Regional Assessment of Strategic Electrification

NEEP Strategic Electrification Summit

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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

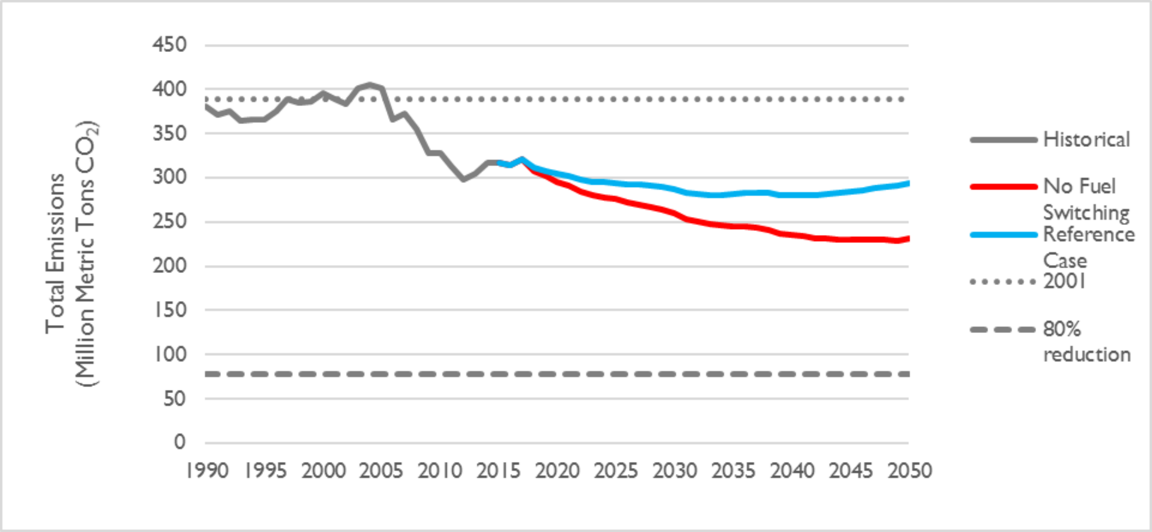
- International Boston-based sustainability consulting firm specializing in next generation solutions to today's most pressing challenges
- Advises clients in the United States and across the globe on new strategies in fields such as energy, climate, water, and mobility
- Core project team: Neil, Philip,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



