	
	Capacity Amount (MW)	Bid ($/MWH)	Capacity Amount (MW)	Bid ($/MWH)	Capacity Amount (MW)	Bid ($/MWH)
Unit 1	500	$0	500	$0	500	$0
Unit 2	500	$0	500	$0	500	$0
Unit 3	100	$5	100	$5	100	$5
Unit 4	100	$5	100	$5	100	$5
Unit 5	100	$10	100	$10	100	$10
Unit 6	200	$15	200	$15	200	$15
Unit 7	250	$16	250	$16	250	$16
Unit 8	250	$16	250	$16	250	$16
Unit 9	100	$20	100	$20	100	$20
Unit 10	250	$30	250	$30	250	$30
Unit 11	250	$31	250	$31	250	$31
Unit 12	400	$50	400	$50	400	$50
Unit 13	50	$56	50	$56	50	$56
Unit 14	25	$70	25	$70	25	$70
Unit 15	50	$75	50	$75	50	$75
Marginal Price		$50		$56		$75

Electricity trends

Historical

NE Utility-scale Capacity



Notes: 2014 data through October 2014 only
Source: EIA 860

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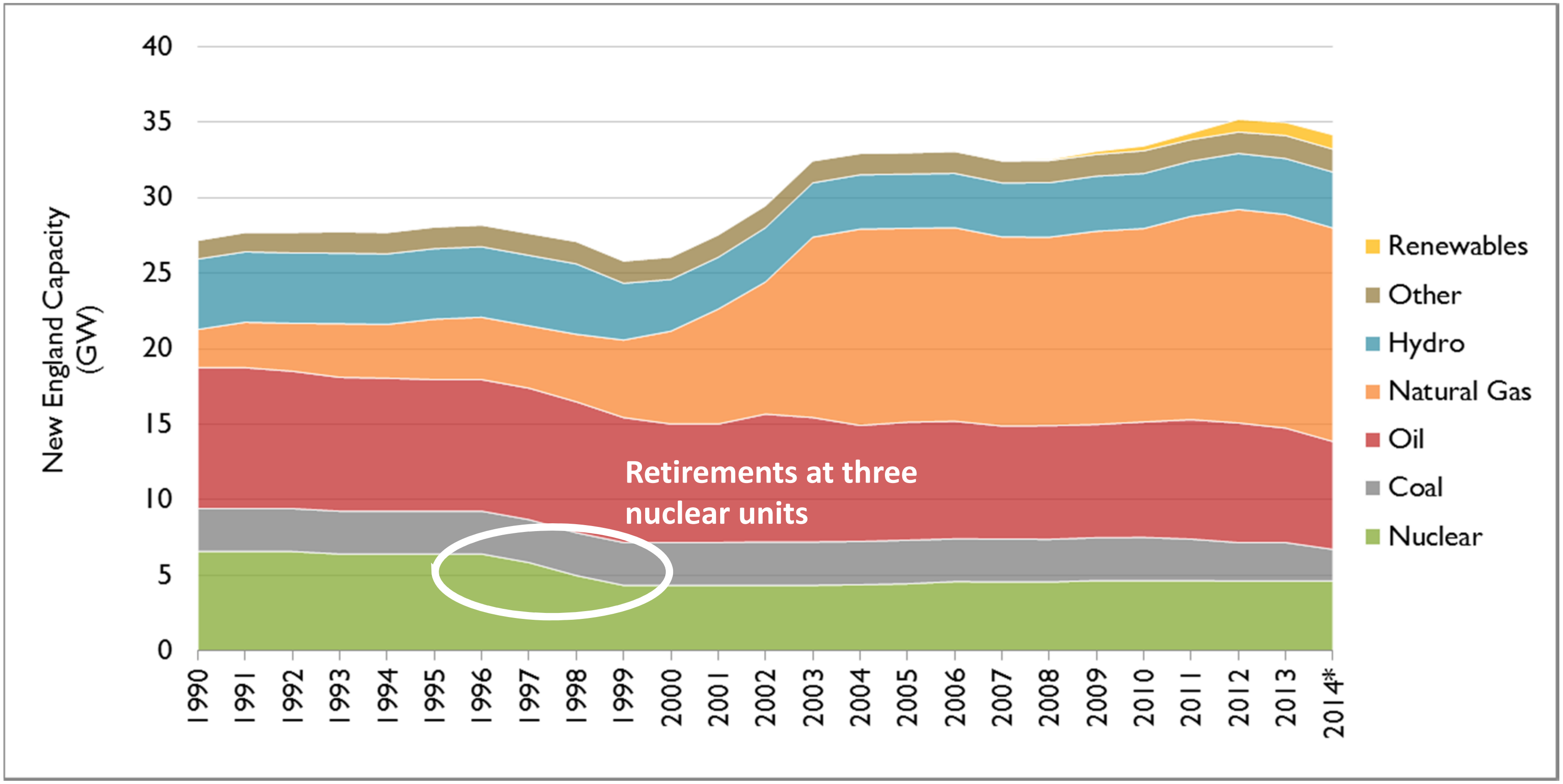

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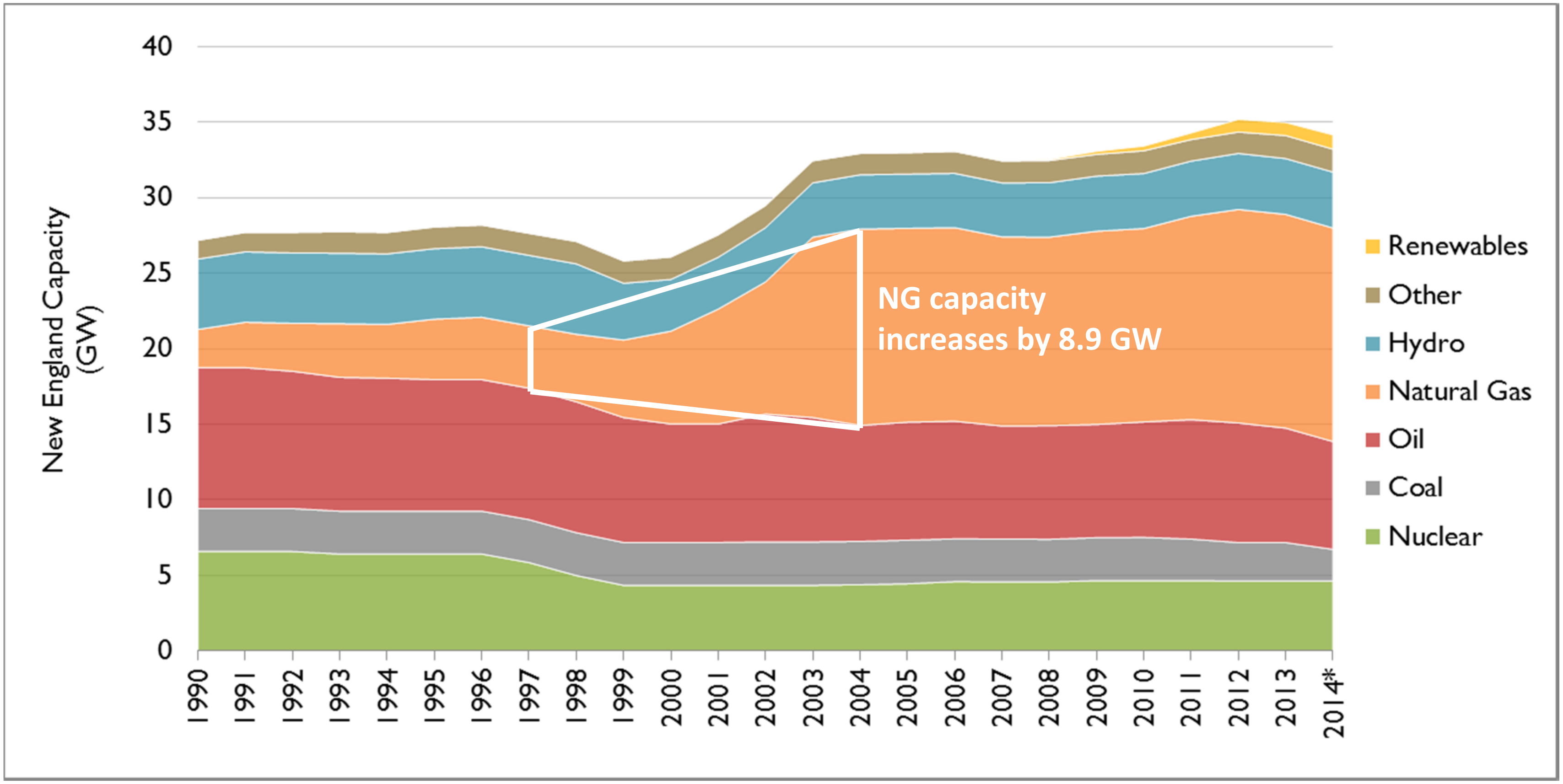

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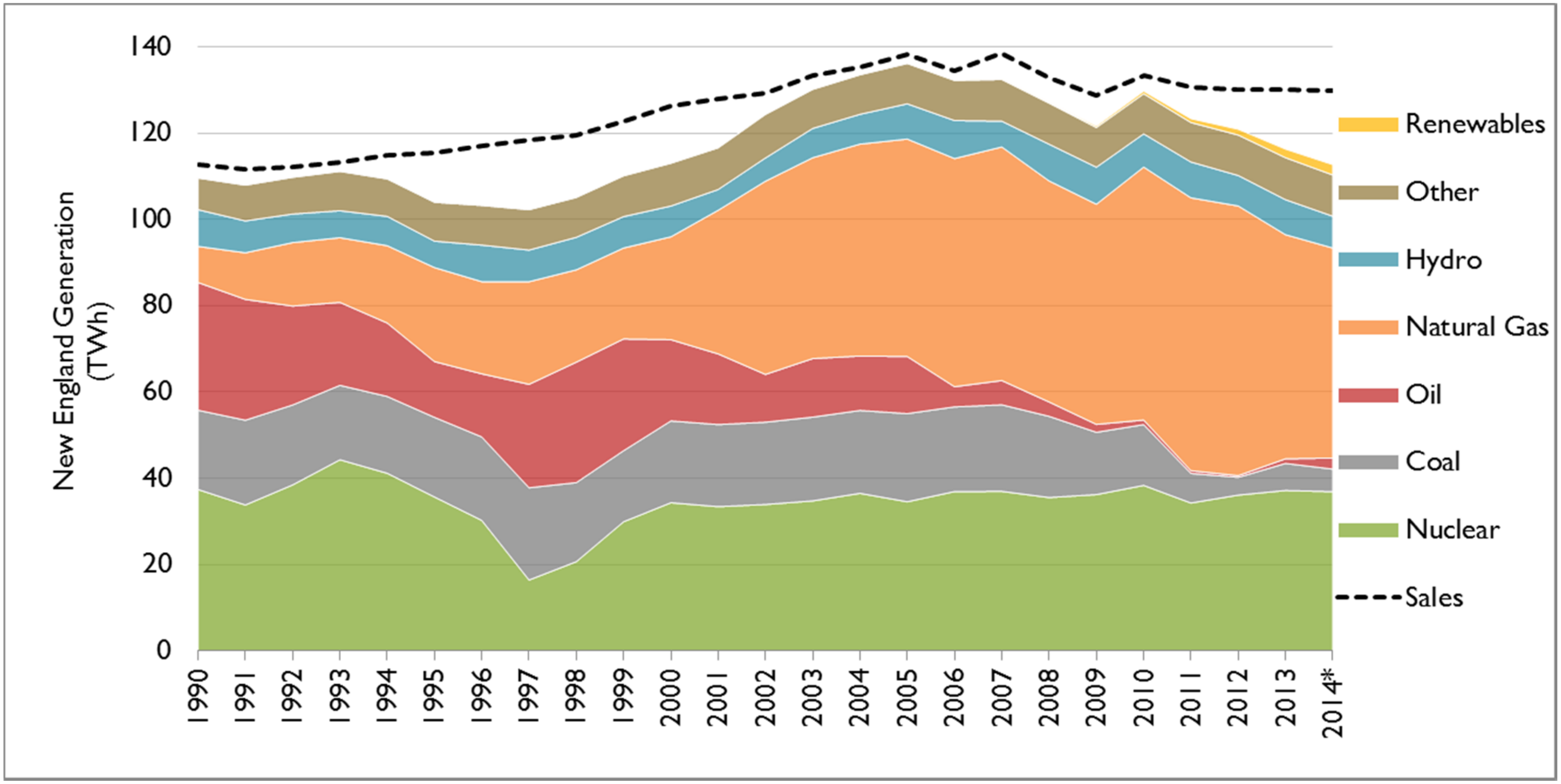
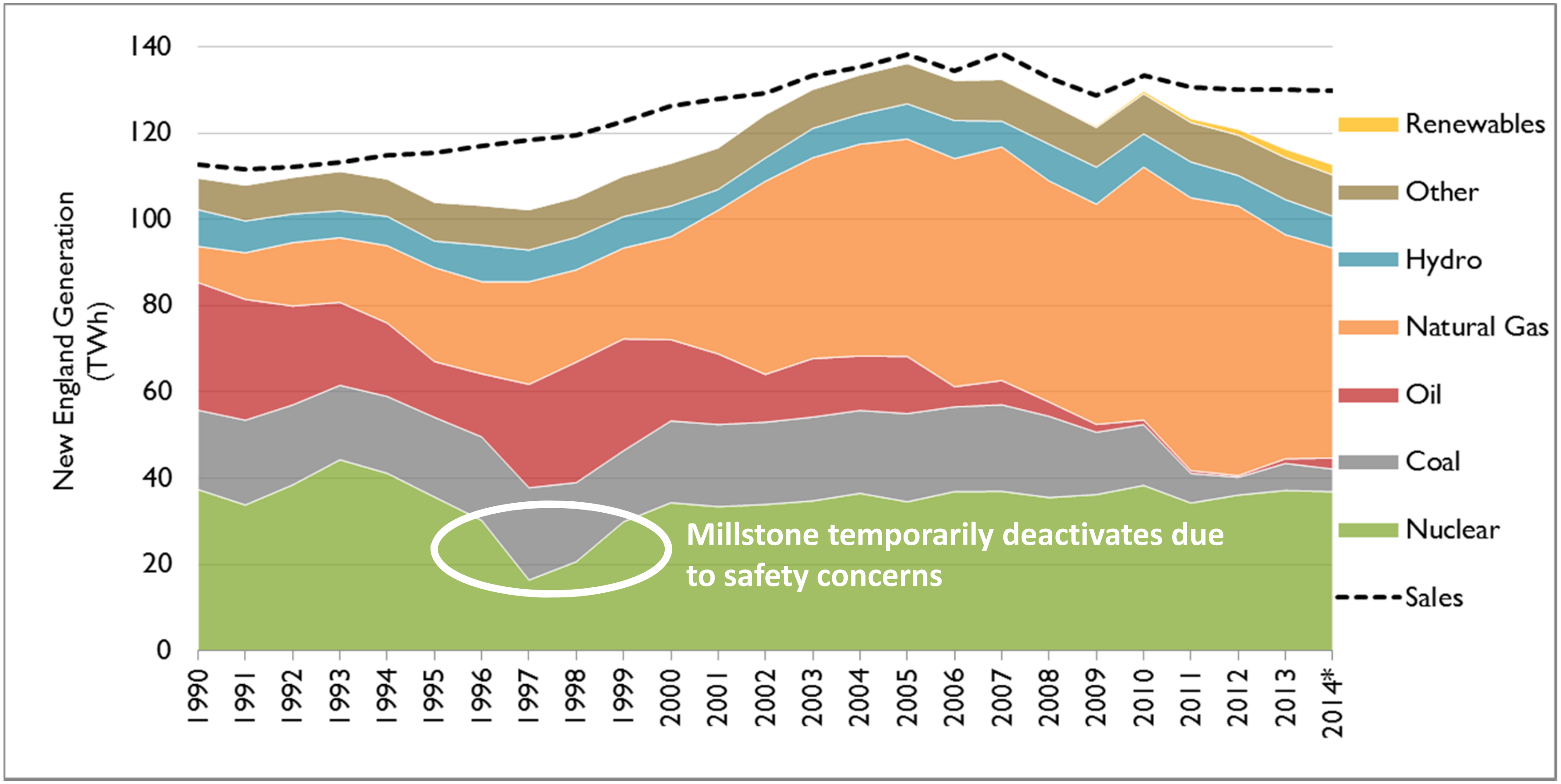
NE Utility-scale Generation



Notes: 2014 data through October only – values for 2014 have been grossed up to 12 months; sales have been grossed down by 8 percent to account for transmission
Source: EIA 923

NE Utility-scale Generation



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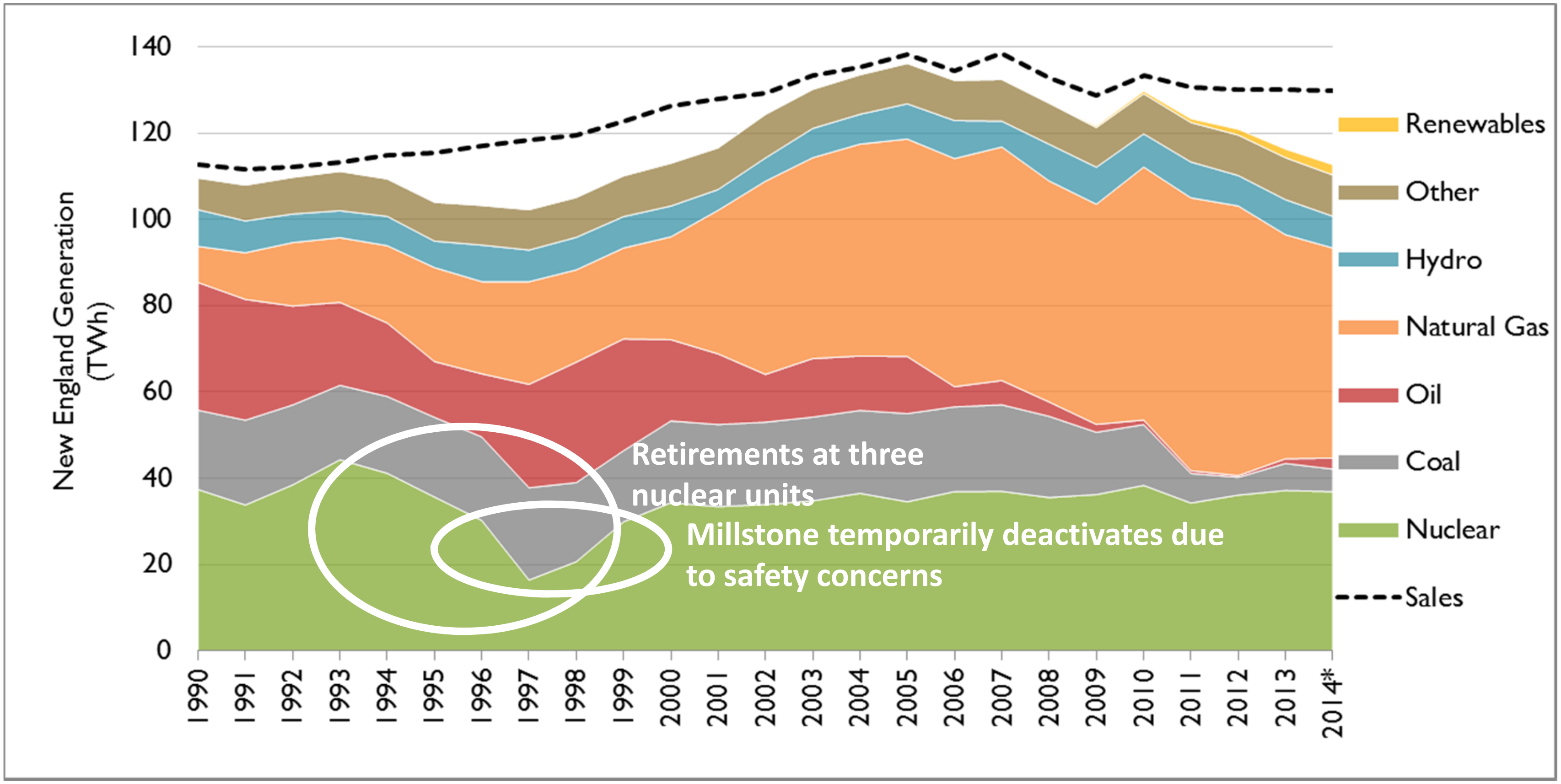

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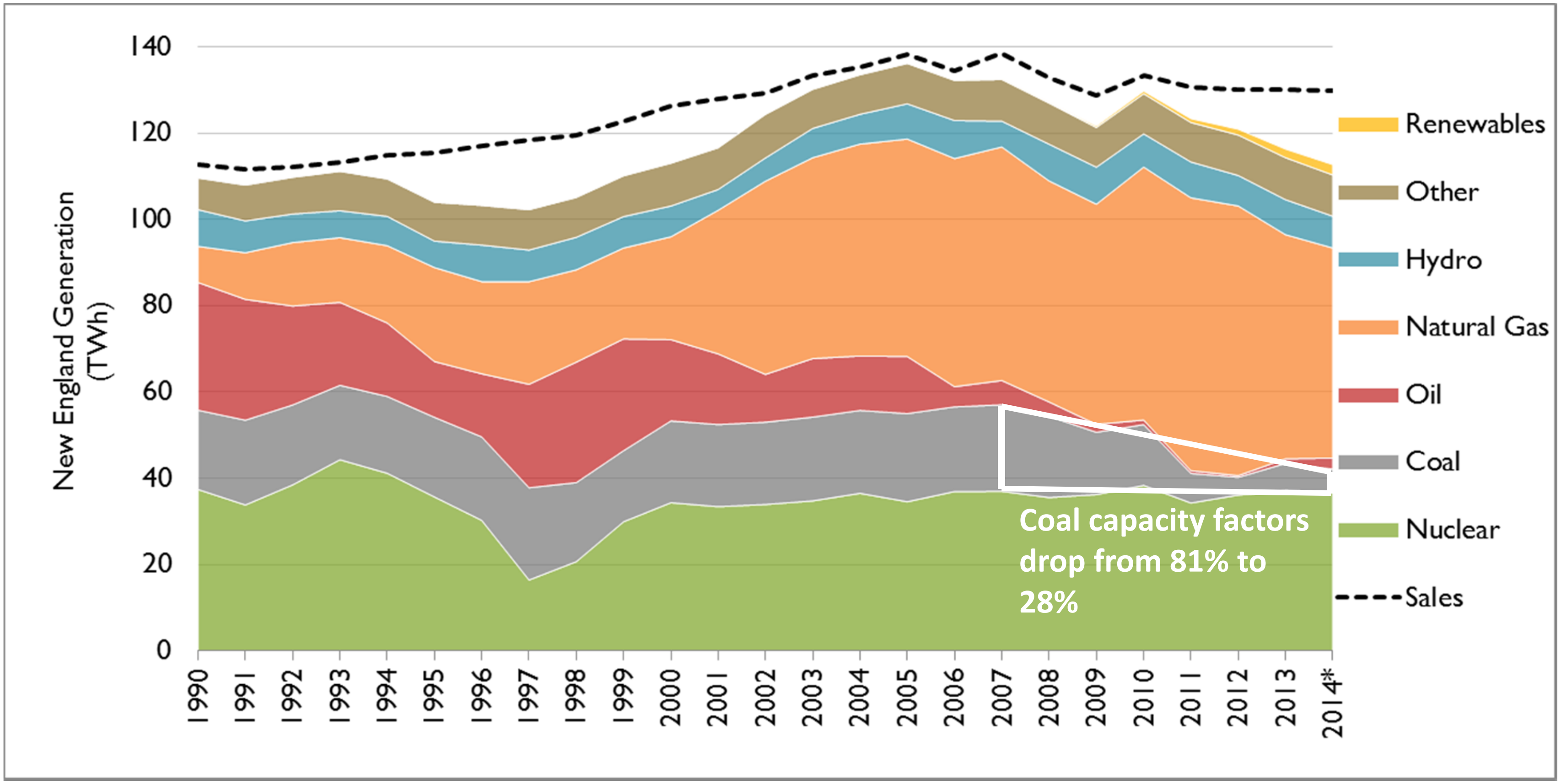

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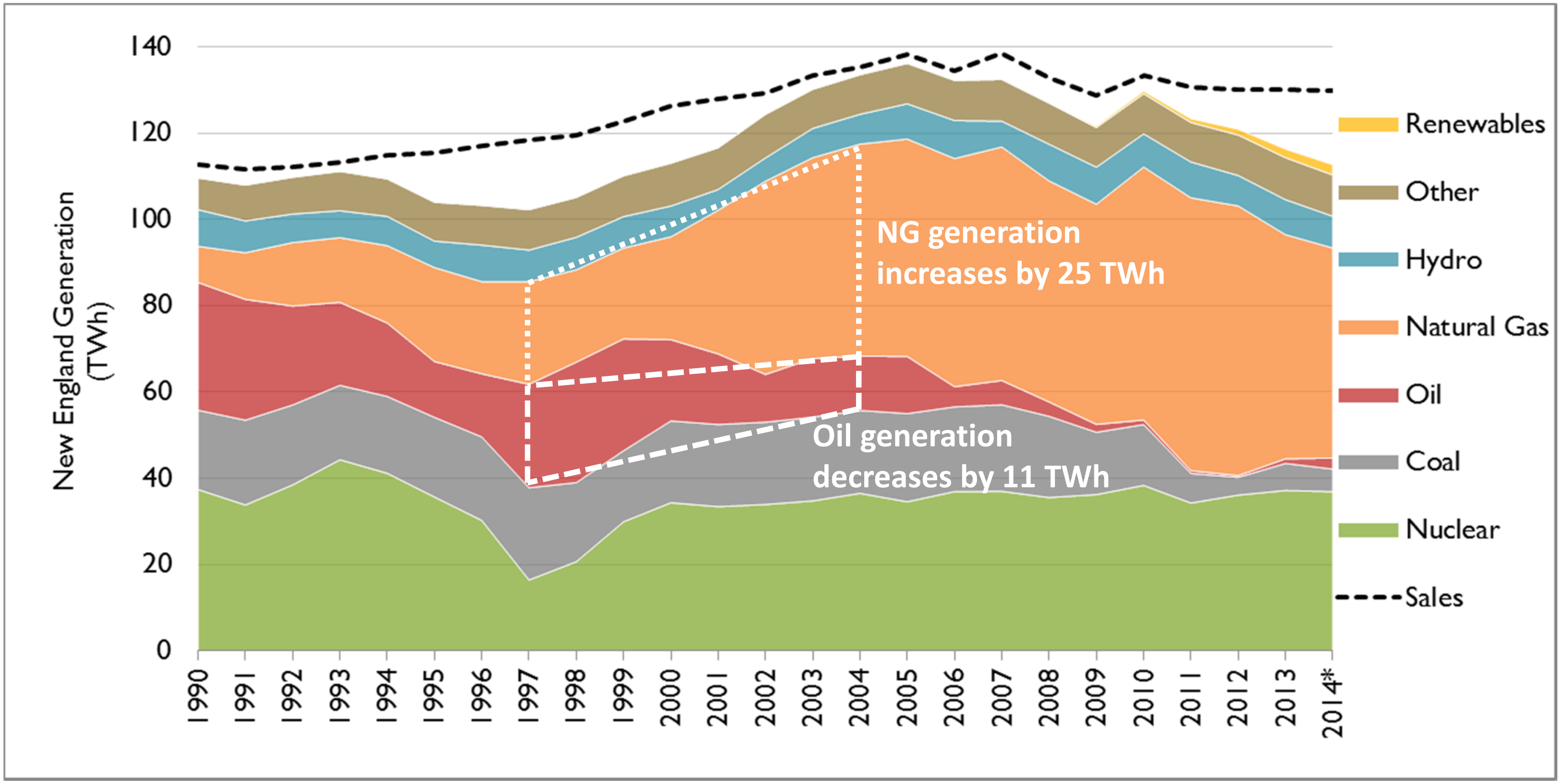

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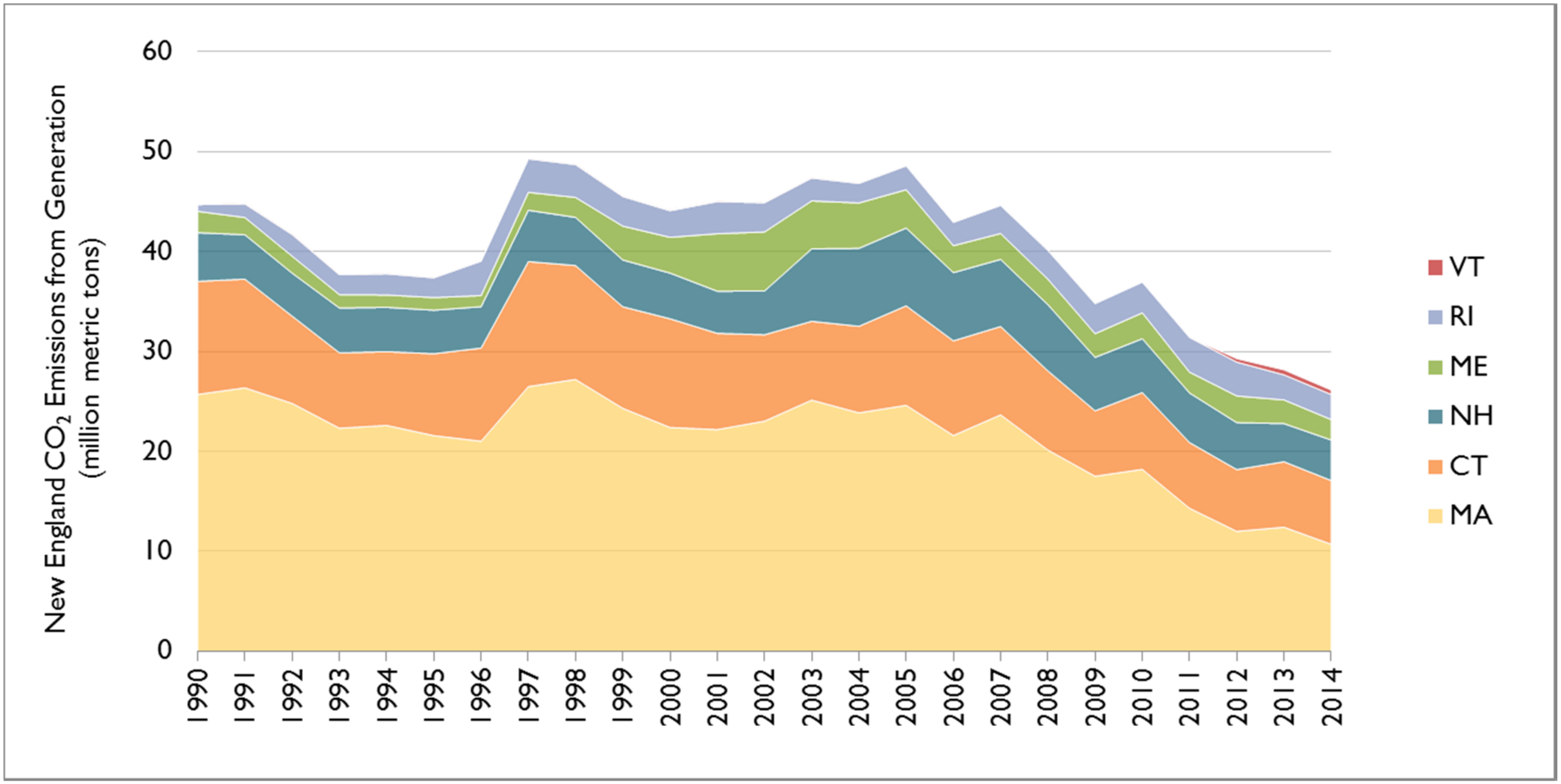
NE Emissions – Electric Sector

