DECEMBER 18, 2013 | AUGUSTA, MAINE

ISO new england

Regional Update

Maine Joint Standing Committee on Energy, Utilities & Technology

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EXTERNAL AFFAIRS

OVERVIEW

About ISO New England

- Private not-for-profit
- Regulated by the federal government
- Independent of companies doing business in market
- Primary Responsibilities
  - Operate the regional power system
  - Administer wholesale electricity markets
  - Power system planning

New England Control Area

Aroostook County Maine Outside
ISO New England Footprint

- ISO New England Control Area includes:
  - Maine (excluding northern portions)
  - New Hampshire
  - Vermont
  - Massachusetts
  - Connecticut
  - Rhode Island

(Note: Map not to scale for illustrative purpose only)

New England's Electric Power Grid at a Glance

- 14 million residents
- 6.5 million meters
- 31,750+ megawatts (MW) of generating capacity and approximately 1,850 MW of demand resources
- 8,400 miles of high-voltage transmission
- 13 interconnections with neighbors
- 28,130 MW all-time peak demand
- $5 billion total energy market (2012)

ISO New England's Strategic Planning Initiative

Focused on developing solutions to the top five challenges facing the region

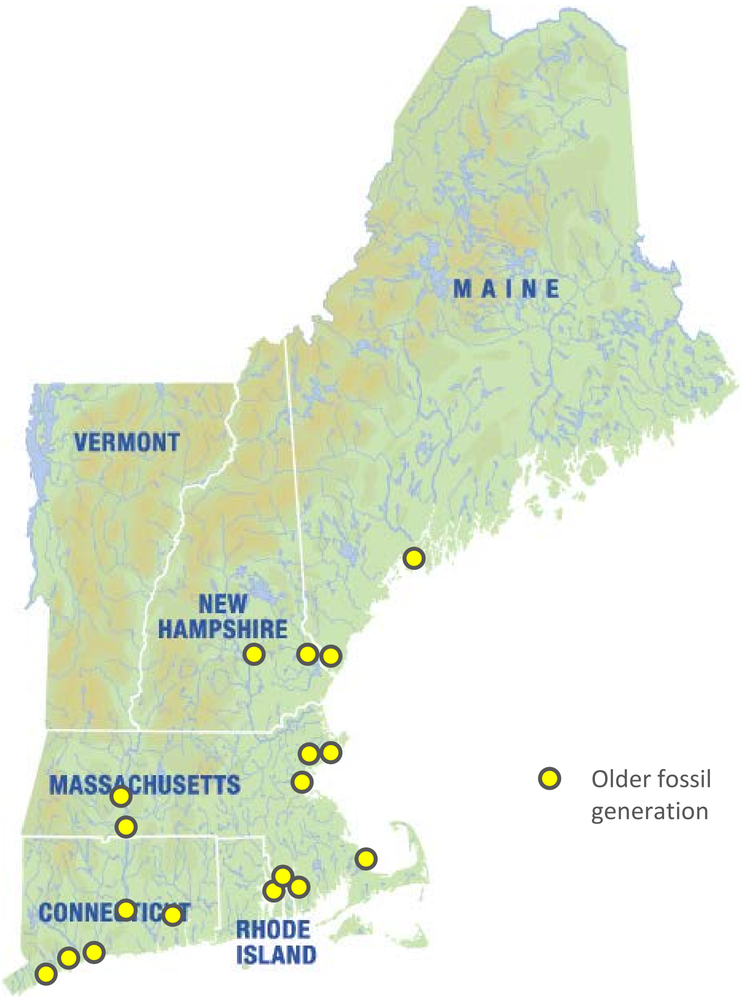
SPI
STRATEGIC PLANNING INITIATIVE

1. Resource Performance and Flexibility
2. Increased Reliance on Natural Gas-Fired Capacity
3. Retirement of Generators
4. Integration of a Greater Level of Variable Resources
5. Alignment of Markets with Planning

RETIREMENTS

Strategic Transmission Analysis Study Objective

- Evaluate the reliability impacts associated with the retirement of 28, 40+ year-old coal- and oil-fired resources by 2020
- Determine whether these retirements totaling 8.3 GW pose transmission security or resource adequacy issues



Capacity Resources Assumed to be at Risk of Retirement (from 2010 Economic Study)