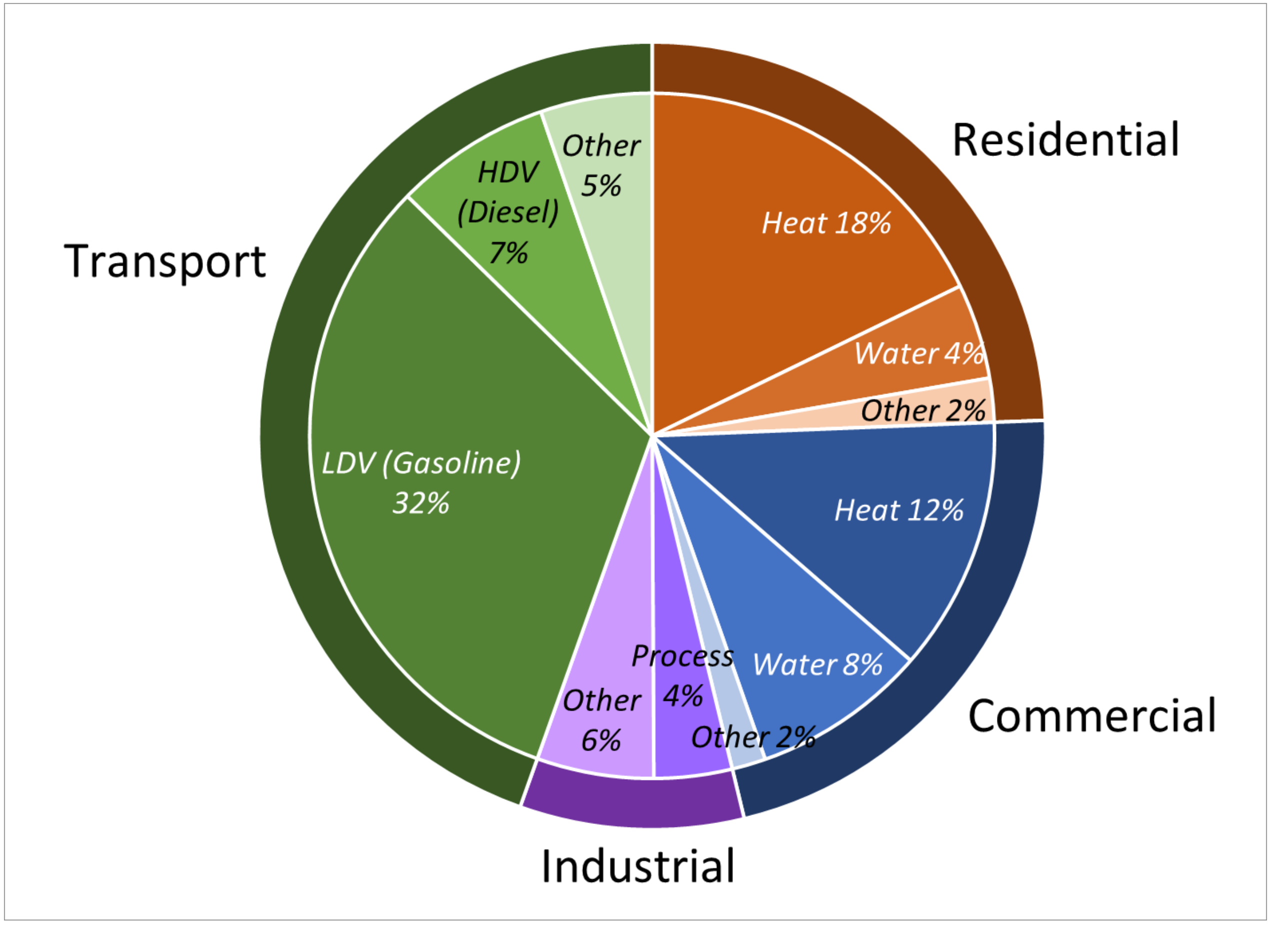
GHG reduction: 41% below 2001 levels

- 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

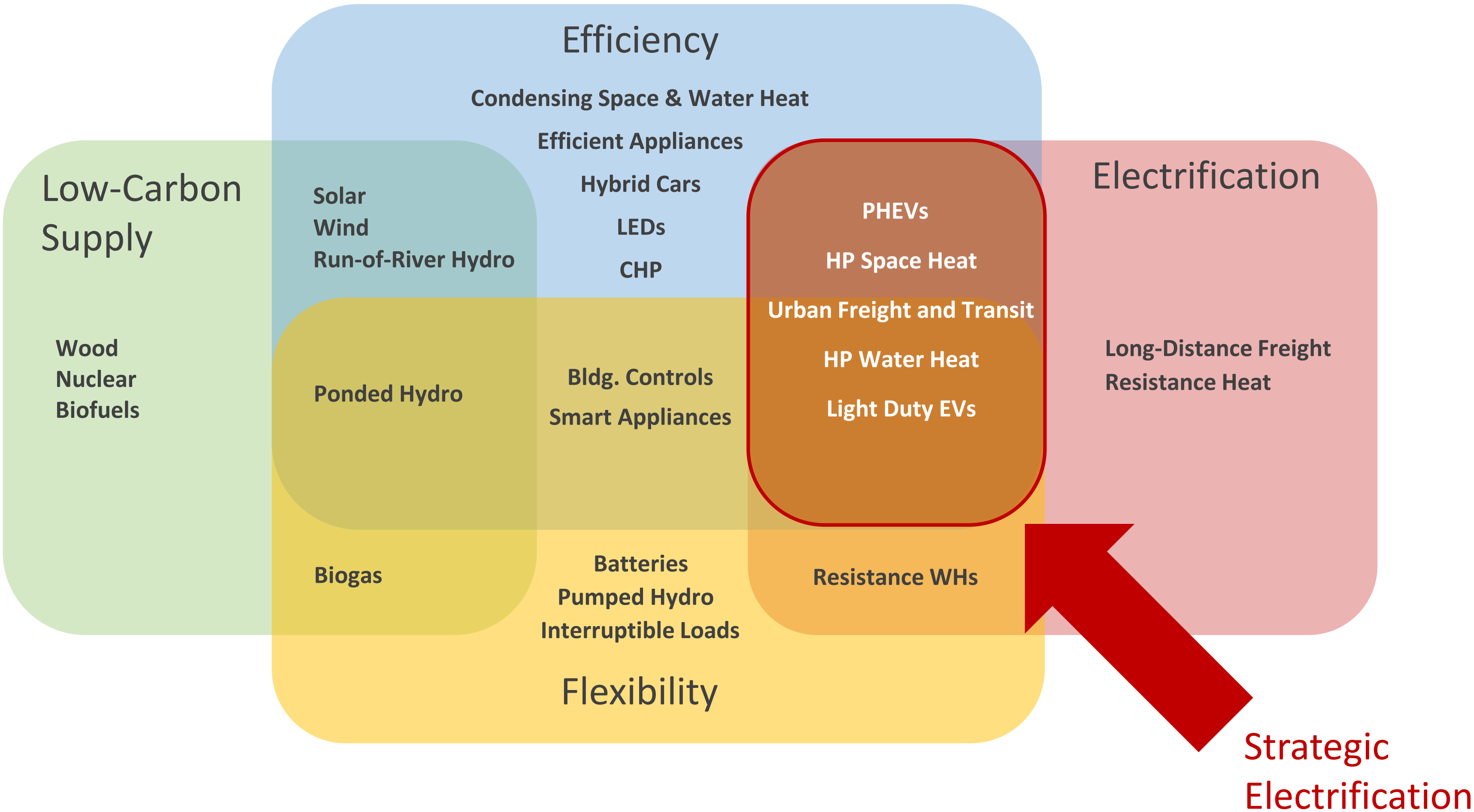
Fossil fuel use in New York and New England