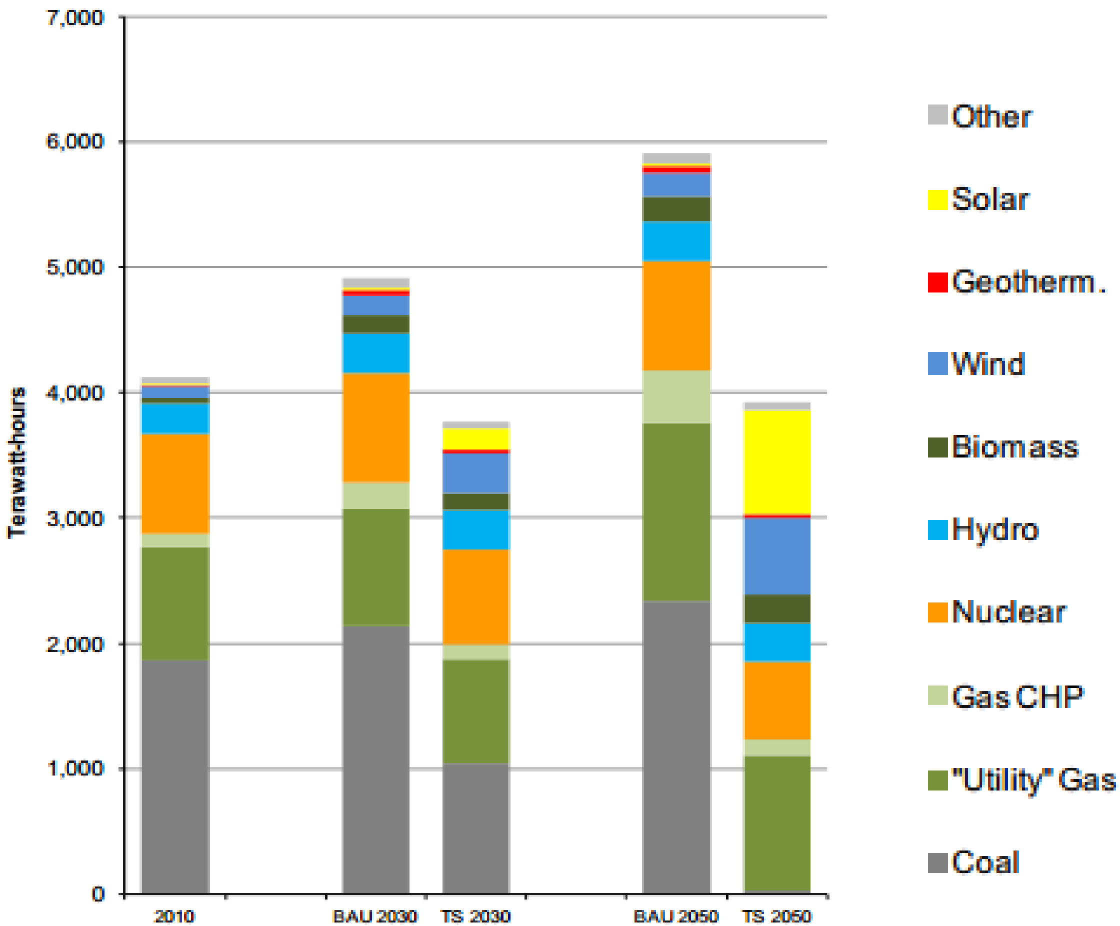


Source: EIA State CO_2 Emissions (1990-2011); EPA AMP Dataset (2012-2014)

Electricity trends

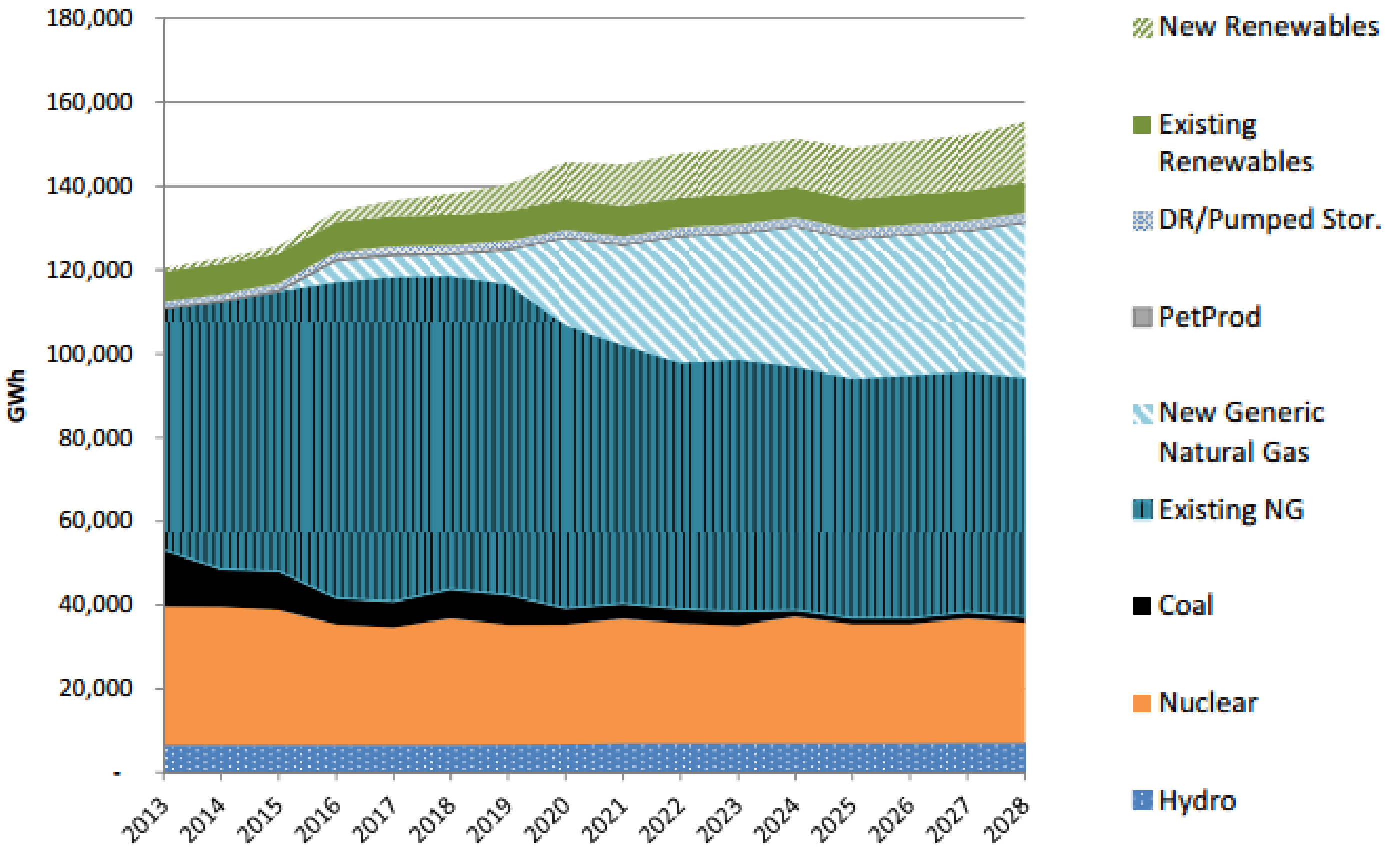
Potential Futures

U.S. Electric Generation Fuel Mix



Source: *Toward a Sustainable Future for the U.S. Power Sector: Beyond Business as Usual 2011.* Synapse Energy Economics for the Civil Society Institute, November 2011.

New England Electric Generation Fuel Mix



Source: *Avoided Energy Supply Costs in New England: 2013 Report.* Synapse Energy Economics for the Avoided-Energy-Supply-Component Study Group, July 2013.

Helpful data sources

- EIA Form 923: Monthly and annual unit generation, fuel consumption
  - http://www.eia.gov/electricity/data/eia923/
- EIA Form 860: Annual power plant specifics
  - http://www.eia.gov/electricity/data/eia860/index.html
- EIA Form 861: Annual sales, revenues, number of ratepayers
  - http://www.eia.gov/electricity/data/eia861/index.html
- EPA Air Markets Dataset: Annual, monthly, and hourly data on generation and emissions (CO_2, NO_X, SO_2)
  - http://ampd.epa.gov/

The ISO and Energy Markets

The New England Grid

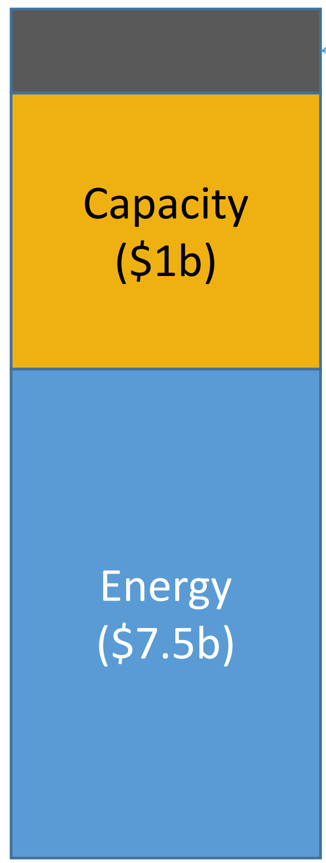
- 6.5 million households and businesses; 14 million people
- Approximately 350 generators
- Approximately 31,000 MW of total generation for 2014
- Over 8,500 miles of transmission lines
- 13 interconnections to electricity systems in New York and Canada
- Approximately 2,100 MW of demand resources for 2014
- All-time peak demand of 28,130 MW, set on August 2, 2006
- Approximately 500 participants in the marketplace (those who generate, buy, sell, transport, and use wholesale electricity and implement demand resources)
- Approximately $6.5 billion in transmission investment since 2002; approximately $4.5 billion planned

Source: RSP14, Fig 2.1a

New England Wholesale Markets

Total Annual Cost to Load in 2013

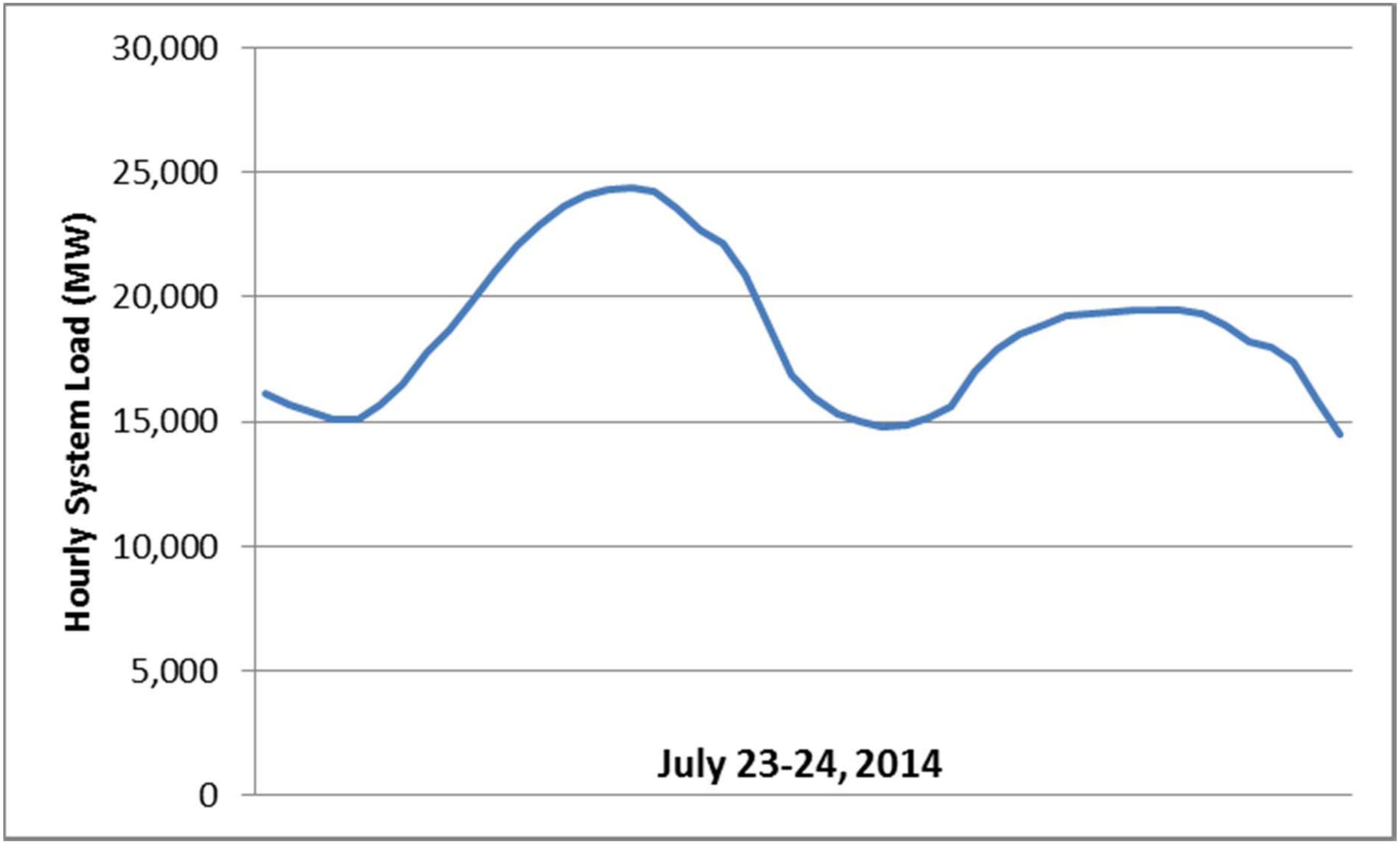
Revenue to any one specific unit will vary greatly from this ratio. Nuclear earns more from energy. Peakers (incl. DR) earn almost all from capacity and reserves.



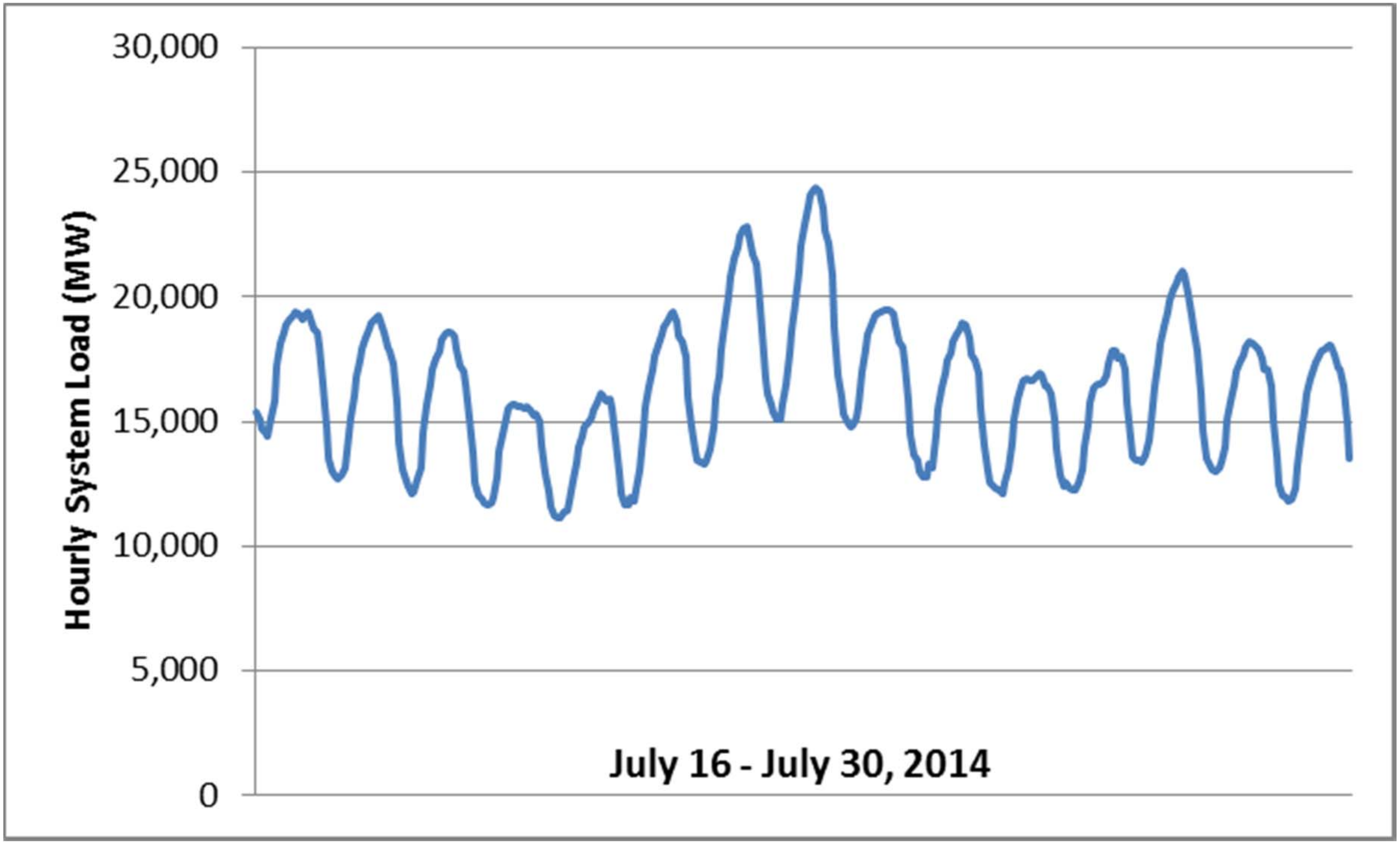
Other Ancillary Services
$270m in 2013
Forward Reserves
Operating Reserves
Regulation
Black Start
Voltage Support
Financial Transmission Rights (FTRs)
And more …

Good sources: Regional System Plan, Wholesale Load Cost Report

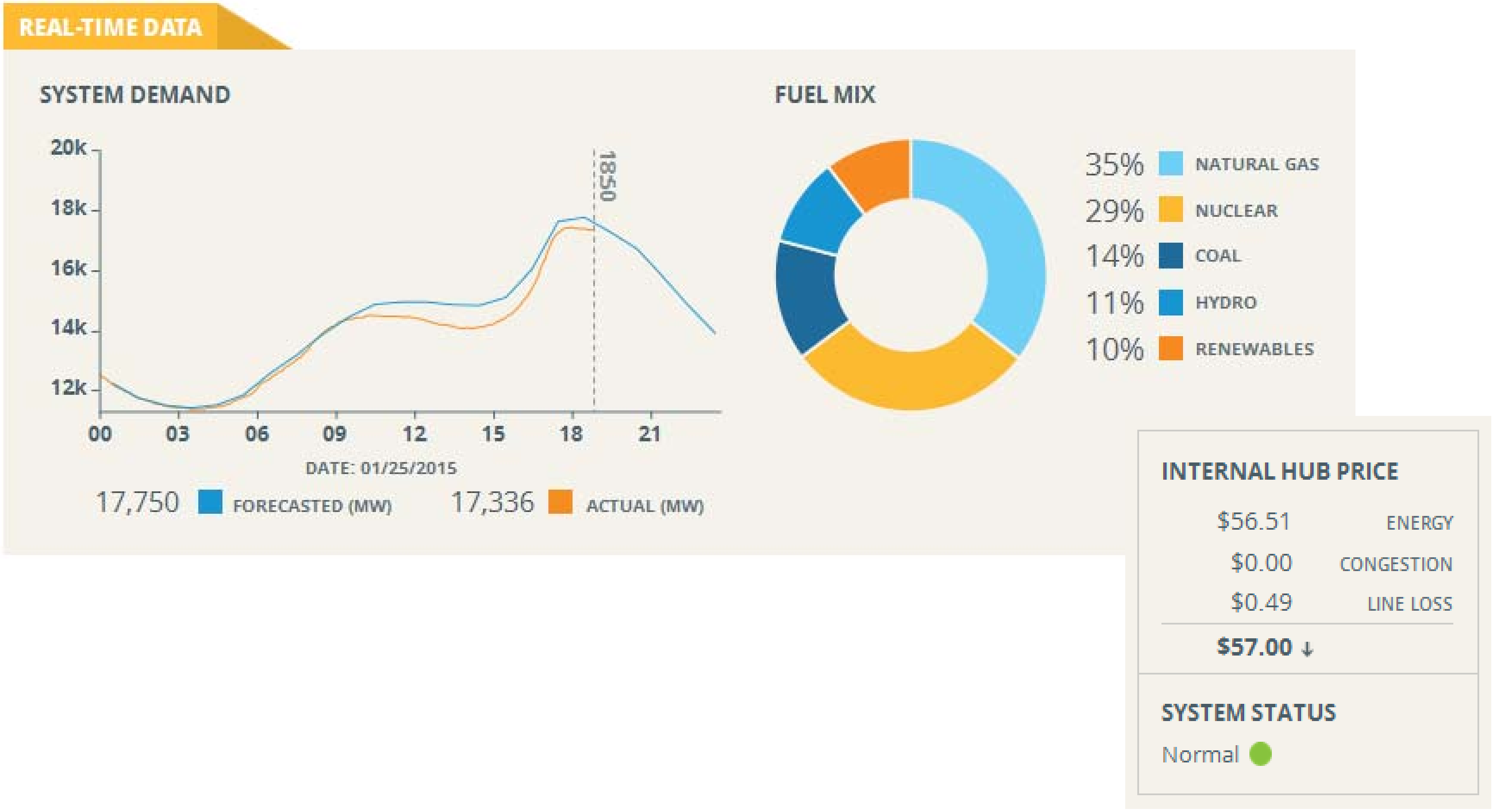
Demand – Summer



Demand – Summer

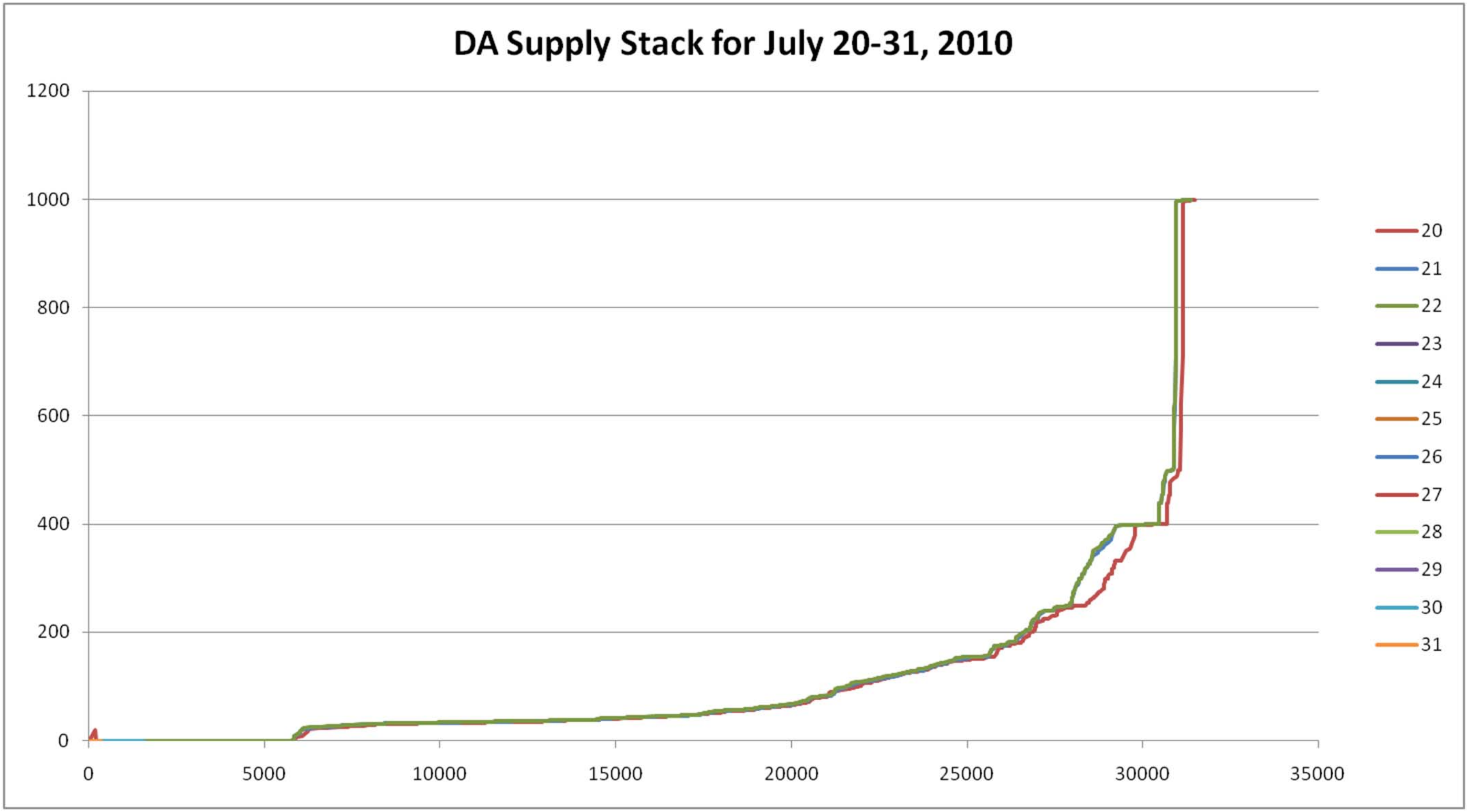


Demand - Winter



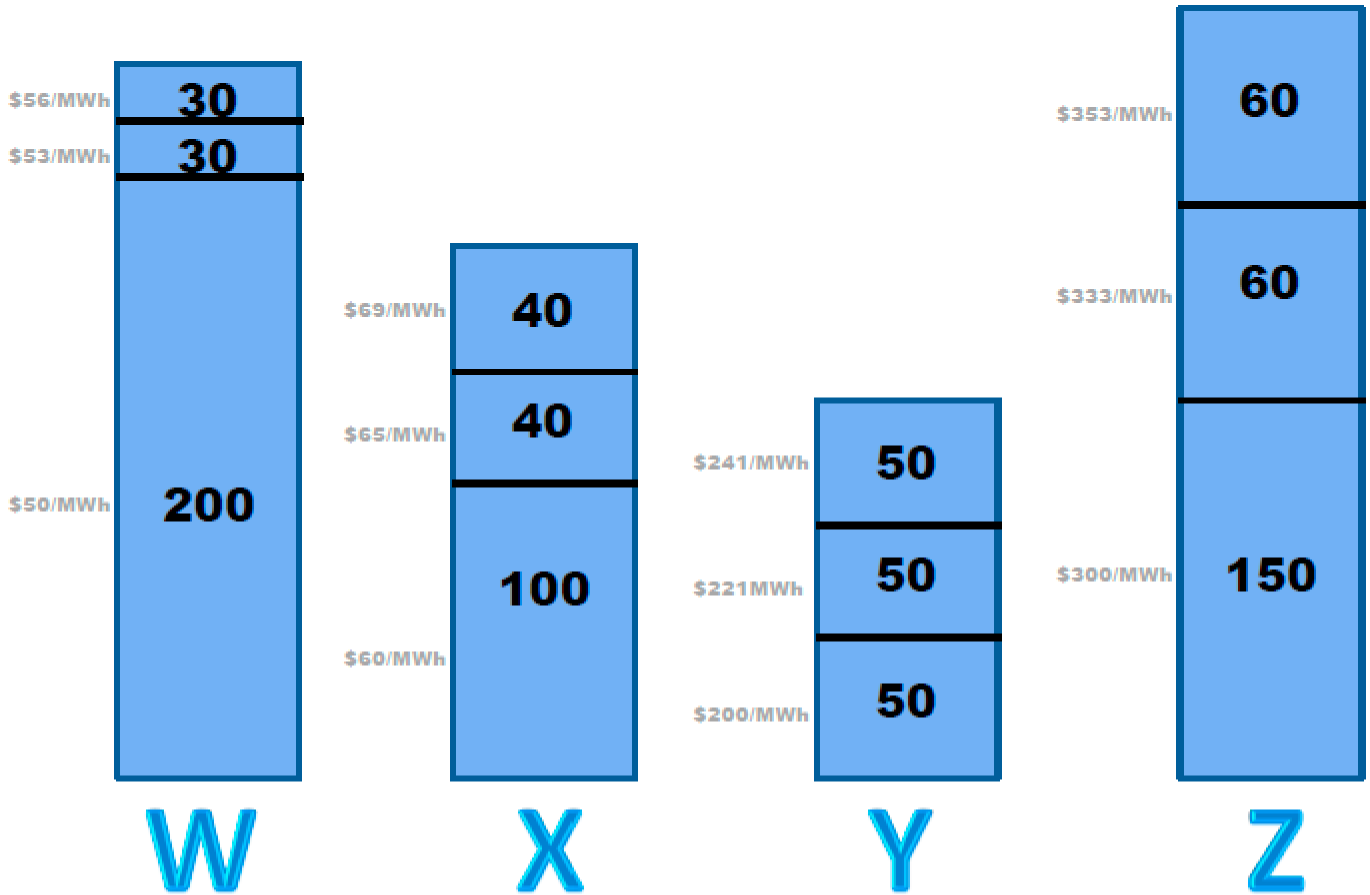
Source: ISO-NE Home Page. 25 Jan 2015, 7pm.