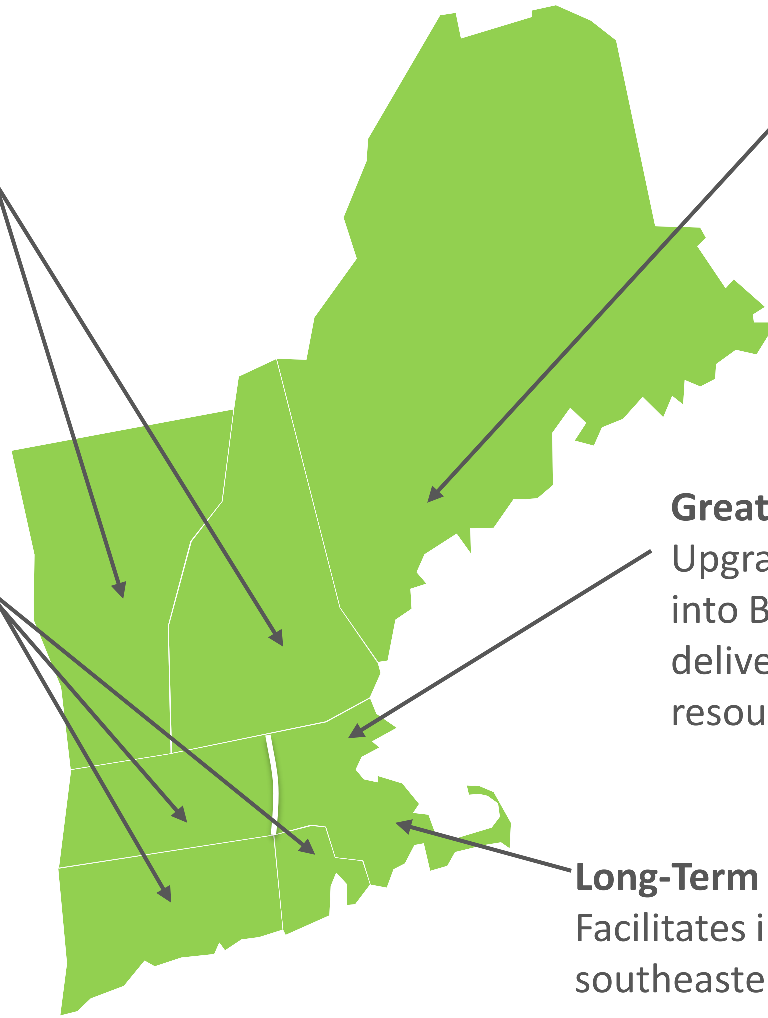
Unit	Unit Type	MW Maximum Assumed	In-service Date	Age in 2020	Unit	Unit Type	MW Maximum Assumed	In-service Date	Age in 2020
BRAYTON POINT	Coal	261	01-Aug-63	57	MONTVILLE	Oil	418	01-Jul-71	49
BRAYTON POINT	Coal	258	01-Jul-64	56	MOUNT TOM	Coal	159	01-Jun-60	60
BRAYTON POINT	Coal	643	01-Jul-69	51	MYSTIC	Oil	615	01-Jun-75	45
BRAYTON POINT	Oil	458	01-Dec-74	46	NEW HAVEN HBR	Oil	483	01-Aug-75	45
BRIDGEPORT HBR	Oil	190	01-Aug-61	59	NEWINGTON	Oil	424	01-Jun-74	46
BRIDGEPORT HBR	Coal	401	01-Aug-68	52	NORWALK HBR	Oil	173	01-Jan-60	60
CANAL	Oil	597	01-Jul-68	52	NORWALK HBR	Oil	179	01-Jan-63	57
CANAL	Oil	599	01-Feb-76	44	SCHILLER	Coal	51	01-Apr-52	68
MERRIMACK	Coal	121	01-Dec-60	60	SCHILLER	Coal	51	01-Jul-57	63
MERRIMACK	Coal	343	30-Apr-68	52	W. SPRINGFIELD	Oil	111	01-Jan-57	63
MIDDLETOWN	Oil	123	01-Jan-58	62	YARMOUTH	Oil	56	01-Jan-57	63
MIDDLETOWN	Oil	248	01-Jan-64	56	YARMOUTH	Oil	56	01-Jan-58	62
MIDDLETOWN	Oil	415	01-Jun-73	47	YARMOUTH	Oil	122	01-Jul-65	55
MONTVILLE	Oil	85	01-Jan-54	66	YARMOUTH	Oil	632	01-Dec-78	42
TOTAL 8,281 MW									

Transmission Development

Regional transmission projects will facilitate retirements, improve deliverability of existing resources, and provide significant flexibility for locating new resources

VT/NH Upgrades
Improves deliverability in Vermont and New Hampshire

New England East West Solution
Allows higher import capability into Connecticut and Rhode Island; improves east-west and west-east transferability

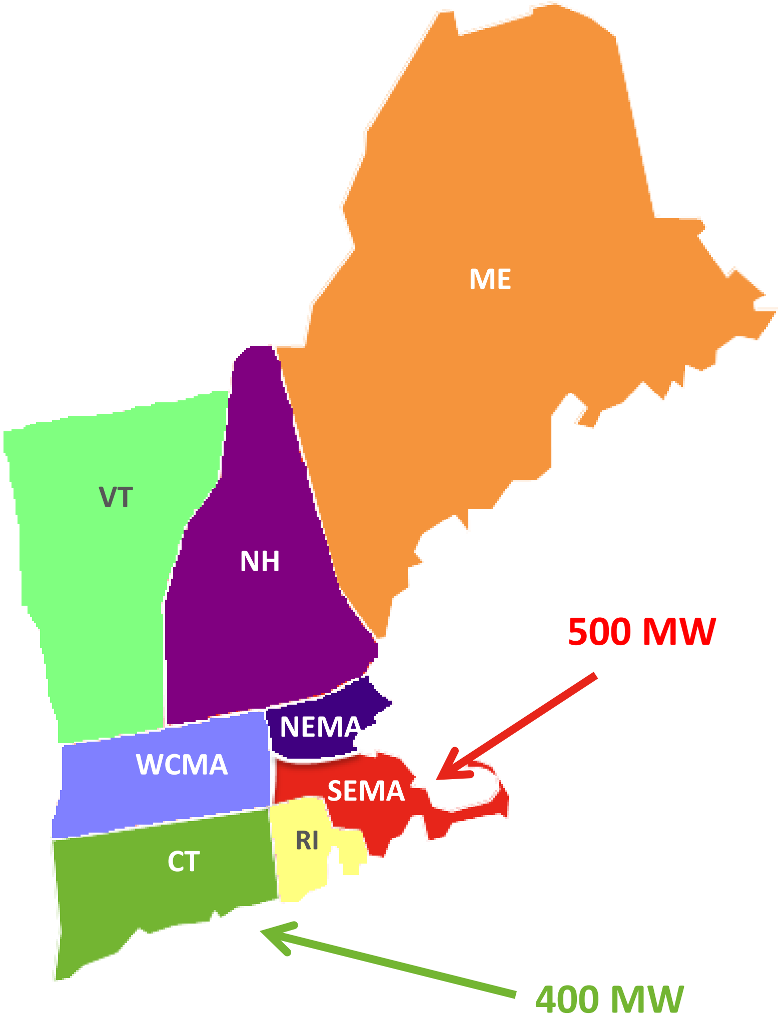


Maine Power Reliability Program
Facilitates deliverability to load in Maine; modest increases to transfer capabilities across interfaces within Maine and Maine-New Hampshire