4.2 Quadrillion BTUs per year of direct fossil fuel use

85% addressable with electrification technologies assessed in this report



Decarbonization context



“Strategic Electrification” means…

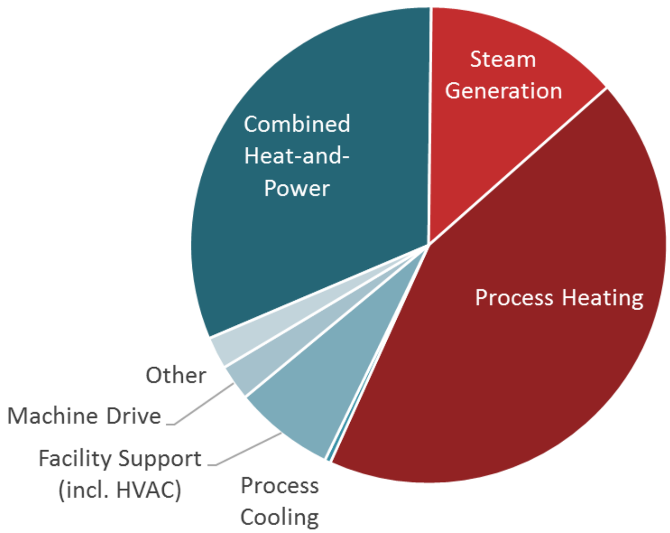
- powering end uses with electricity instead of fossil fuels
- in a way that increases energy efficiency and reduces pollution,
- while lowering costs to customers and society,
- as part of an integrated approach to deep decarbonization.

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

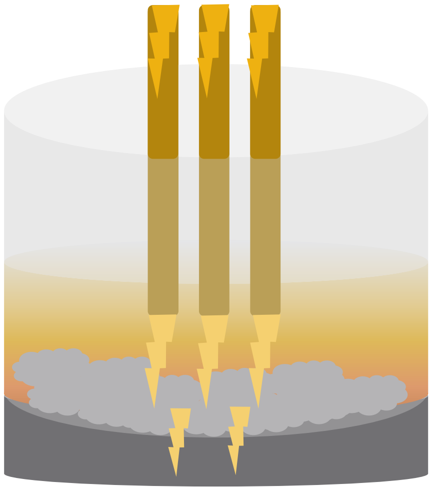
Space Heat	Water Heat
• Driven by air-source; ground-source play a role in new construction • Variable refrigerant flow growing in commercial • 70,000 HPs installed in the region in 2015 • ASHPs are not always suitable as a full-building solution • Can be added to, rather than replace, existing heating 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

