London Economics International LLC

The economics of meeting renewable policies in New England

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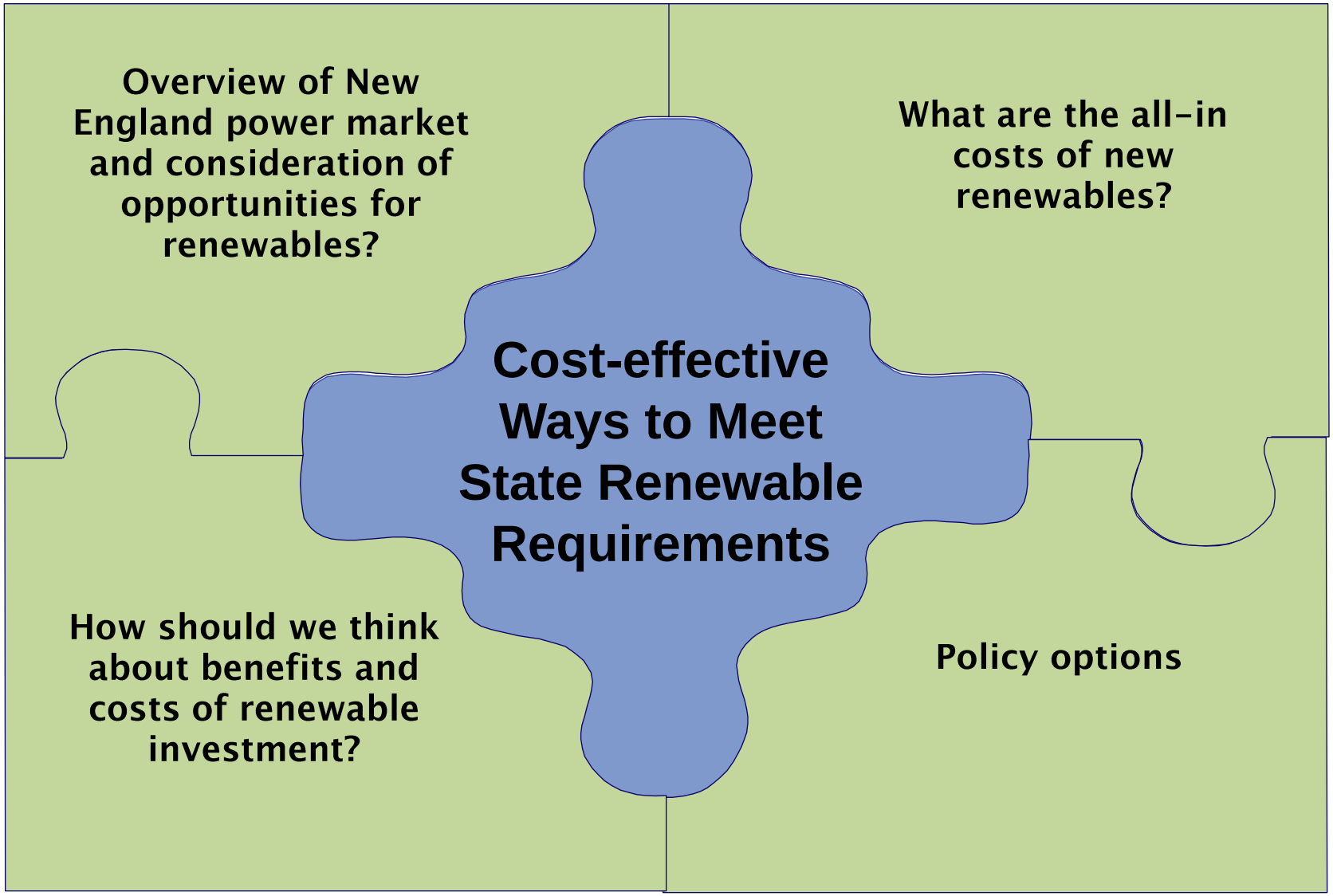
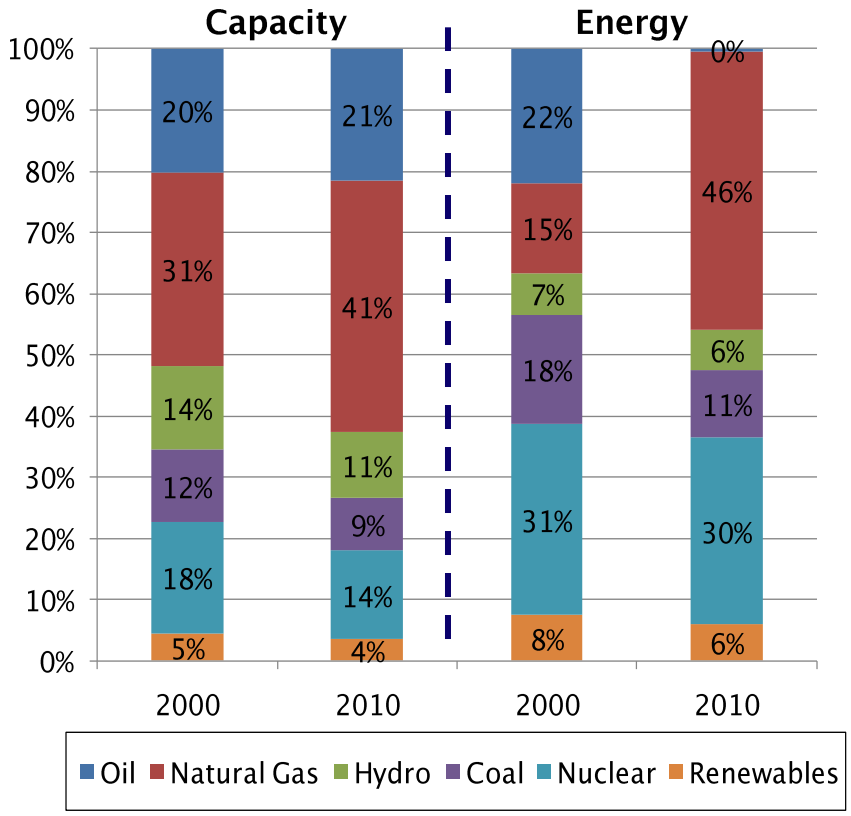
What will I talk about today?