Supply

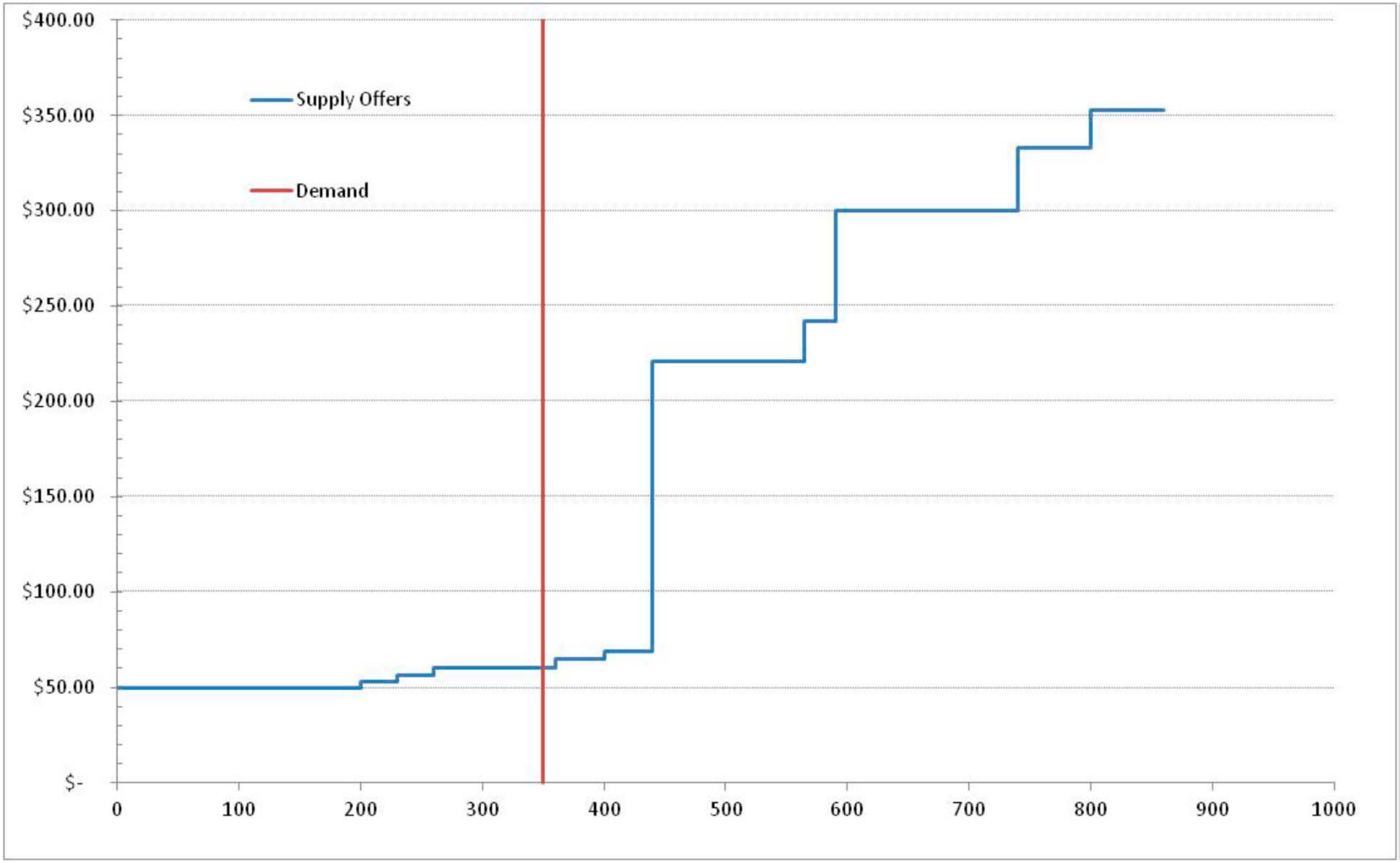

DA Supply Stack for July 20-31, 2010
1200
1000
800
600
400
200
0
0
5000
10000
15000
20000
25000
30000
35000
20
21
22
23
24
25
26
27
28
29
30
31

Supply Example

Example #1 – Offer Blocks (MW)



Supply Curve Example – Load at 350 MW



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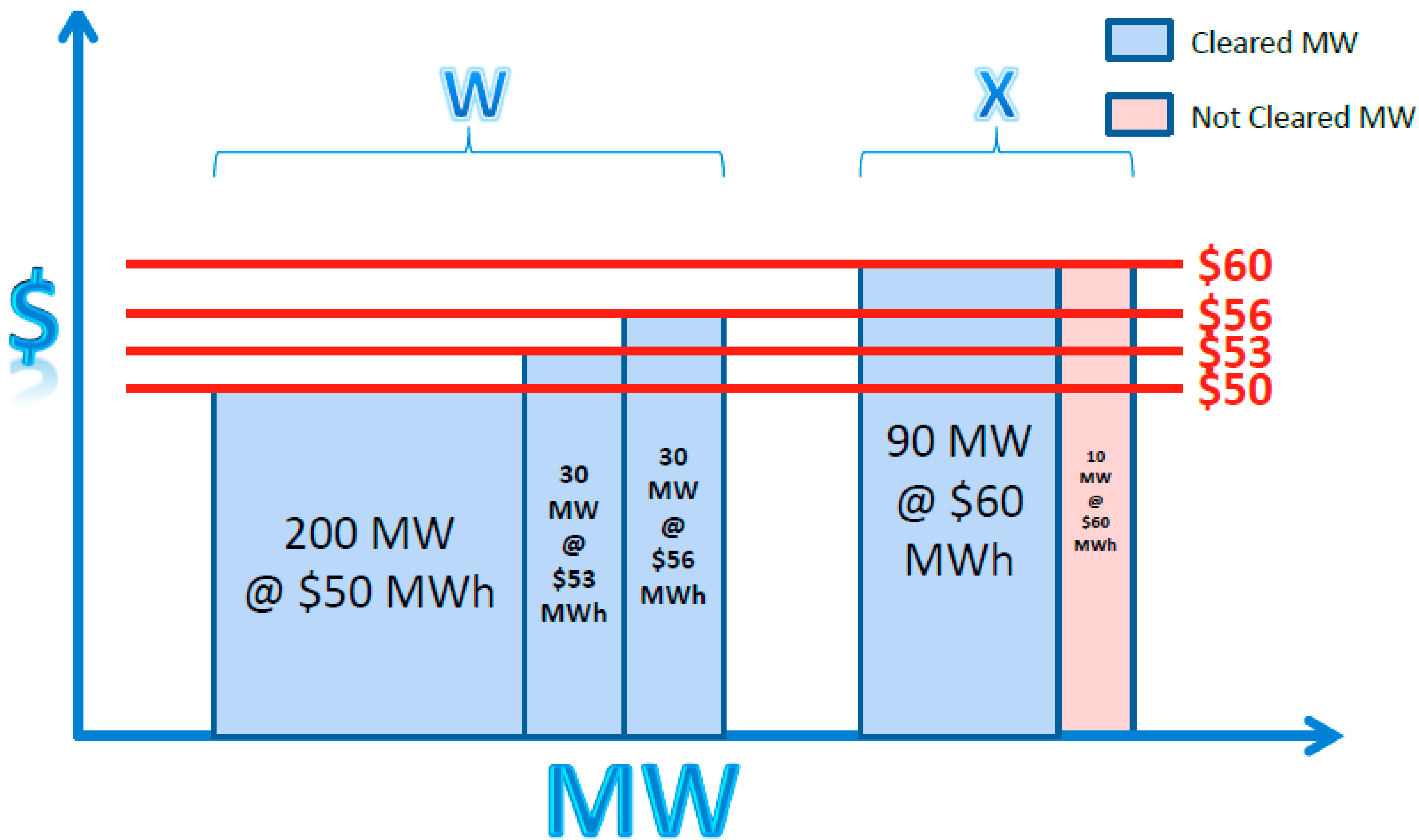
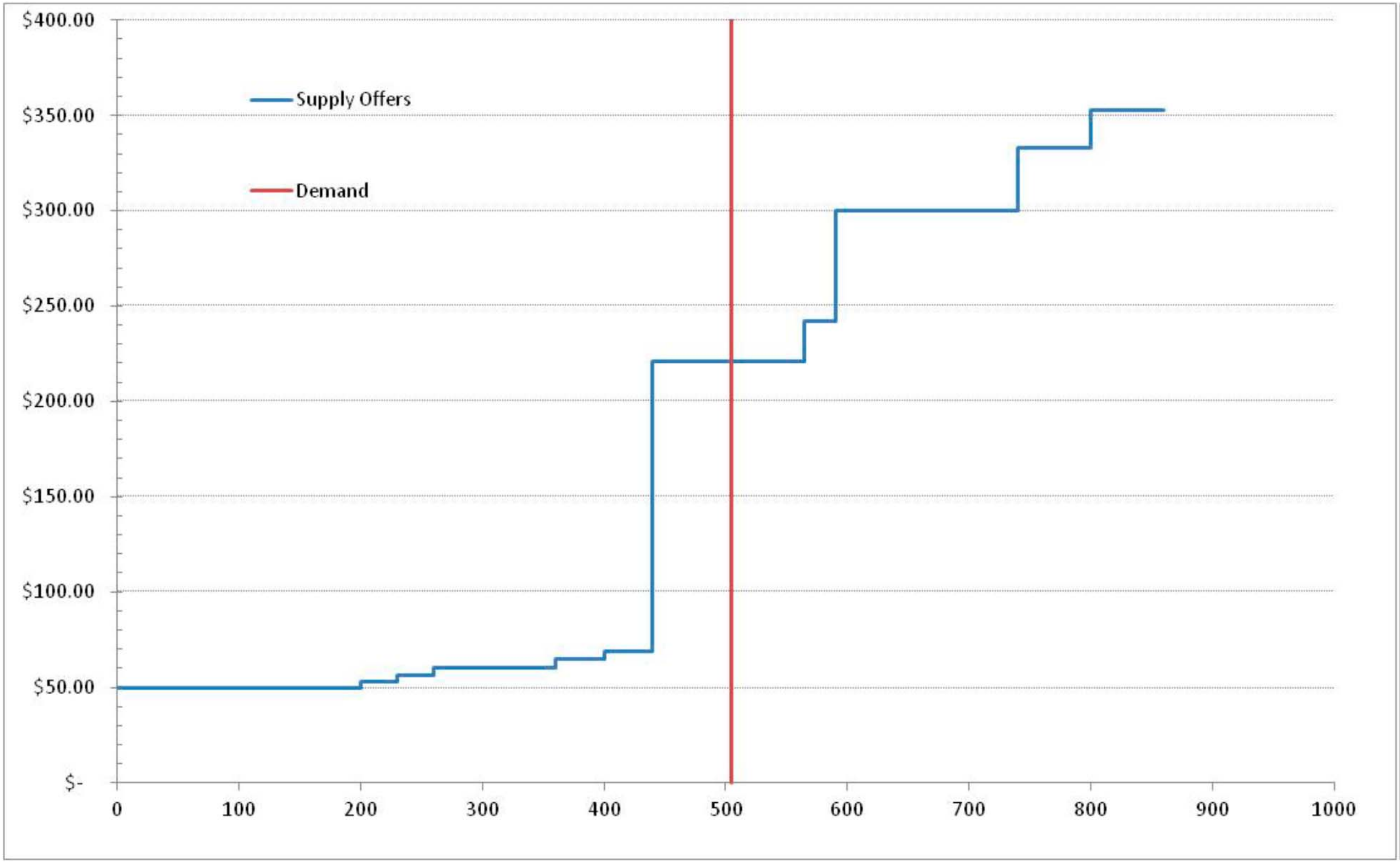
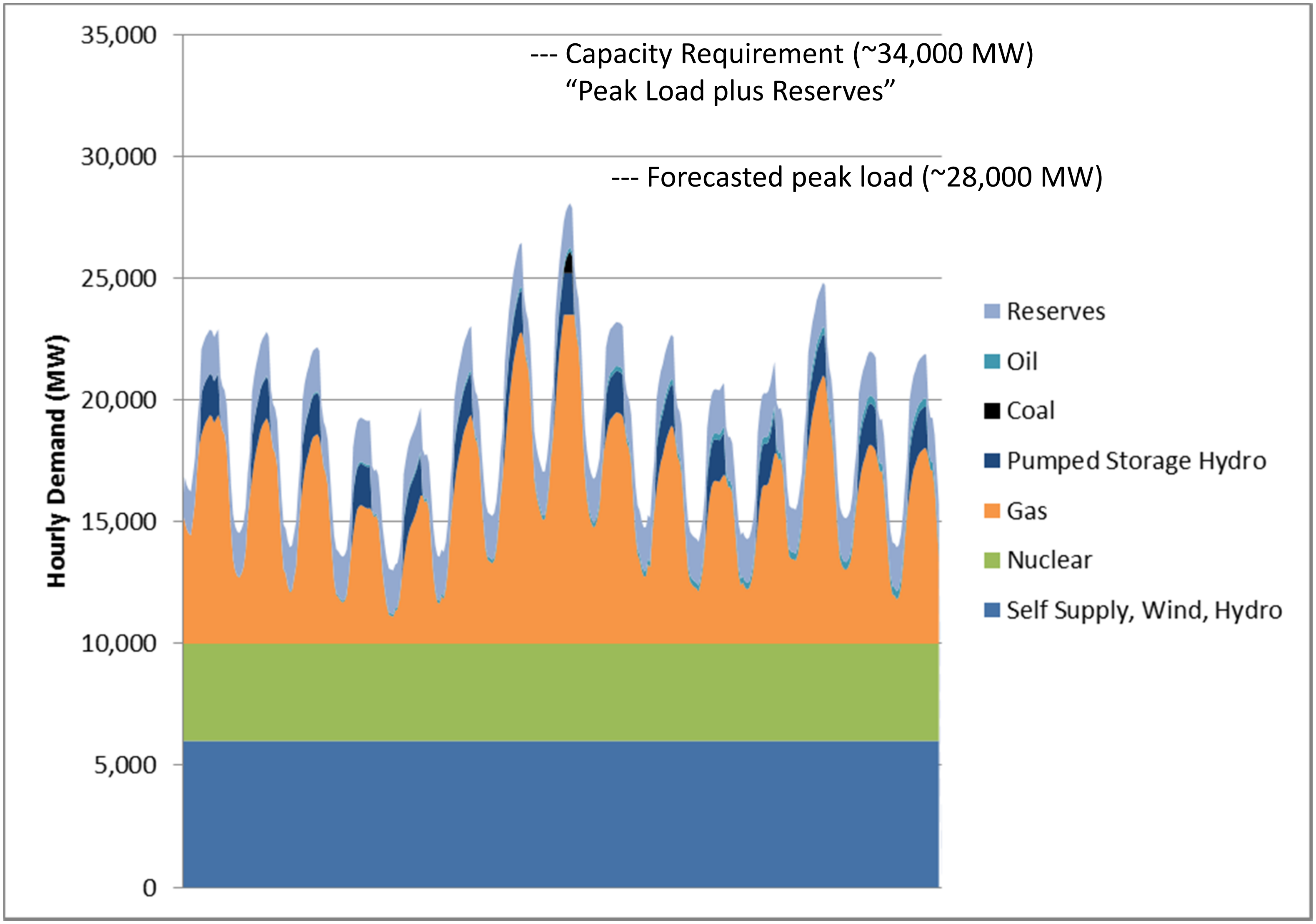


Supply Curve Example – Load at 500 MW



Supply and Demand



Energy Market

- Supply must equal Demand at every instant, every day
- Reserves to cover two largest contingencies (30-min start or ramp)
- Day-Ahead Market
  - Supply offers stacked up in order of price, and ISO clears the market using
  - Single clearing price market (as opposed to pay-as-bid)
  - Financially binding market. Usually clears >95% of actual real-time load
- Real-Time energy market
  - Security Constrained Economic Dispatch
    - Lowest cost resources, modified to meet reliability where necessary
  - Adjust day-ahead schedule for real-time load and events (generation or transmission outages, storms, weather fronts, wind output, etc.)
  - Deviation from DA schedule incurs penalties

 |

Capacity Market

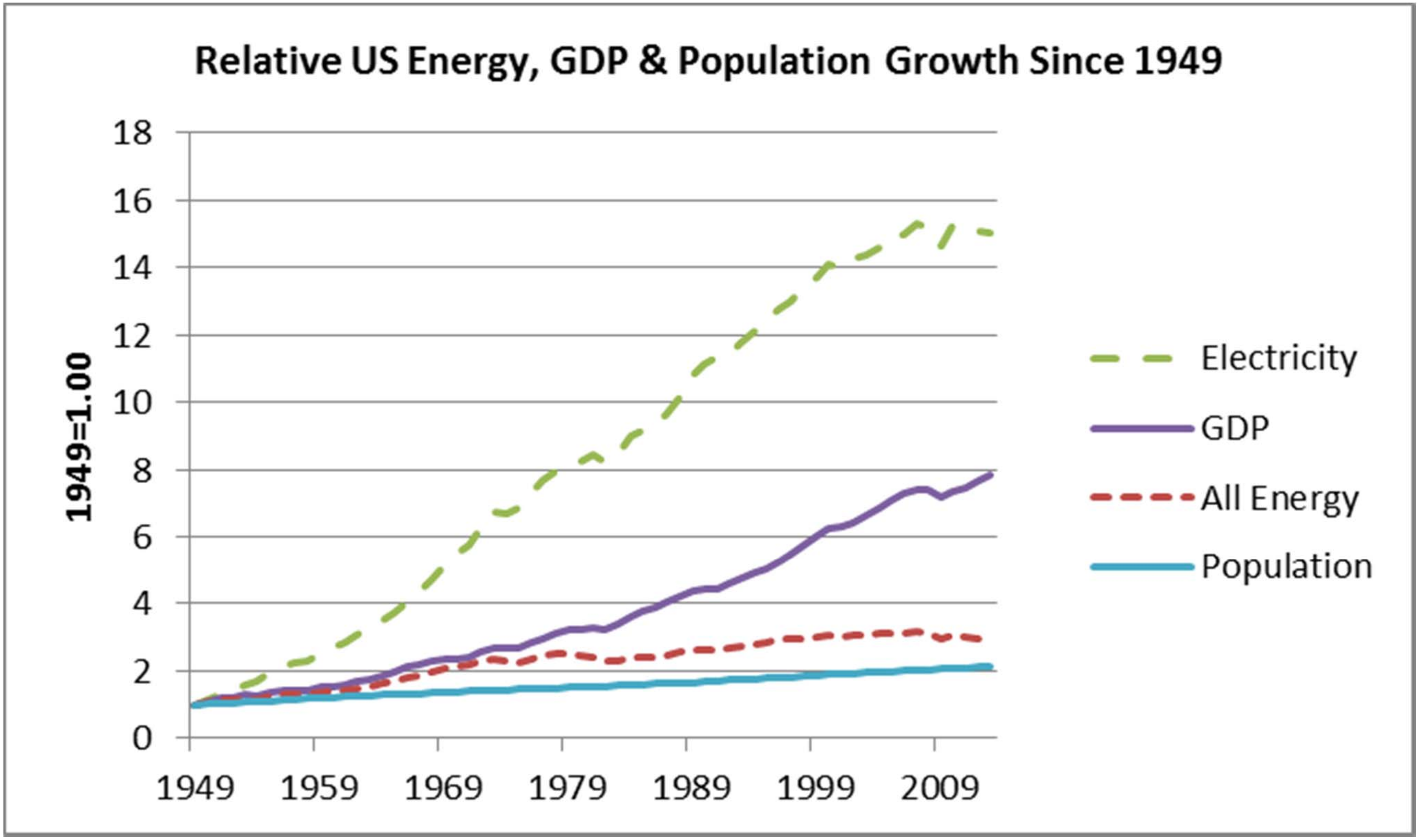
- Allows for planning "resource adequacy" in wholesale market regions. Not used everywhere.
    - Does not guarantee reliability
    - Texas is an energy-only market.
- Primary auction run three years in advance of delivery
    - Numerous reconfiguration auctions and bilateral trading windows to true-up obligations
- "Product" is a promise to delivery energy (or savings) when called upon for a 12-month power year, June through May.

Current Electric Planning in New England

Topics

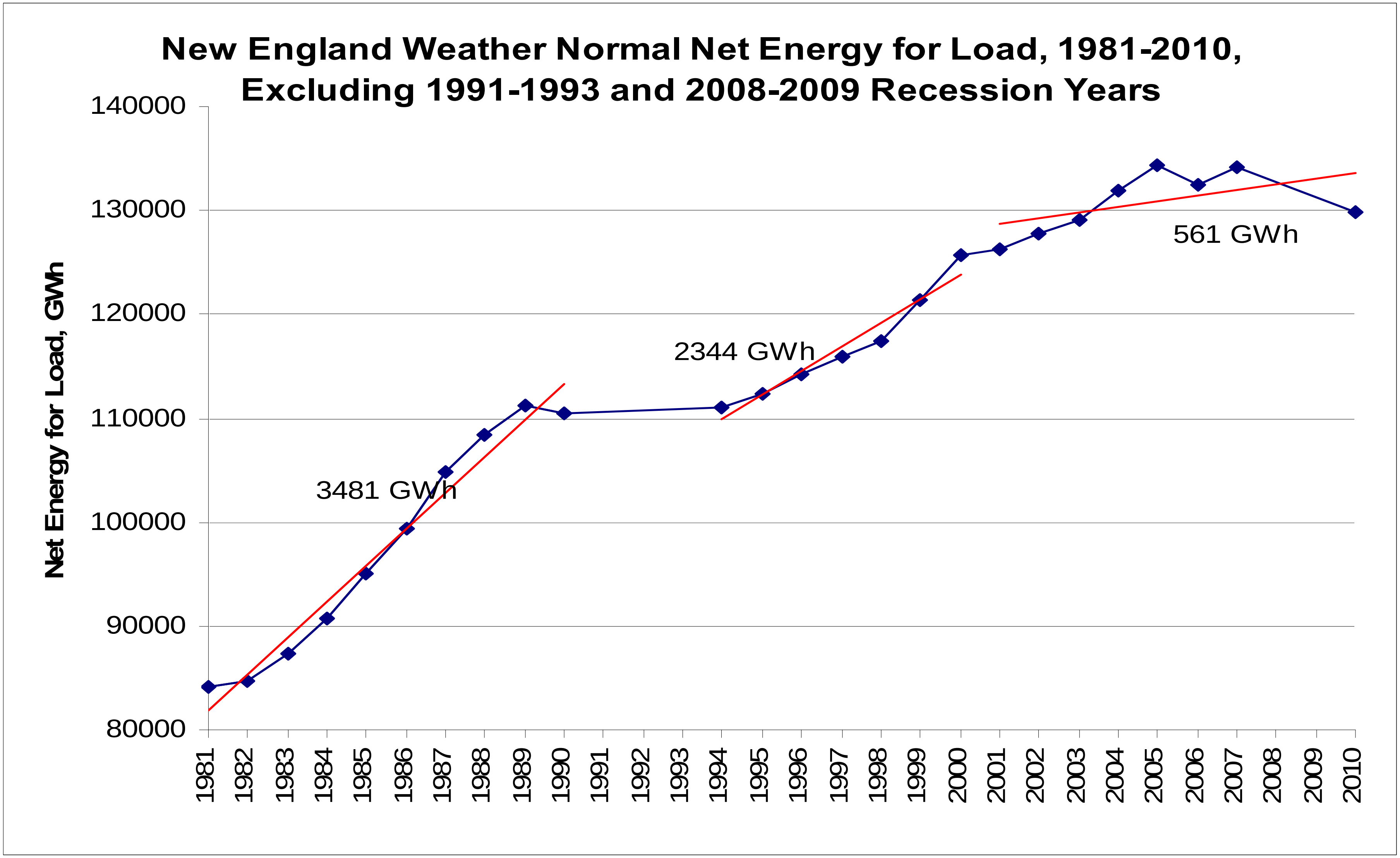
- Electric system planning issues
  - Consumption, annual energy, peak loads, generation
  - Load forecasts
    - Adjust for energy efficiency
    - Adjust for distributed generation
    - Each country’s energy intensity value, by itself, does not indicate “good” or “bad,” it is just a way of understanding and comparing one aspect of energy consumption
  - Transmission facilities
- Gas supply and delivery issues
  - Firm load and power generation
  - New supply options

History

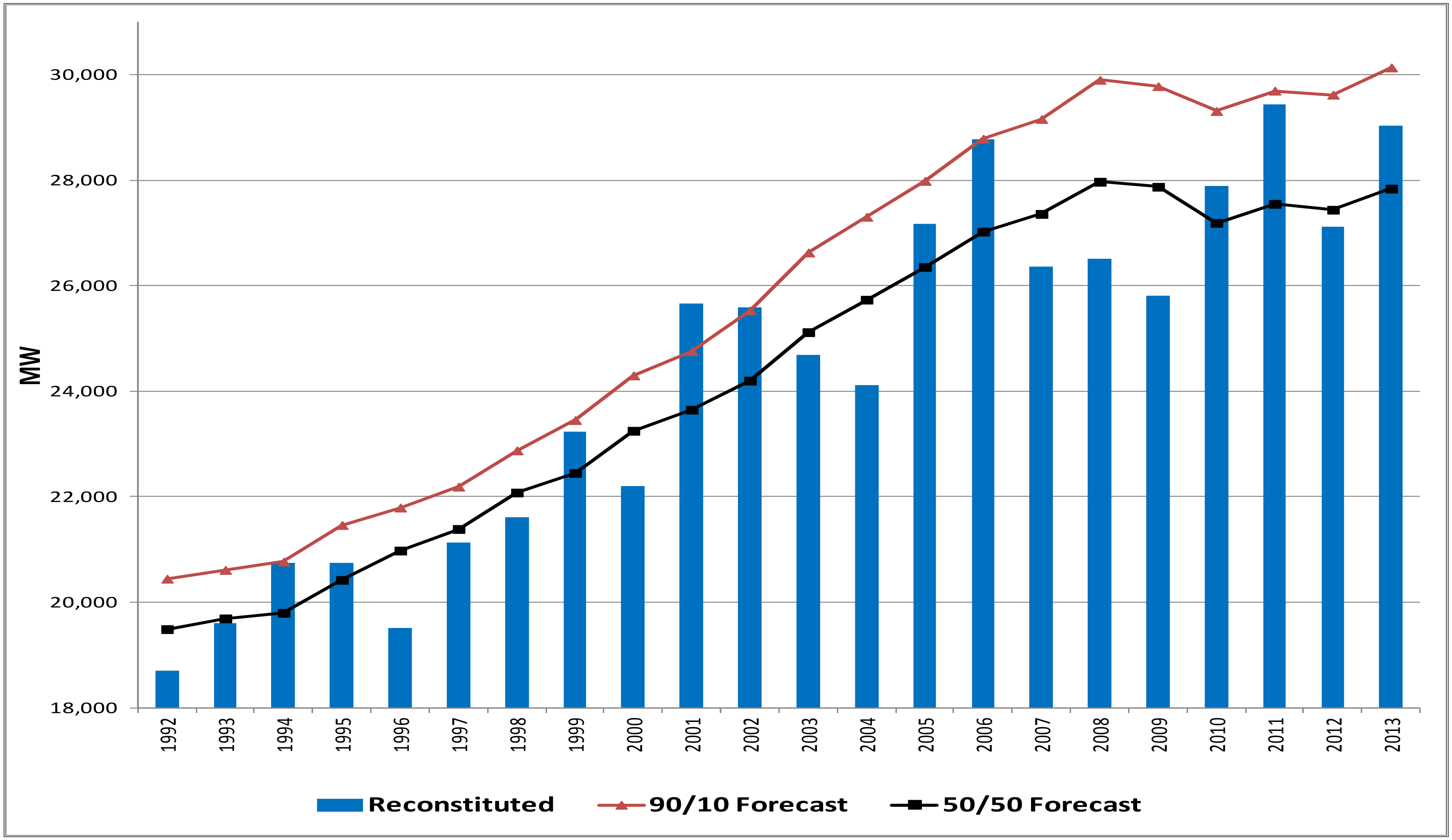


Relative US Energy, GDP & Population Growth Since 1949
1949=1.00
18
16
14
12
10
8
6
4
2
0
1949
1959
1969
1979
1989
1999
2009
Electricity
GDP
All Energy
Population

Long-Term Trend in 10-Year Averages



ISO Summer Peak Loads and Forecasts



The ISO's actual summer peak loads (i.e., reconstituted for OP 4 and FCM passive demand resources) and the 50/50 and 90/10 forecasts, 1992 to 2013 (MW). Source: ISO New England 2014 Regional System Plan, Figure 3-1.

2014 Energy and Summer Peak Energy Efficiency Forecast Data

GWh Savings

	ME	NH	VT	CT	RI	MA	ISO-NE
2018	142	76	125	401	141	880	1,764
2019	132	73	120	379	132	823	1,658
2020	122	69	117	358	123	769	1,560
2021	114	66	110	338	114	719	1,462
2022	106	63	106	319	106	672	1,373
2023	99	60	102	300	99	628	1,288
Total	714	408	681	2,096	715	4,491	9,105
Average	119	68	113	349	119	749	1,518

MW Savings

	ME	NH	VT	CT	RI	MA	ISO-NE
2018	20	12	18	49	22	118	239
2019	19	12	17	46	20	111	225
2020	17	11	17	44	19	104	211
2021	16	11	16	41	18	97	198
2022	15	10	15	39	16	90	186
2023	14	10	14	37	15	85	174
Total	101	66	96	255	111	605	1,233
Average	17	11	16	42	18	101	205

Key Parameters for ISO-NE Energy Efficiency Forecast Model

MW = $ * % Spent * MWh/$ * Realization Rate * MW/MWh

- $: an estimate of the dollars to be spent on energy efficiency (including budget uncertainty)
- % Spent: percentage of dollars that can be spent on energy efficiency programs in that time period—developed from historical data
- MWh/$: MWh savings per dollar spent—developed from historical data
- Realization Rate: comparison of observed/measured savings to estimated savings—developed from historical data
- MW/MWh: peak to energy ratio (inverse of load factor)—developed from historical data and possibly load forecast

2014 Regional System Plan Forecasts

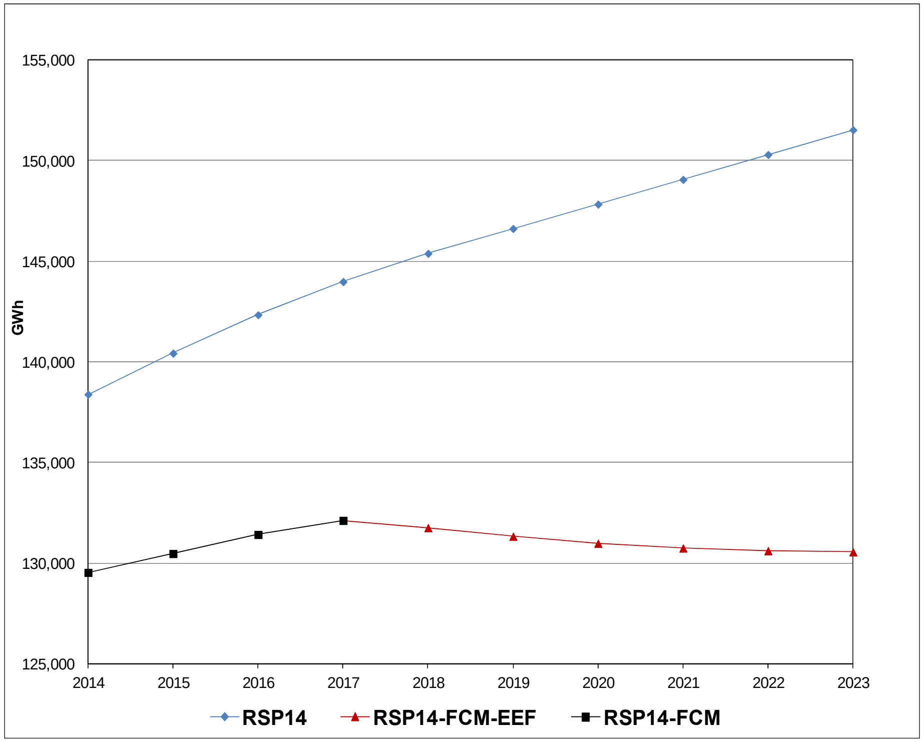


Figure 3-3: RSP14 annual energy-use load forecast (diamond), load forecast minus FCM #8 results through 2017 (square), and load forecast minus FCM results and minus the energy efficiency forecast (triangle) for 2018 to 2023 (GWh).

