GC3 Analysis, Data, and Metrics Working Group Meeting

May 5, 2016
1:00 — 3:00 p.m.
<table>
<thead>
<tr>
<th>Time</th>
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Public Comments

3:35
Energy Market: Drivers and Developments

May 5, 2016
Deputy Commissioner Katie Dykes
GC3 ADM Working Group Meeting
Evolution of the Energy Markets

Electricity as an *Unbundled* Product

- **1900**
- **1978**
- **1990**
- **2000**
- **2016**

Vertically Integrated Monopolies → Deregulation/Restructuring → Regional ISO-NE Markets

- Customer choice
- Complexity
- Differences between States

**Diagram:**
- Generation
- Ancillary Services
- Metering and Billing Services
- Transmission
- Distribution
**Forward Capacity Market (FCM):** Three-year forward market that commits “capacity” resources to meet system resource-adequacy needs

**Energy Market:** Daily market for wholesale customers to buy and sell electric “energy

**Ancillary Markets:** Reserves and regulation provide support for system operations
Transformation of Region’s Resource Mix

Cumulative New Generating Capacity in New England (MW) 1997-2018

- Natural gas
- Oil
- Wind
- Nuclear
- Biomass
- Solar
- Hydro
- Fuel Cell
- Natural Gas
New Natural Gas Generation is Clearing in the Capacity Market

More than **1,600 MW** of new gas-fired generation have come forward in the last few auctions; **147 new resources** representing 6,700 MW have qualified for the next auction.

- **Wallingford (90 MW)**
  - Combustion Turbines
  - Commercial: June 1, 2018

- **Towantic (725 MW)**
  - Combined-Cycle Gas Turbine
  - Commercial: June 1, 2018

- **Footprint (674 MW)**
  - Combined-Cycle Gas Turbine
  - Commercial: June 1, 2017

- **Medway (195 MW)**
  - Combustion Turbine
  - Commercial: June 1, 2018
The fuels used to produce the region’s electric energy have shifted as a result of economic and environmental factors.

* The figures are preliminary, based on pre-90-day resettlement data. Starting with 2015, data more closely approximate the amount of generation by individual fuels used by dual-fuel units, such as natural-gas-fired generators that can switch to run on oil and vice versa. Previously, generation from such units was attributed only to the primary fuel type registered for the unit.

** Includes pondage, run-of-river, and pumped storage.

*** Fuels include: landfill gas, methane, refuse, solar, steam, wind, and wood. Hydro is not included primarily because the various sources that make up hydroelectric generation are not universally defined as renewable in the six New England states.
Power Plant Emissions Have Declined with Changes in the Fuel Mix

**Reduction in Aggregate Emissions (ktons/yr)**

<table>
<thead>
<tr>
<th>Year</th>
<th>NO(_x)</th>
<th>SO(_2)</th>
<th>CO(_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>59.73</td>
<td>200.01</td>
<td>52,991</td>
</tr>
<tr>
<td>2014</td>
<td>20.49</td>
<td>11.68</td>
<td>39,317</td>
</tr>
<tr>
<td>% Reduction, 2001–2014</td>
<td>↓ 66%</td>
<td>↓ 94%</td>
<td>↓ 26%</td>
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**Reduction in Average Emission Rates (lb/MWh)**

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<th>NO(_x)</th>
<th>SO(_2)</th>
<th>CO(_2)</th>
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<tr>
<td>1999</td>
<td>1.36</td>
<td>4.52</td>
<td>1,009</td>
</tr>
<tr>
<td>2014</td>
<td>0.38</td>
<td>0.22</td>
<td>726</td>
</tr>
<tr>
<td>% Reduction, 1999–2014</td>
<td>↓ 72%</td>
<td>↓ 95%</td>
<td>↓ 28%</td>
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Connecticut’s Emission Reduction Story

96% reduction in SOx, 86% reduction in NOx, and 26% reduction in CO2!

*CO2 emission shown in as 100s of tons, all else in tons
The size of the circles represents the relative amount of pollutant emitted. In our urban areas, we significantly reduced emissions of NOx and Sox, the pollutants that have relatively immediate and acute adverse health impacts on Connecticut residents.
Natural Gas and Wholesale Electricity Prices Are Linked

With natural gas the primary fuel used to produce electricity, natural-gas-fired power plants typically set the price for wholesale electricity.
Natural Gas Causing Lower Energy Market Prices

Historically Low Gas Prices Causes Historically Low Energy Prices

April-October only, eliminates winter congestion

![Graph showing electricity generation price and natural gas price over time]
New England Shifts to Coal and Oil in the Winter

Winter 2014–2015 Fossil Fuel Mix

- Oil
- Coal
- Natural Gas / LNG

Daily Energy MWh

December 2014
January 2015
February 2015
Winter v. Summer Power Prices

Average seasonal power and natural gas prices, summer vs. winter

Underlying natural gas data furnished by:

ICE Global markets in clear view
Generator Retirements

New England Shifts to Coal and Oil in the Winter

Major Generator Retirements:

- **Salem Harbor Station** (749 MW)
  - 4 units (coal & oil)
- **Vermont Yankee Station** (604 MW)
  - 1 unit (nuclear)
- **Norwalk Harbor Station** (342 MW)
  - 3 units (oil)
- **Brayton Point Station** (1,535 MW)
  - 4 units (coal & oil)
- **Mount Tom Station** (143 MW)
  - 1 unit (coal)
- **Pilgrim Nuclear Power Station** (677 MW)
  - 1 unit (nuclear)

Additional retirements are looming
Energy Efficiency Is Slowing Peak Demand Growth and Flattening Energy Use

**Summer Peak (MW)**

- The gross forecast of peak demand and energy use
- The forecast minus the impact of EE participating in the Forward Capacity Market (FCM) to date
- The forecast minus anticipated EE growth beyond FCM years

**Annual Energy (GWh)**

Statewide, Connecticut achieved a 10.5 percent reduction in greenhouse gas emissions between 1990 and 2012.
State Policy Requirements Drive Proposals for Renewable Energy

State Renewable Portfolio Standard (RPS)* for Class I or New Renewable Energy by 2020

- ME: 10%
- NH: 11%
- RI: 12.5%
- MA: 15%
- CT: 20%
- VT: 59%*

* State Renewable Portfolio Standards (RPS) promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Vermont’s new Renewable Energy Standard has a ‘total renewable energy’ requirement (reflected above), which recognizes large-scale hydro and all other classes of renewable energy.
Renewable and EE Resources Are Trending Up

- **Wind (MW)**
  - Existing: 800
  - Proposed: 4,000

- **Solar (MW)**
  - PV thru 2014: 900
  - PV in 2024: 2,400

- **Energy Efficiency (MW)**
  - EE thru 2014: 1,500
  - EE in 2024: 3,600

*Nameplate capacity of existing wind resources and proposals in the ISO-NE Generator Interconnection Queue; megawatts (MW).*

*2015 ISO-NE Solar PV Forecast, nameplate capacity, based on state policies.*

*2015 CELT Report, EE through 2014 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2024 includes an ISO-NE forecast of incremental EE beyond the FCM.*
State Public Policy

*Interactions with the Market*

“Cleaner, Cheaper, More Reliable”

2013 CES & 2014 IRP

- Air Regulations
- Siting of in-state Generation, Transmission, Gas Infrastructure
- Procurement of Natural Gas Resources
- Regional Greenhouse Gas Initiative
- Renewable Portfolio Standard
  - Long-term contracts
- Conservation & Load Management Plans
- Smart Meters, Time-Varying Rates
- Incentives for Behind-the-meter Generation
State policies drive renewable resource development

- Mostly large-scale wind and behind-the-meter solar
- Other, fast & flexible resources will be needed to balance intermittent resources’ variable output
- New transmission needed to bring wind farms’ energy from their remote locations to population centers

Distributed generation and the “hybrid” grid

- A significant portion of New England’s future grid could be “behind-the-meter” (solar facilities on distribution system)
- That will change how much and when power is used by consumers
Connecticut climate action

CT signs NEG/ECP 2001 Climate Change Action Plan

2004

CT is one of 11 states to launch the Transportation & Climate Initiative

2005 CT Climate Change Action Plan

2005

Govt Malloy issues Executive Order 46 establishing the Governor’s Council on Climate Change (GC3)

2008

9-month stakeholder dialogue process develops 2004 Connecticut Stakeholder Recommendations

2010

An Act Concerning Climate Change (Public Act 04-252) sets GHG goals that align with NEG/ECP regional goals

2013

CT Global Warming Solutions Act (Public Act 08-98) reaffirms commitment to GHG targets for 2020 and 2050

2015

CT and other northeastern states participate in first auction of Regional Greenhouse Gas Initiative (RGGI), the nation’s first carbon cap-and-trade program.

2013 Comprehensive Energy Strategy

Executive Order 46

Review timeline details
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Comprehensive Energy Strategy: Timeline

May 2016 – Public Scoping Meeting

October 2016 – Draft CES

November 2016 – Technical Meetings

December 2016 – Public hearings

January 2017 – Finalize CES
Major Segments Covered

**Residential Buildings & Equipment**
- Mainstreaming of Efficient and Weatherized Homes
- Decarbonizing heating fuels

**Commercial & Industrial Buildings & Processes**
- Segmentation
- Customization of Approach

**Electric Power Generation**
- Affordable electricity for families and businesses
- Deployment & Integration of Clean Energy Resources

**Transportation**
- Moving People (Advanced Vehicle Technology, Advanced Alternative Fuels, Responsible Growth, Transit Oriented Development)
- Moving Goods (Freight, Ports, Aviation)
Developing Low-Cost Renewable Generation

2013 CT’s Comprehensive Energy Strategy (CES) Goals
Develop low-cost renewable electric generation to make the electricity sector more diverse, affordable, and reliable, while also meeting the State’s commitment to reducing the environmental impacts from electricity generation.