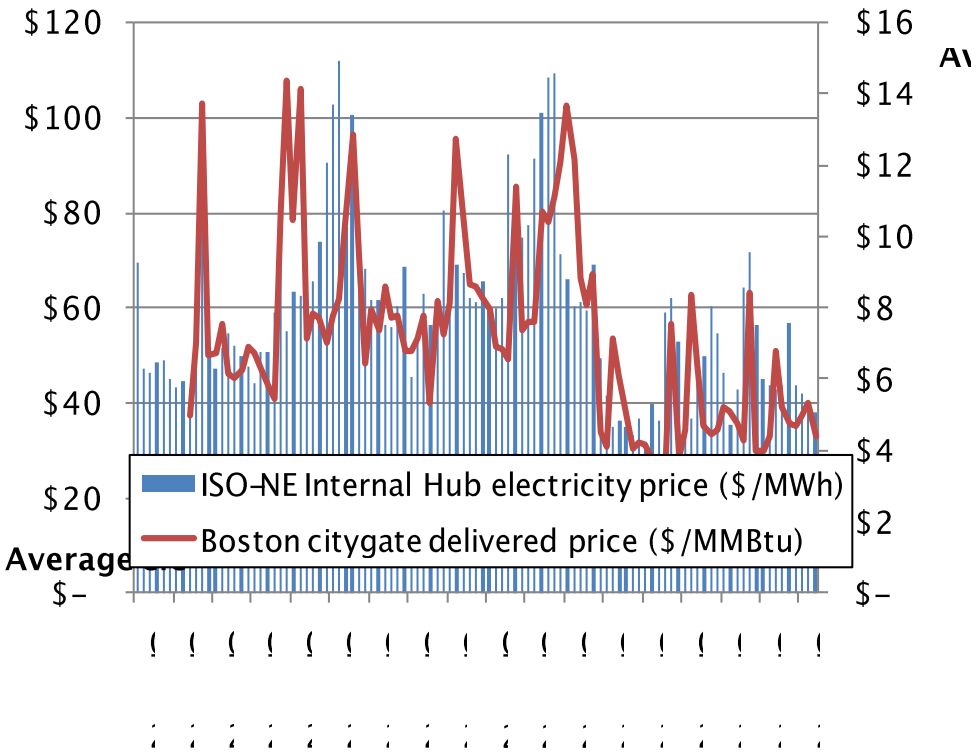
New England has become increasingly dependent on natural gas-fired capacity over the past decade

Capacity and energy by fuel type (2000 and 2010)



Sources: ISO-NE 2011 Regional System Plan

Monthly average natural gas and electricity prices in New England



Sources: EV (ISO-NE electricity price data) and Bloomberg (gas price data)
Note: ISO-NE price data starting from 2003 with commencement of locational marginal pricing

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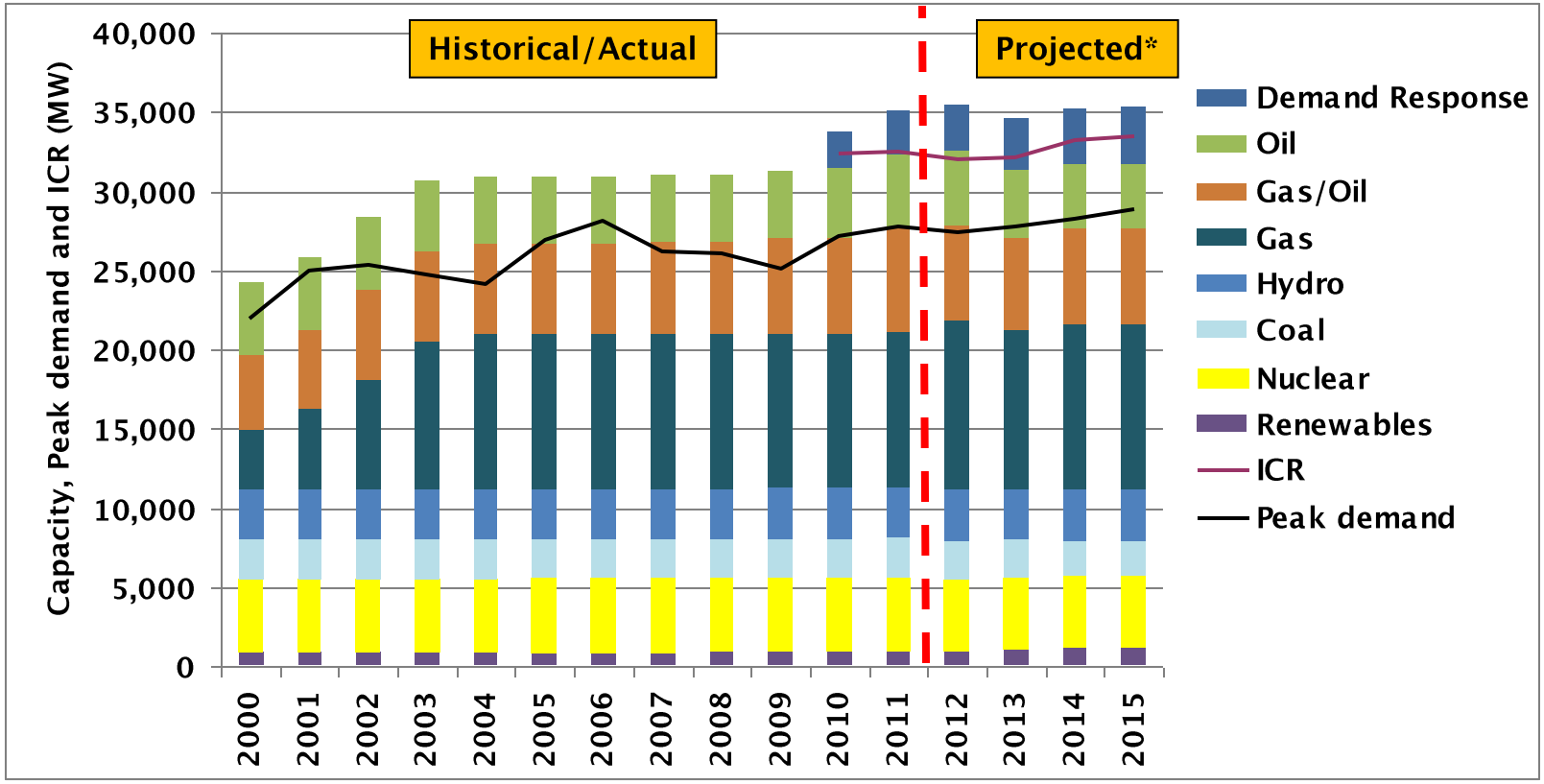
New England is over supplied in terms of capacity