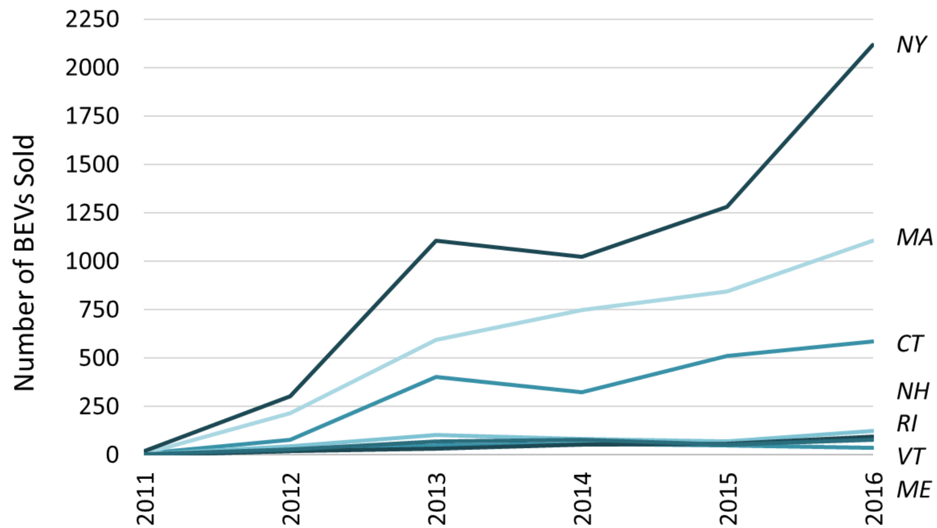
- Process heat and steam dominate addressable fuel use
- Process heat: glass, iron, and steel
  - Steel: Arc furnaces
  - More targeted heat than combustion-based tech
- Steam: food and chemicals
  - Resistance, electrode, induction, microwave
- Existing infrastructure dominates; transformation not governed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

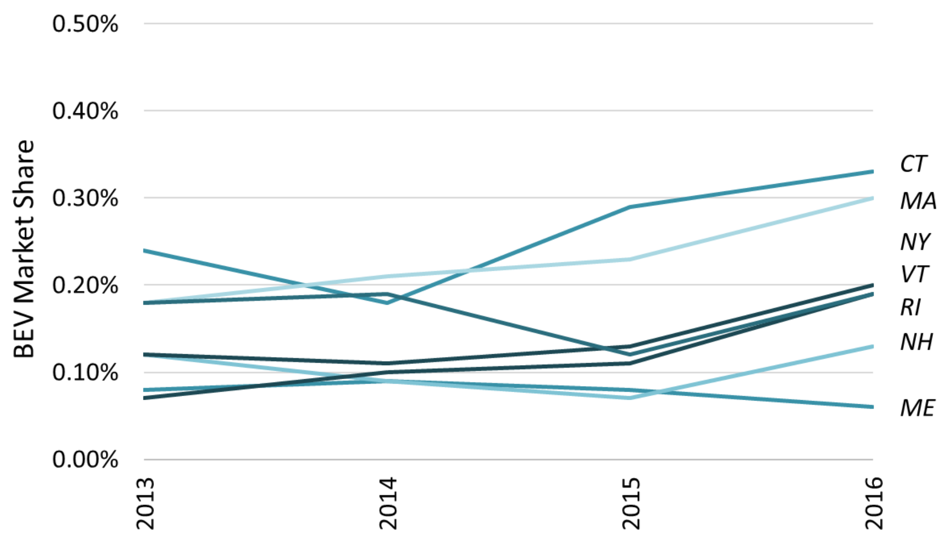
In electric arc furnace-based steelmaking, electric current travels through solid iron, melting and transforming it into steel without burning fuel



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

Transit

Credit: Drive Electric Vermont

Freight

Percent of MDV/HDV Freight Trips <100 mi. by state of origin

Connecticut	91
Maine	87
Massachusetts	80
New Hampshire	72
New York	85
Rhode Island	59
Vermont	79
Region	**85**

- Long-distance
  - Electrification doesn't compare favorably to biofuels and increased engine and vehicle efficiency

Market Barriers and Policy Assessment

Market barriers

Supply Chain Barriers

- Insufficient contractor base
- Staff training for O&M
- Inefficient supply chain compared to competitors

Technical & Infrastructure Barriers

- Low refurb rates
- Inadequate performance data
- Inadequate EV charging stations

Economic Barriers

- Inadequate financing and ROI
- High installed costs
- Capital constraints

Awareness Barriers

- Lack of consumer awareness
- Lack of contractor education

Decision-Making Barriers

- Uncertainty on incentives and pricing
- Split incentives
- Other priorities
- Consumers lack confidence

Policy & Regulatory Barriers

- Fuel switching regulations in EE programs
- Fossil fuel subsidies
- Lack of economy-wide carbon pricing

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:

Fuel switching rules	• EE programs generally cannot provide incentives to encourage switching fuels
Cost effectiveness requirements	• Heat pumps may or may not be deemed cost effective in each state
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

