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Rhode Island Heating Sector Transformation

June 18, 2020

STATE OF RHODE ISLAND
OFFICE OF
ENERGY RESOURCES

Rhode Island's Heating Sector Transformation

June 18, 2020

Clean

Reduce carbon-intensity of supply portfolio

Affordable

Consumer cost as a lens for all policies, from procurement to investment

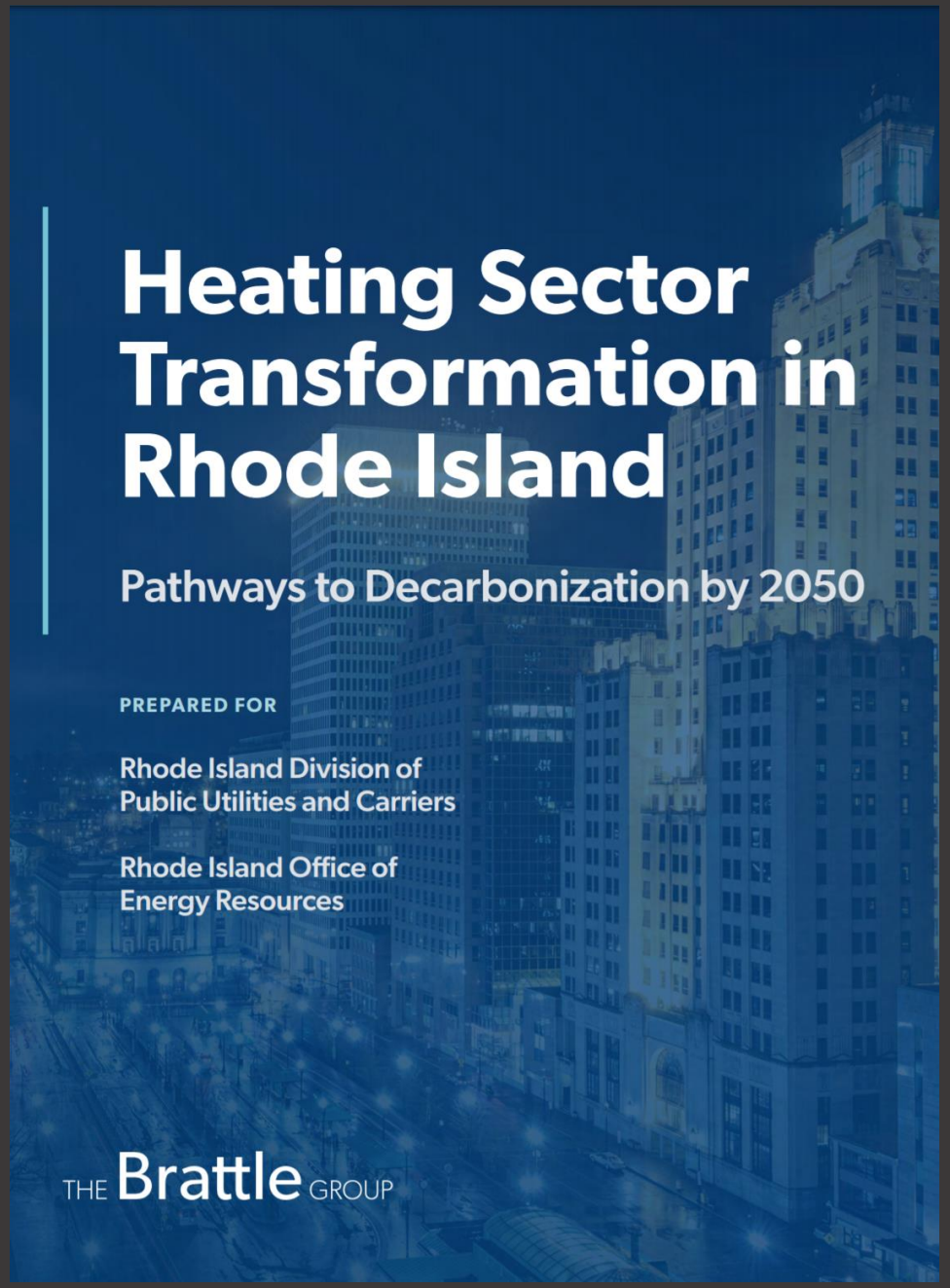
Reliable

Invest in a diverse resource portfolio through infrastructure, supply and system redesign