Greater Boston
Upgrades improve import capability into Boston; has a positive impact on delivery of New Hampshire and Maine resources to Boston

Long-Term Lower SEMA
Facilitates improved load-serving capability in southeastern Massachusetts and Cape Cod

Overall Generator Retirement Study Observations



- With assumed resources and transmission in 2020, ≤ 950 MW may be retired
- Up to 5,100 MW of the 5900 MW needed replacement capacity can be integrated into the Hub
- At least 900 MW of the replacement capacity must be in specific locations due to transmission constraints
  - 500 MW must be in southeastern Massachusetts
  - 400 MW must be in Connecticut
- Major transmission projects significantly improve deliverability of most existing resources, and greatly facilitate retirement of assumed at risk resources

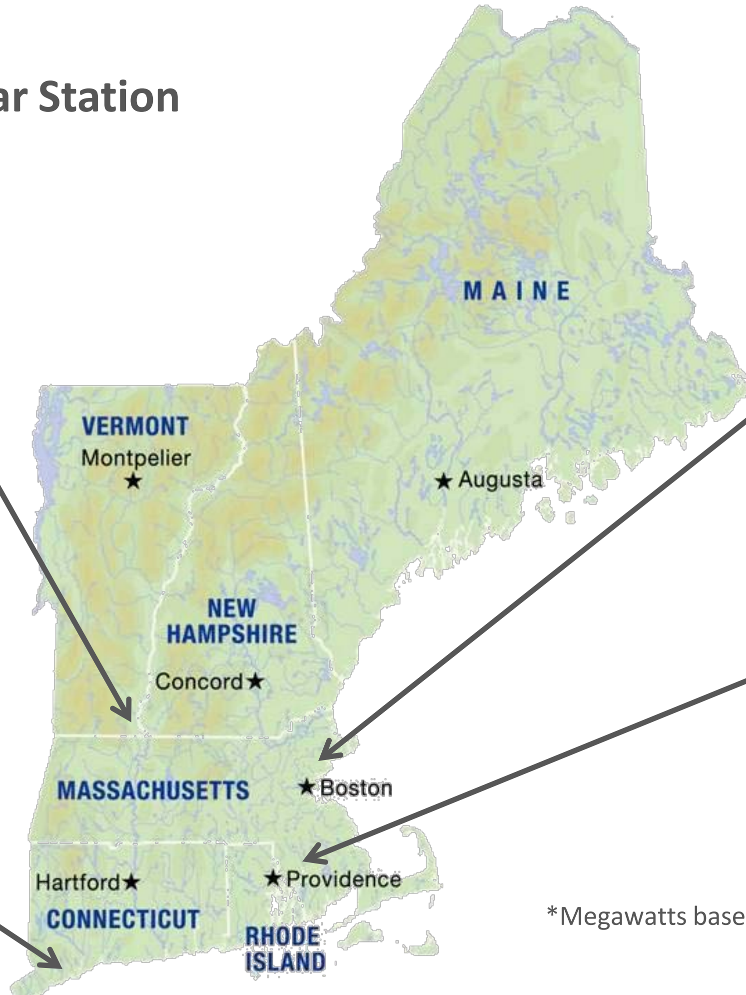
Major Generator Retirement Requests

Vermont Yankee Nuclear Station

Unit 1: 604 MW
Total: 604 MW

Salem Harbor Station

Unit 1: 82 MW (coal)
Unit 2: 80 MW (coal)
Unit 3: 150 MW (coal)
Unit 4: 437 MW (oil)
Total: 749 MW



Norwalk Harbor Station

Unit 1: 162 MW (oil)
Unit 2: 168 MW (oil)
Unit 10: 12 MW (oil)
Total: 342 MW

Brayton Point Station

Unit 1: 239 MW (coal)
Unit 2: 239 MW (coal)
Unit 3: 612 MW (coal)
Unit 4: 435 MW (oil)
Brayton Diesels 1-4: 10 MW
Total: 1535 MW

*Megawatts based on relevant FCA summer qualified capacity

Source: Status of Non-Price Retirement Requests; October 23, 2013

DISTRIBUTED GENERATION UPDATE

Overview

- Existing and new ISO planning processes address two types of non-transmission alternatives (NTA)
  - Energy efficiency (EE)
  - Distributed generation (DG)
- The ISO developed a forecast for future EE, and incorporates this into planning decisions for the grid
  - The third EE forecast process currently underway
  - See www.iso-ne.com/eefwg
- The ISO recently launched a stakeholder process that will develop a long-term DG forecast

Overview

- What is distributed generation (DG)?
  - 5 MW or less in nameplate capacity
  - Interconnected to the distribution system (typically 69 kV or below)
  - Use state-jurisdictional interconnection standards
- Penetrations of DG continue to grow in New England
  - Approximately 2,000 MW of DG – mostly solar photovoltaic (PV) resources– are anticipated in the region by the end of 2021
- Most of the region's DG will continue to be PV
  - Actual costs of PV falling
  - Federal tax incentives
  - State incentives
- Currently about 400MW of operational PV in the region
- Potential reliability impacts of higher penetrations of DG due to current state interconnection standards

Regional Policy Pushing Growth of PV and DG

- Massachusetts: reached its 250 MW PV goal three years early
  - May 2013: Announced expanded goal of 1,600 MW of PV by 2020
- Connecticut: Public Act 11-80 is stimulating growth in DG
  - Could result in more than 300 MW of DG by 2022, mostly PV
- Vermont: State goal of 127.5 MW of DG by 2012
  - Approximately 26 MW of PV installed in VT by end of 2012
- Rhode Island: DGSC program aimed at stimulating 40 MW of DG by 2014
  - RI is considering expanding program to 120 MW by 2018
- New Hampshire: Class II RPS will require about 25 MW of PV by 2015

What Will Growth of DG Mean?