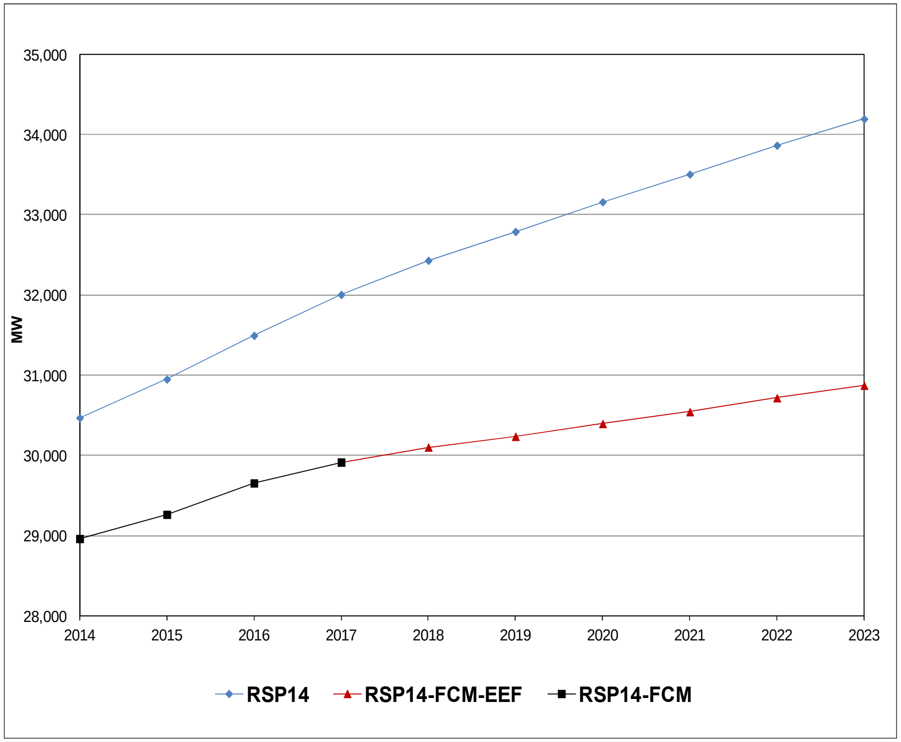


Figure 3-4: RSP14 summer peak demand forecast (90/10) (diamond), load forecast minus FCM #8 results through 2017 (square), and load forecast minus FCM results and minus the energy efficiency forecast (triangle) for 2018 to 2023 (MW).

Final Interim PV Forecast, 2014 CELT Report

States	Annual Total MW (AC nameplate rating)											Totals
	Through 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
CT	73.8	46.2	39.3	53.0	34.7	34.7	13.1	13.1	13.1	13.1	11.6	**345.4**
MA	361.6	168.5	117.4	110.5	103.6	98.7	98.7	98.7	32.9	32.9	32.9	**1,256.4**
ME	8.1	2.0	1.9	1.8	1.6	1.6	1.6	1.6	1.6	1.6	1.6	**25.2**
NH	8.2	2.5	2.3	2.2	2.0	2.0	2.0	2.0	2.0	0.7	0.7	**26.7**
RI	10.9	7.3	5.4	3.7	1.2	1.2	1.2	1.2	1.2	1.2	1.2	**35.5**
VT	36.1	20.1	13.4	7.0	6.5	6.5	6.5	6.5	6.5	6.5	1.7	**117.3**
Regional - Annual (MW)	**498.7**	**246.5**	**179.6**	**178.1**	**149.6**	**144.8**	**123.1**	**123.1**	**57.3**	**56.0**	**49.7**	**1,806.5**
Regional - Cumulative (MW)	**498.7**	**745.2**	**924.8**	**1102.9**	**1252.5**	**1397.3**	**1520.4**	**1643.6**	**1700.9**	**1756.9**	**1806.5**	**1,806.5**

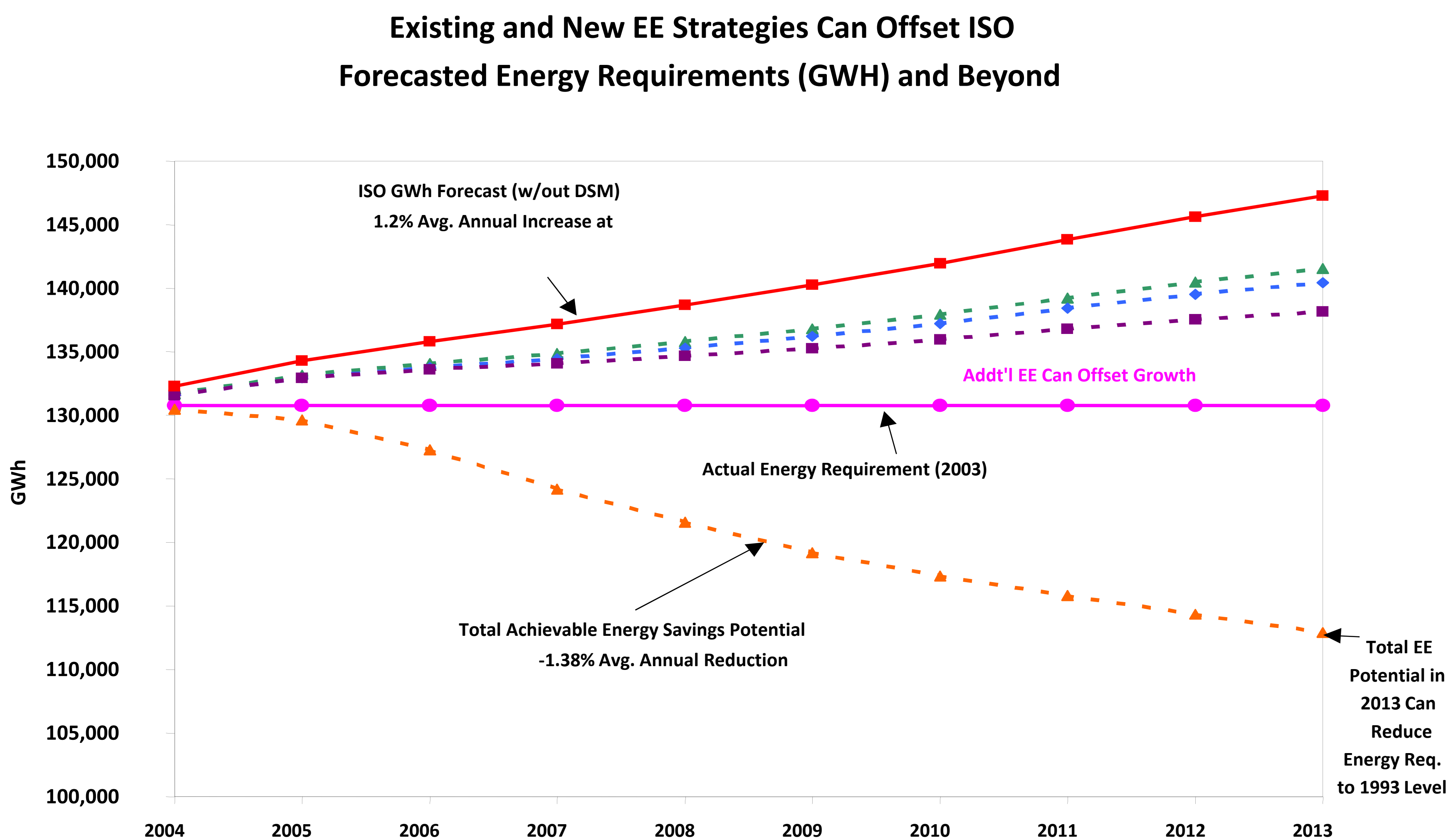
Notes:

(1) Forecast values include cumulative PV installed at beginning of forecast period

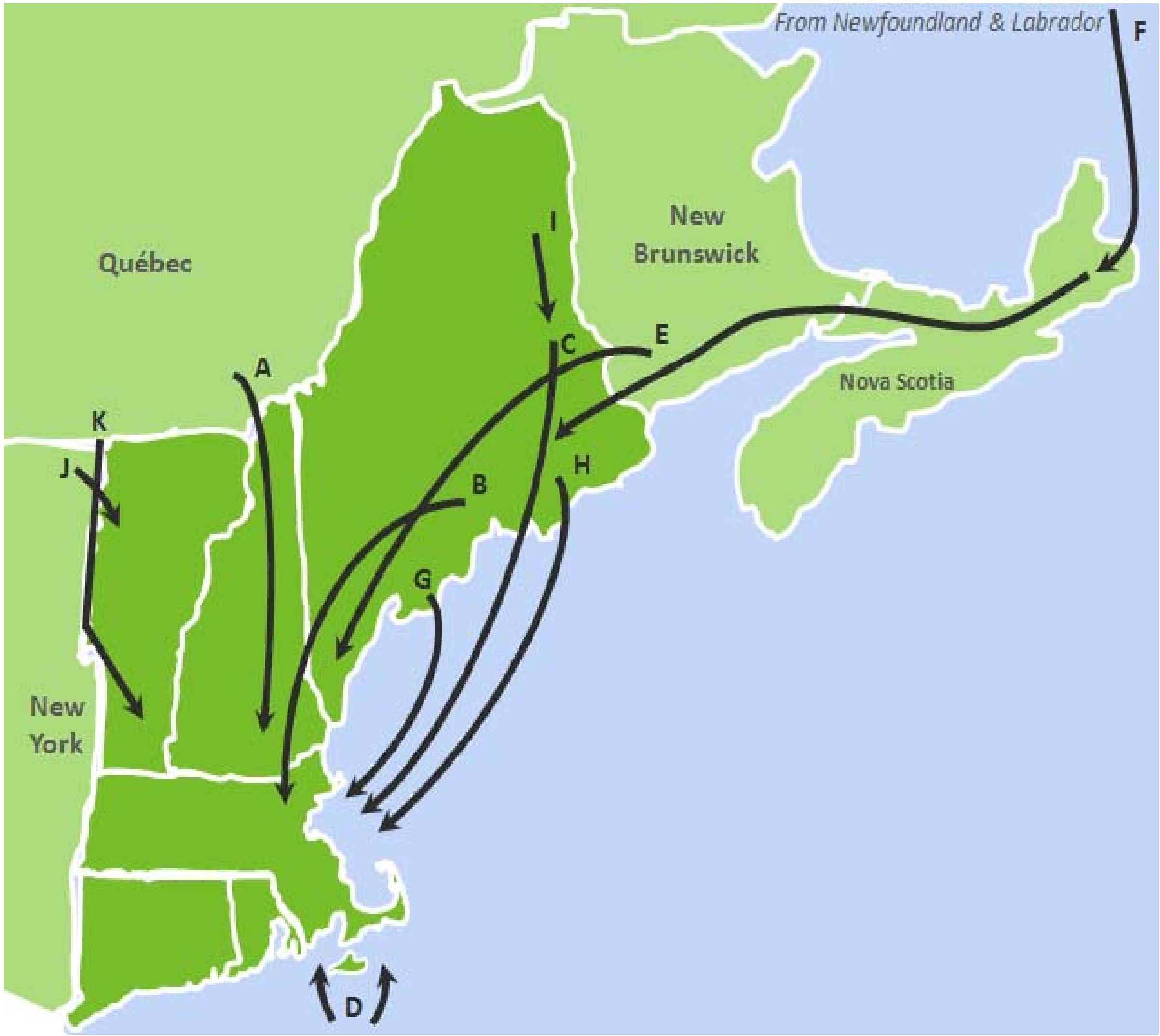
(2) All PV resources, including FCM Resources, non-FCM Settlement Only Generators, and load reducing PV, are included in values above

(3) All values represent end-of-year installed capacities

2005 Northeast Energy Efficiency Partnerships Estimate of Energy Efficiency Potential



Large-scale Transmission in New England
(including some proposed direct-current transmission)



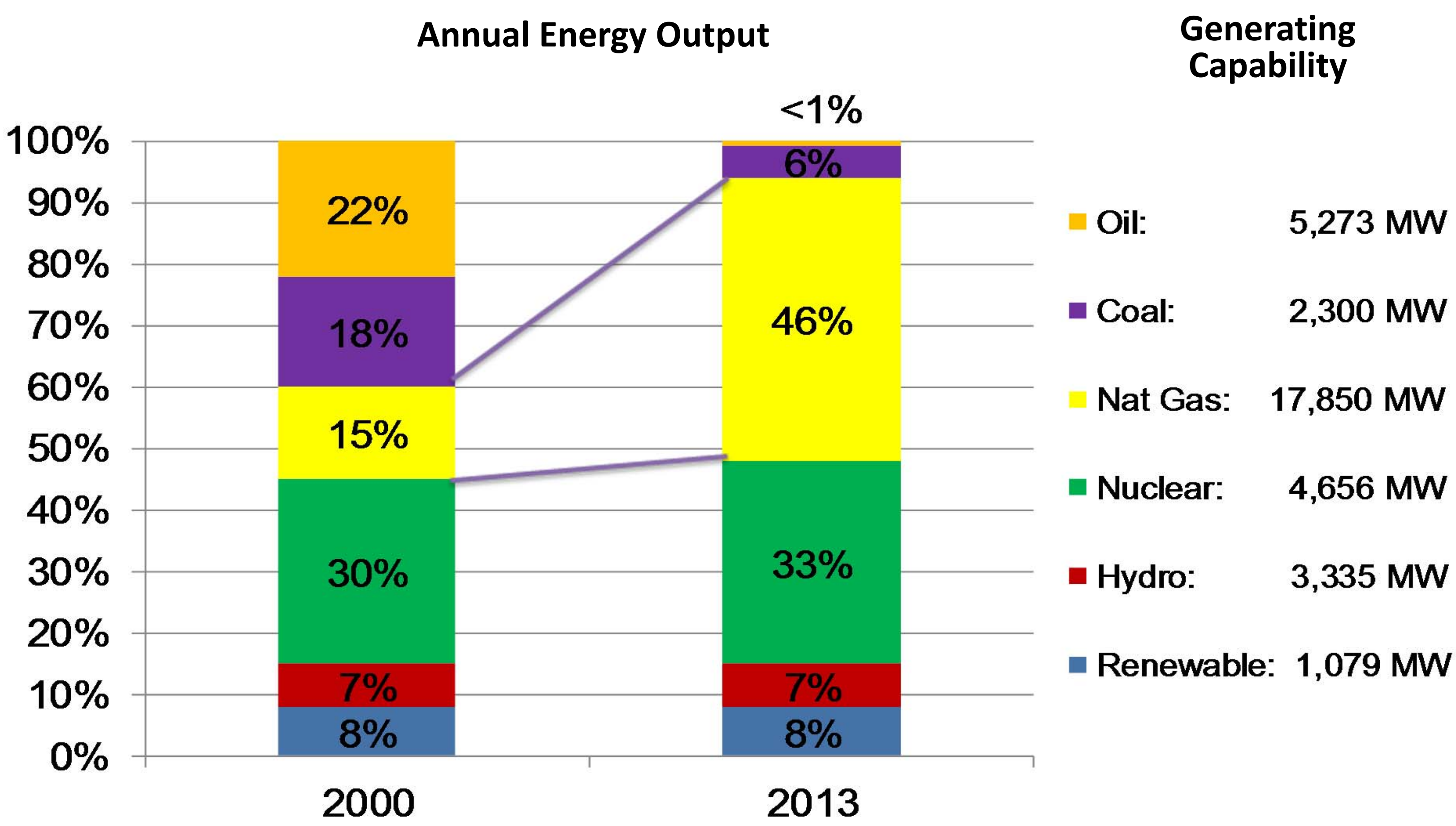
Representative Projects and Concept Proposals

- **A** Northern Pass—Hydro Québec/Northeast Utilities
- **B** Northeast Energy Link— Emera Maine/National Grid
- **C** Green Line—New England ITC
- **D** Bay State Offshore Wind Transmission System—Anbaric Transmission
- **E** Northeast Energy Corridor—Maine/New Brunswick/Irving
- **F** Muskrat Falls/Lower Churchill—Nalcor Energy
- **G** Maine Yankee—Greater Boston
- **H** Maine—Greater Boston
- **I** Northern Maine—New England
- **J** Plattsburgh, NY—New Haven, VT
- **K** New England Clean Power Link—TDI New

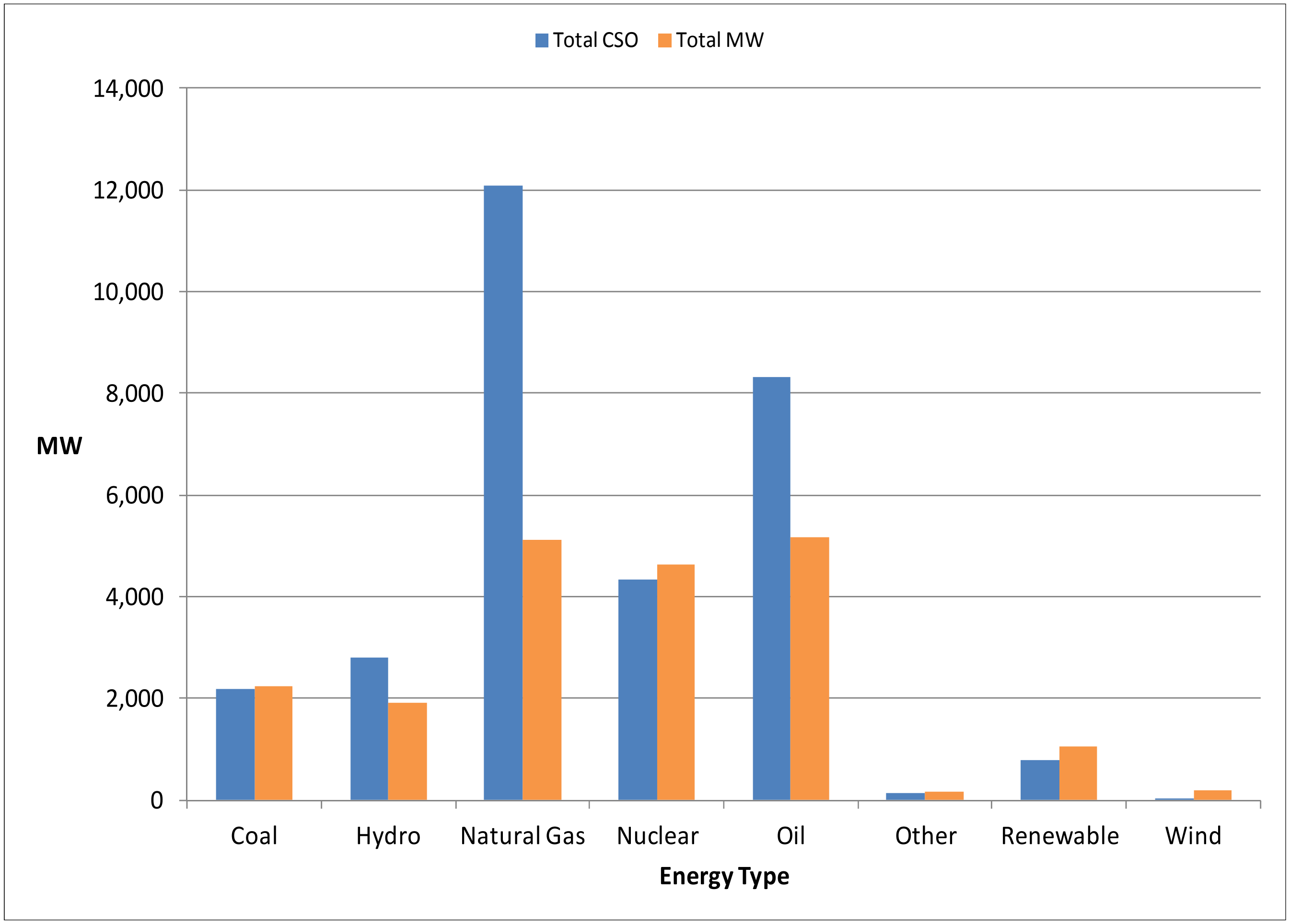
Source: ISO New England 2014 Regional System Plan, Figure 7-3.

Northeast Utilities, MA Roundtable

November 21, 2014

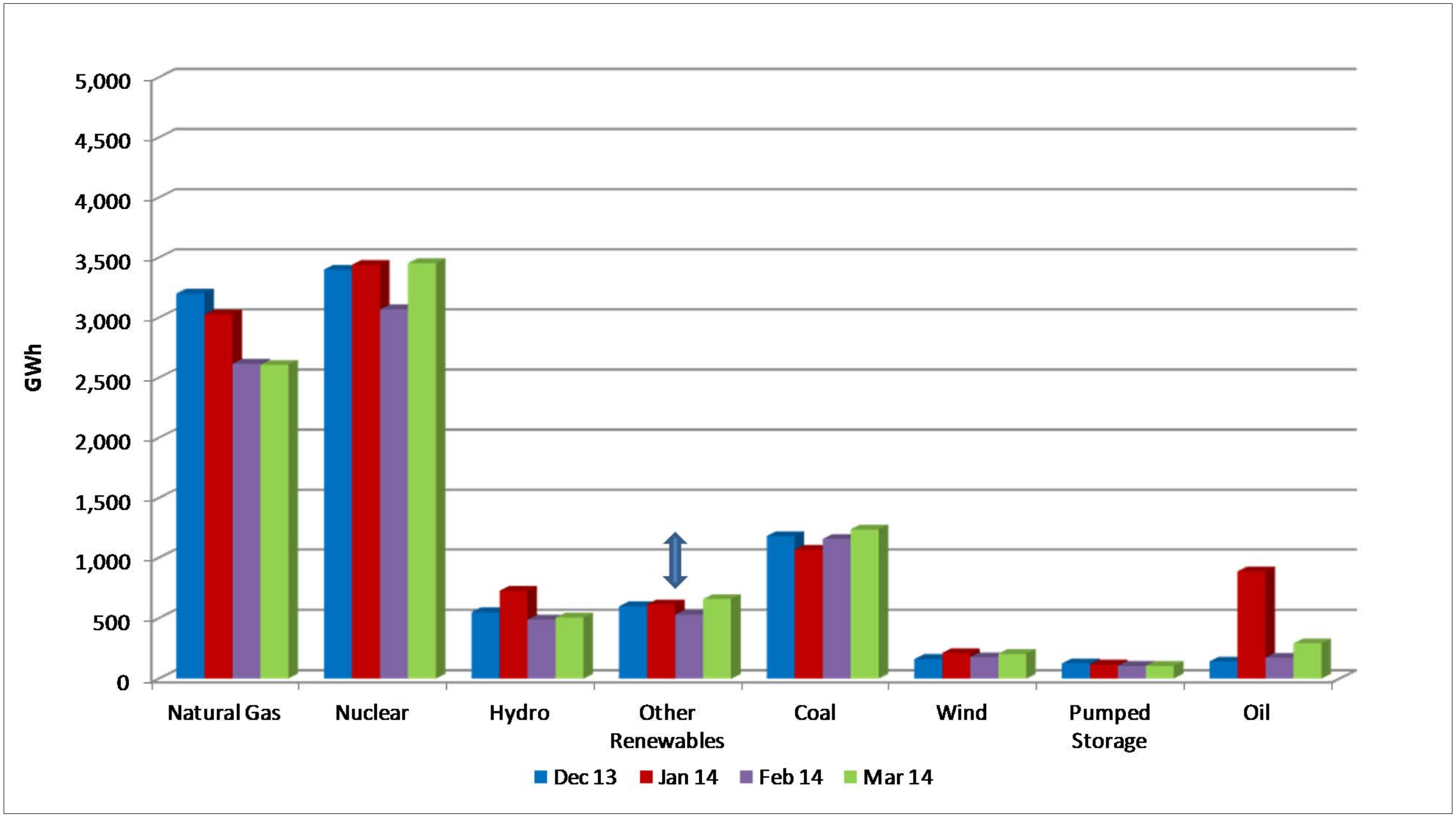


Generation by Fuel Type Compared with CSO, January 7, 2014, Evening Peak (MW)



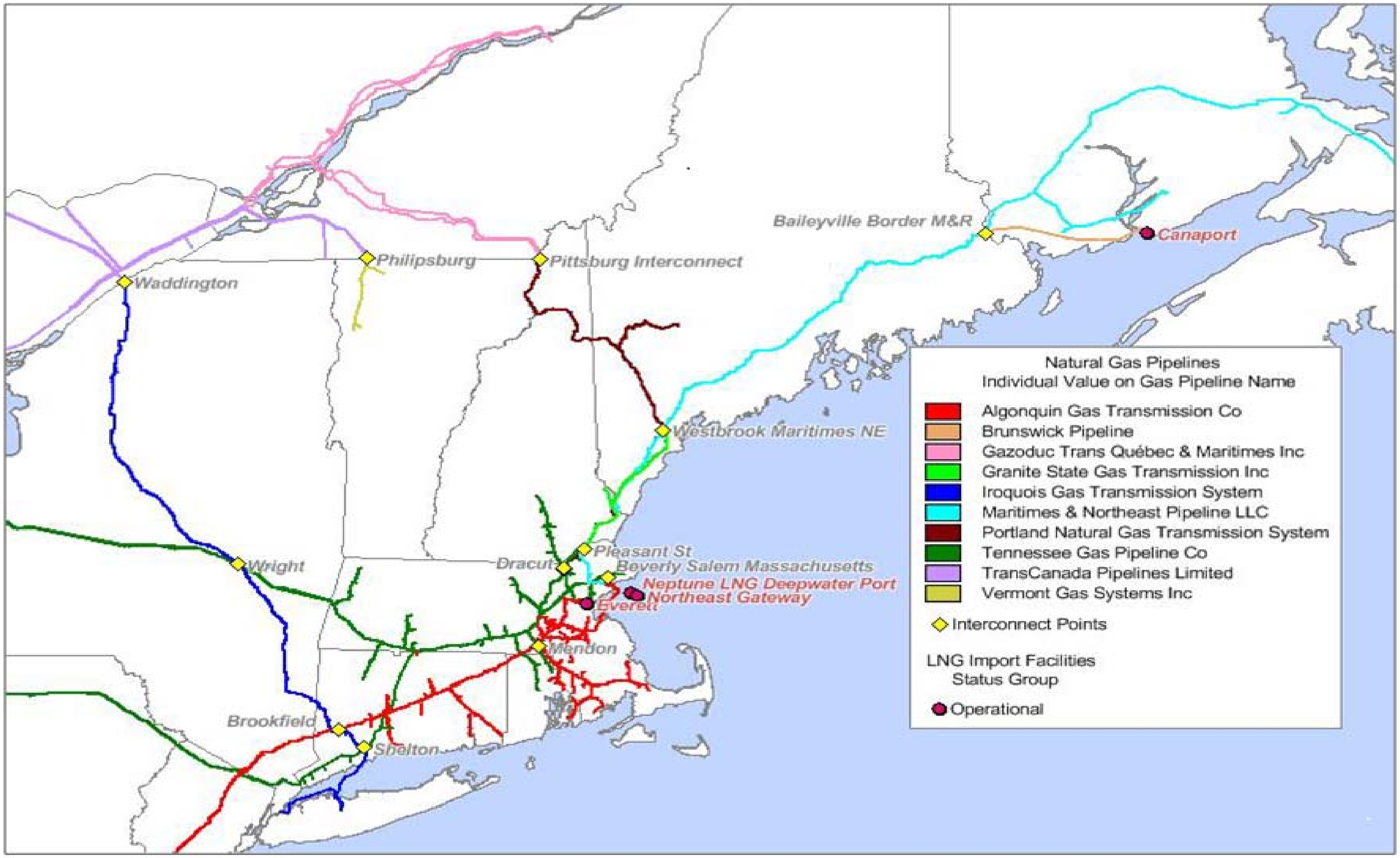
Source: ISO New England 2014 Regional System Plan, Figure 6-9.

Generator Energy Production by Fuel Type for December 2013, and January, February, and March 2014



Source: ISO New England 2014 Regional System Plan, Figure 6-6.