Historical and forecasted capacity, peak demand, and incremental capacity requirements (2000-2015)

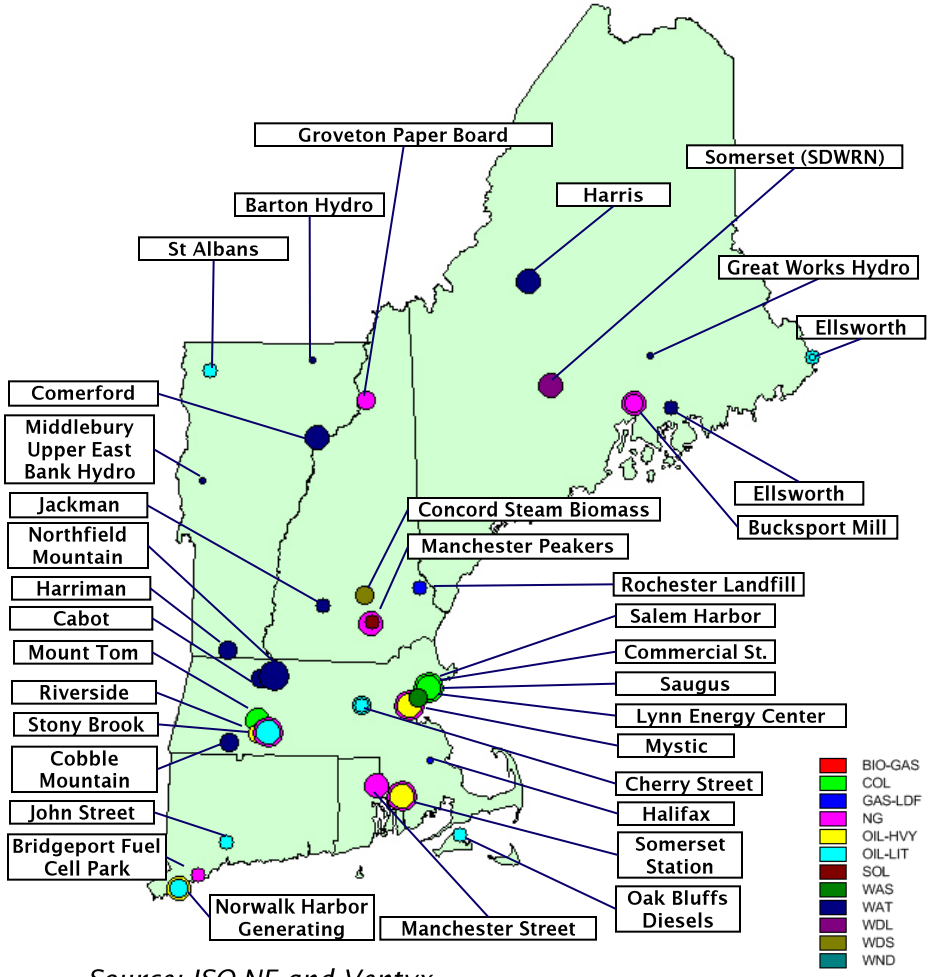


**Projected peak demand is based the latest ISO-NE 2012 CELT forecast. ICRs are based on the ISO-NE news releases on April 6 regarding the latest FCA#6 result, and supply shows commitments made in FCAs.*

Sources: ISO-NE 2012 CELT, ISO-NE news release, "Sixth Forward Capacity Market Auction Procures Power System Resources Needed for 2015-2016" issued April 6, 2012

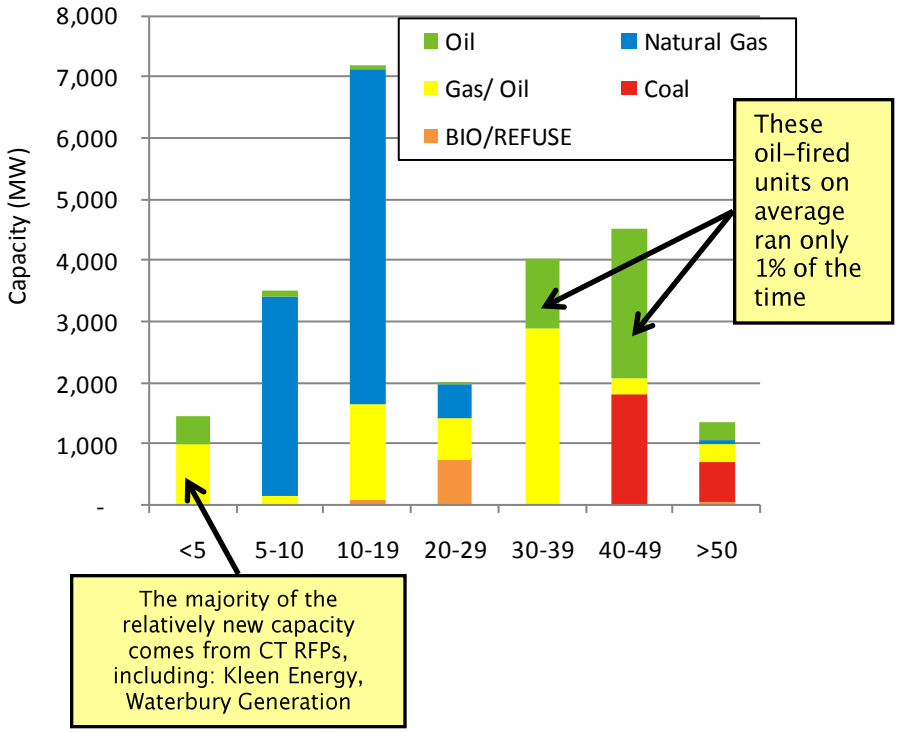
However, the generating fleet is aging and there are many MWs of older, less efficient generating plants at risk for retirement

