Regional Assessment of Strategic Electrification

NEEP Strategic Electrification Summit

June 29, 2017

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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
• Core project team: Asa, Kenji, Pat, and Ariel

Meister Consultants Group

• International Boston-based sustainability consulting firm specializing in next generation solutions to today’s most pressing challenges
• Advises clients in the United States and across the globe on new strategies in fields such as energy, climate, water, and mobility
• Core project team: Neil, Philip, Jeremy
Outline

• Why Electrification?
• Defining “Strategic Electrification”
• Technology and Market Assessment: Buildings, Industry, Transport
• Market Barriers and Policy Assessment
• Looking toward 2050: Modeling and Impacts
• Next Steps
Decarbonizing via EE and zero-carbon electricity falls short

- 95% zero carbon electricity on the grid, plus aggressive electric and thermal energy efficiency

Emissions are nearly triple the goal of 80% reduction

Conclusion: need to switch some or all of the direct fuel use to zero- or low-carbon sources, like electricity

GHG reduction: 41% below 2001 levels
Fossil fuel use in New York and New England

4.2 Quadrillion BTUs per year of direct fossil fuel use

85% addressable with electrification technologies assessed in this report
Decarbonization context

Low-Carbon Supply
- Wood
- Nuclear
- Biofuels

Efficiency
- Condensing Space & Water Heat
- Efficient Appliances
  - Hybrid Cars
  - LEDs
  - CHP

Flexibility
- Ponded Hydro
- Bldg. Controls
- Smart Appliances
- Batteries
- Pumped Hydro
- Interruptible Loads

Electrification
- PHEVs
- HP Space Heat
- Urban Freight and Transit
- HP Water Heat
- Light Duty EVs

Strategic Electrification
- Long-Distance Freight
- Resistance Heat
“Strategic Electrification” means…

• powering end uses with electricity instead of fossil fuels
• in a way that increases energy efficiency and reduces pollution,
• while lowering costs to customers and society,
• as part of an integrated approach to deep decarbonization.
Technology and Market Assessment
**Buildings: Space and water heat**

- Heat pumps competitive in markets dominated by delivered fuels or resistance heat, not natural gas
- Over time: Rising efficiency and more customer options

<table>
<thead>
<tr>
<th>Space Heat</th>
<th>Water Heat</th>
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| • Driven by air-source; ground-source play a role in new construction  
  • Variable refrigerant flow growing in commercial  
  • 70,000 HPs installed in the region in 2015  
  • ASHPs are not always suitable as a full-building solution  
  • Can be added to, rather than replace, existing heating systems  
  • Occupants must learn new habits to maximize ASHP benefits  
  • Residential market more advanced  | • Market driven by like-for-like replacements  
  • HPs have lower market share than in space heating  
  • Limited by air and space needs  
  • Advancing technology  
  • Upstream rebates show promise to shift market |
Industry

- Process heat and steam dominate addressable fuel use
- Process heat: glass, iron, and steel
  - Steel: Arc furnaces
  - More targeted heat than combustion-based tech
- Steam: food and chemicals
  - Resistance, electrode, induction, microwave
- Existing infrastructure dominates; transformation not governed by stock turnover
- Biofuels may be more attractive for facilities to reduce emissions

In electric arc furnace-based steelmaking, electric current travels through solid iron, melting and transforming it into steel without burning fuel.
Transportation: Cars and light trucks

- All about electric vehicles
- EV charging infrastructure build out as market grows
- Customer economic proposition improving rapidly
- Annual sales of light-duty battery-powered electric vehicles have nearly doubled since 2013 – but market share is still small
- Lots of new models and increased range coming in the next few years
- Possible synergies with autonomous driving and “transportation as a service”
Transportation: Medium and heavy duty

• Fleet-based markets
• 20-year vehicle life expected – slow turnover
• Less mature technology than cars; pilot stage adoption