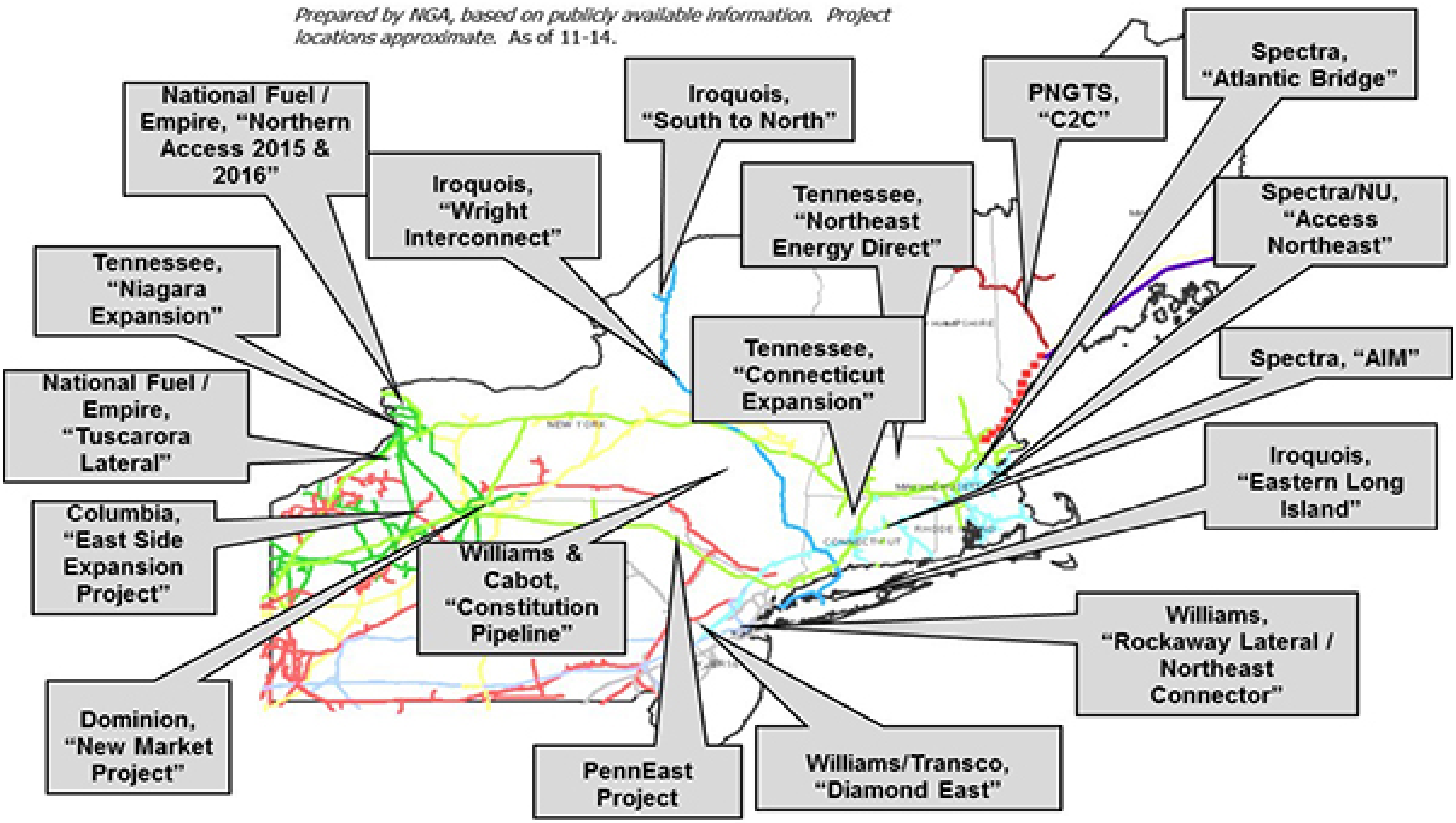
Overview Map of the Natural Gas Infrastructure Serving New England



Source: ISO New England 2014 Regional System Plan, Figure 6-3.

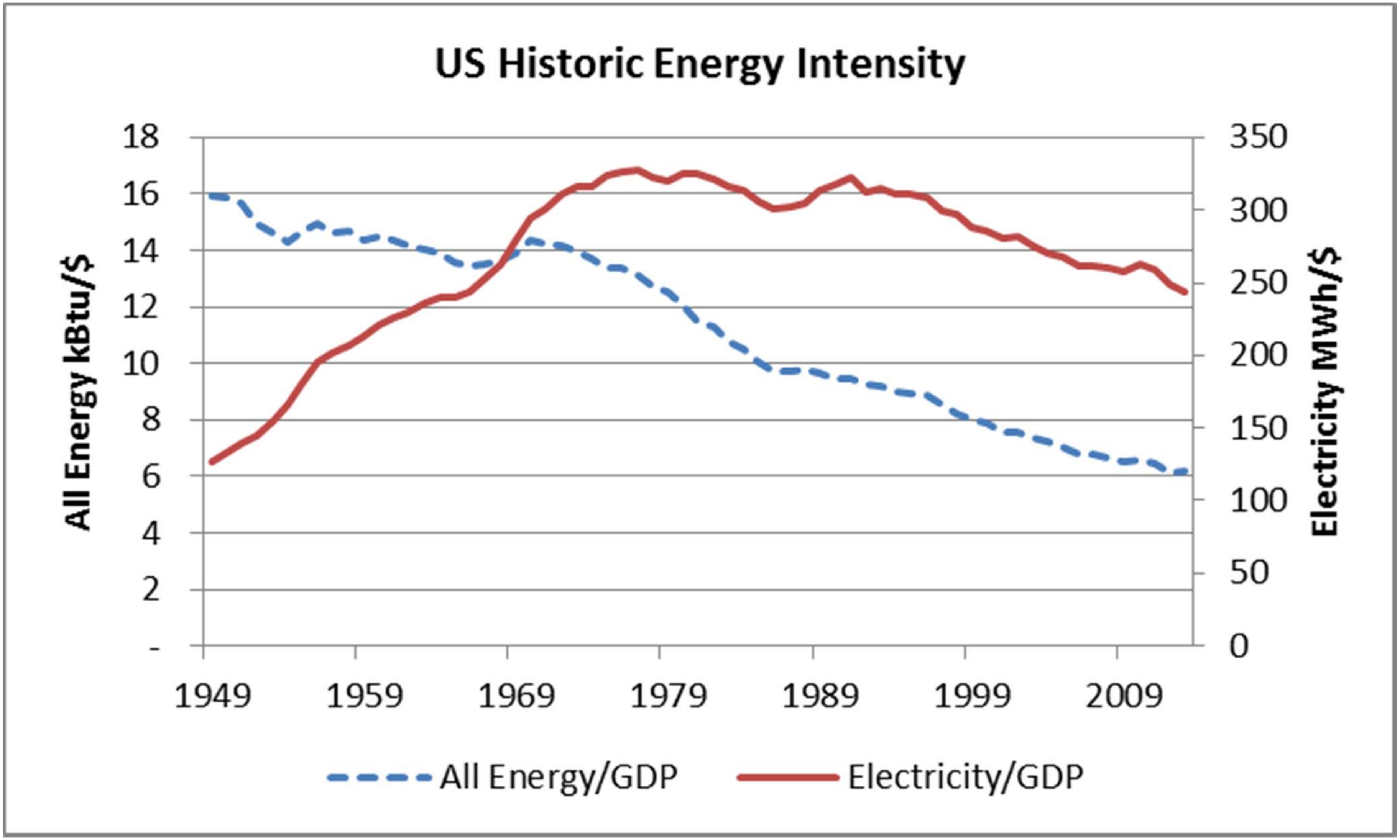
Levitan Associates, MA Roundtable

November 21, 2014

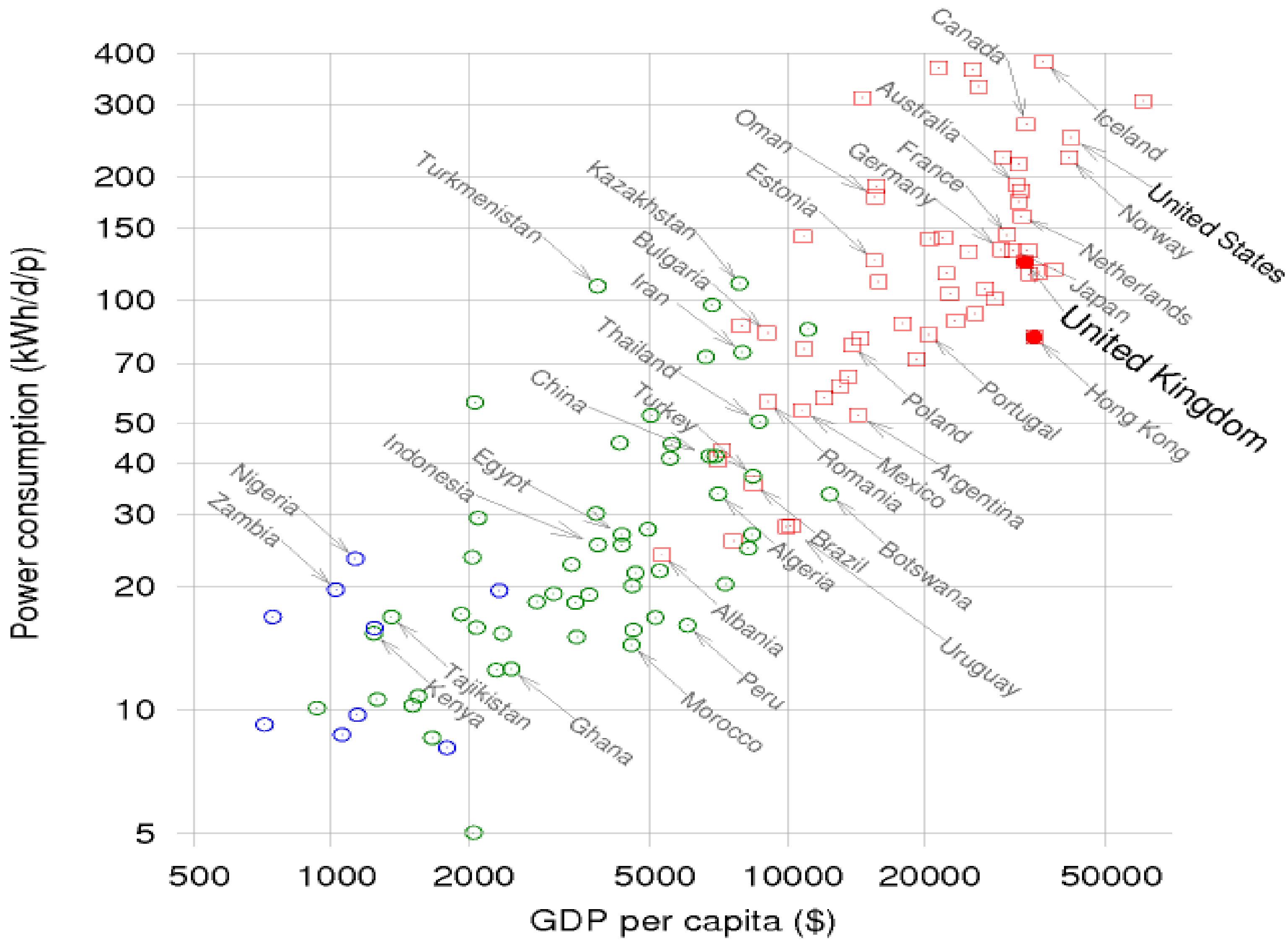


Appendix

Energy Intensity



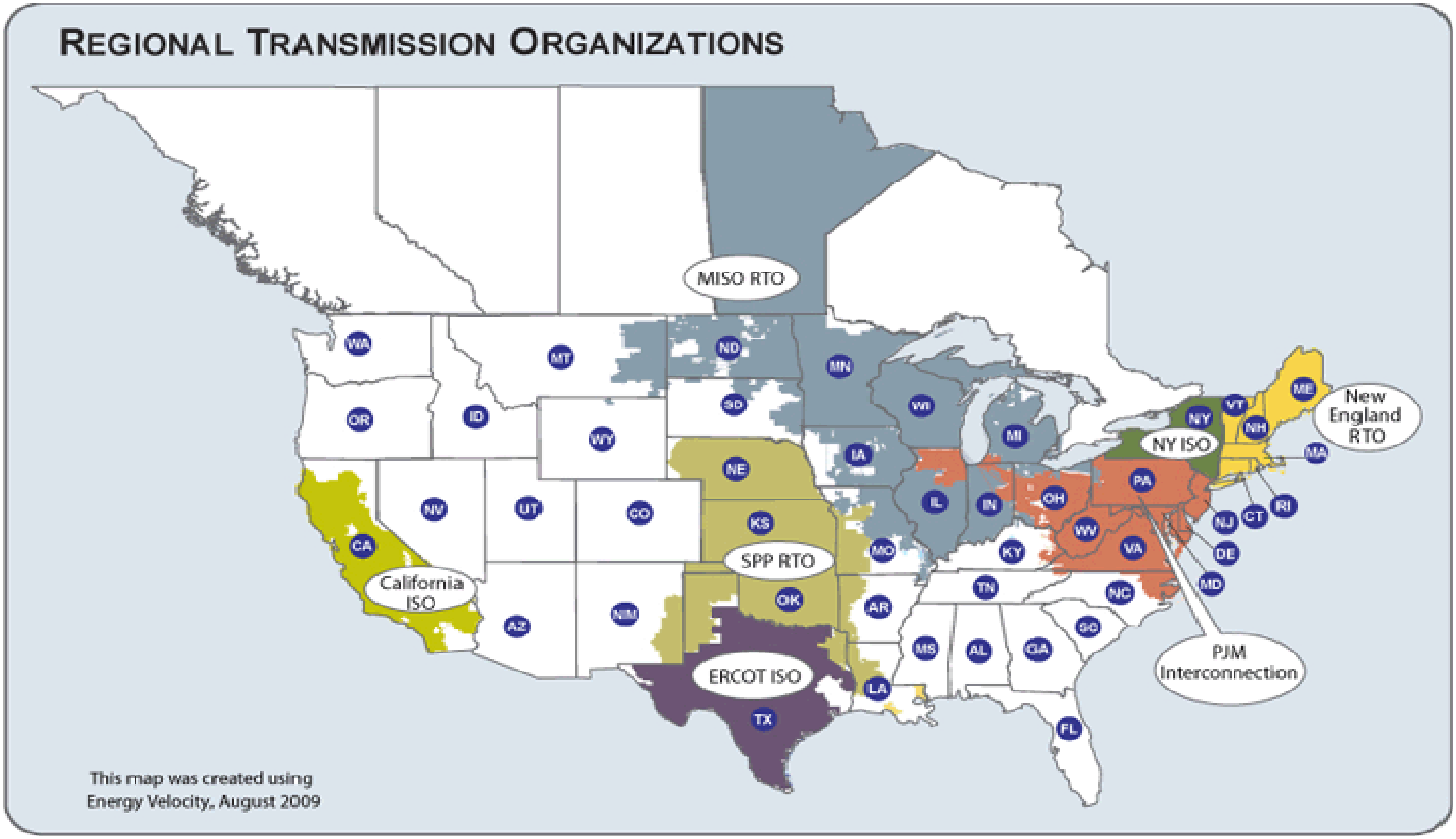
Energy Intensity



Understanding Energy Intensity Values

- Each country's energy intensity value, by itself, does not indicate "good" or "bad," it is just a way of understanding and comparing one aspect of energy consumption
- Geography, development, and access to natural resources (low-cost) are key factors
- For the USA, in general, a lower energy intensity value equates to greater efficiency and, therefore, insulation from energy price volatility

North America Machines



Electric System Overview

- Three elements to power system
  - Supply (resources)
  - Demand (loads)
  - Wires (T&D systems)
- Inter-connected electric systems are the largest machines every built
  - 24/7 balancing of supply and demand
  - Cascading effect of disruptions

Electric System Overview

- Traditional operation of power grids
  - Day-ahead forecast of hourly loads (weather)
  - Day-ahead commitment of generation
  - Real-time management of generation by operators
- Evolving operation of power grids
  - Day-ahead offers by Supply and Load
  - Day-ahead dispatch schedule includes instructions to both Supply and Load
  - Real-time balancing based on offers
- Supply <u>and</u> load are variable/manageable

Background Concepts

- Peak Load
  - Summer: MW needed for summer peak day
  - Winter: MW needed for winter peak day
  - Daily: MW needed for each daily peak
- Energy
  - MWh needed to meet total annual demand
- Reliability Needs
  - Resource adequacy (thermal loads on wires)
  - Voltage and stability (additional reliability tests)
  - Operational issues (daily reliability issues)

Lunch and Networking

Multiple Resource Choices

Planning Considerations

- Resource Potential
- Cost
  - Capital
  - Fuel and VOM
  - FOM
- Emissions
- Reliability
- Siting
- Impacts
  - Environmental
  - Economic
  - Other
- Risk
  - Regulatory
  - Fuel cost and availability
  - Market prices
  - Construction overruns and/or delays

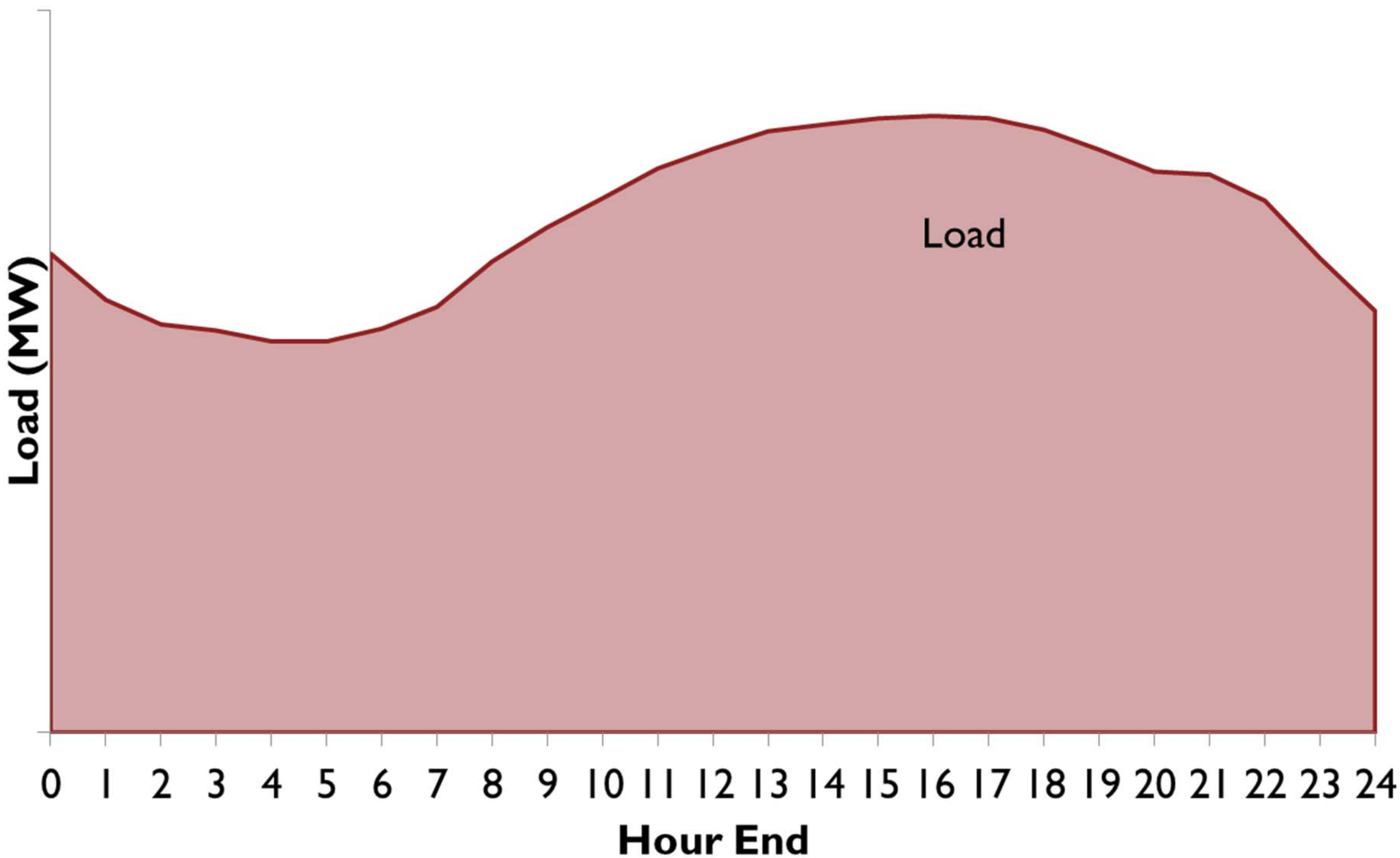
Timeline for Potential Non-fossil Resource Additions in New England

2015	**'16-'20**	**'21-'30**	**'31-'40**
Small PV	*2015 plus*	*2015 plus*	*2015 plus*
Small wind	EE	*'16-'20 plus*	*'16-'20 plus*
	DR	Off-shore wind	*'21-'30 plus*
	Large PV	New transmission	New nuclear
	Large wind	Biomass	Wave
		Nuclear uprate	Tidal
			Geothermal

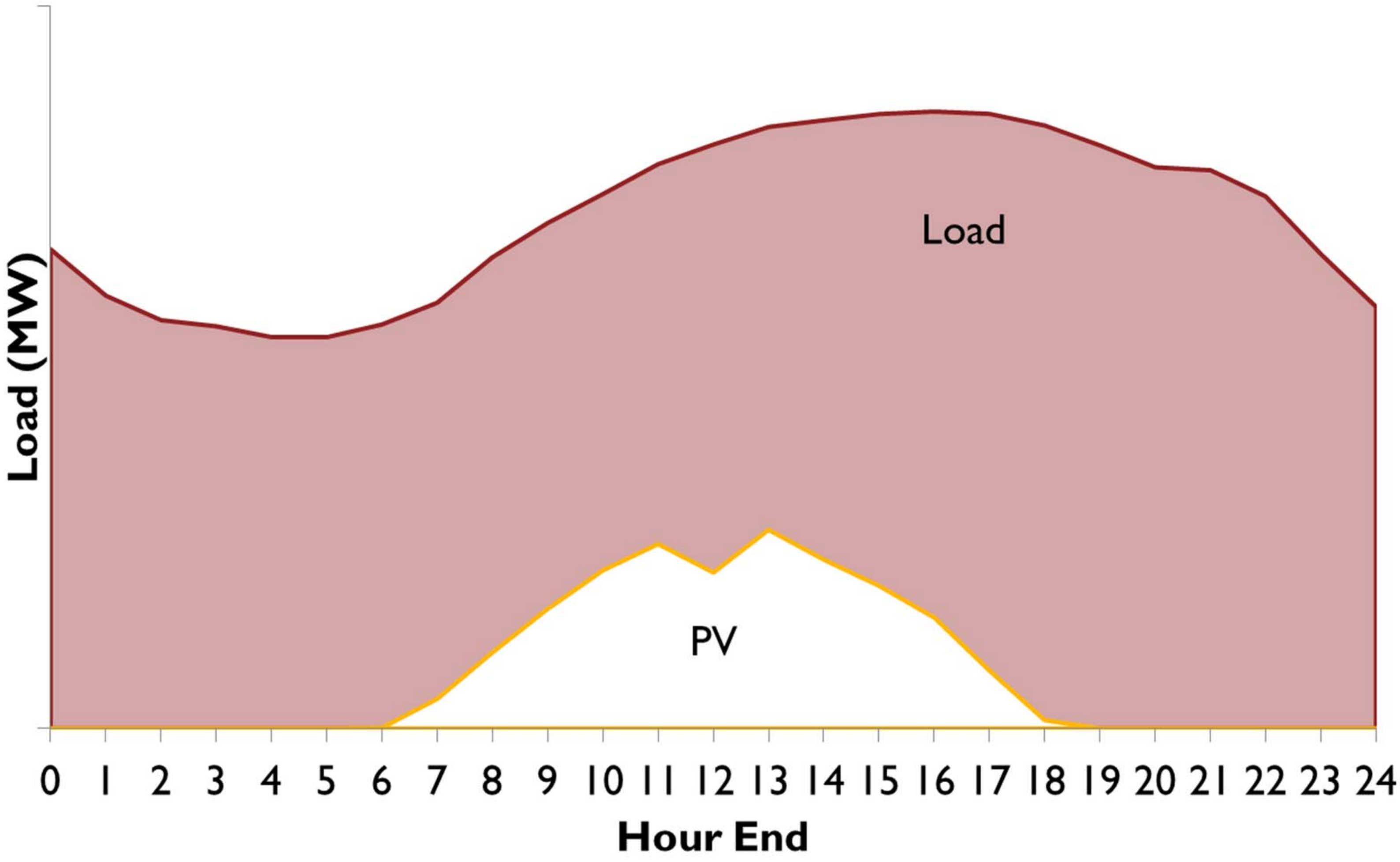
Emissions

- Emissions are produced during any hours when *any* fossil fueled generation resources are running.
- In any hour, the impact of reducing electric demand on emissions depends on which resource will be backed down. That resource, the most expensive to operate currently dispatched resource, is called the marginal resource.
- In New England, gas-fired generators are almost always on the margin.