Permanent and Static Delists in FCAs to date



Source: ISO-NE and Ventyx

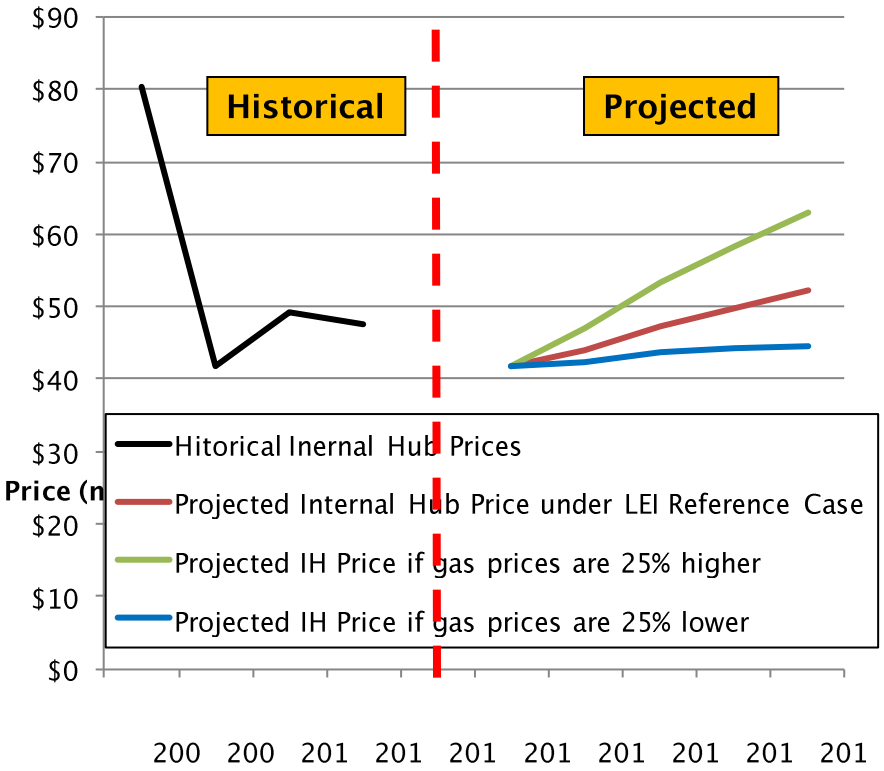
Age profile of operating fossil fuel fired plants in New England



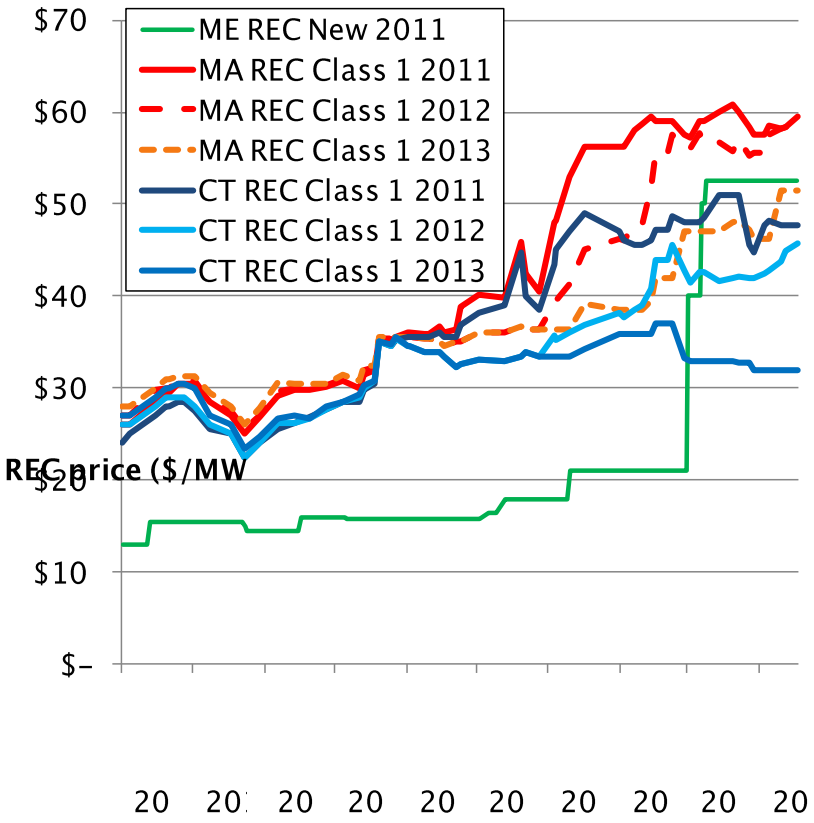
Note: Age profile of fossil plants operating in New England as of January 2012 (source: ISO-NE 2012 CELT)

Outlook on future electricity prices contingent on gas prices, while REC prices are sensitive to supply and demand changes