	Definition	Benefits
Mandates & Targets	• Mandates: obligations on private sector, public agencies, and utilities • Targets: goals for deployment	• Provides signals to investors • If binding, can provide certainty on outcomes
Pricing-Based Options	• Policies that change costs of conventional and/or replacement technologies – e.g. incentives, rate structures, or pricing externalities	• Overcomes upfront cost premiums • Leverages private sector investment
Marketing, Outreach, & Education	• Efforts to raise local awareness among vendors, installers, and consumers	• Overcomes lack of awareness • Strengthens commitment and interest from consumers
Emerging Financing & Business Models	• Policies to encourage/enable new models such as 3rd party ownership, ESCOs, mobility as a service, and standardization of financial contracts	• Increases access to private sector innovation • Overcomes upfront costs • Simplifies consumer decision-making
QA/QC and EM&V	• QA: ensure that technologies meet minimum workmanship and performance standards • EM&V: assess energy performance	• Increases consumer confidence • Unlocks performance-based incentives

Regional policy landscape - Buildings

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)

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

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)

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Regional policy landscape - Transportation

NEW HAMPSHIRE
- TOU rate through Liberty Utilities for EVs

MAINE

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)

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

RHODE ISLAND
- Variable rebates for PHEVs and BEVs (DRIVE)
- Goal: zero-emission rail by 2050.

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

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Looking Toward 2050

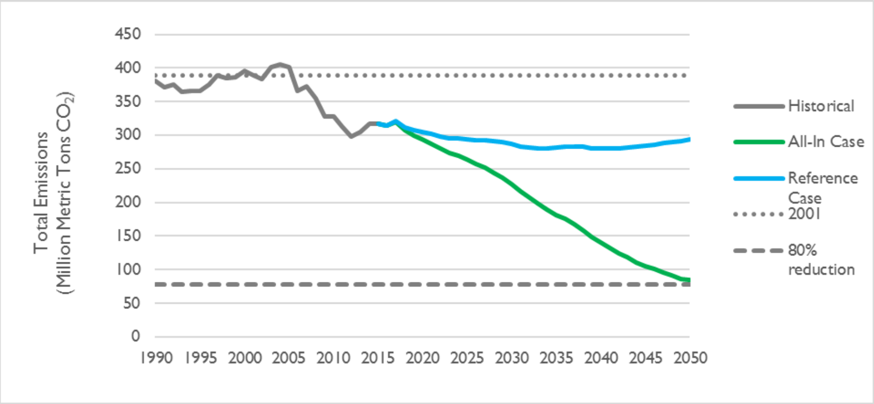
Getting to 80% GHG reduction by 2050

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?

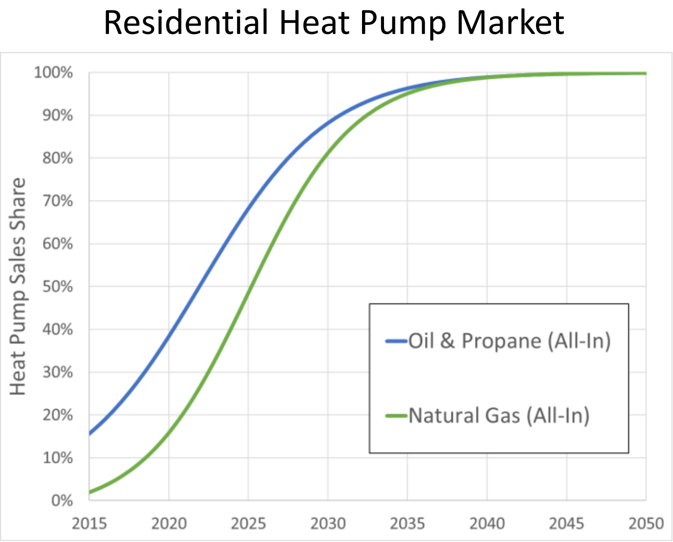
“MaxElectric” case: 80% via electrification

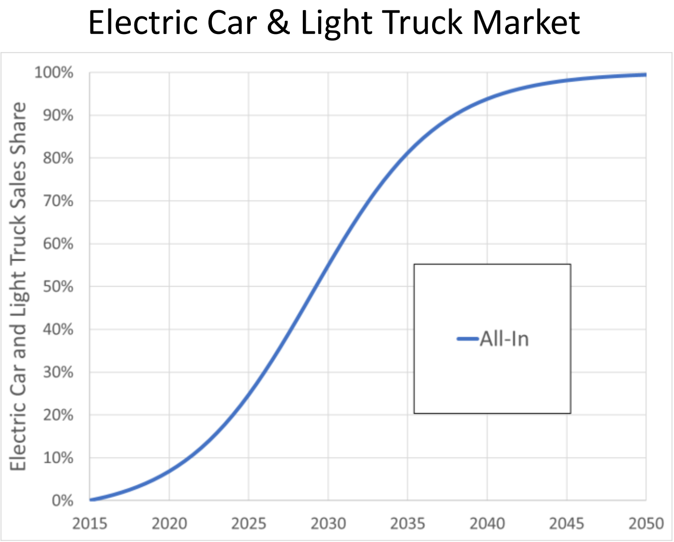
GHG emissions 78% below 2001 levels by 2050 electrifying heat and on-road transport (get the rest from miscellaneous uses)