Principles for Policy and Programmatic Decision-Making

RHODE ISLAND
CLEAN ENERGY LEADERSHIP

HEATING SECTOR TRANSFORMATION



Governor Raimondo
signed Executive Order 19-06 in July 2019

Led by OER & DPUC
Retained The Brattle Group as consultant

Final Report Issued
April 22, 2020

3 Public Workshops
Attracted 60+ attendees each

Heating Sector Transformation

INSIGHTS FROM RHODE ISLAND WORK

PRESENTED BY

Dean Murphy

Jurgen Weiss

PREPARED FOR

Connecticut Department of Energy & Environmental Protection

JUNE 18, 2020

THE Brattle GROUP

Disclaimer

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The presenters

Dr. Dean Murphy is an economist with a background in engineering and over 25 years of experience in the power industry. He has expertise in energy economics, competitive and regulatory economics and finance, and quantitative modeling. His work centers on the electric industry, including issues including climate change policy and analysis, and he has performed a number of long-term power sector forecasting and planning studies examining the transition to a largely decarbonized generation sector. He also has experience in renewable solicitations, resource and investment planning, and nuclear economics.

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Dr. Jürgen Weiss is an energy and industrial organization economist with 20 years of consulting experience in the United States, Europe, and the Middle East. He currently spearheads Brattle's electrification-related initiatives. Dr. Weiss's consulting practice focuses on issues broadly motivated by climate change, such as electrification of transportation and heating, deep decarbonization of the power sector and the impact these changes have on existing assets, market structures, long-term planning needs, and business models for electric utilities.

Jurgen.Weiss@brattle.com

Agenda

- Background on Project
- High-Level Observations
- Basic Results and Implications for Policy