Historical and projected Internal Hub ("IH") prices



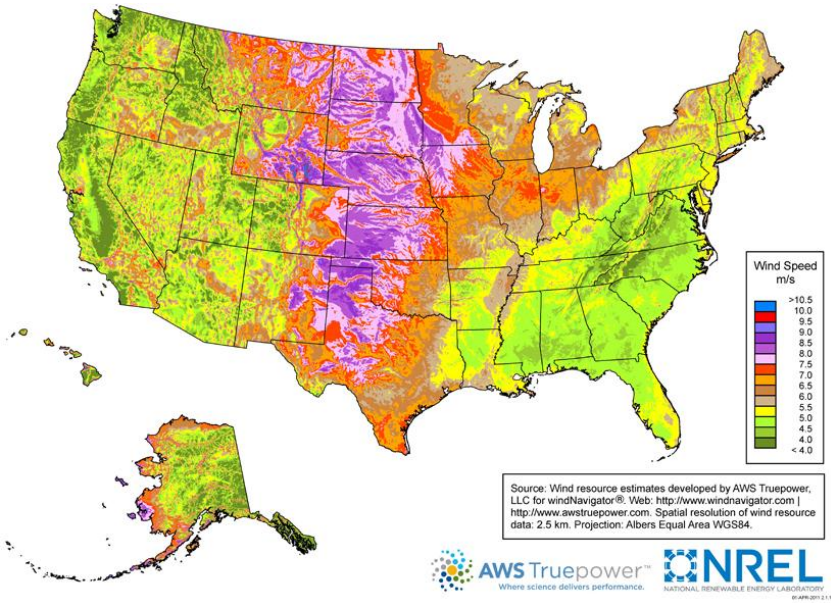
REC prices for various vintage



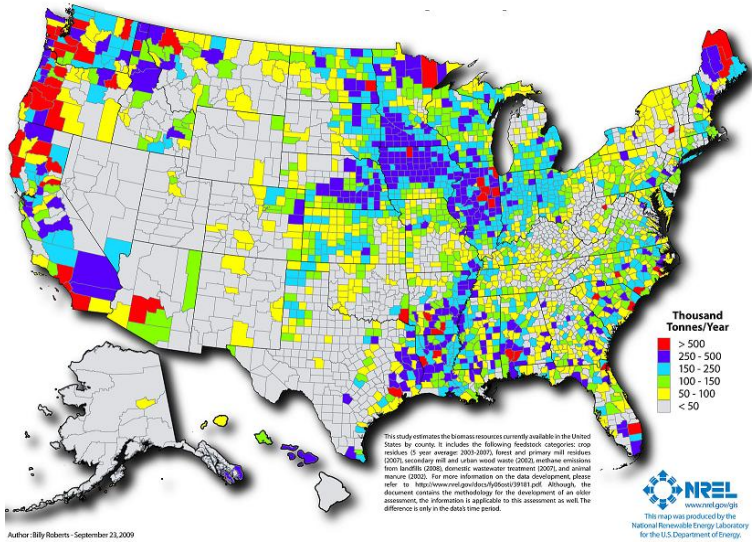
- Projected Internal Hub prices for New England range from $45/MWh to over $50/MWh with a +/-25% divergence in gas price around current forward outlook for 2015
- Massachusetts and Connecticut RECs for 2013 compliance periods have recently traded at $51/MWh and $32/MWh, respectively

What is the potential for "home grown" renewables in New England?

U.S. wind Resource Maps



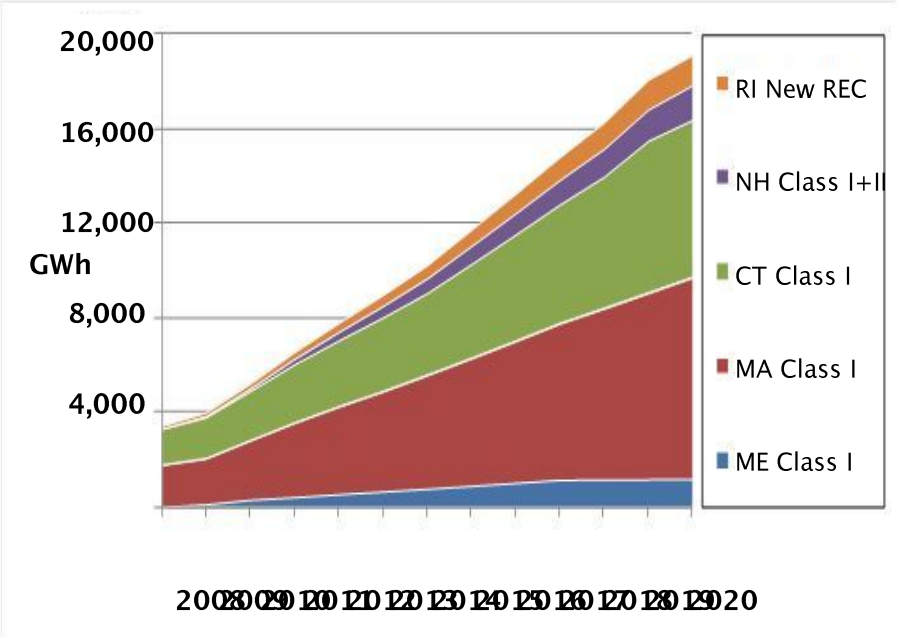
U.S. Biomass Resource Maps (total biomass per Square Kilometer)



- *According to* "New England Governors' Renewable Energy Blueprint", *"…New England has a significant quantity of untapped renewable resources, on the order of over ten thousand (10,000) Megawatts (MW) combined of on-shore and off-shore wind power potential…"*
- New England, especially Northern Maine, has good quality biomass resources for electric generation.

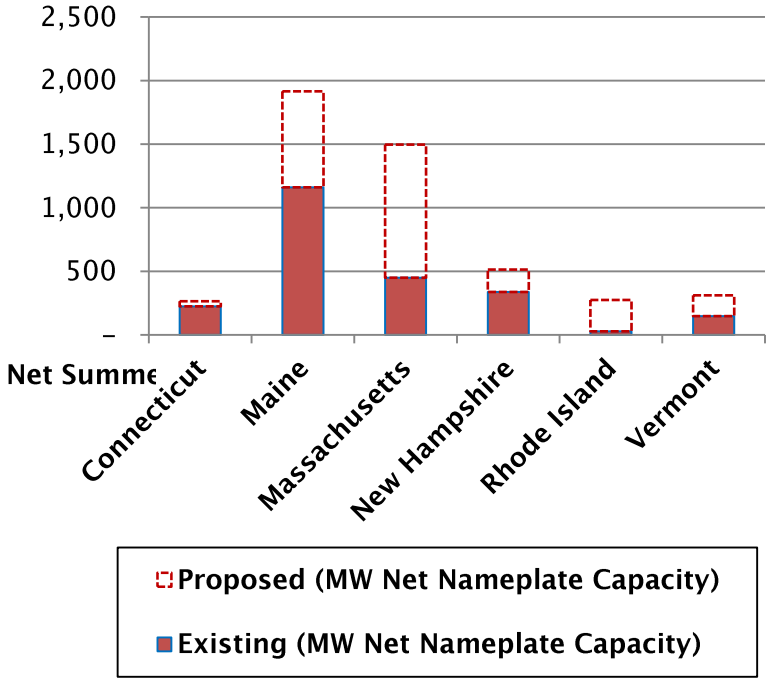
Renewable resource potential and REC demand do not line up with state boundaries

2008-2020 RPS requirements in New England by state (Class I)



Massachusetts RPS requirement reaches 15% of retail electric sales by 2020; Connecticut Class I RPS reaches 20% by 2020

Existing and Proposed Renewables in ISO-NE (up to 2020)