Electric consumption rises 58% from current levels

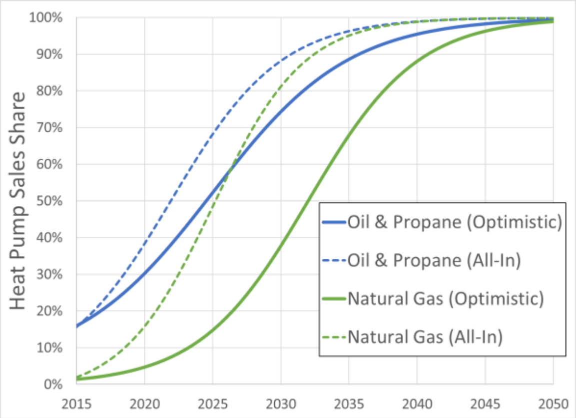
Markets need to transform *fast*



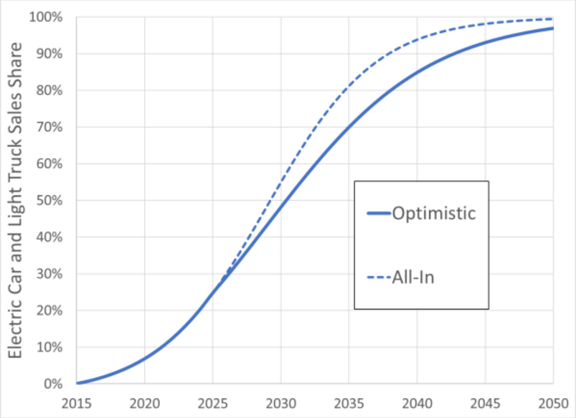


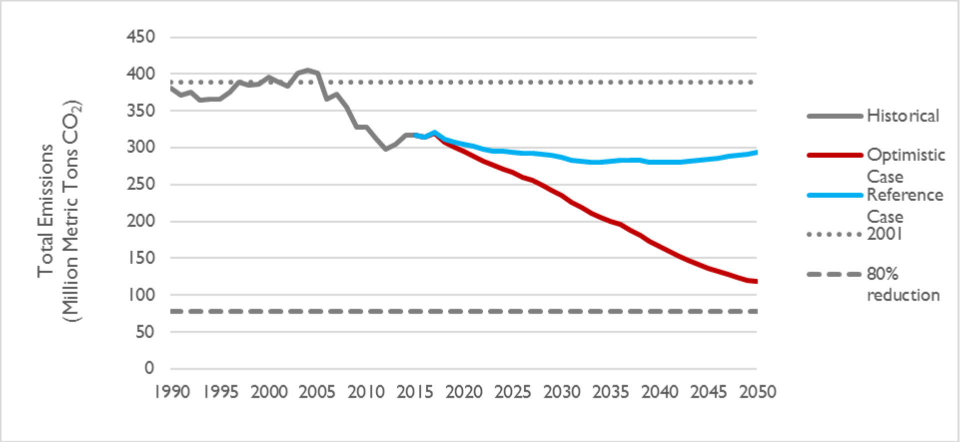
“Optimistic” case: 70% from electrification

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



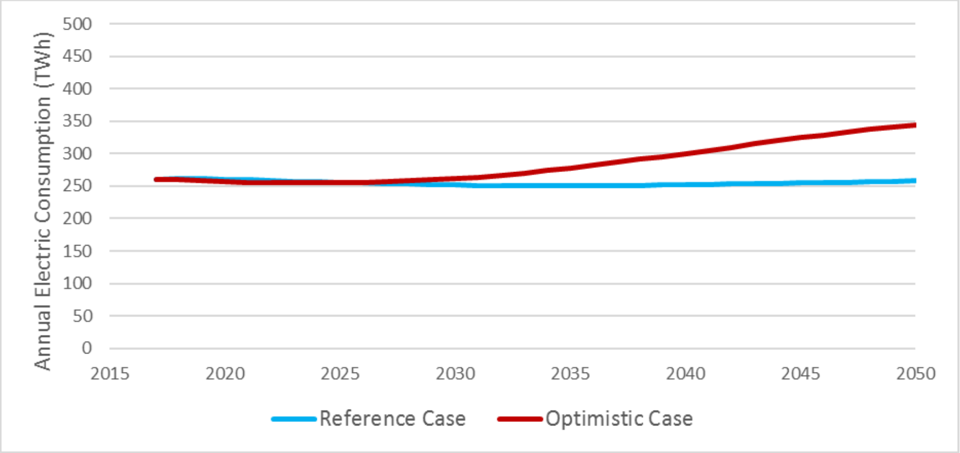
Light EV same through 2025, but slower after