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<tr>
<th>Transit</th>
<th>Freight</th>
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<tr>
<td></td>
<td>Percent of MDV/HDV Freight Trips &lt;100 mi. by state of origin</td>
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<td></td>
<td>Connecticut 91</td>
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<td>Maine 87</td>
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<td>Massachusetts 80</td>
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<td>Rhode Island 59</td>
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<td>Vermont 79</td>
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<td><strong>Region</strong> 85</td>
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• Long-distance
  • Electrification doesn’t compare favorably to biofuels and increased engine and vehicle efficiency

Credit: Drive Electric Vermont
Market Barriers and Policy Assessment
Many of these barriers also contribute to real or perceived investment risk, which drives up the cost of capital.
**Regulatory context**

- Utility energy efficiency (EE) programs are a critical and well-funded tool that help states pursue GHG reduction goals

- Four major EE program barriers hinder strategic electrification:

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<tr>
<th>Fuel switching rules</th>
<th>• EE programs generally cannot provide incentives to encourage switching fuels</th>
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<td>Cost effectiveness requirements</td>
<td>• Heat pumps may or may not be deemed cost effective in each state</td>
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  | Utility incentives | • Electric decoupling removes incentive for utilities to push EV or HP tech  
  | | • Gas utilities will lose customers and may worry about stranded assets long term |
  | Consumer incentives for fossil fuel appliances | • E.g. rebates for high efficiency condensing boilers  
  | | • While these may achieve short term EE savings, they lock customers into another 15-30 years of fossil fuel usage |
# Policy and program options

<table>
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<tr>
<th>Mandates &amp; Targets</th>
<th>Definition</th>
<th>Benefits</th>
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<td>• Mandates: obligations on private sector, public agencies, and utilities</td>
<td>• Targets: goals for deployment</td>
<td>• Provides signals to investors</td>
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<td>• If binding, can provide certainty on outcomes</td>
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<th>Pricing-Based Options</th>
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<td>• Leverages private sector investment</td>
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<th>Marketing, Outreach, &amp; Education</th>
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<th>Benefits</th>
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<td>• Efforts to raise local awareness among vendors, installers, and consumers</td>
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<td>• Strengthens commitment and interest from consumers</td>
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<th>Emerging Financing &amp; Business Models</th>
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<td>• Policies to encourage/enable new models such as 3rd party ownership, ESCOs, mobility as a service, and standardization of financial contracts</td>
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<td>• Increases access to private sector innovation</td>
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<td>• Simplifies consumer decision-making</td>
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<td>• Unlocks performance-based incentives</td>
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Regional policy landscape - Buildings

VERMONT
• Incentives for ASHPs and HPWHs through Efficiency VT and utilities
• GMP leasing ASHPs and HPWHs for RES compliance

NEW YORK
• NYSERDA developing rebate program for GSHP; targeting heat pump cost reductions

NEW HAMPSHIRE
• Developed first-in-nation RPS carveout for renewable thermal
• ASHP and HPWH rebates from individual utilities

MAINE
• Significant uptake in residential ASHP/HPWH through Efficiency Maine rebate and financing programs (over 20,000 rebates FY14-FY16)

MASSACHUSETTS
• Integrating renewable thermal energy into Alternative Portfolio Standard
• Rebates for ASHP, GSHP, and HPWH through MassCEC and Mass Save programs
• Solarize Mass Plus will include heat pumps, EVs, and storage

CONNECTICUT
• Heat pump rebates available through Energize CT

RHODE ISLAND
• Exploring workforce development programs to drive heat pump uptake (e.g. engaging delivered fuel dealers)
Regional policy landscape - Transportation

**VERMONT**
- Utilities offering EV incentives for Renewable Energy Standard compliance

**NEW YORK**
- Variable rebates for PHEVs and BEVs (Drive Clean Rebate)
- Incentives such as free use of certain HOV lanes and discounted EZ-Pass
- Residential and non-residential TOU rates for EV charging (ConEd)
- Rebates for EVSE installation (EV Charger Rebate Program)

**MAINE**
- TOU rate through Liberty Utilities for EVs

**MASSACHUSETTS**
- Variable rebates for PHEVs and BEVs (MOR-EV)
- Grants to businesses and government agencies for installation of EVSE through EVIP