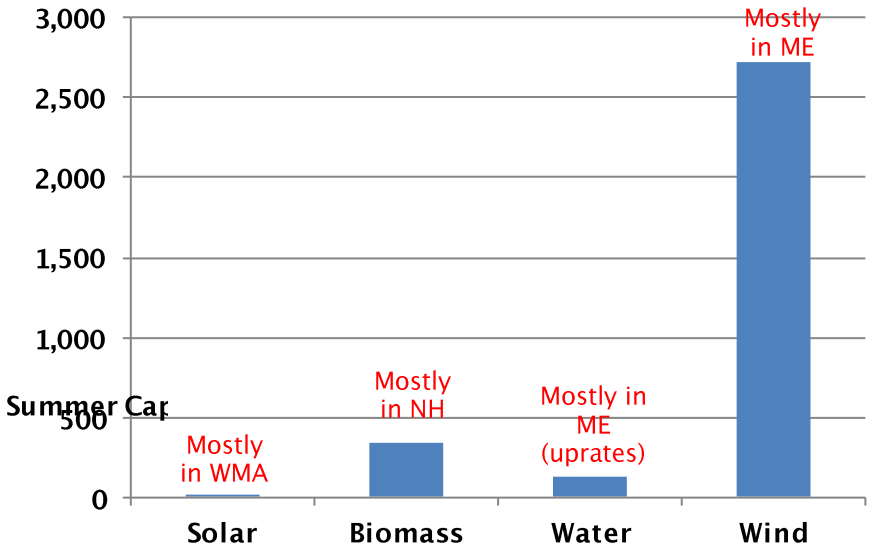


Note: Estimate for "Proposed Renewables" are based on developer proposals at 100% of targeted capacity levels for 2012 and reduced by 50% thereafter

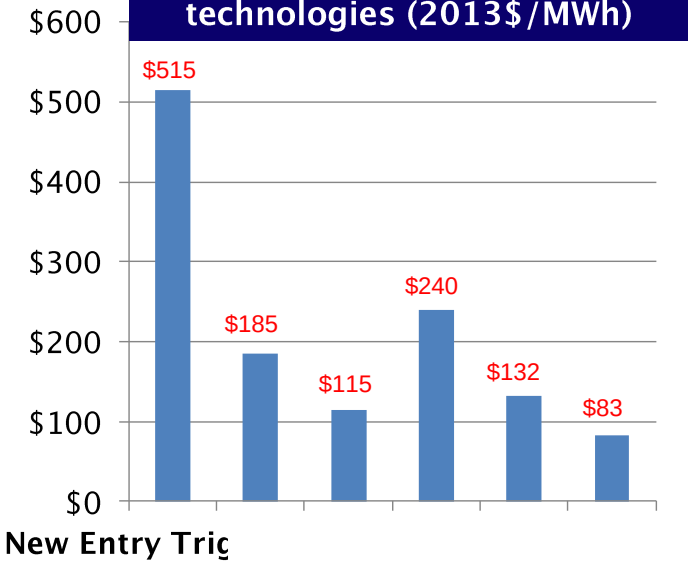
Maine and Massachusetts have the greatest potential to grow their renewable capacity while Connecticut has the least

The break-even costs of various renewable technologies vary a lot, ranging from $83/MWh for hydro to $515/MWh for solar PV

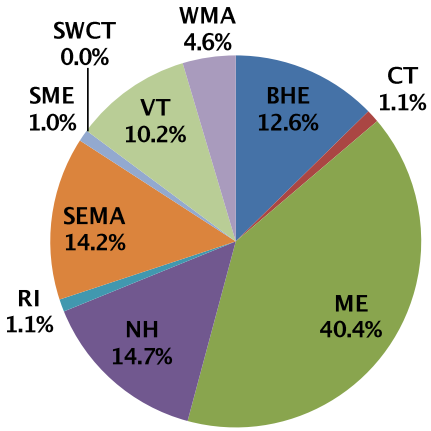
Proposed renewables by fuel type (2012-2016)



All-in levelized costs for various renewable technologies (2013$/MWh)



Proposed renewables by location (2012-2016)



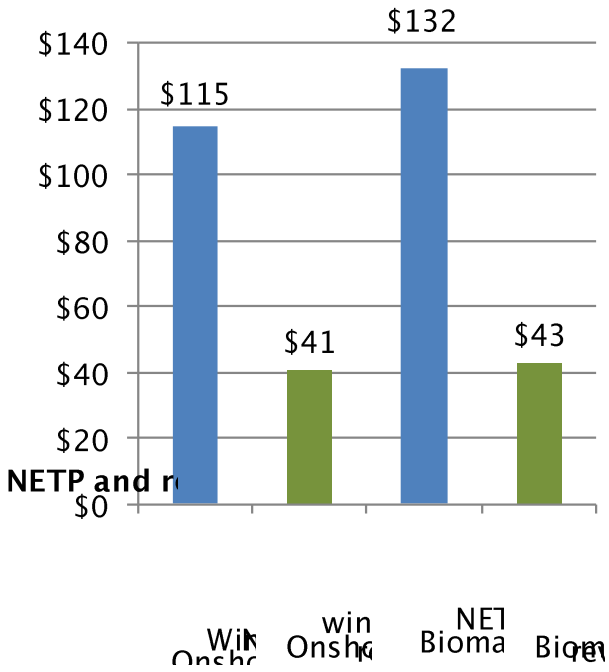
Source: ISO-NE Interconnection Queue as of May 1, 2012

Key Assumptions	Solar PV	Solar thermal	Onshore wind	Offshore wind	biomass	hydro
LF (%)	15%	45%	36%	47%	80%	48%
construction time, months	24	36	24	48	36	48
Capital cost ($/kW)	5,199	5,131	2,666	6,703	4,122	2,595

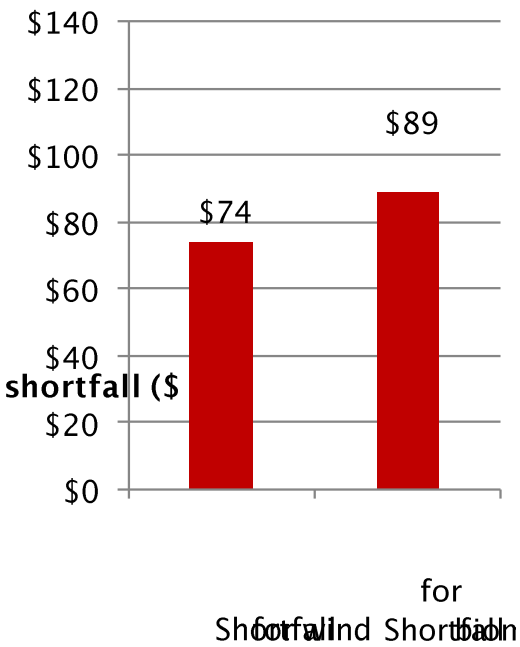
*Financing assumptions: Leverage of 60%, after-tax ROE of 15%, debt interest rate of 8%, corporate income tax rate of 40%, debt financing term of 18 years, equity contribution capital recovery term of 20 years; no PTCs assumed

What are the costs of "home grown" renewables?