- There may be as many as 10,000 PV installations in New England
- To date, PV not large enough to impact grid operations
- Some of the PV, especially the larger units, participate in the ISO's markets
  - The participating units are a known quantity
- But much of the PV is not visible to the ISO
- How much PV can be expected in the future?
  - ISO determined a forecast of DG resources is necessary
  - Similar to the ISO's energy-efficiency forecast

Challenges to Developing a DG Forecast

- No methodology currently exists forecast DG growth
- Avoid double-counting DG resources
  - Need to consider the ways in which existing DG are already treated in long-term planning (i.e., in FCA, as SOGs or historical loads used for CELT)
- How to determine resource capacity?
  - Nameplate minus various factors
- Where is future DG going to be located?
  - DG resources will likely be unevenly distributed across region, and also across individual states

Distributed Generation Forecast Working Group

- ISO created and chairs a DG stakeholder group
- Distributed Generation Forecast Working Group
  - Mission: to foster collaboration between ISO, state policymakers, state regulators, distribution companies and others possessing needed expertise to address the operational, planning, and market implications of high penetrations of DG
  - Will assist ISO in developing a long-term PV forecast
  - www.iso-ne.com/dgfwg
  - Next meeting: January 27, 2014 in Westborough, MA

INTERIM PV FORECAST

Introduction

- Given the complex and interrelated factors influencing the commercialization of solar PV resources, a data-driven approach analogous to the ISO's Energy-Efficiency forecast methodology cannot be developed in the short term
- In the interim, a more qualitative forecasting approach is proposed, based primarily on state policy goals and funding
- Based on recent discussions with stakeholders and data exchange with the New England states, existing PV-related programs have thus far demonstrated success in achieving policy goals
  - No evidence to suggest a significant departure from the current path towards implementing the policy goals

Interim PV Forecast

States	Annual Total MW (MW, AC nameplate rating)											Totals
	Through 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
CT	54.3	51.3	41.3	61.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	497.0
MA	322.2	199.2	146.1	146.1	146.1	132.8	132.8	132.8	132.8	132.8	132.8	1,756.4
ME	2.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	10.0
NH	5.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	22.0
RI	10.1	8.4	8.4	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	80.4
VT	54.0	20.3	13.5	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	141.8
Annual Policy-Based MWs	447.5	281.9	212.0	223.6	196.9	183.6	145.4	145.4	11.6	10.6	0.8	1,859.0
Annual Post-Policy MWs	0.0	0.0	0.0	0.0	6.7	6.7	45.0	45.0	177.8	178.8	188.6	648.6
Annual Nondiscounted Total (MW)	447.5	281.9	212.0	223.6	203.6	190.3	190.4	190.4	189.4	189.4	189.4	2,507.6
Cumulative Nondiscounted Total (MW)	447.5	729.3	941.3	1,164.9	1,368.5	1,558.8	1,749.2	1,939.5	2,128.9	2,318.2	2,507.6	2,507.6

Discounted MWs

Total Discounted Annual	447.5	253.7	180.2	178.9	149.3	139.4	120.3	120.3	53.1	52.6	47.8	1,742.9
Total Discounted Cumulative	447.5	701.1	881.4	1,060.2	1,209.6	1,348.9	1,469.2	1,589.5	1,642.6	1,695.2	1,742.9	1,742.9

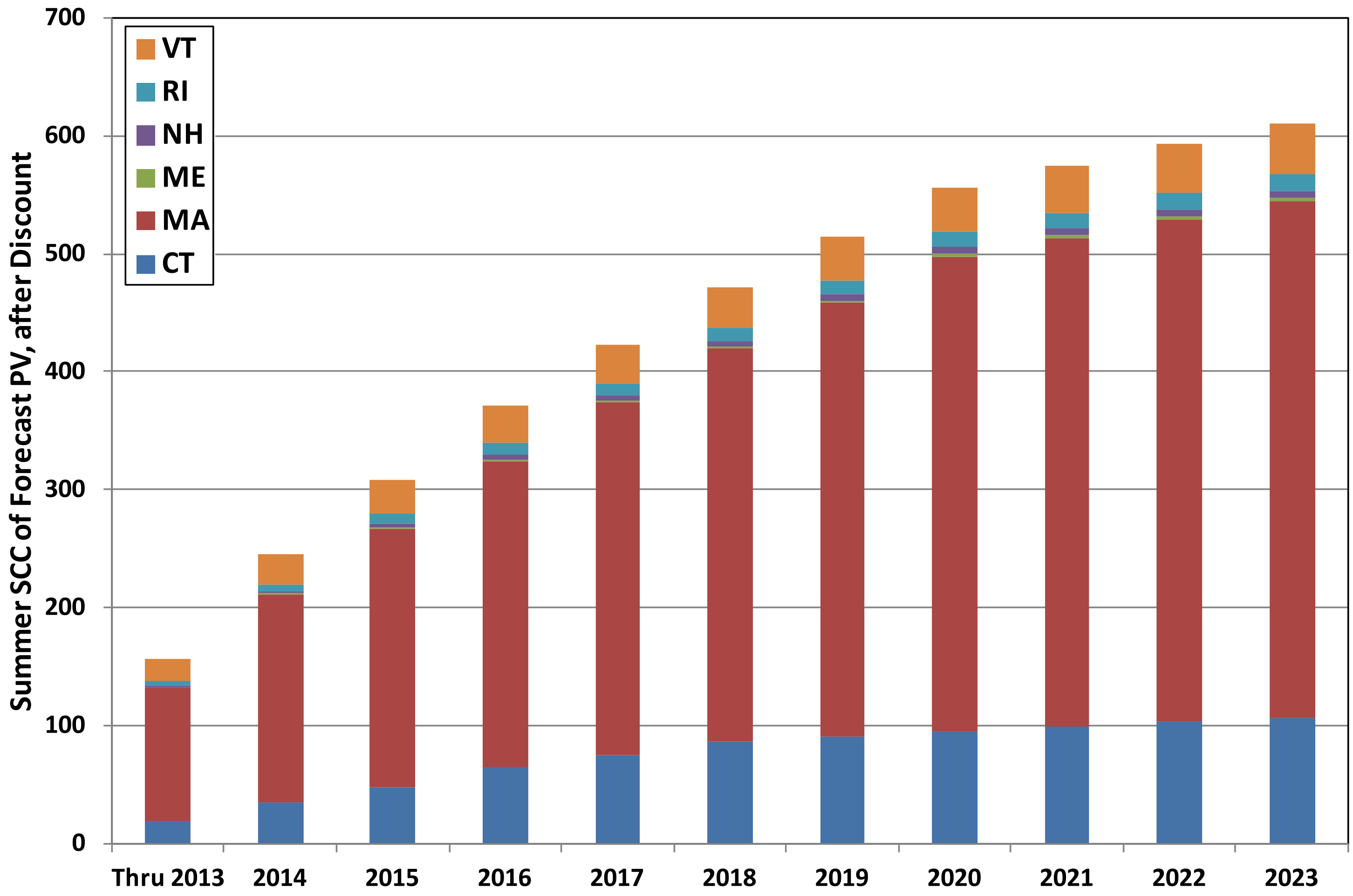
Final Summer SCC (MW) Based on 35% [Assume Winter SCC equal to zero]