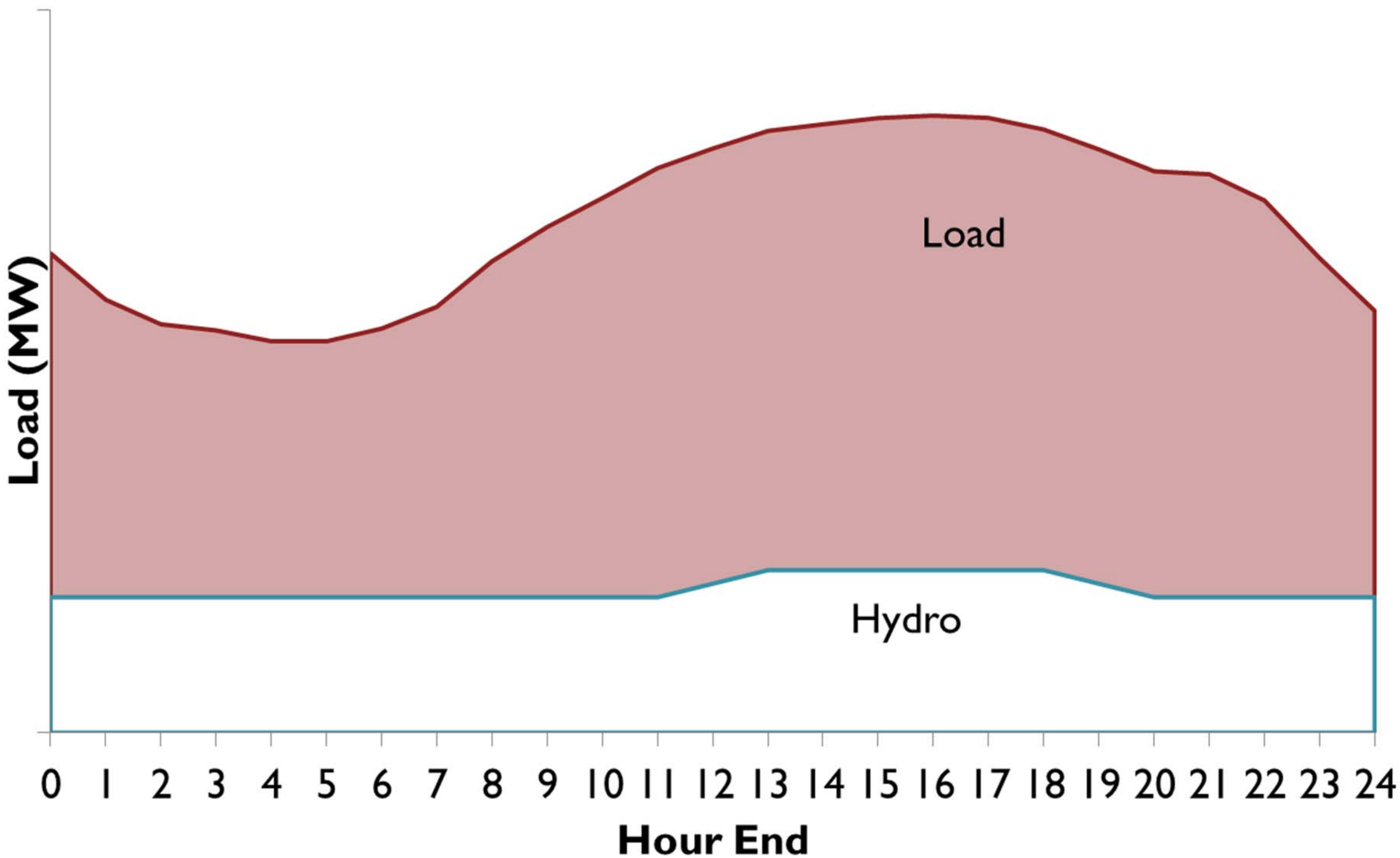
Emissions: a summer example



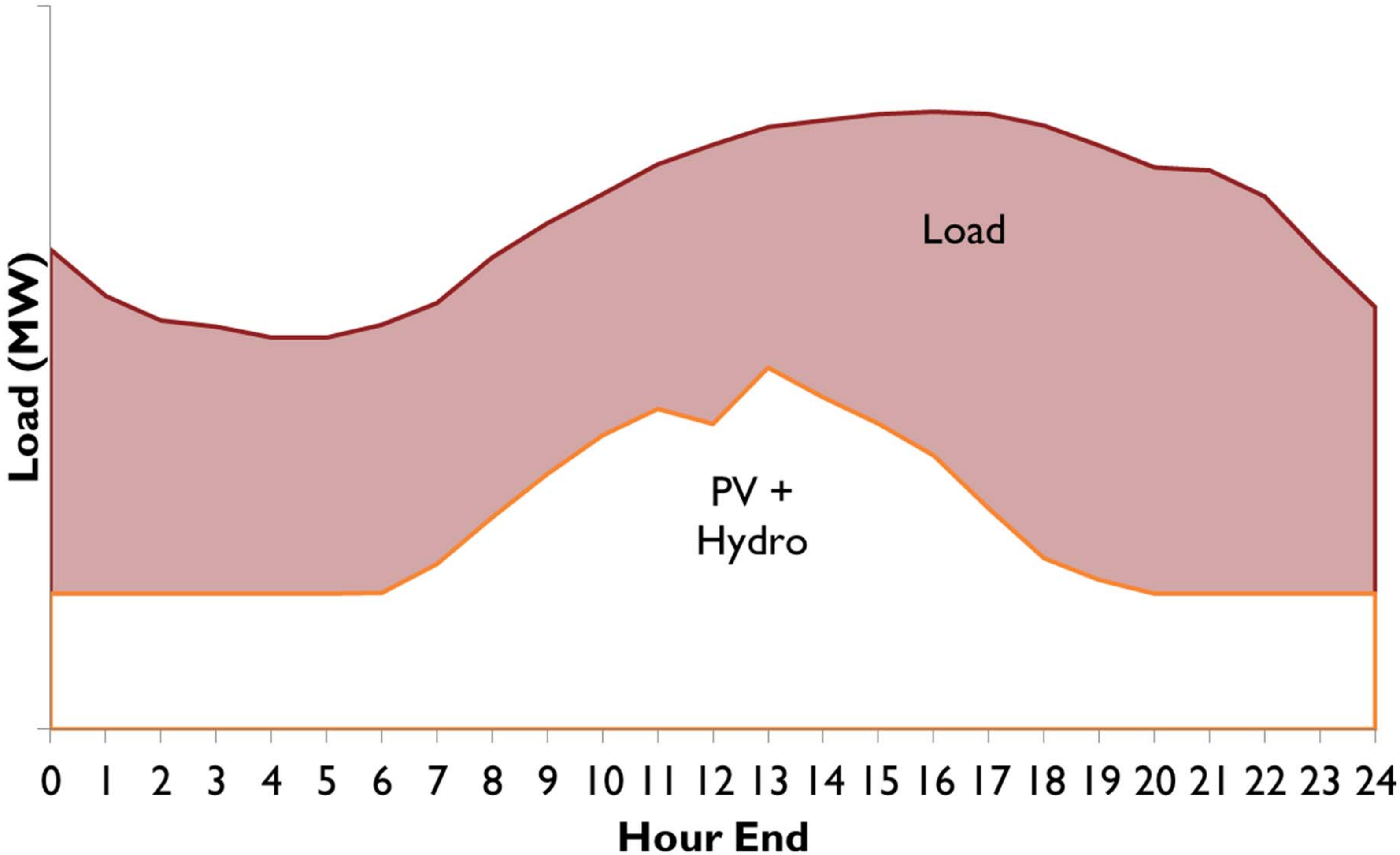
Emissions: a summer example



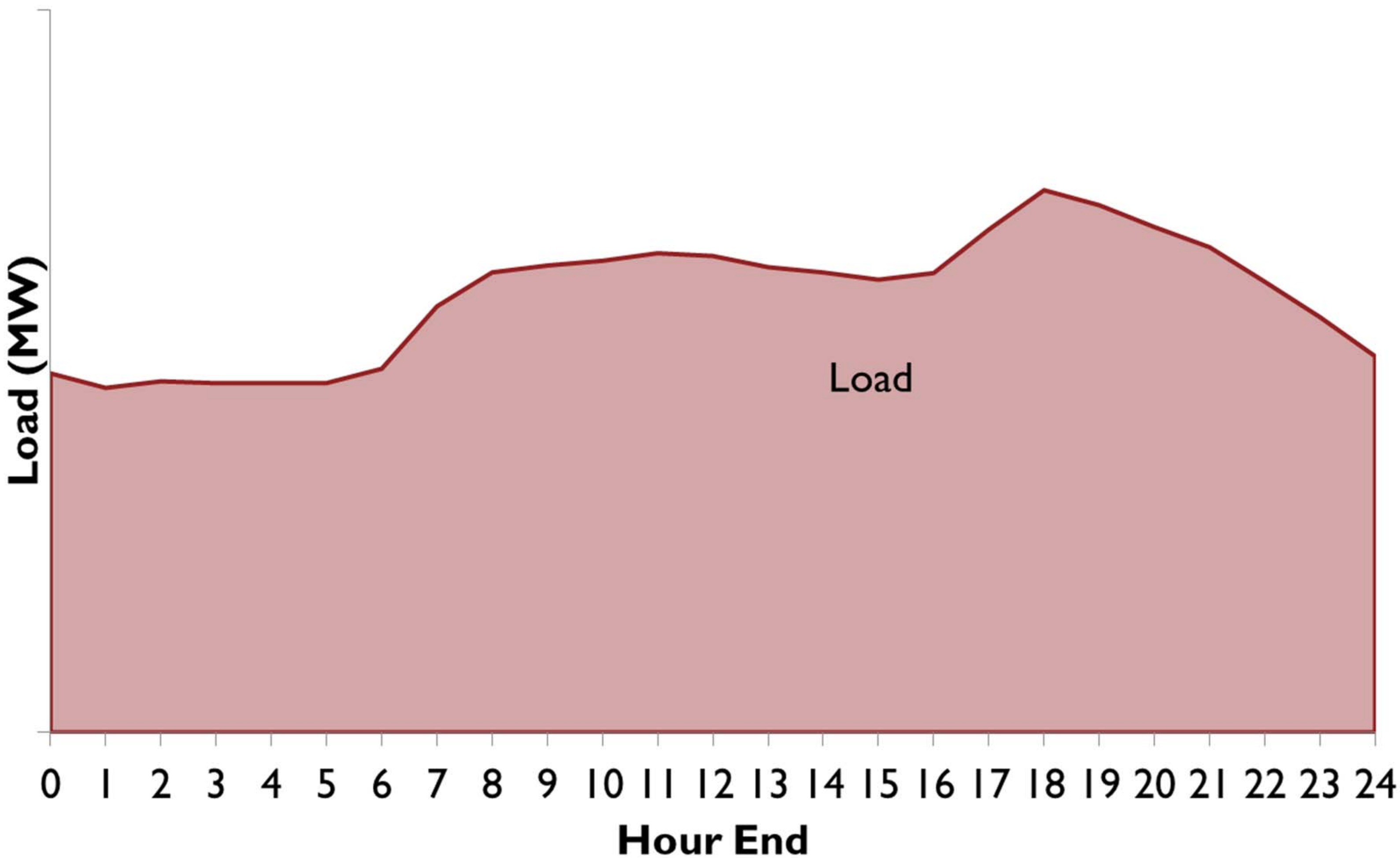
Emissions: a summer example



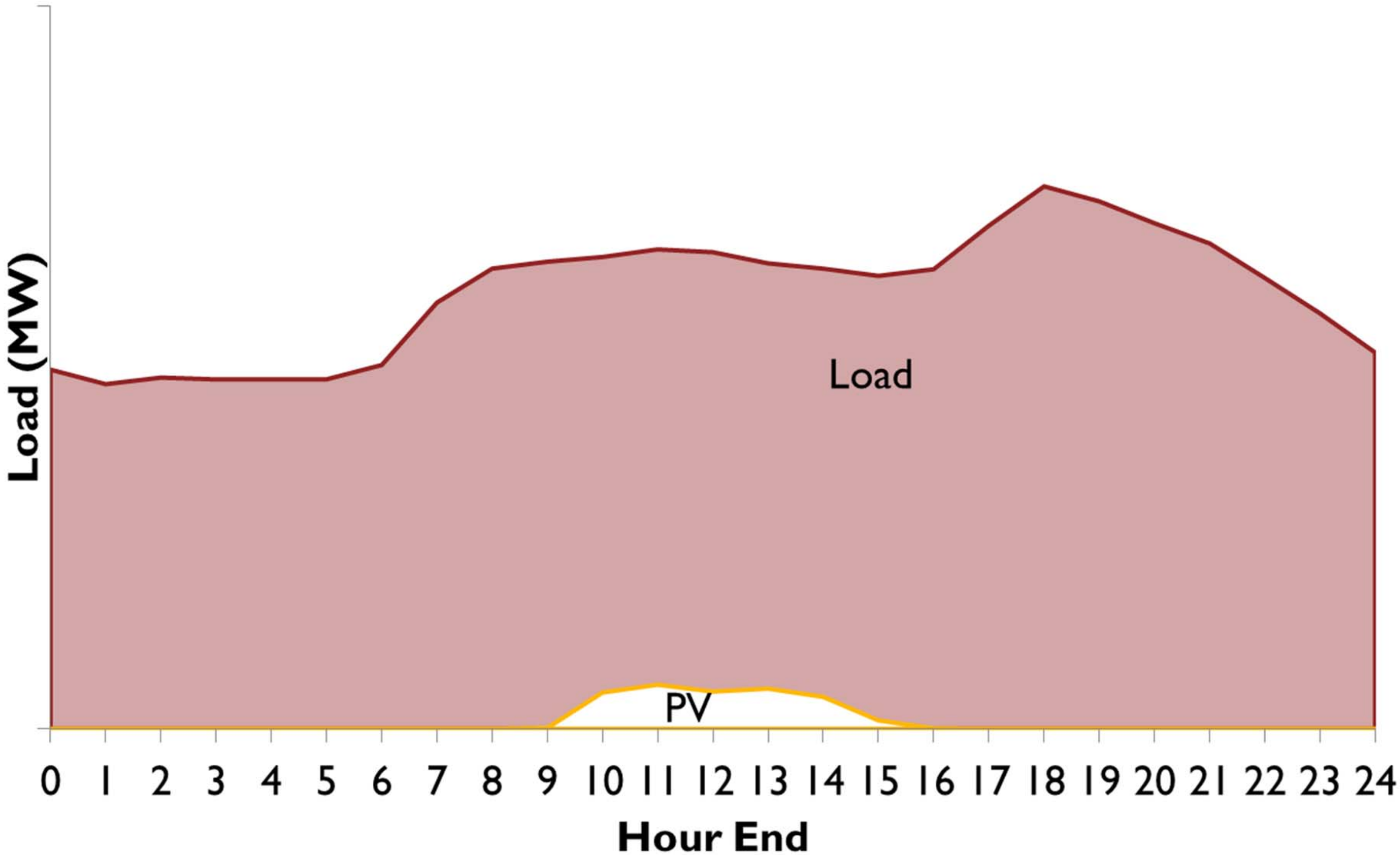
Emissions: a summer example



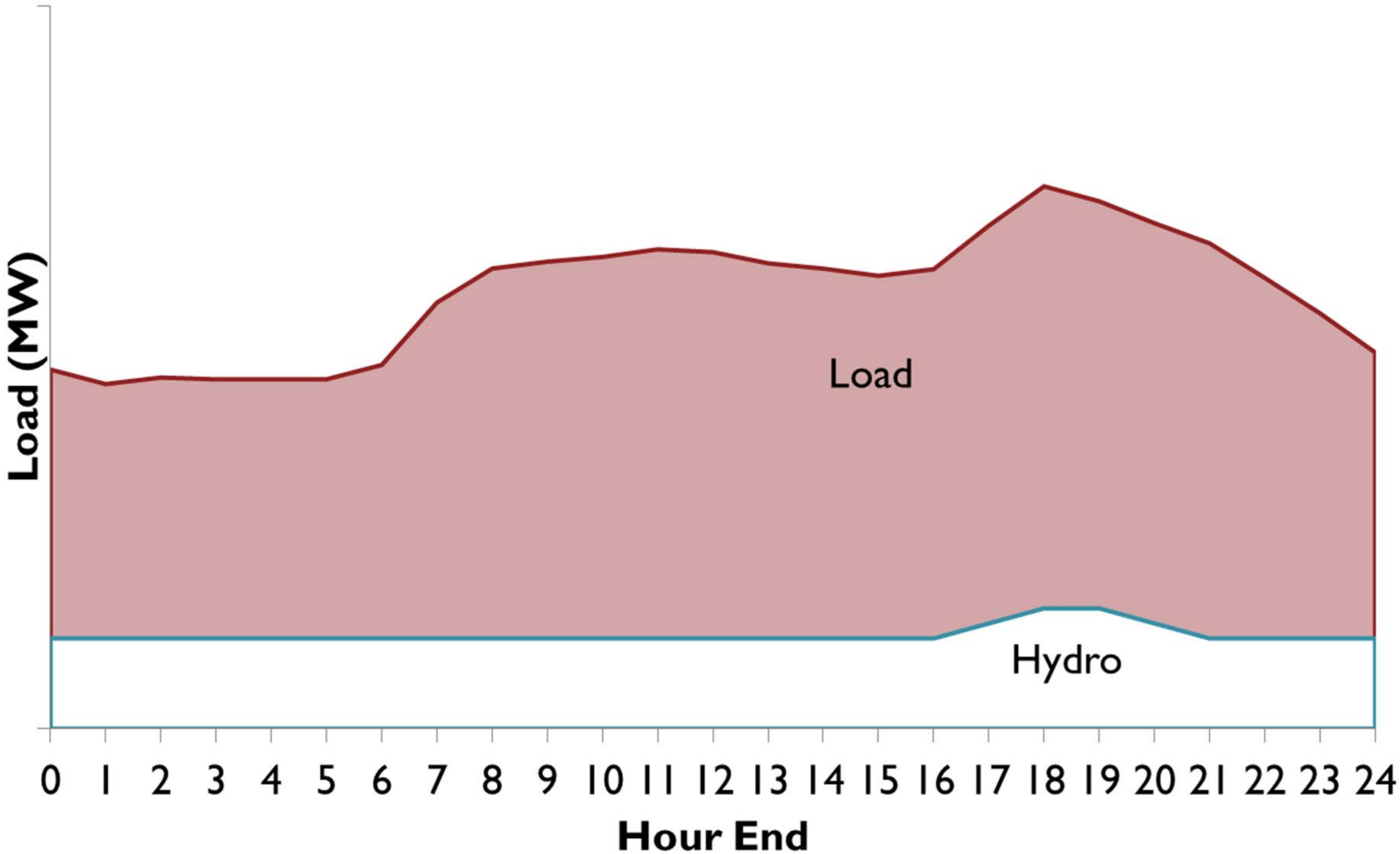
Emissions: a winter example



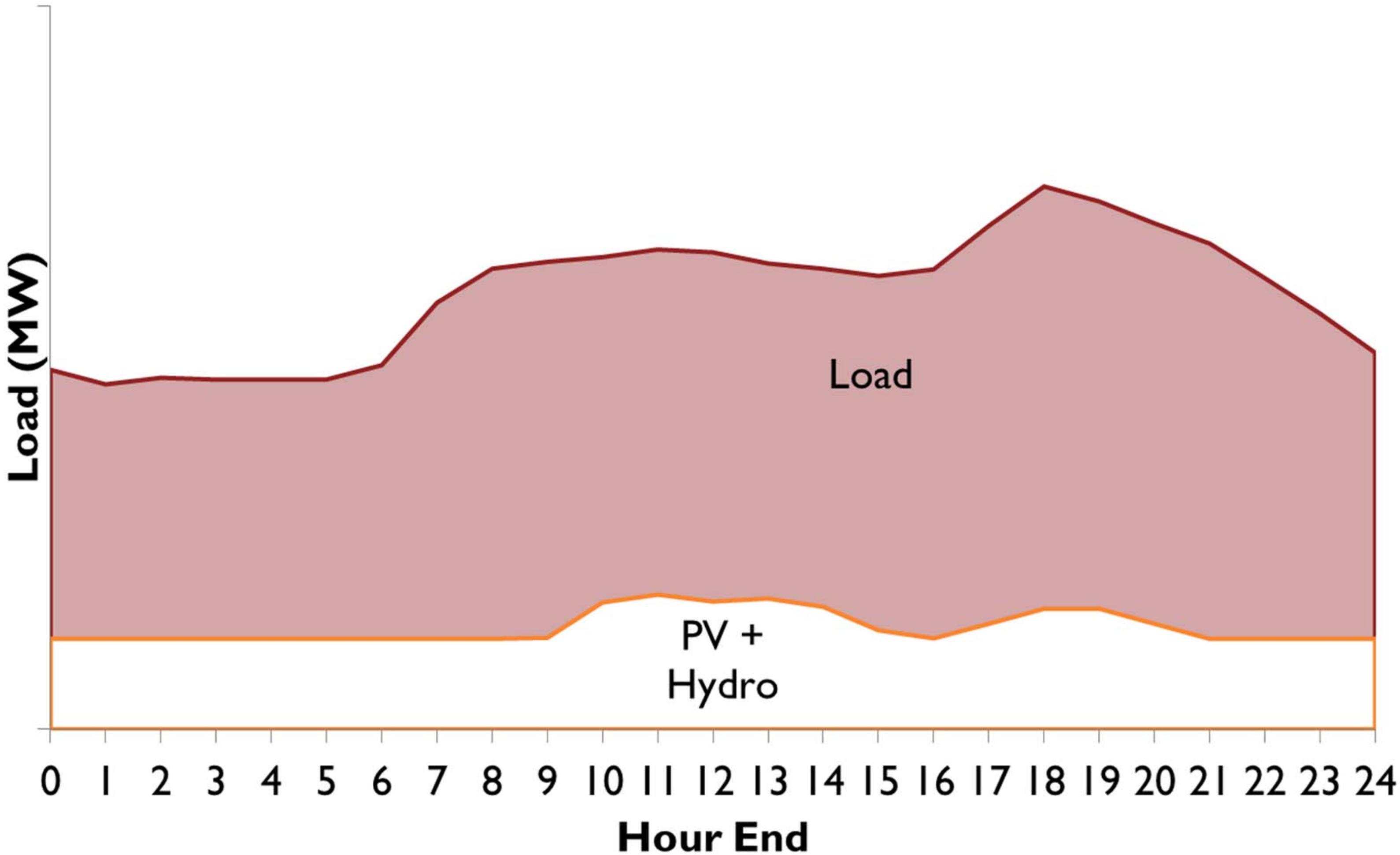
Emissions: a winter example



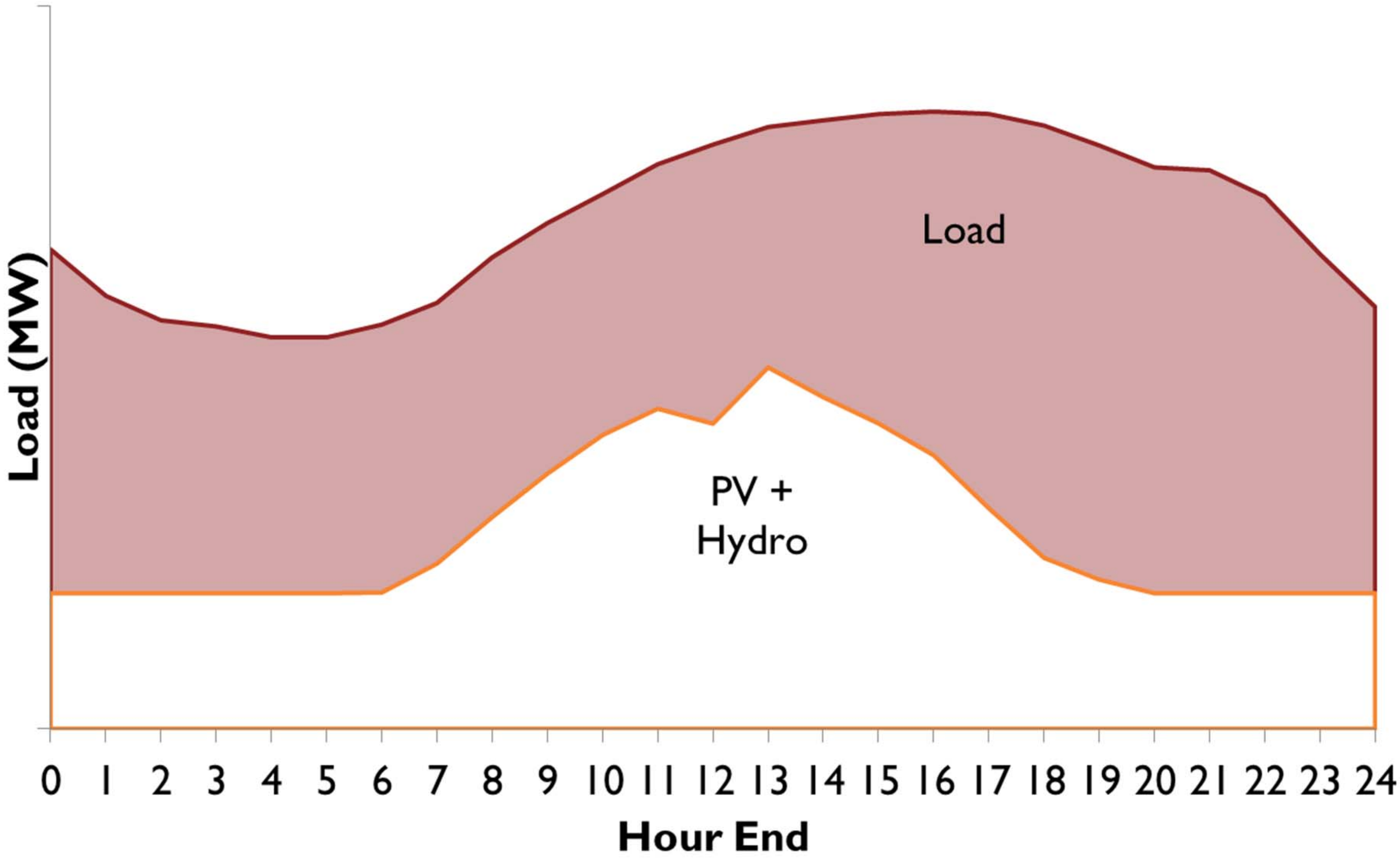
Emissions: a winter example



Emissions: a winter example



Emissions: a summer example

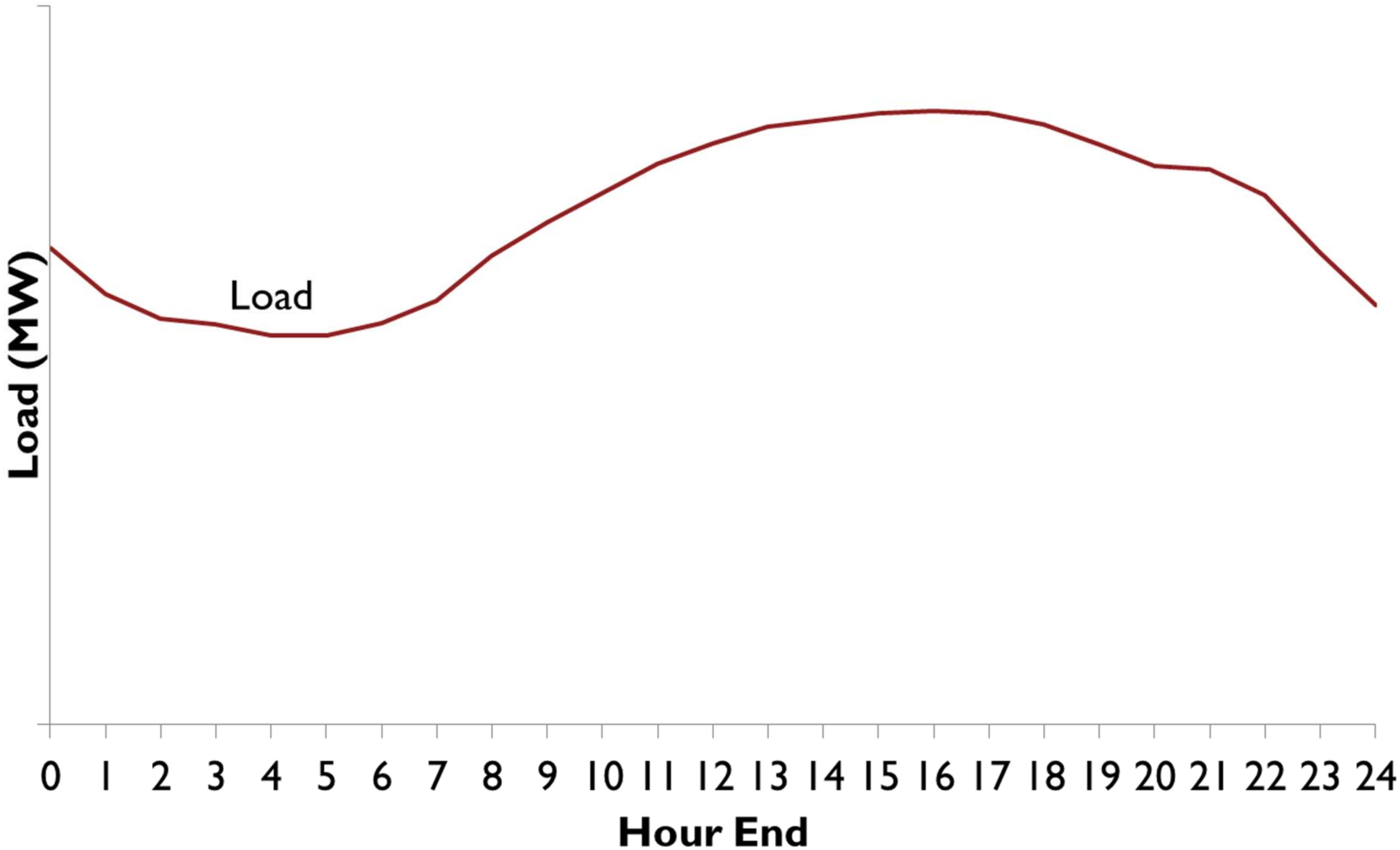


Reliability

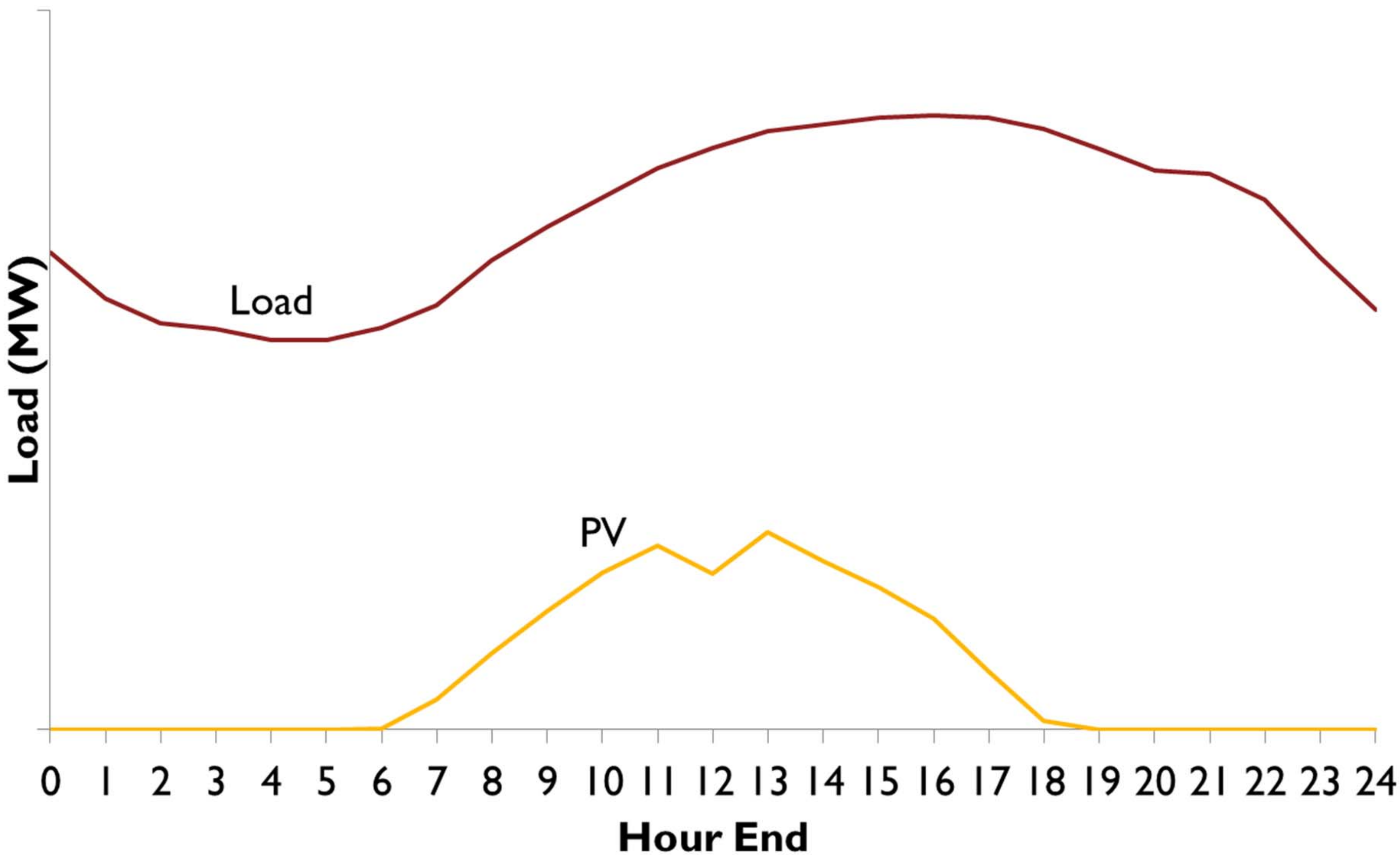
- Definition: the ability of the power system components to deliver electricity to all points of consumption, in the quantity and with the quality demanded by the customer. (LBNL 2001)

- Peak hours are often a focus of reliability efforts, because most grid resources are already dispatched and alternate resources may not be available if multiple grid resources fail during those hours.