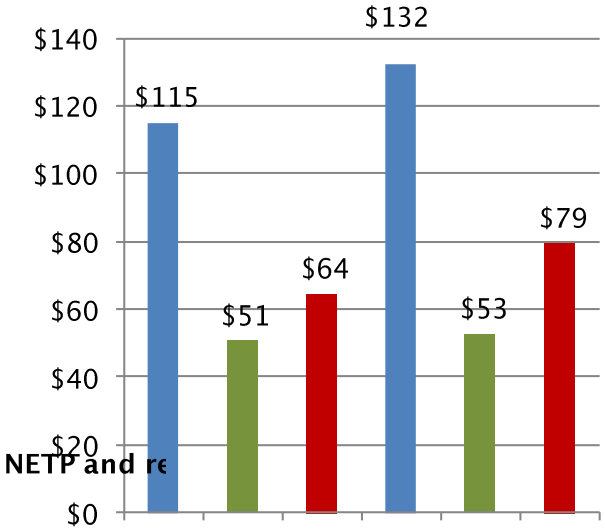
- *New wind and biomass projects in New England unlikely to cover their all-in costs from market revenues*



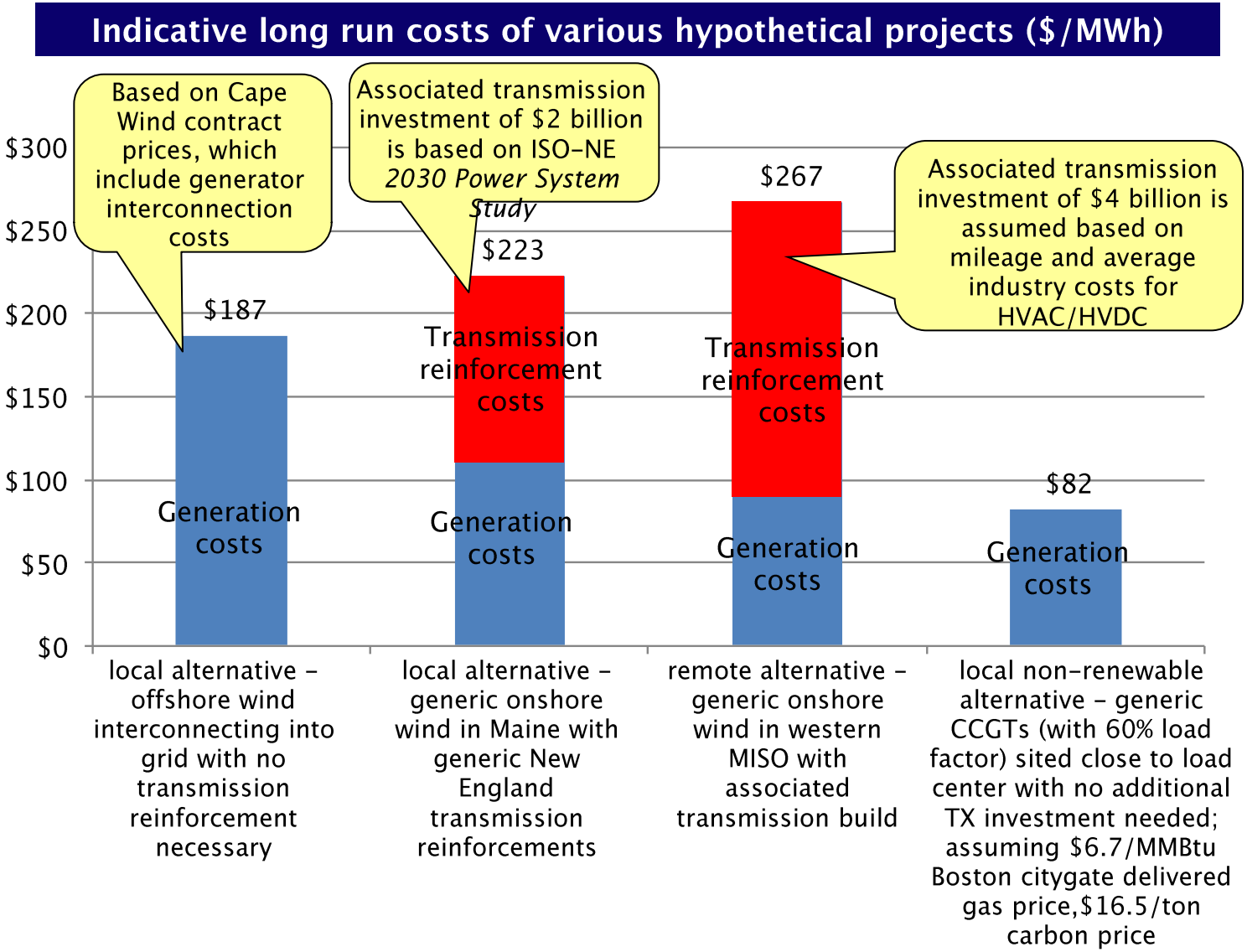
- *How much REC revenues and/or subsidies are needed to cover the shortfall in revenues?*



- *What if gas prices were 25% higher?*



Under what conditions would importing renewables make sense?