Annual: Total Discounted SSCC (MW)	156.6	88.8	63.1	62.6	52.3	48.8	42.1	42.1	18.6	18.4	16.7	610.0
Cumulative: Total Discounted SSCC (MW)	156.6	245.4	308.5	371.1	423.3	472.1	514.2	556.3	574.9	593.3	610.0	610.0

Note:

(1) Yellow highlighted cells indicate that values contain post-policy MWs

Interim PV Forecast: Summer SCC after Discounts



INTERCONNECTION ISSUES

Potential System Reliability Impacts of DG

- State jurisdictional interconnection standards for DG are generally consistent with IEEE Standard 1547™
  - IEEE 1547™ originally developed with the assumption that DG would not reach significant levels with regards to the regional power system
- IEEE 1547™ is a "don't ride through" requirement
  - May lose significant amounts of DG after grid disturbance (if interconnected according to current IEEE standards)
- IEEE 1547™ prohibits DG from regulating feeder voltage

Next Steps

- Based on work done by NERC and ISO's own analysis, ISO will participate in the revision of IEEE Standard 1547™ to improve the coordination of distribution system needs and transmission system performance requirements
  - Address low voltage ride-through interconnection requirements for DG
  - Address under frequency ride through interconnection requirements of DG
- ISO will be meeting with the DGFWG, Transmission Owners, the Distribution Owners, and the states to discuss possible revisions to the state mandated DG interconnection requirements
- Work on revising the interim DG forecast will continue based on stakeholder comments
- ISO will discuss applications of the forecast at future meetings of the DGFWG

Questions

APPENDIX

Interim Forecast Methodology (1 of 6)
MA Assumptions

- A DC-to-AC derate ratio of 83% is applied to the MA SREC goal to determine AC nameplate of state goal
  - PV system designers/developers typically choose to oversize their solar panel array with respect to their inverter(s) by a factor of 1.2**
  - DC nameplate capacity is determined by the sum of the DC ratings of all the panels that make up the solar array, and AC nameplate capacity is determined by the (sum of the) inverter(s) rating(s).
    - E.g., a 120 kW_{DC} solar panel array is connected to 100 kW_{AC} inverter
  - This factor is called any of the following:
    - Array-to-inverter ratio
    - Oversizing ratio
    - Overloading ratio
    - DC-to-AC ratio
  - 1/1.2 = **83%**

**Source: J. Fiorelli and M.Z. Martinson, *How oversizing your array-to-inverter ratio can improve solar-power system performance,* Solar Power World, July 2013, available at: http://www.solren.com/articles/Solectria_Oversizing_Your_Array_July2013.pdf

Interim Forecast Methodology (2 of 6)
MA Assumptions

- MA SREC I/II programs successfully achieve 2020 state goal
- There is a ramp-up of large-scale projects attempting to garner SREC I eligibility prior to mid-2014. This will result in increased PV commercialization through 2014
- Potential expiration of federal ITC in 2016 will promote increased development through 2016, with residual impact continuing through 2017
- Program stabilizes from 2018-2020 until goal is achieved
- Post-SREC (after 2020) values remain constant, but are more significantly discounted

Interim Forecast Methodology (3 of 6)
CT Assumptions

- ZREC program will be satisfied entirely with PV
  - 170 MW CL&P + 42.5 MW UI = 212.5 MW total (see CT presentation here)
    - Divided into 35.4 MW/year applied during 6-year program roll-out duration, from 2013-2018, and corroborated with CT utility data through 2013
    - Program review in year four will find technology costs have decreased and extend program for its last two years (refer to PA 11-80, Section 107(c)(2))
    - Projects completed and operational within 12-months of procurement
  - CEFIA 30 MW residential program divided into ten 3 MW allocations for period between 2013-2022
  - Discrete utility-scale projects
    - Two 5 MW projects (East Lyme & Somers) are operational in 2014
    - A 20 MW project in Sprague/Lisbon is operational in 2016
  - "Legacy" MWs – 30 MWs of PV that pre-existed aforementioned programs
  - Post-ZREC (after 2018) values remain constant, but are more significantly discounted

Interim Forecast Methodology (4 of 6)
VT Assumptions

- PV comprises 75% of Standard Offer Program MWs until 127.5 MW goal is reached → 95 MWs total
  - No PV projects are determined to yield "sufficient benefits" and all are therefore counted towards the program goal**
- Assume 80% of net metered projects will be PV
  - Total of 40 MW
- Timing and total capacity of annual installed PV are consistent with VT's presentation to DGFWG on 9/30/13.
- Annual value kept constant for 2023 (beyond Std Offer), but is more significantly discounted