**NEW HAMPSHIRE**
- TOU rate through Liberty Utilities for EVs

**CONNECTICUT**
- Variable rebates for PHEVs and BEVs (CHEAPR).

**RHODE ISLAND**
- Variable rebates for PHEVs and BEVs (DRIVE)
- Goal: zero-emission rail by 2050.
Looking Toward 2050
Getting to 80% GHG reduction by 2050

Assume we do the “right” things on efficiency, flexibility, and low-carbon electric supply:

• How fast do electrification markets need to transform to get to 80% GHG reduction?
• What if we also plan to use some bioenergy?
• What are the electric supply needs?
• What impacts should we expect on the grid, and on consumers?
“MaxElectric” case: 80% via electrification

GHG emissions 78% below 2001 levels by 2050 electrifying heat and on-road transport (get the rest from miscellaneous uses)

Electric consumption rises 58% from current levels

Markets need to transform fast

Residential Heat Pump Market

Electric Car & Light Truck Market
“Optimistic” case: 70% from electrification

Res. HP market penetration: 5-15 years slower than “all-in” case

Need biogas/biofuels to get to 80% reduction

Light EV same through 2025, but slower after

Annual electric consumption rises 32% from current
Shifting seasonal load shape

- January consumption passes August in mid-2030s
- Need more than double the low-carbon electricity currently used in the region, biased toward winter
- One grid challenge: Reach and integrate new variable supplies
Higher efficiency HPs have grid benefits

- Illustrative calculation indicates that higher-efficiency HPs can delay the region’s shift to winter peaking by 4-5 years
- Clustering on distribution system => winter peaks sooner
- Potential for substantial T&D cost savings from winter EE
Displacing natural gas

- Biggest economic and emissions win from displacing oil in heating and transportation, and the market is going there today (with policy help)
- What if we stop there, and don’t electrify natural gas end uses?

A long way from GHG goals:

Much less electric system impact:
Shared infrastructure ➞ shared impacts

**Electric load factor up**
- Rate ($/kWh) relief possible, if peaks are managed well
- New flexible end uses could avoid some infrastructure costs

**Gas load factor down**
- Increased rate pressure; risk of self-perpetuating cycle
- Equity issues
- Stranded cost risk

**Costs for enabling infrastructure**
- Who pays; who benefits?
Next Steps:
- Policies and programs
- Data and research
- Thorny questions
Near-term policies and programs

**Grow Markets**
- Focus where it’s most cost-effective (with greatest emissions reduction)

**Get on Track**
- ASHPs to half of delivered fuel heating system market by 2025
- ASHPs displacing natural gas in 2025 where delivered fuel market is today
- EVs to 1/4 of sales by 2025 (ZEV Rule target)

**Examples**
- Set explicit targets, goals, and mandates for electrification to create certainty
- Launch or support marketing campaigns to increase customer awareness
- Support and expand incentives for EVs, heat pumps, and heat pump water heaters
- Expand EV charging infrastructure, particularly in multi-family housing, workplaces, and fast charging for longer-distance travel
- Develop and scale new financing models for cost-effective electric technologies
- Continue characterizing technology performance
Data and research needs

• Data on the market uptake and performance of heat pumps and electric vehicles
• Pilots on the control and capabilities of electrification technologies as grid resources
• Analysis of the capacity of distribution circuits to meet electrification needs before significant upgrades are required
• Analysis of power supply and transmission options for a very different seasonal load shape, supplied by low-carbon resources, across the northeastern United States and eastern Canada
Thorny questions

• What are the appropriate roles for electric distribution utilities (including regulated EE programs) in fostering electrification?
• Do these roles require changes in the utility business model or regulatory paradigm?
• What is the right balance between biogas and electrification for current gas uses?
• What is the future of the natural gas utilities and their pipeline networks?
• What rate structures would help to advance strategic electrification, and will advanced meters be deployed if they are necessary to implement these rates?
• If incentives are going to play a significant role in advancing electrification, where will the money come from?
Thank you

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