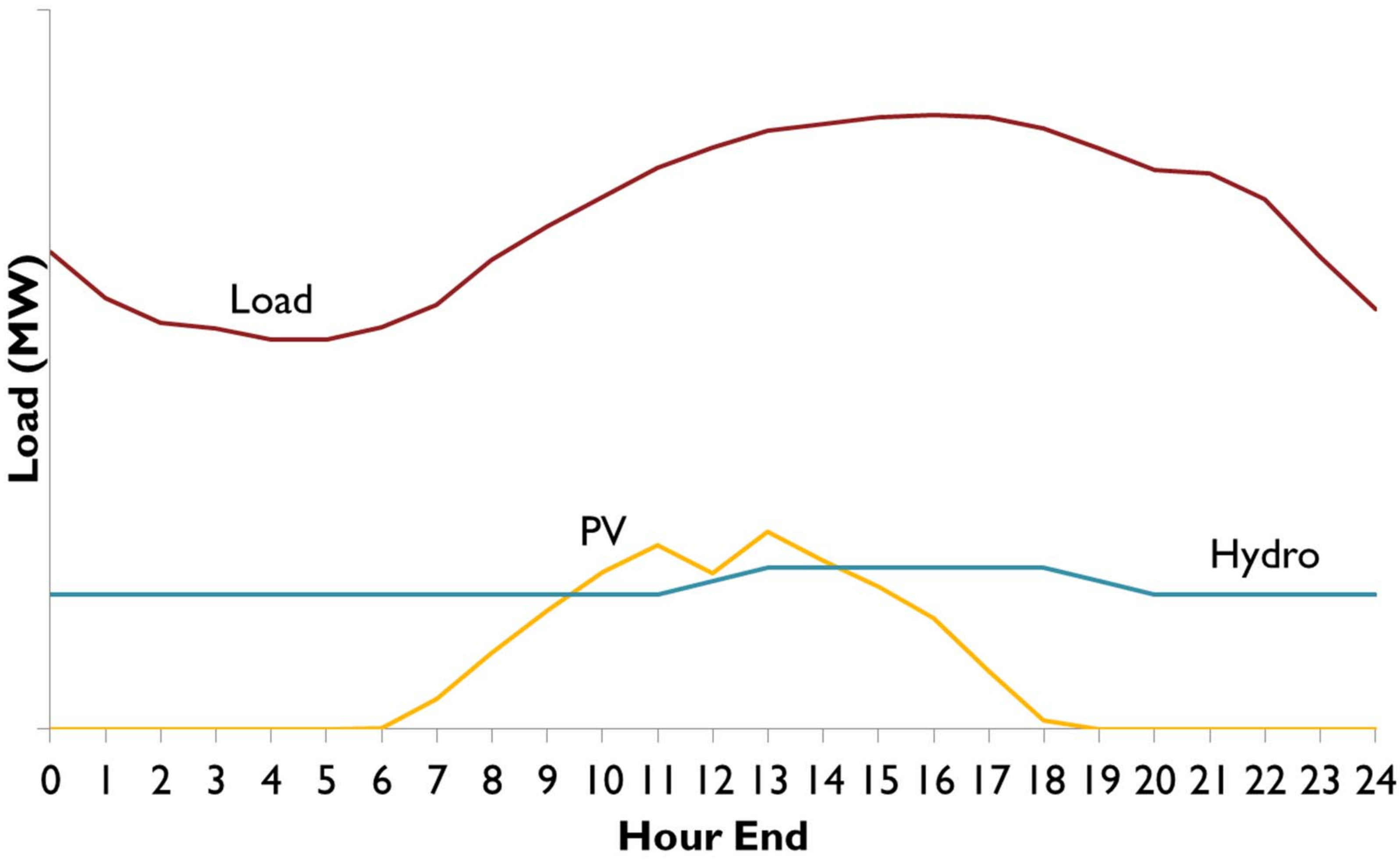
Reliability: a summer example



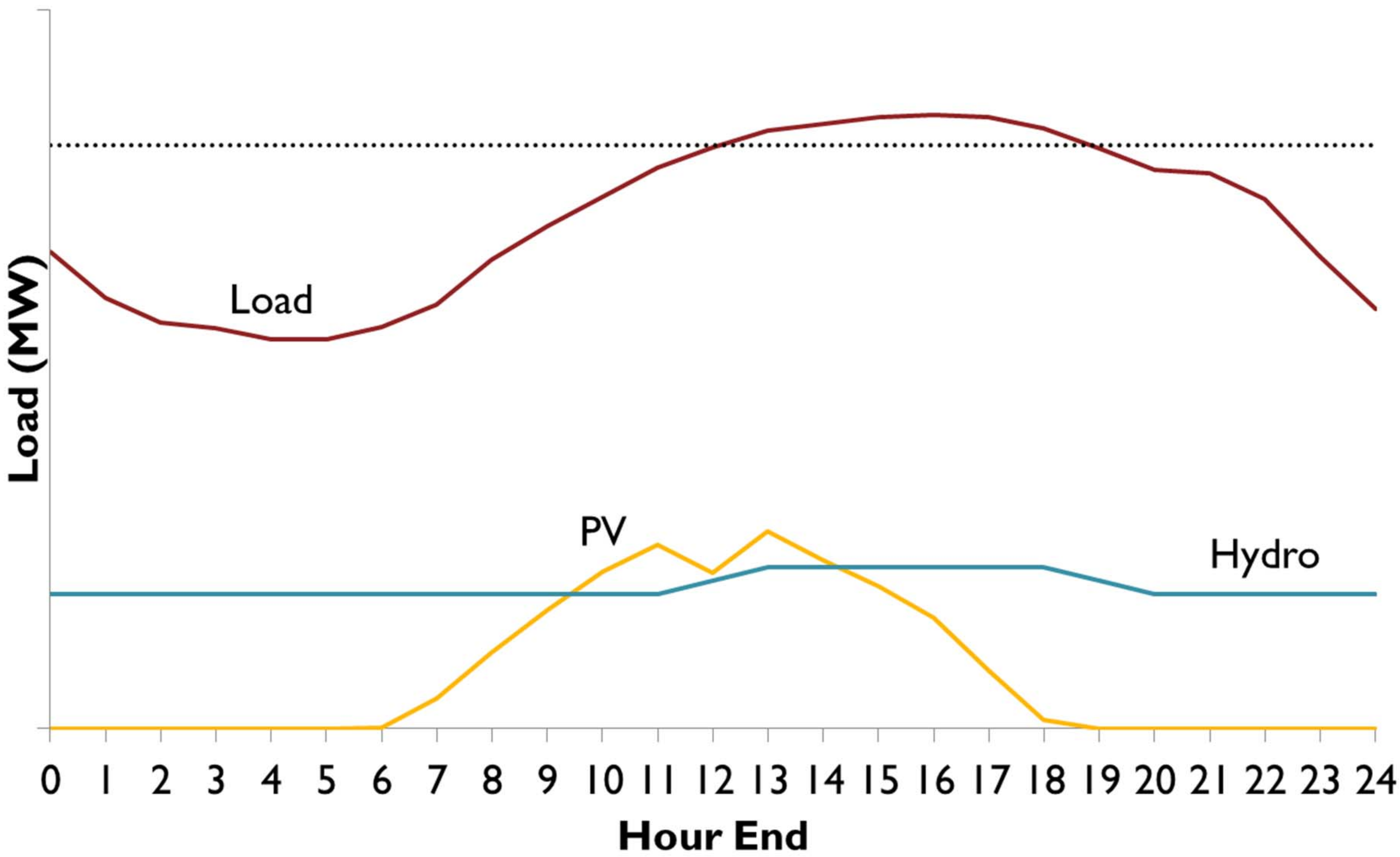
Reliability: a summer example



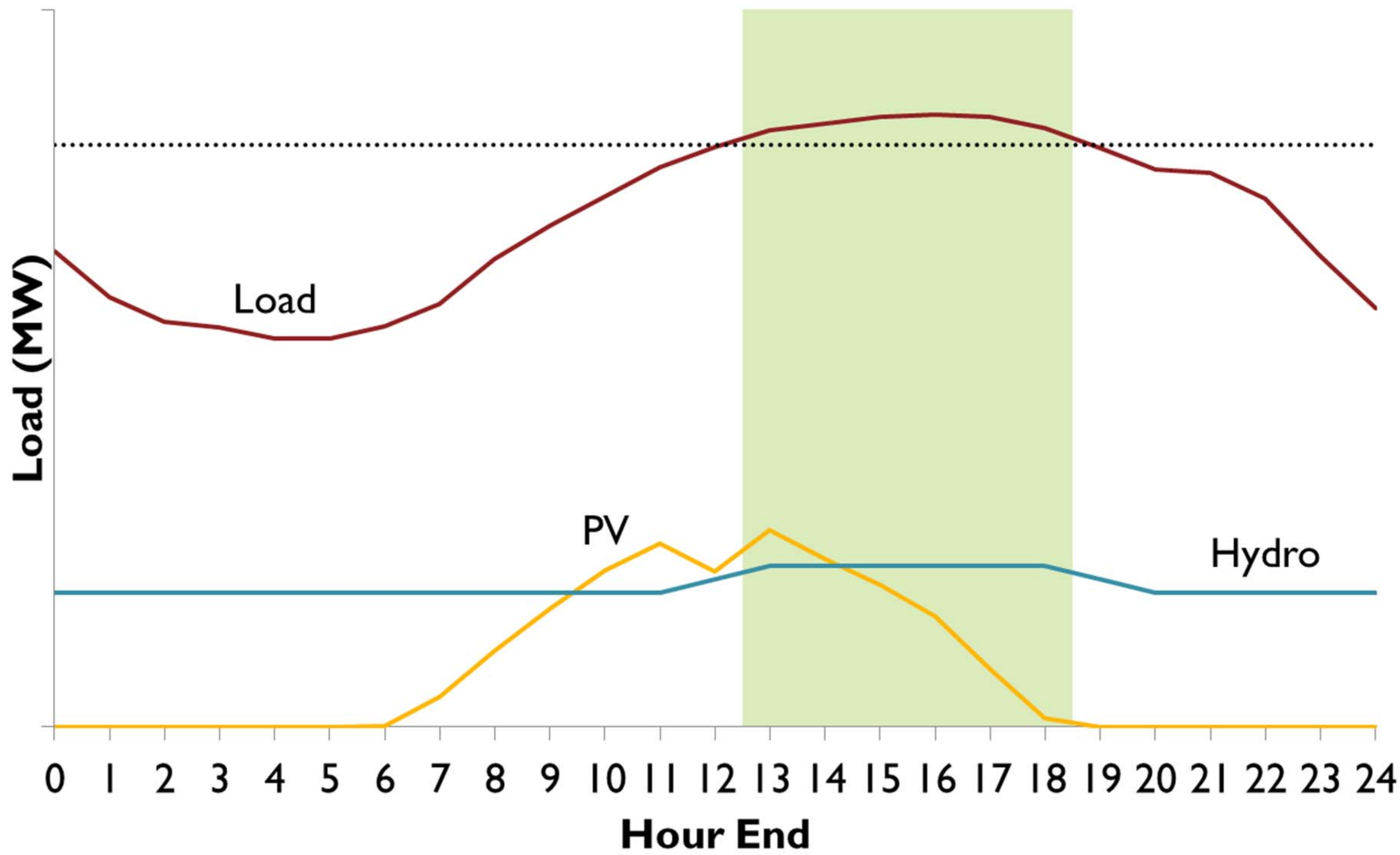
Reliability: a summer example



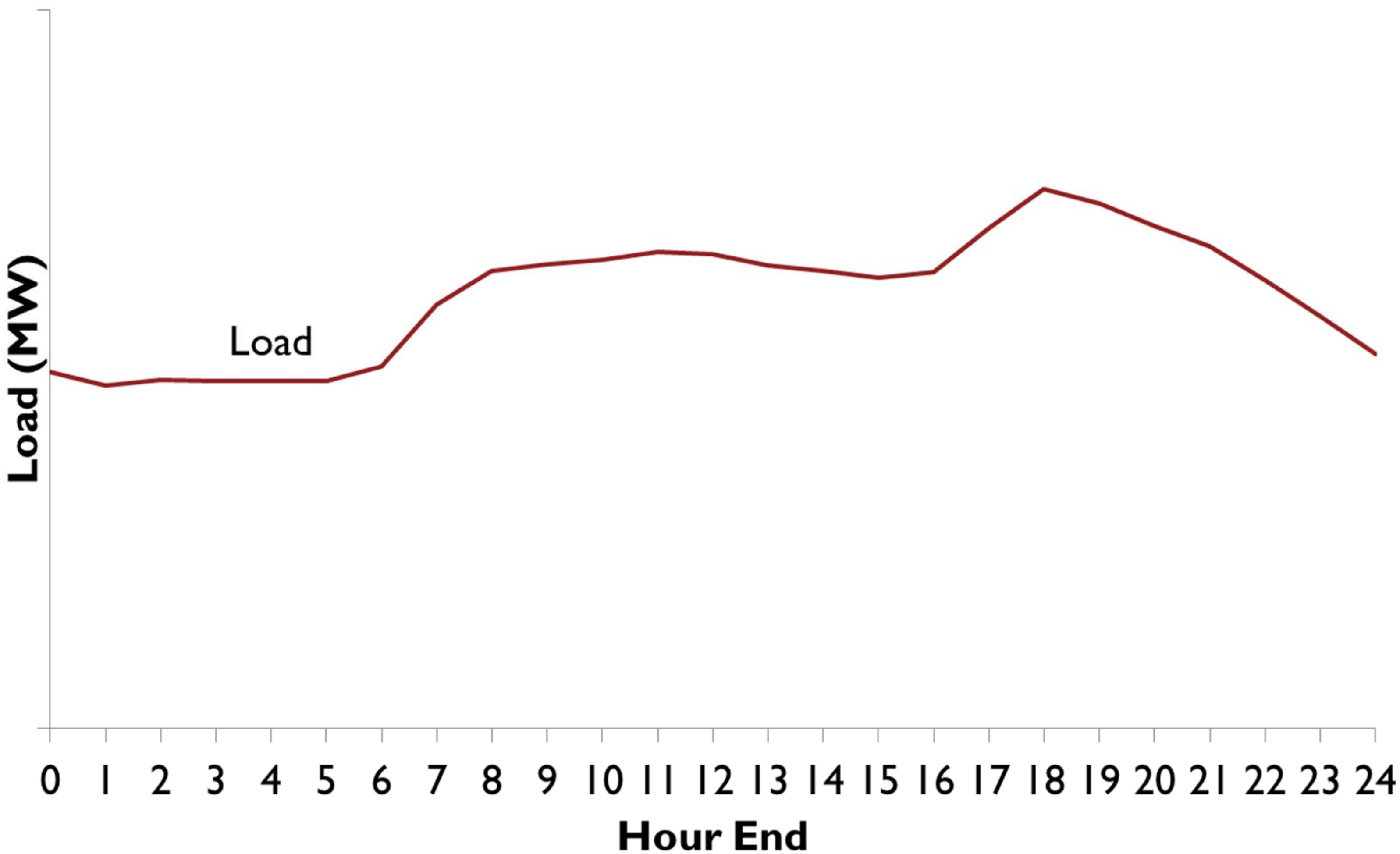
Reliability: a summer example



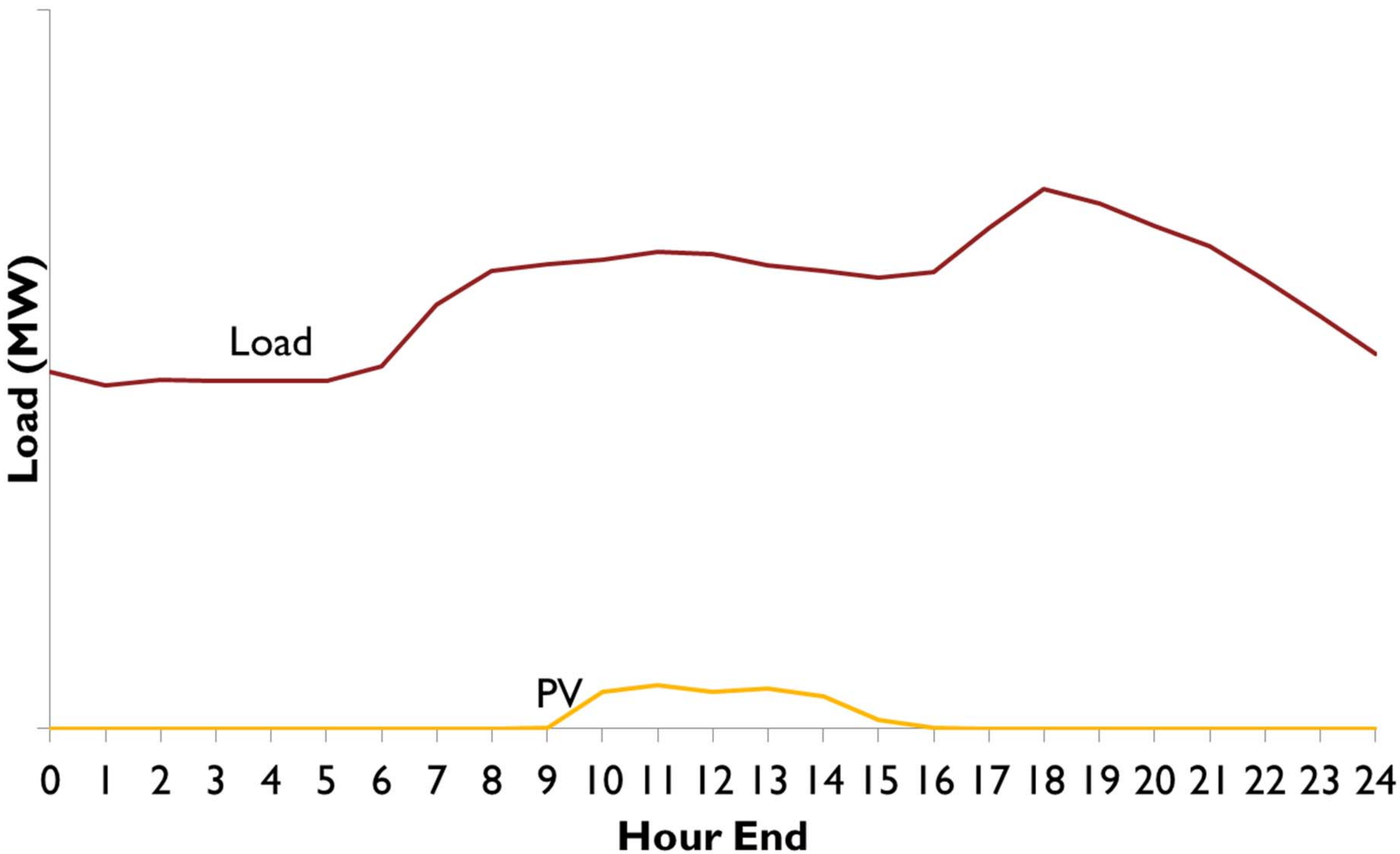
Reliability: a summer example



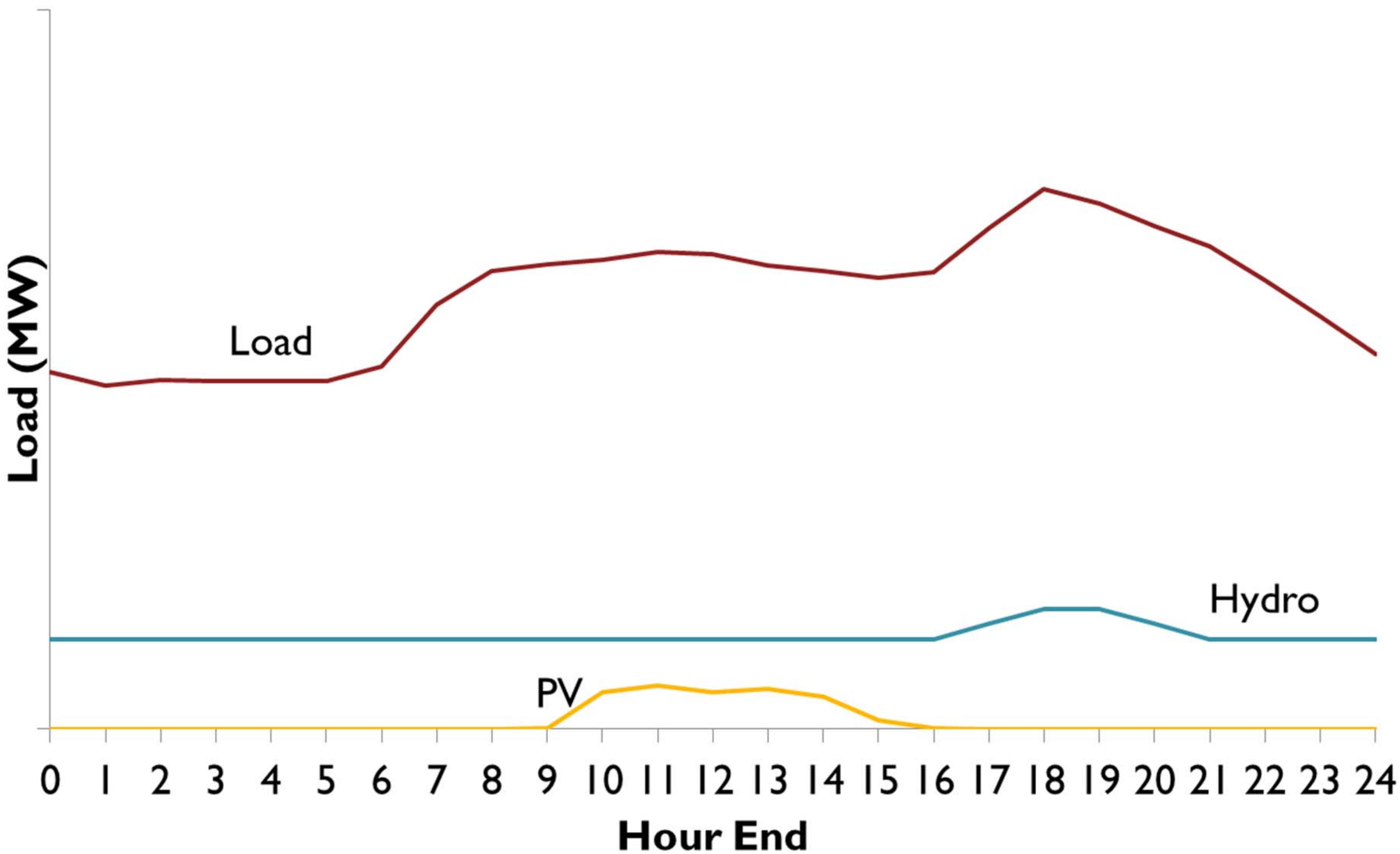
Reliability: a winter example



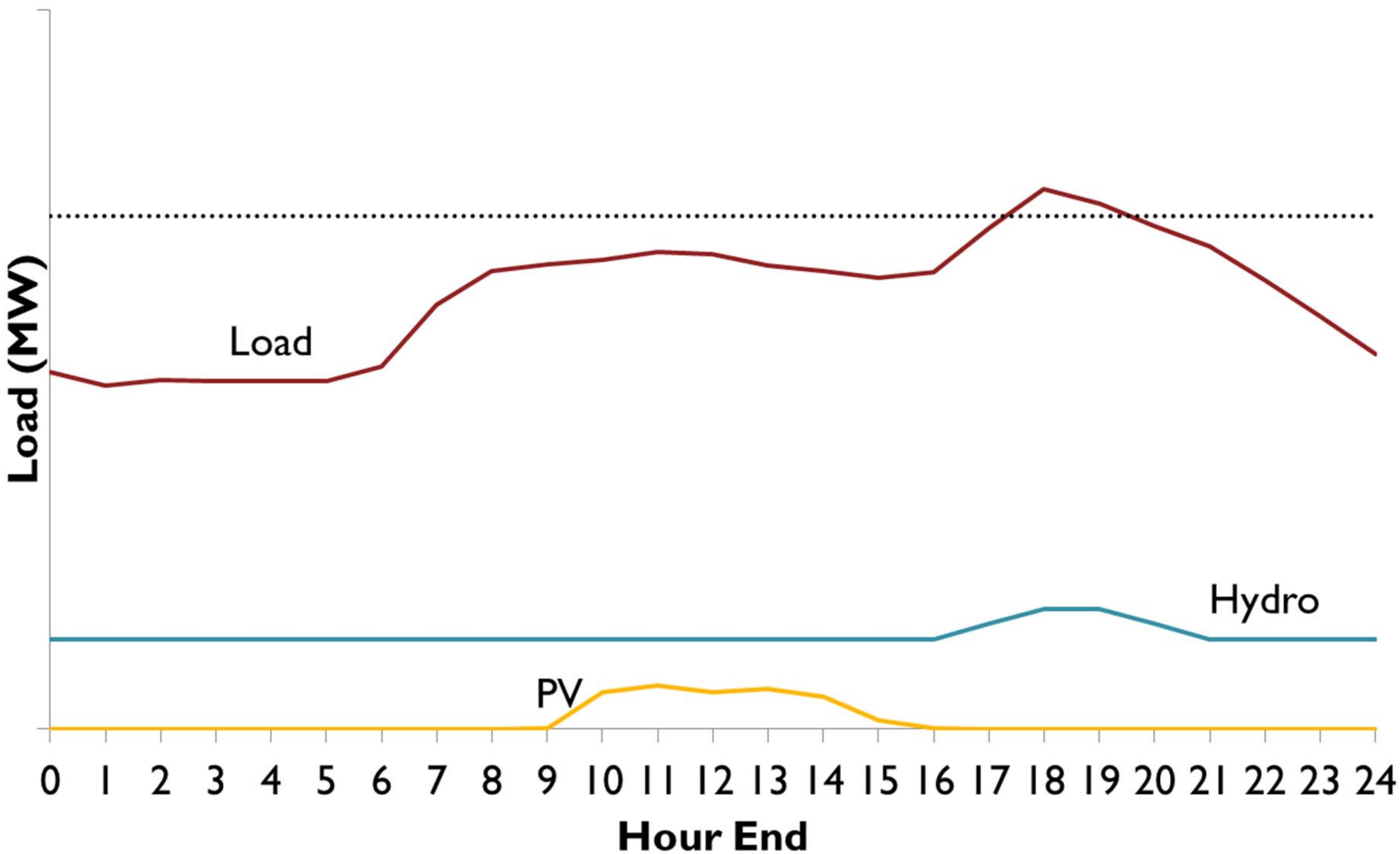
Reliability: a winter example



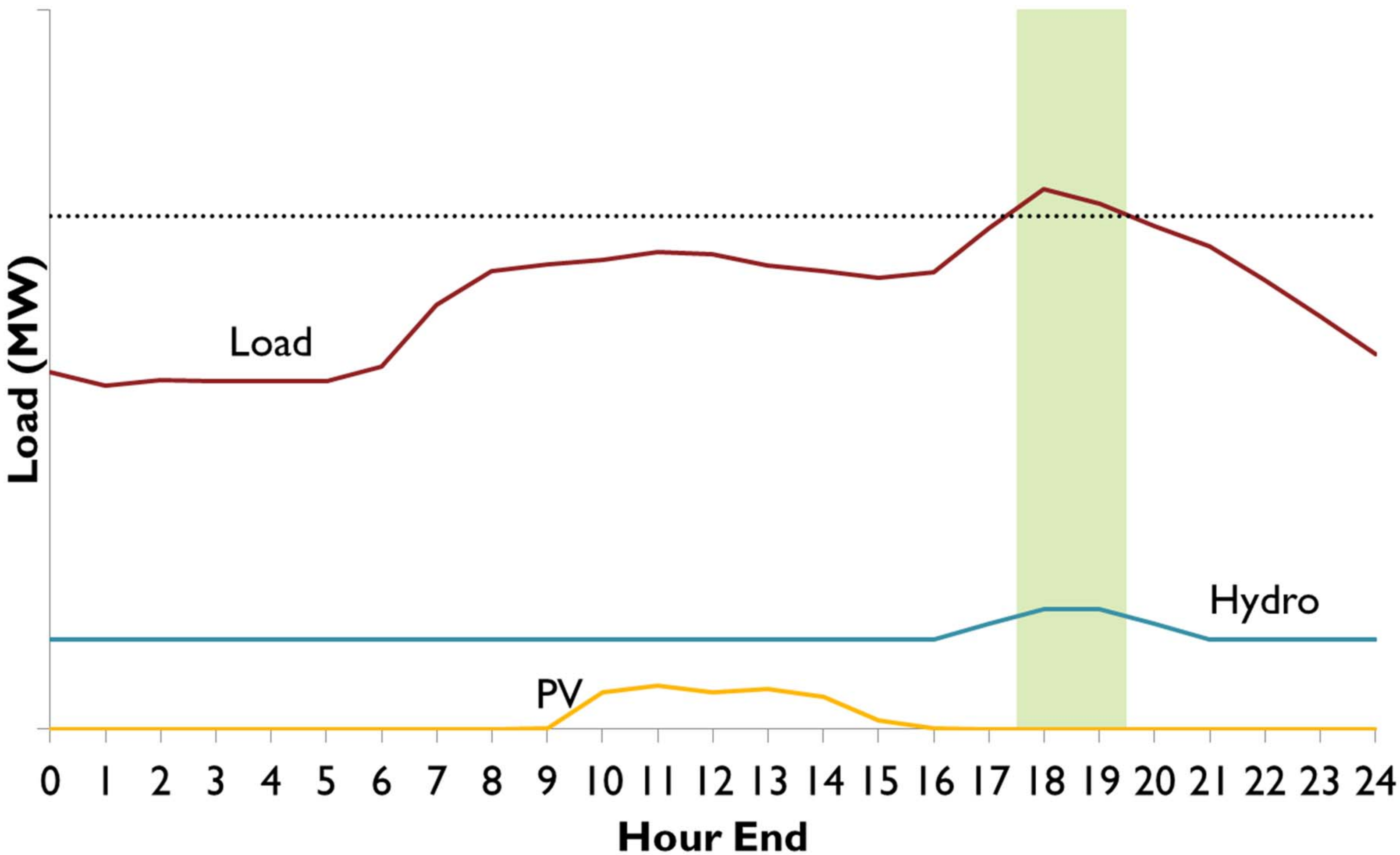
Reliability: a winter example



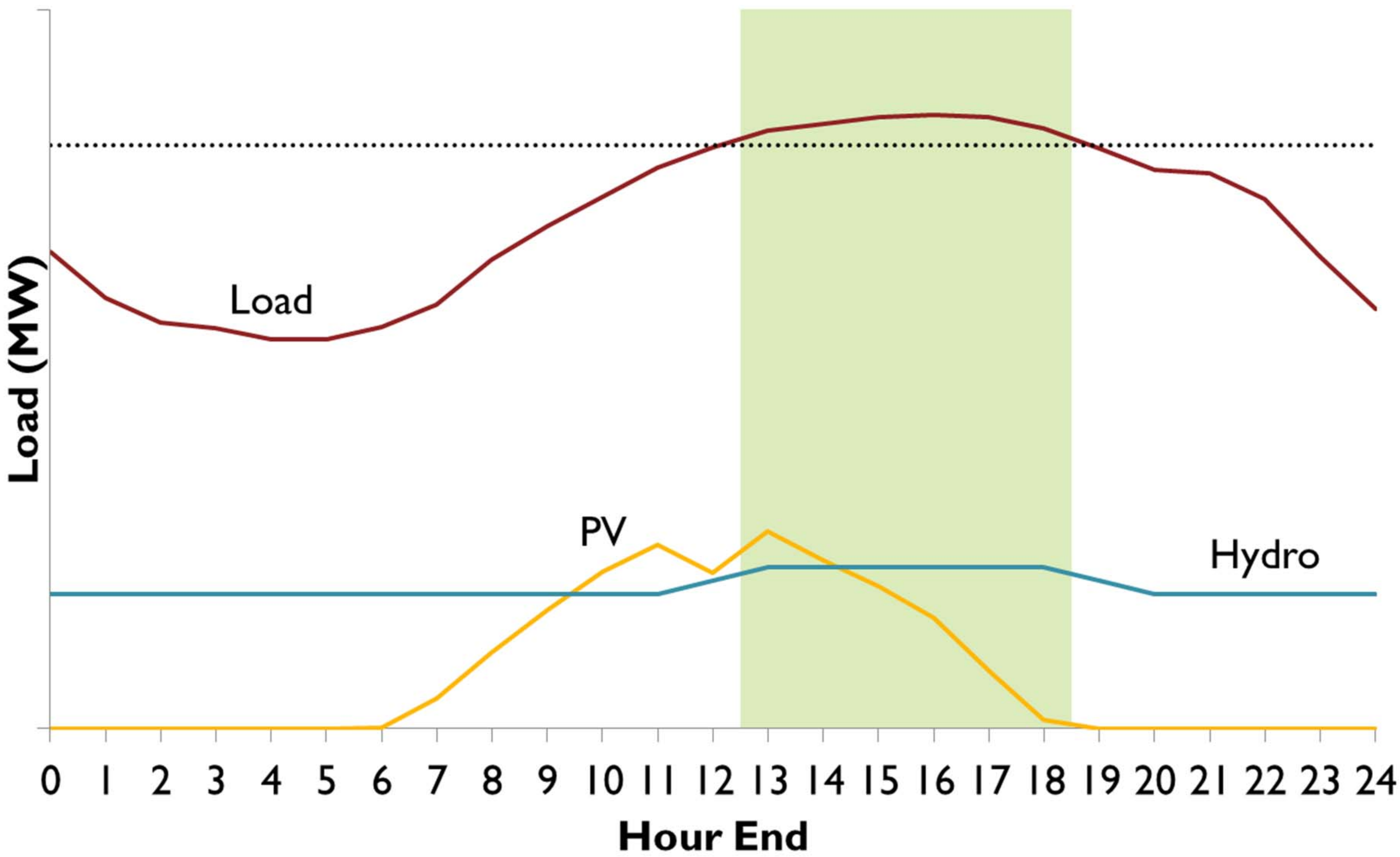
Reliability: a winter example



Reliability: a winter example



Reliability: a summer example



An Example: Winter Gas Crunch

Scenario: Very cold, region wide, for days or weeks at a time

Implications: insufficient gas pipeline capacity to meet 100% gas demand for *both*

- heating demands of residential, commercial, industrial
- Gas-fired electric generating stations

Near term approaches?