Proposed Methods for accomplishing these goals in the 2013 CES
Connecticut’s Green Bank Residential Solar Investment Program (RSIP)
- Public Act 11-80 required the Connecticut Green Bank to deploy 30 MW of Residential Solar; recent legislation permits the deployment of an additional 300 MW.

LREC/ZREC, Public Act 11-80, Sections 107 and 110
- Required the development of a Low Emissions and Zero Emissions Renewable Energy Credit Program to buy down the cost of RECs through a reverse auction process.

Utility Scale Renewable Energy Procurement, Public Act 11-80, Section 127
- Allowed DEEP to require the EDCs to enter into long-term PPAs in the procurement of renewable energy generation through a competitive bidding process.

Utility Scale Renewable Energy Procurement, Public Act 13-303, Section 6
- Allowed DEEP to require the EDCs to enter into long-term PPAs in the procurement of renewable energy generation through a competitive bidding process.
Deploying Distributed Generation: Looking Ahead

**Procurements Currently Underway**

Public Act 15-303, Section 7
- Procure 5% of Class 1 generation

Public Act 15-107, Section B and C, Large Scale and Small Scale Clean Energy Procurement
- Requires DEEP to Procure large and small scale Class I and III energy resources for electric generation, including energy storage and transmission. DEEP can procure up to 10% of the Connecticut EDC load of the aforementioned resources.
- These procurements will allow the State to meet its clean energy goals and improve winter reliability.

**Meet our Global Warming Solutions Act Goals by 2050**
- Clean energy must be expanded beyond our 2020 RPS goals in order to meet our Global Warming Solutions Act goals in reducing our greenhouse gas emissions by 80% by 2050.
- Retain non-emitting energy resources, such as nuclear generation.

**Utilize the Most Cost-Effective Options for Procuring Clean Energy Generation**
- Implement innovative mechanisms to reduce the reliance of subsidies for clean energy electric generation
- Promote programs and procurements that will yield the most cost-effective clean energy sources of generation.
- Balance the procurement of in-state and out-of-state resources to minimize the impact on ratepayers.
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Hypothetical: Building Future Scenarios in LEAP

Demonstration of using LEAP with groupings of technologies/measures to achieve CT’s 80% goal
Purpose of Hypothetical

- Initiate your thinking on bundling technologies & measures into scenarios, along with their trade-offs
- Give sense of scale and pace of GHG reductions over the 2050 planning horizon
- Show an example in LEAP of “front loading” GHG reductions
- Keep in mind -- This is a hypothetical to illustrate scenario development. It isn’t real.
Hypothetical Scenario Elements: Efficiency and Conservation  
(*Faster Implementation 2015 – 2030*)

- Vehicle miles traveled (light - duty cars & trucks) reduced 10% by 2050 from smart growth practices
- CT EE programs for natural gas and electricity increase 5x by 2030 and 10x by 2050
Hypothetical Scenario Elements: Fuel Switching
*(Faster Implementation 2015 – 2030)*

- **Space heating:** oil furnaces / radiators along with gas radiators phased out by 2050; replaced by air and ground source heat pumps
  - Res – 40% by 2030

- **Water heating:** gas and oil water heaters phased out by 2050; replaced by solar thermal water heaters
  - Com – 50% by 2030

- **Transportation:**
  - 90% of light-duty cars and trucks electric by 2050
  - 80% of commercial trucks and transit busses electric by 2050
  - 60% of short haul trucks electric by 2050
  - Electricity replaces diesel in passenger and freight rail by 2050
Hypothetical Scenario Elements: Decarbonize Electricity

- No new gas plants built after 2020
- Increased electric load from vehicle charging and electric heating is met by a mix of solar, onshore wind and demand response
• No new gas plants built after 2020
• Increased load between 2015 and 2050 is met by additional solar PV, Onshore Wind, and Demand Response
Hypothetical Economy-Wide GHG Trends

- Faster reductions in the 2050 – 2030 timeframe
- 42% below 2001 by 2030
- 80% is achieved if aggressively pursuing all key technologies and measures
Electric Sector Barriers and Opportunities

Barriers
• Natural gas generation plays a dominant role in forward capacity market.
• State regulatory levers to change fuel mix are limited.
• Still waiting for breakthrough technologies (battery storage)
• Build out of renewables cannot happen overnight.

Opportunities
• Price of renewables continues to decline.
• Use of long-term contracts for clean energy (Three-state RFP)
• Move to a decentralized smart electric grid – “grid modernization”
• Grid modernization pilot project including battery storage
• In-state programs to support deployment of renewables (RSIP, SHREC, CPACE, LREC, ZREC)
Summary

• Demonstrated a hypothetical bundle of technologies and measures in LEAP

• Illustrated LEAP’s ability to simulate non-straight line GHG reductions through faster implementation

• Showed example of possible fuel shifts in one energy sector (electricity)

• Indicates need for aggressive penetration levels across all energy sectors for multiple technologies and measures
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