**For a description of "sufficient benefits" refer to VT's 30 V.S.A. § 8005a. SPEED; standard offer program, available at:
http://www.leg.state.vt.us/statutes/fullsection.cfm?Title=30&Chapter=089&Section=08005a

Interim Forecast Methodology (5 of 6)
RI Assumptions

- Consistent with program data to date, 84% of 40 MW DG Standard Contract program will be PV → 33.5 MW
- Post-2016 (after DG contract installations end), annual forecast values are kept constant, but are more significantly discounted

Interim Forecast Methodology (6 of 6)
NH & ME Assumptions

- NH
  - Class II RPS program and net metering will result in the development of 20 MW of PV through 2021
  - Post-2021 growth of 1 MW/yr discounted more heavily
- ME
  - Net metering and other state grants/incentives will result in the development of 10 MW of PV by 2023, applied evenly throughout the forecast horizon

Discount Factors (1 of 2)

- Notwithstanding the recent success of state programs, a discount factor reflecting a degree of uncertainty in policy achievement was suggested in NESCOE's request language for an interim PV forecast
- In general, discount factors are applied to forecast values of policy-supported MWs of PV, are applied equally in all states, and annually increase over time up to a value of 25%
- PV that is forecast beyond the existing state program duration is more heavily discounted (75%), since there is a much higher degree of uncertainty in forecasting future policy and market/price conditions necessary to support the continued development of PV
  - Note that the U.S. Energy Information Agency's (EIA) 2013 Annual Energy Outlook (AEO) indicates that national PV growth rates between 2016 and 2023 may be as low as 4%.**
  - Applying EIA's post-2016 growth rate to New England would yield a forecast that would not allow for the achievement of existing state policies

**EIA cites a slower electricity demand growth rate, low natural gas prices, and the stagnation or expiration of state and federal policies the support renewables as the reasons for their slow growth prediction. The EIA's 2013 AEO is available at: http://www.eia.gov/forecasts/aeo/

Discount Factors (2 of 2)

- Proposed annual discount factors for policy-based PV MWs are tabulated below
- All post-policy MWs are discounted by 75% as shown

Policy-based MWs											Post-policy MWs
Through 2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	
0% but must be confirmed via utility data	10%	15%	20%	25%	25%	25%	25%	25%	25%	25%	75%

Interim PV Forecast: State Breakdown of Discounted PV

States	Annual Discounted (MW)											Totals
	Through 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
CT	54.3	46.1	35.1	49.0	30.9	30.9	11.8	11.8	11.8	11.8	10.3	**303.9**
MA	322.2	179.3	124.2	116.9	109.6	99.6	99.6	99.6	33.2	33.2	33.2	**1,250.4**
ME	2.0	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	**8.2**
NH	5.0	1.8	1.7	1.6	1.5	1.5	1.5	1.5	0.8	0.3	0.3	**17.4**
RI	10.1	7.5	7.1	5.4	1.7	1.7	1.7	1.7	1.7	1.7	1.7	**41.8**
VT	54.0	18.2	11.5	5.4	5.1	5.1	5.1	5.1	5.1	5.1	1.7	**121.2**
Totals	447.5	253.7	180.2	178.9	149.3	139.4	120.3	120.3	53.1	52.6	47.8	1,742.9

Notes:

(1) Yellow highlighted cells indicate that values contain post-policy MWs

Interim PV Forecast: State Breakdown of Summer SCC after Discount

States	Summer SCC (MW)											Totals
	Through 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
CT	19.0	16.1	12.3	17.2	10.8	10.8	4.1	4.1	4.1	4.1	3.6	**106.4**
MA	112.8	62.7	43.5	40.9	38.3	34.9	34.9	34.9	11.6	11.6	11.6	**437.7**
ME	0.7	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	**2.9**
NH	1.8	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.3	0.1	0.1	**6.1**
RI	3.5	2.6	2.5	1.9	0.6	0.6	0.6	0.6	0.6	0.6	0.6	**14.6**
VT	18.9	6.4	4.0	1.9	1.8	1.8	1.8	1.8	1.8	1.8	0.6	**42.4**
Totals	**156.6**	**88.8**	**63.1**	**62.6**	**52.3**	**48.8**	**42.1**	**42.1**	**18.6**	**18.4**	**16.7**	**610.0**

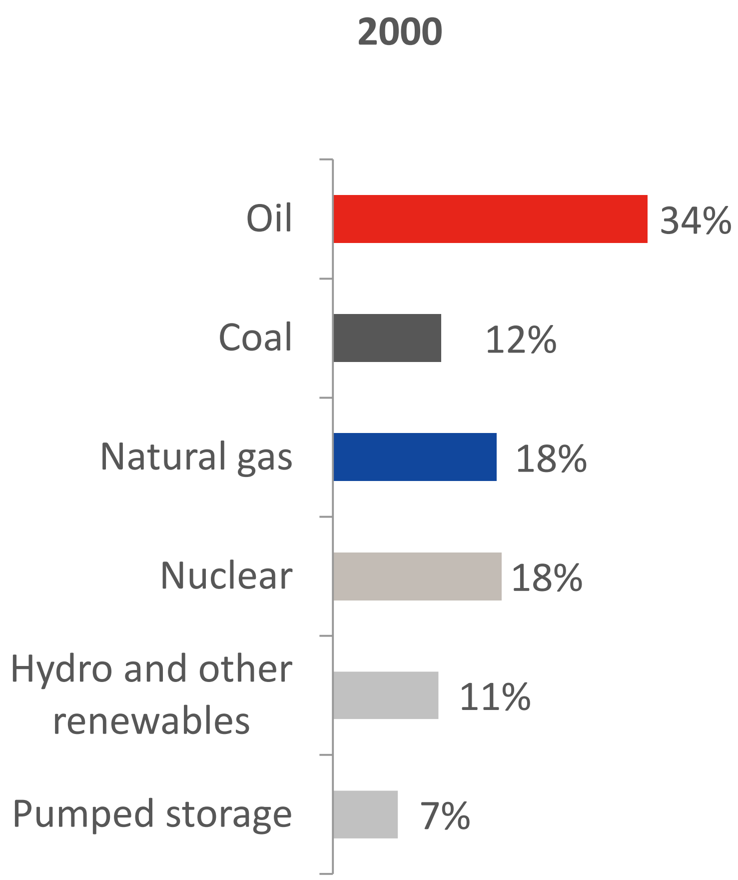
Notes:

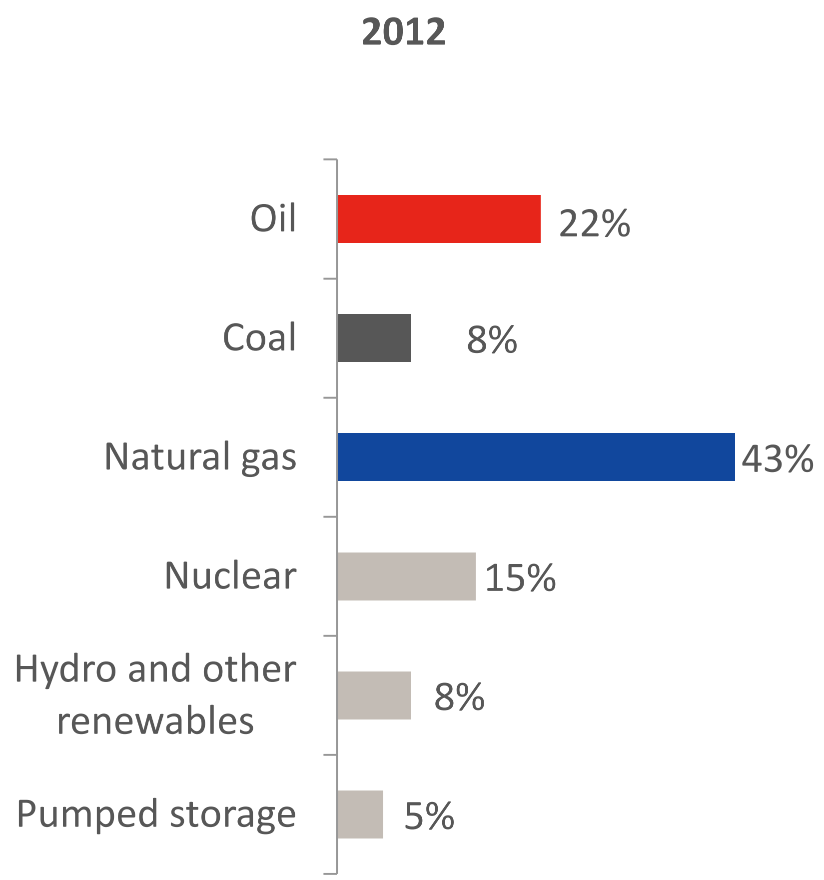
(1) Yellow highlighted cells indicate that values contain post-policy MWs