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To an economist, "need" is defined in terms of costs and benefits…

- **What are Costs associated with renewable investment?**
  - The costs of a specific RPS requirements can be measured in terms of the direct cost to consumer (e.g., RPS Retail compliance cost, annual rate impact), as well as indirect cost to economy (e.g., associated decrease in gross state product (GSP) and a decrease in jobs due to higher electric rates)
  - Externalities such as the cost of additional transmission investment and reliability costs of integrating renewables (e.g., cost of regulation, cost of firming by conventional resources) should also be considered
- **What are Benefits of renewable investment?**
  - Direct benefits stemming from electricity market impact include LMP reductions (ISO-NE study estimated that in 2016 the energy prices can decrease by $0.6/MWh per 1 GW of new on-shore regional wind generation)
  - Primary macro-economic benefits are secondary and tertiary (ripple effect) including an increase in GSP and increase in local jobs (temporary increase during period of construction and permanent increase in long term, as a result of LMP reductions and lower costs of electricity); local economic benefits can also include annual property tax revenues from new business
  - Additional benefits can include emissions reductions, fuel cost savings, fuel diversity (even more important given increasing reliance on gas) and reduced volatility
- **Do we need new renewables? To answer the question, one needs to do a proper Cost-Benefit Analysis**
  - Who's perspective is being considered? If consumer, ensure that costs and benefits are measured from perspective of consumer
  - Consider timing of costs and benefits and other constraints on magnitude (for example, some benefits are function of economies of scale – LMP reductions correlated to magnitude of new capacity)
  - Address all externalities (positive and negative, direct and indirect)
  - Select appropriate discount rate to capture time value and level of risk
  - Take into account interdependencies – collective impact of RPS requirements throughout New England

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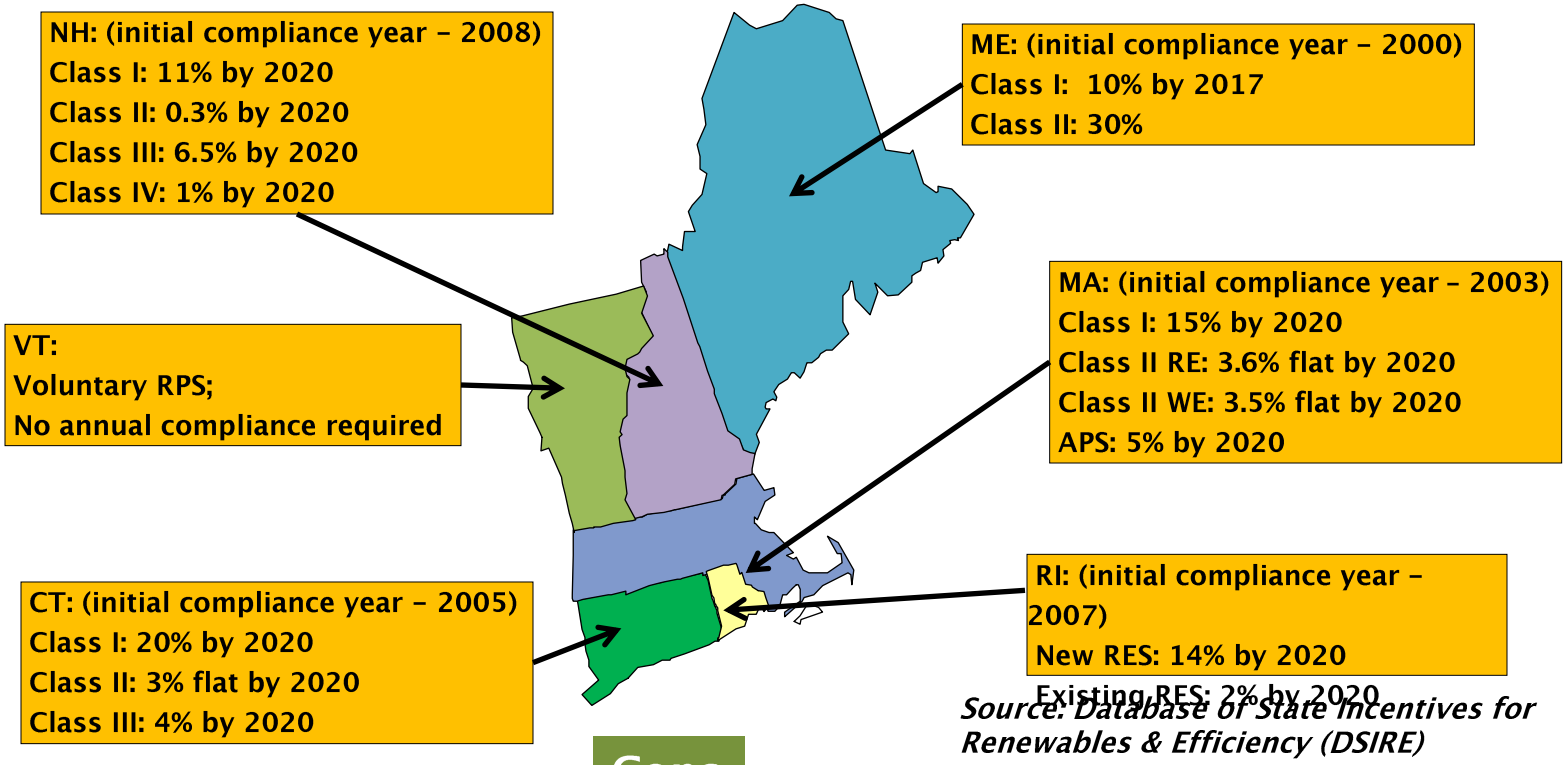
Four key mechanisms could be used to promote renewable energy, though they are not mutually exclusive

- **Feed in tariffs (FITs) set a standard price per kWh for all qualifying resources**
  - may vary depending on technology type, size or location
  - widely used outside the US (for example, in Europe)
- **A central procurement involves central agency providing renewable energy contracts through competitive bidding**
  - government/agency sets explicit renewable energy target (in MW or MWh) and issues requests for proposals (RFPs)
- **A Quota system (often referred as Renewable Portfolio Standard ("RPS")) determines quantity (MWh) of renewable energy to be procured (annually), and allow market to set price**
  - often combined with marketable/ tradable instruments, with transparent price
  - compliance with quota placed mainly on load serving entities
- **Financial incentives and related support mechanisms can influence a renewable energy developer's future cash flows**
  - financial incentives can be directed both at renewable energy developers and the manufacturers of renewable energy products
  - for example, tax credits or subsidized loans (loan guarantees)

A variant of the quota scheme through state mandates (RPS) and institutionalization of RECs has arisen in New England



Source: Database of State Incentives for Renewables & Efficiency (DSIRE)

Pros

- Can ensure specified quantity of renewable generation is achieved at the lowest cost (if all technologies are comparable in REC qualification)
- No need for agencies to second guess price
- Renewables targets automatically calibrate to changes in demand

Cons

- Need stable and well communicated government policy about eligible technologies, who is mandated to meet targets, etc.
- Generators are not guaranteed revenue stream long term
- Trading infrastructure critical to maintain liquidity
- Certification is vital, can be administratively complex