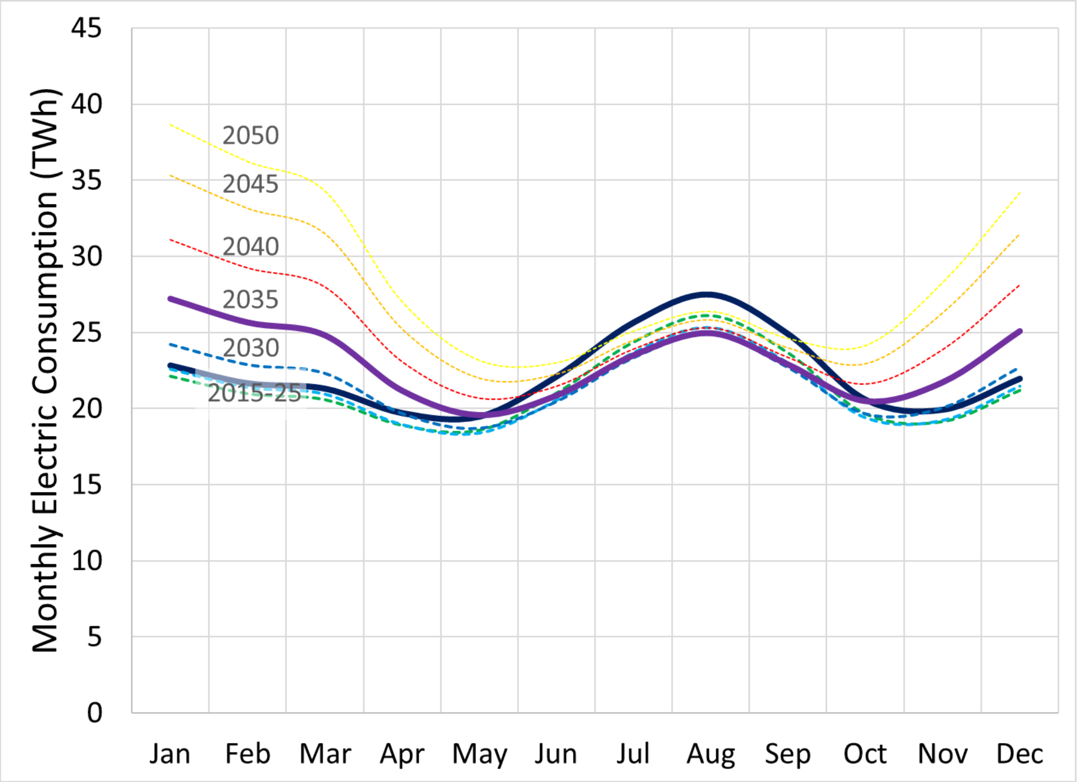
Need biogas/biofuels to get to 80% reduction

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



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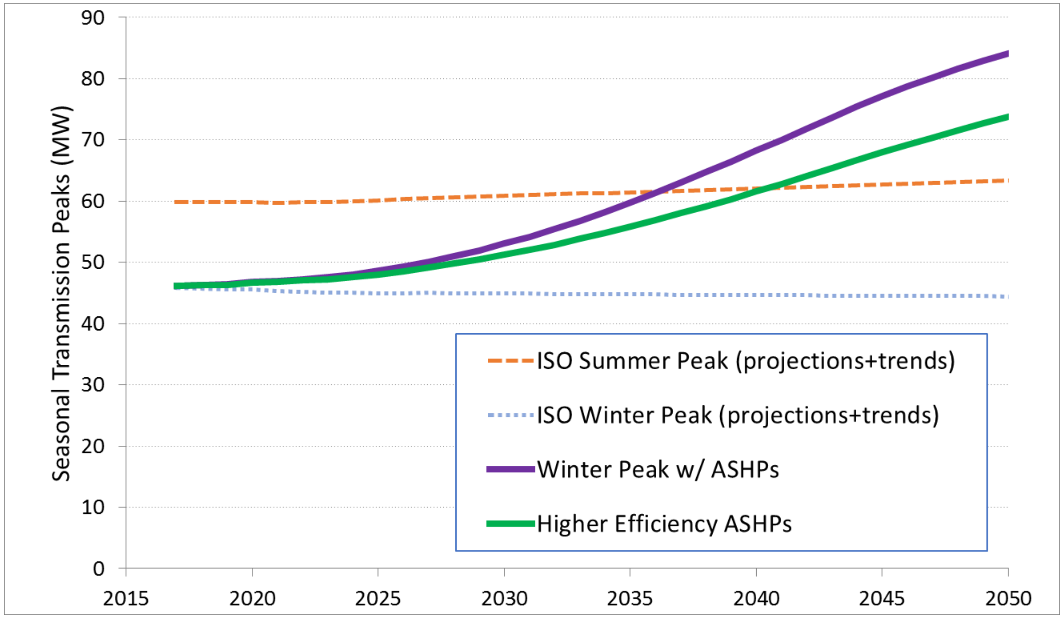
Higher efficiency HPs have grid benefits