ADDITIONAL REQUESTED INFORMATION

Regional *Capacity* has Shifted from Oil to Natural Gas

Percent of Total System Capacity



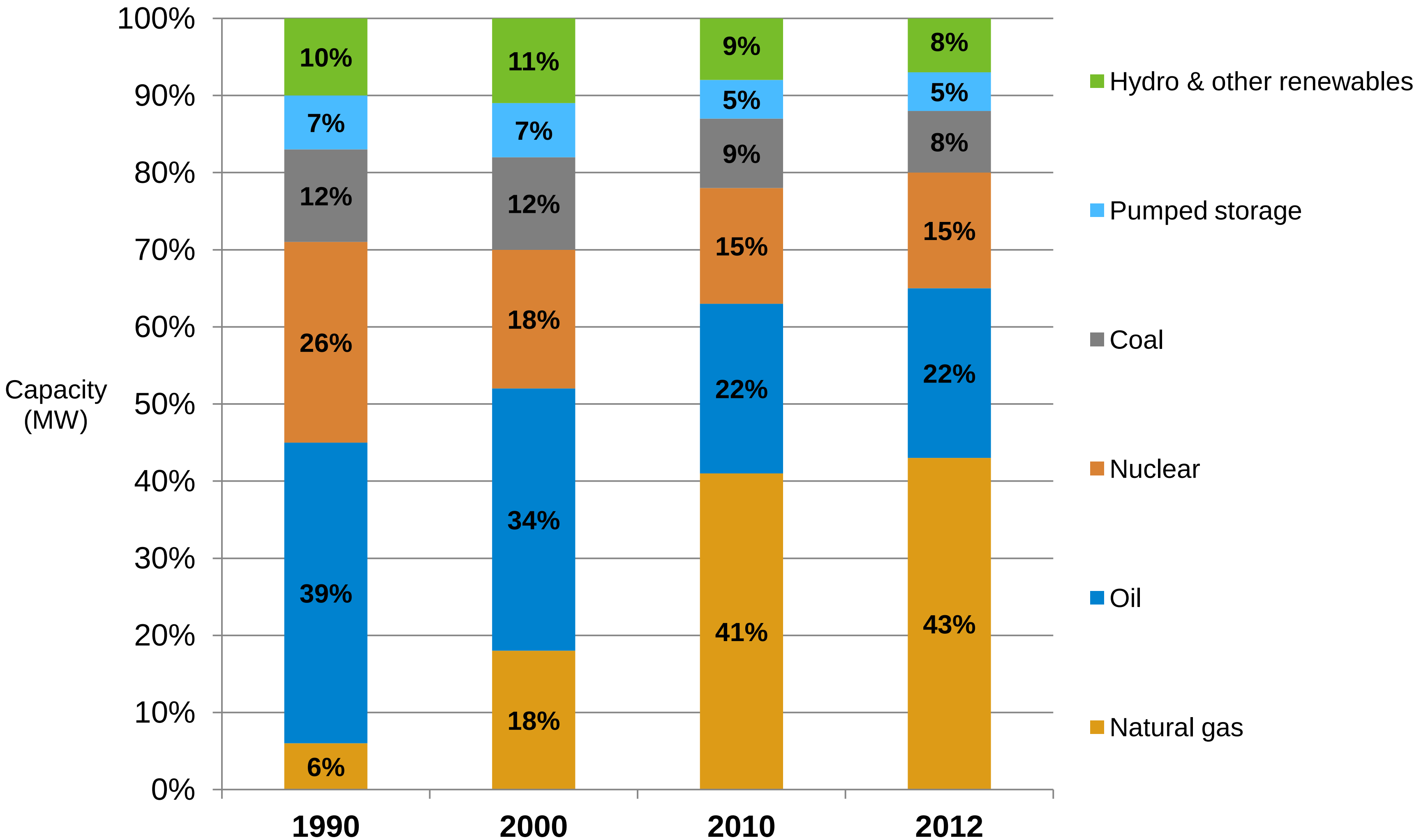


Other renewables include landfill gas, biomass, other biomass gas, wind, solar, municipal solid waste, and misc. fuels.

Source: Regional Profile (2012/13)

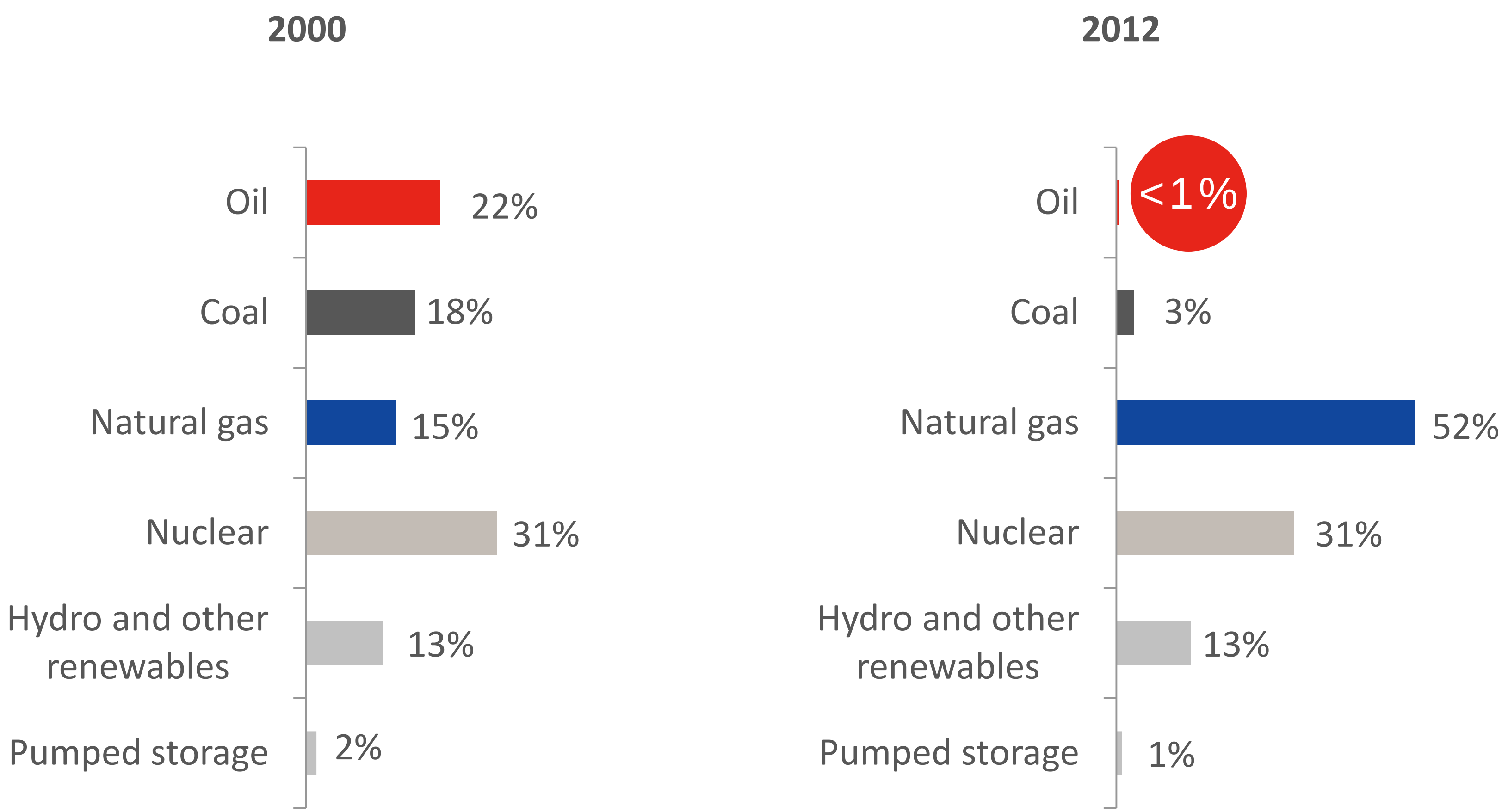
New England's Resource Mix

<u>Capacity</u> has shifted from oil and nuclear power to natural gas



Regional *Energy* has Shifted from Oil to Natural Gas

Percent of Total Electric Energy Production



Other renewables include landfill gas, biomass, other biomass gas, wind, solar, municipal solid waste, and misc. fuels.

Source: Regional Profile (2012/13)

Dramatic Shift in Energy Production

Region has seen shift from oil to natural gas