Long term approaches?

fin

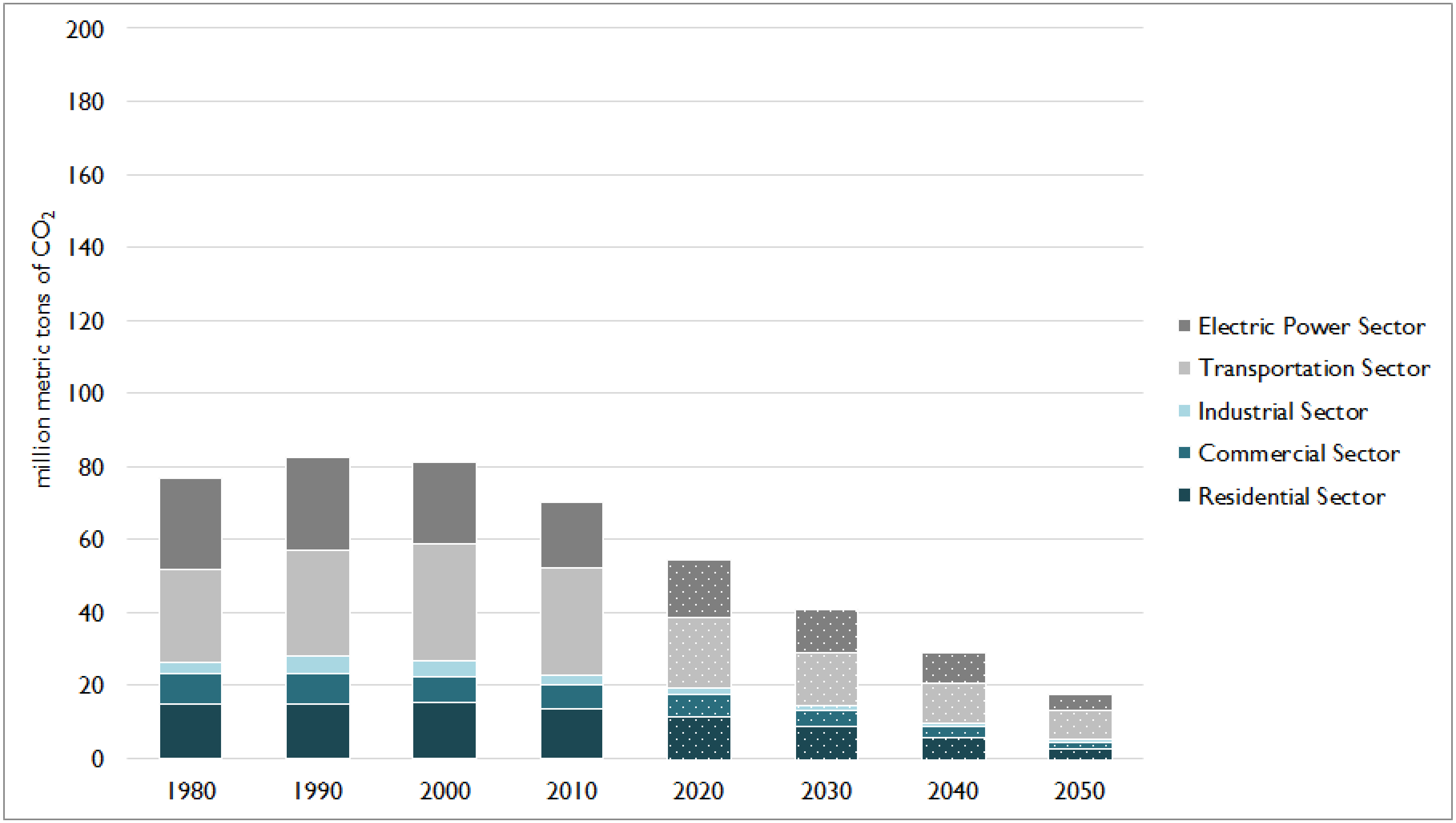
Greenhouse Gas Compliance

State greenhouse gas CO_2 reduction targets

	State greenhouse gas reduction targets from 1990			
	2020	2030	2040	2050
Connecticut	10%	33%	56%	80%
Maine	10%	31%	52%	72%
Massachusetts	25%	43%	62%	80%
New Hampshire	10%	31%	53%	74%
Rhode Island	10%	30%	49%	69%
Vermont	37%	52%	64%	75%
New England Weighted Average	*18%*	*38%*	*58%*	*77%*

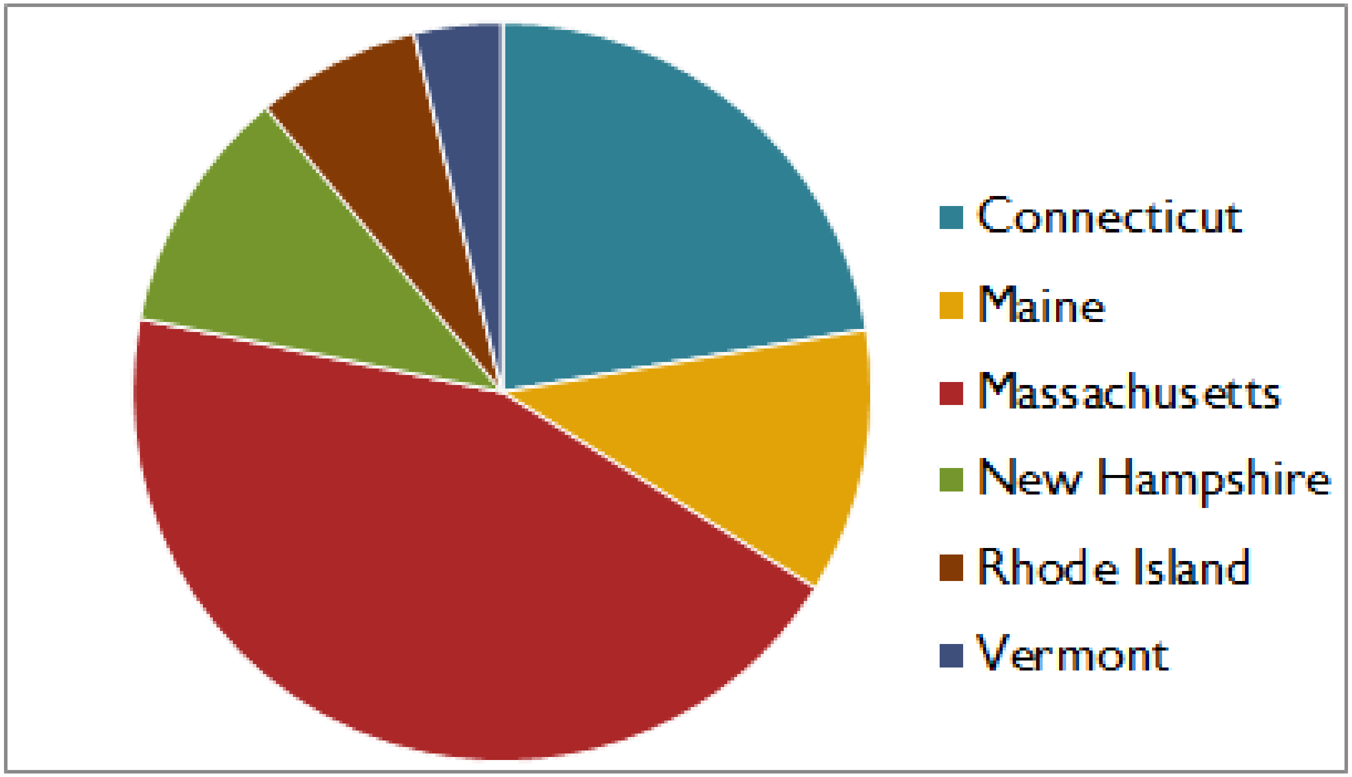
Massachusetts Emissions from Fossil Fuel

- Electric emissions from production
- Target reductions: GWSA
- Equal sector shares



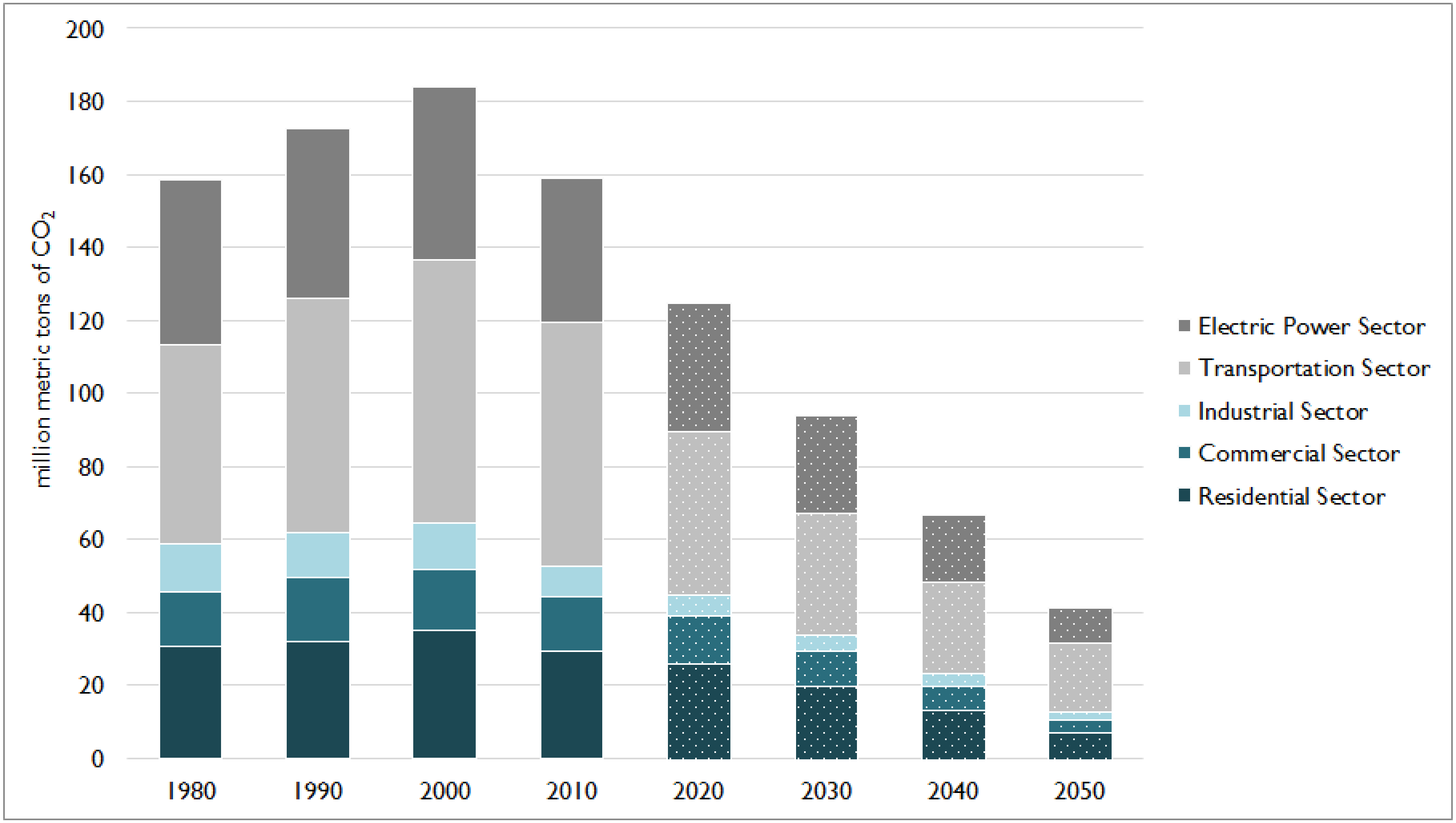
Source: EIA SEDS; http://www.c2es.org; GWSA Appendix 1

New England CO_2 emissions from fossil fuel, 2011



New England Emissions from Fossil Fuel

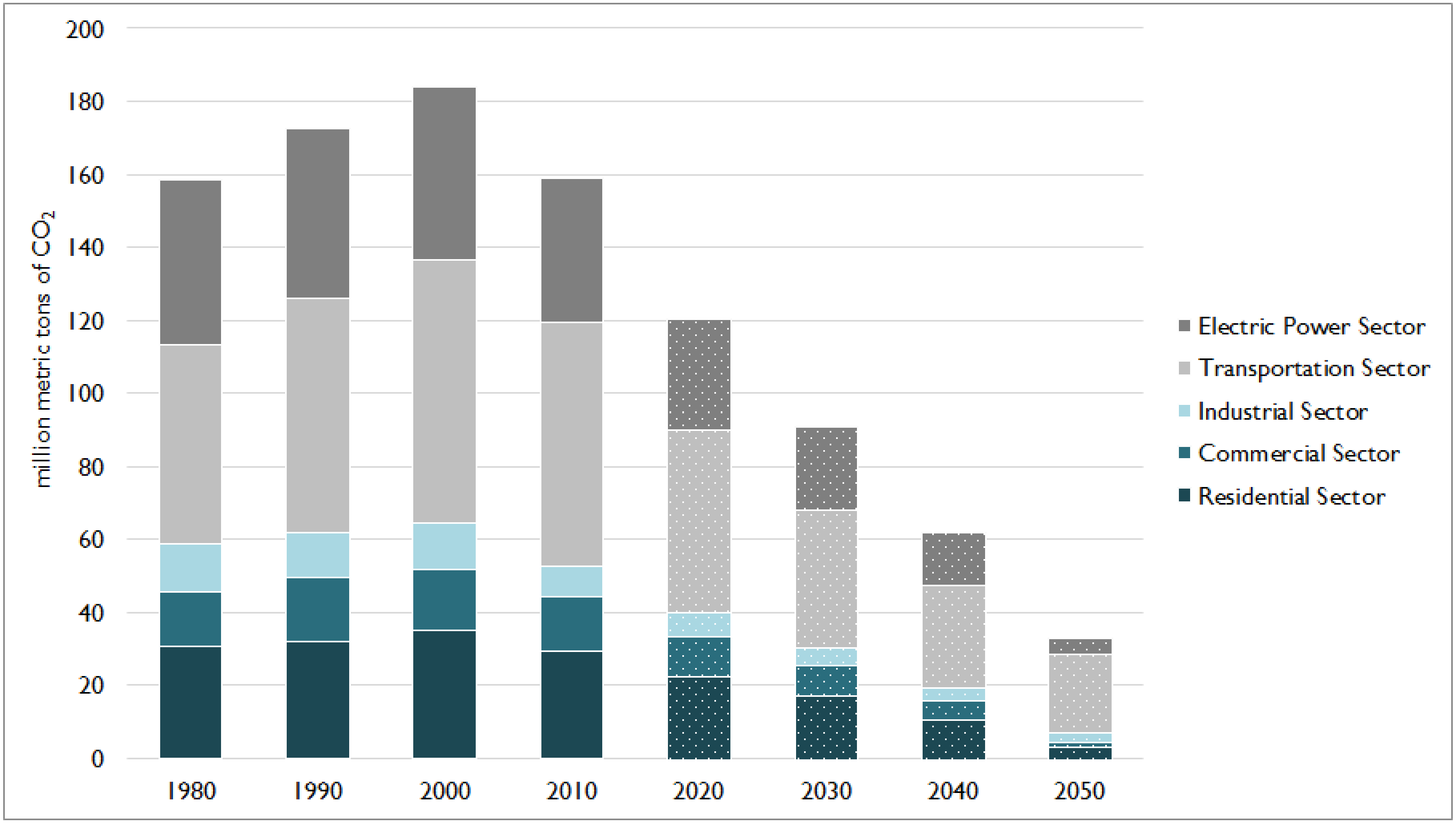
- Electric emissions from consumption
- Target reductions: NE average
- Equal sector shares



Source: EIA SEDS; http://www.c2es.org; GWSA Appendix 1

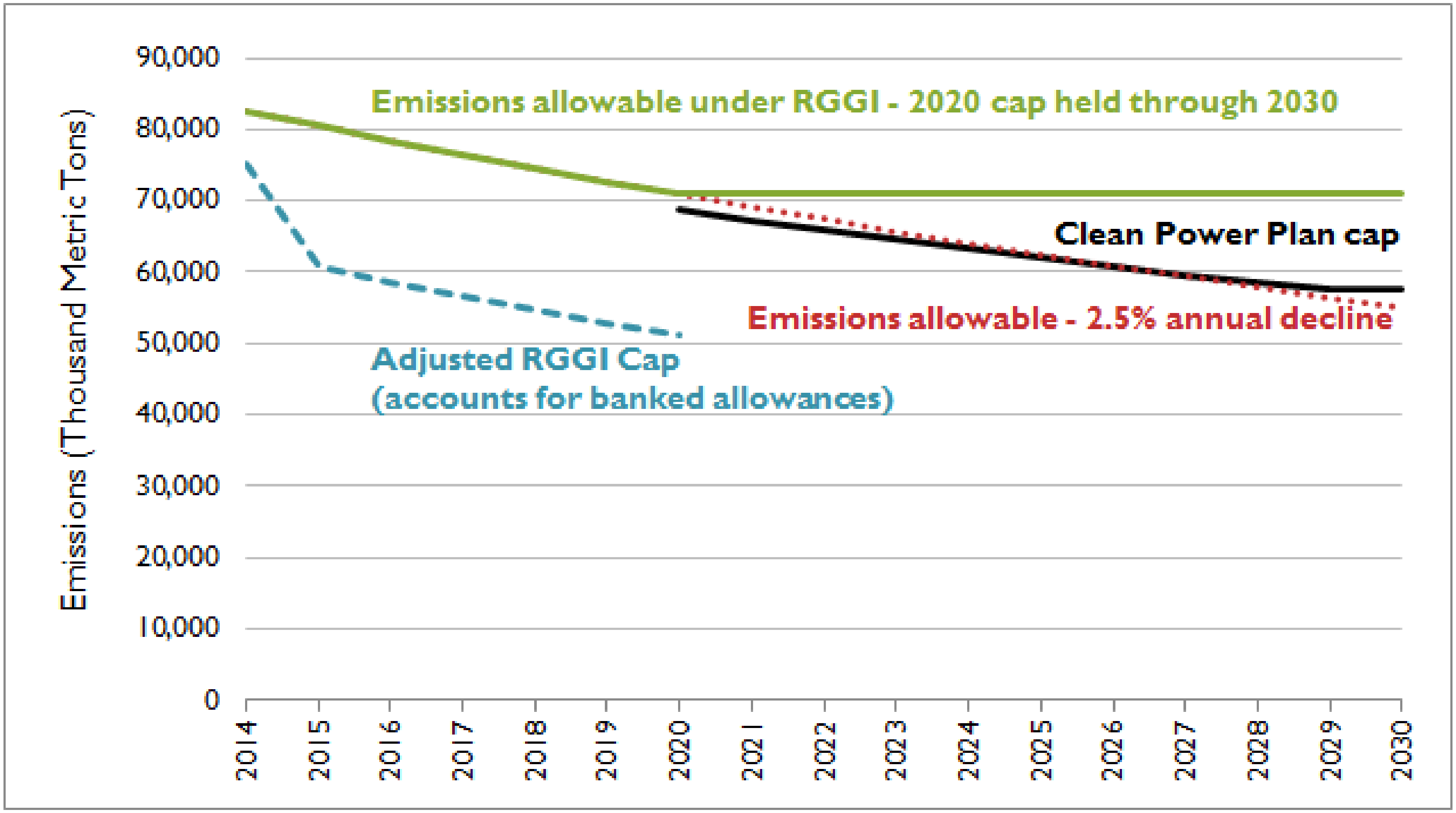
New England Emissions from Fossil Fuel

- Electric emissions from consumption
- Target reductions: NE average
- Electric and Building reliant



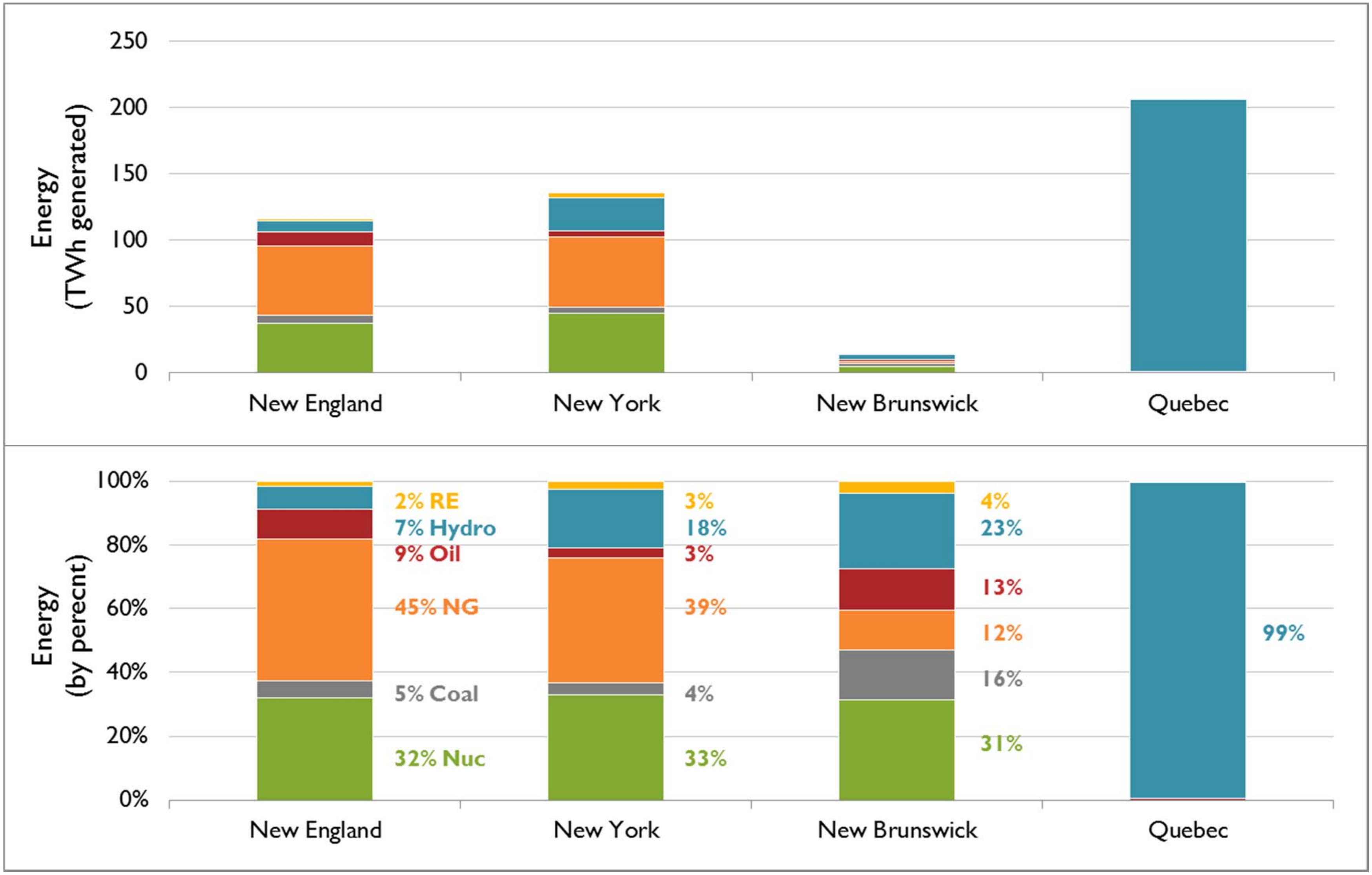
Source: EIA SEDS; http://www.c2es.org; GWSA Appendix 1

RGGI and the Clean Power Plan

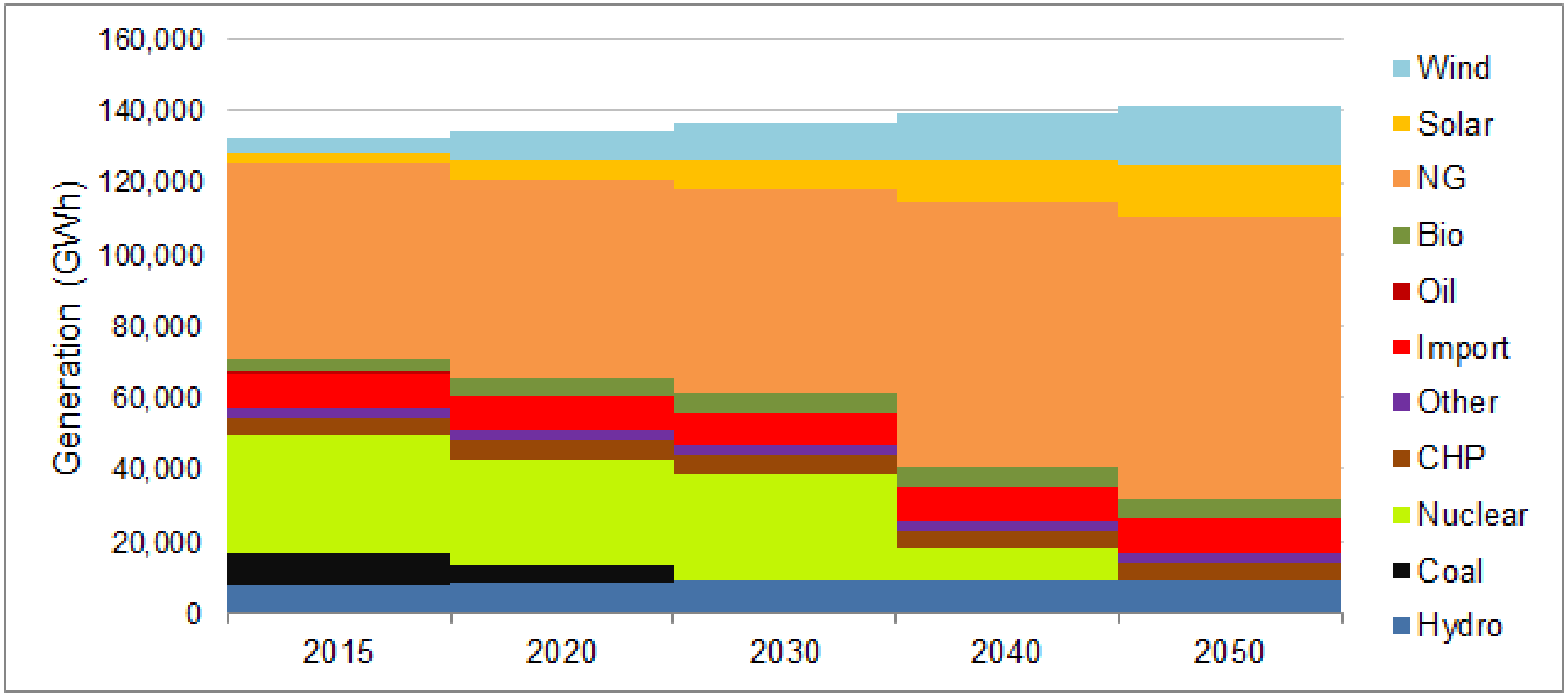


Source: Stanton testimony to NH legislative committee, January 22, 2015

Comparisons of 2013 Energy Mixes

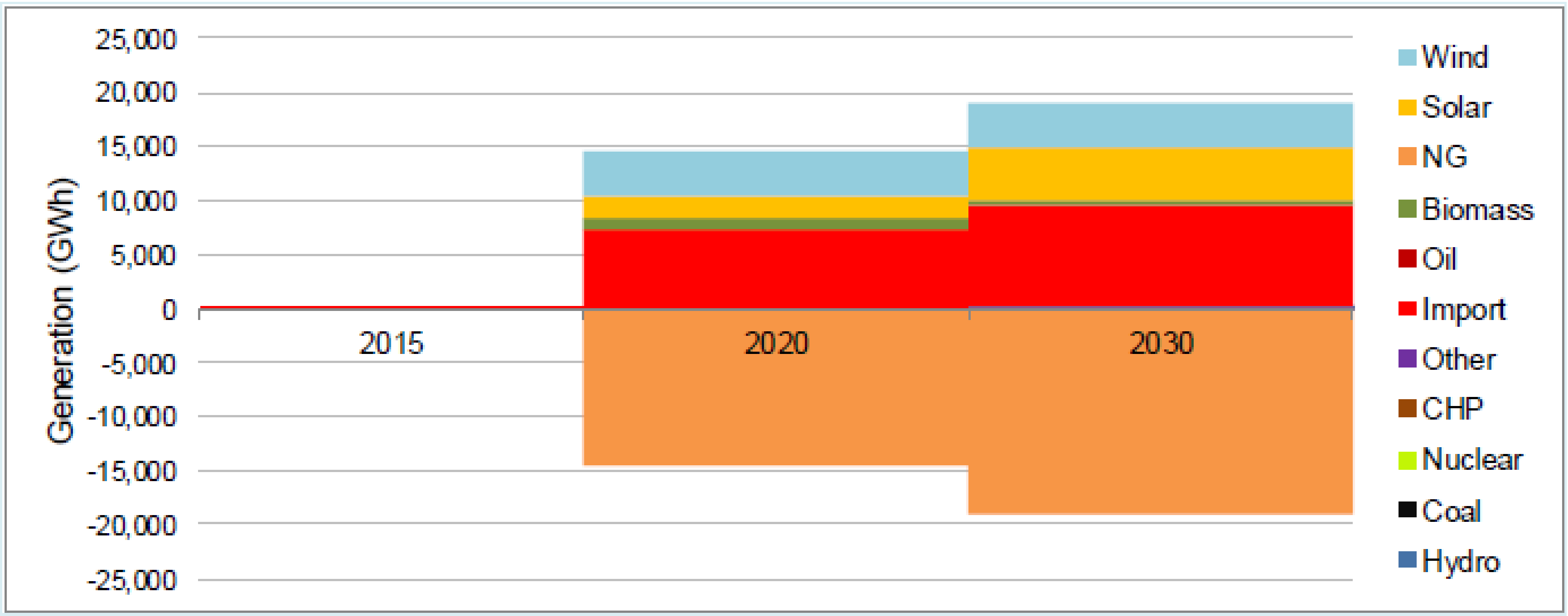


CEPS New England Reference Case



Source: Stanton et al. (2013) A Clean Energy Standard for Massachusetts. MassCEC and Agencies.

CEPS Generation Changes for GWSA Compliance



Source: Stanton et al. (2013) A Clean Energy Standard for Massachusetts. MassCEC and Agencies.

MA Electric System Carbon Inventory

MA carbon emissions = Emissions from consumed electricity

MA carbon emissions = Emissions from MA generators +
Emissions from imports to MA

MA carbon emissions = Emissions from MA generators +
(MWh imported to MA x Emission rate of imports)

MA Electric System Carbon Inventory

MA carbon emissions = Emissions from consumed electricity

MA carbon emissions = Emissions from MA generators +
Emissions from imports to MA

MA carbon emissions = Emissions from MA generators +
(MWh imported to MA x Emission rate of imports)

MWh imported to MA = MA sales – MA generation

Emission rate of imports = MWh generated in rest-of-system / Emissions created in rest-of-system

Emission rate of imports = MWh generated in rest-of-system / [(Generation from other NE states x other NE states' emission rate) + (Generation from NY x NY emission rate) + (Generation from NB x NB emission rate) + (Generation from QC x QC emission rate)]

Group Discussion

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