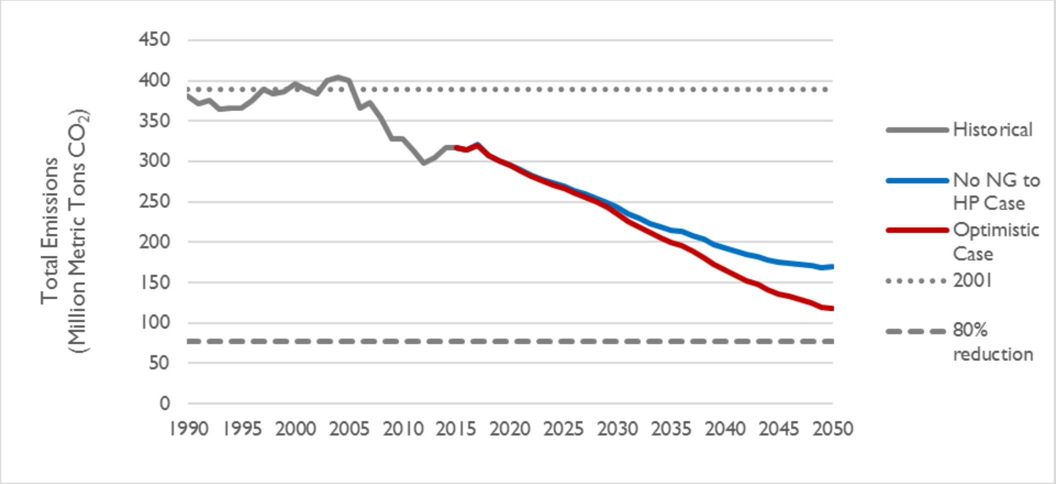


- Illustrative calculation indicates that higher-efficiency HPs can delay the region's shift to winter peaking by 4-5 years
- Clustering on distribution system => winter peaks sooner
- Potential for substantial T&D cost savings from winter EE

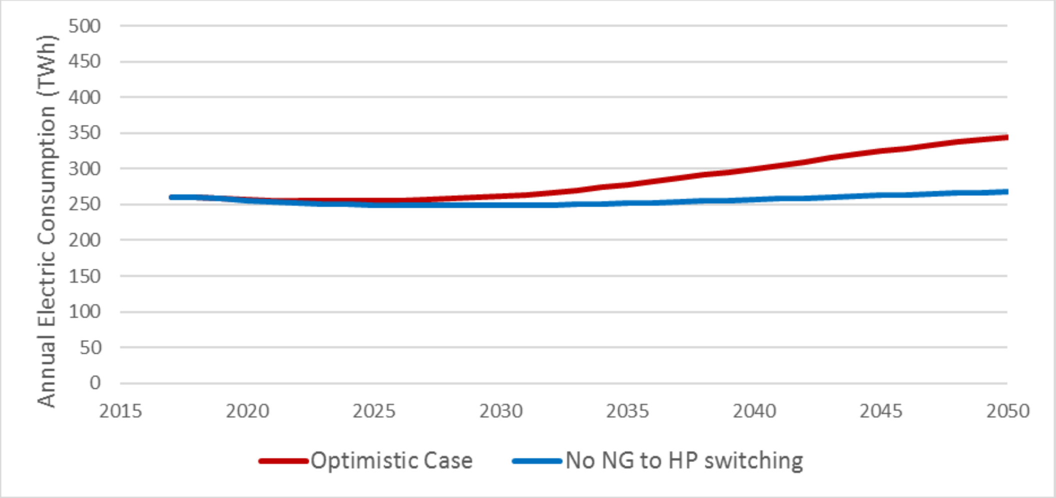
Displacing natural gas

- 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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