Background

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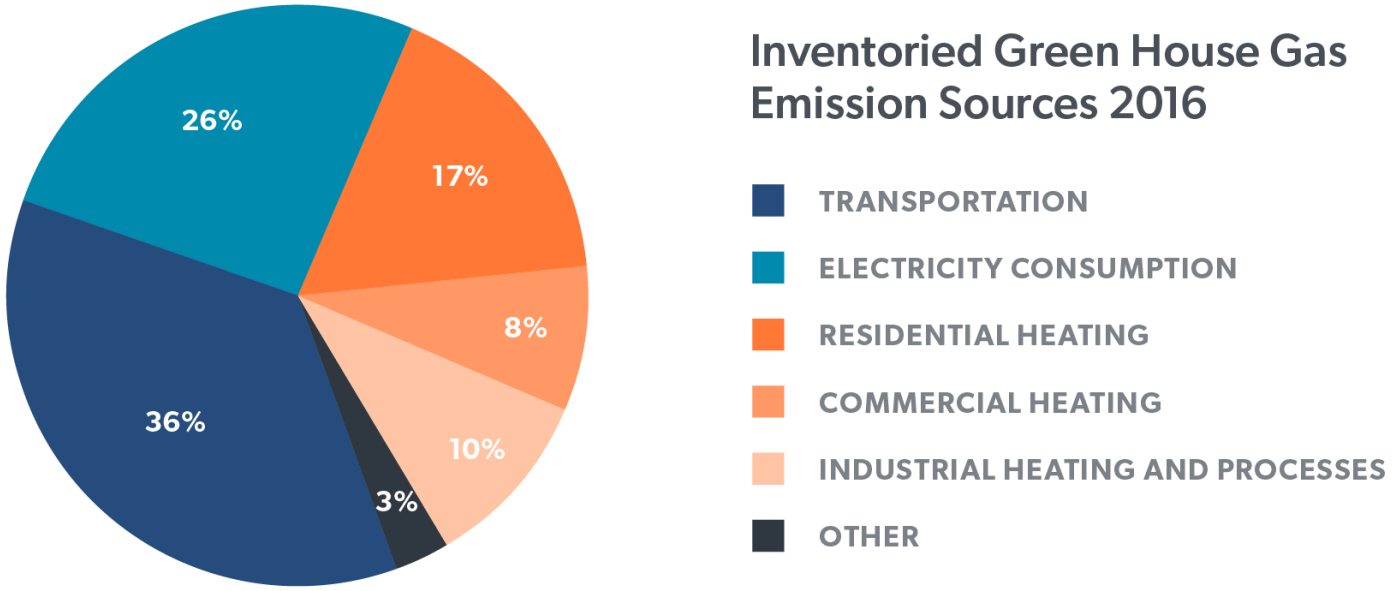
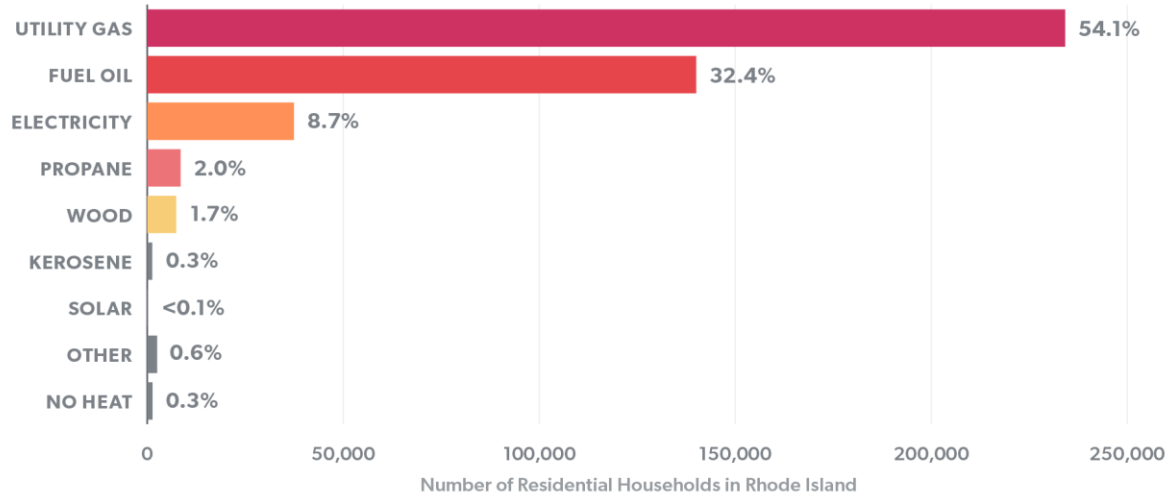
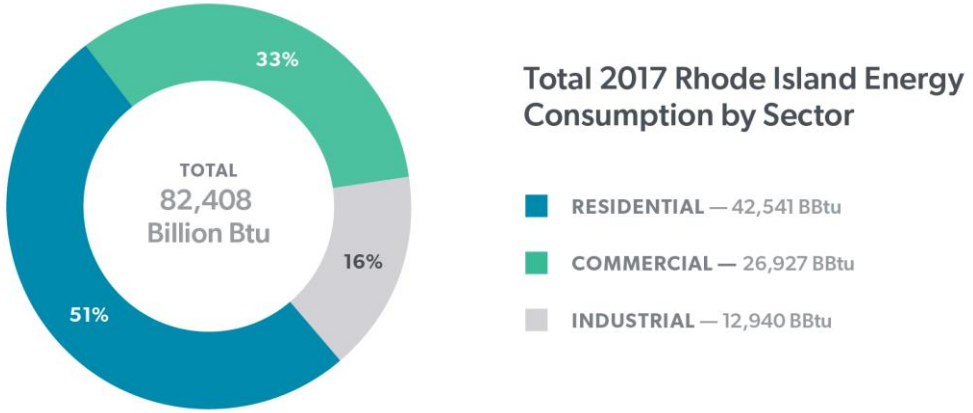
Rhode Island is committed to “80 by 50” (or more)
Heating is about a third of RI GHG emissions



- We were asked by the Rhode Island DPUC and OER to explore heating sector decarbonization strategies for Rhode Island
- “80 by 50” economy-wide likely means (near) full decarbonization of residential and commercial heat
  - Some other sectors (air travel, heavy transport, industry) are likely to be much harder to decarbonize

Natural gas is the largest fuel source; oil also significant
Residential heating is 50% of total





- Natural gas is dominant; heating oil remains important
  - Substantial urban/rural split
- Industrial heat is relatively small
  - Heating-intensive industries are a small part of the RI economy
- Study focused on residential and commercial sector
- Residential/commercial building stock is quite old; little new construction
  - **Focus: decarbonize existing buildings**

A relatively small number of pathways exist to provide decarbonized heat

Efficiency — Reduces heat need & customer costs (modestly)

Space and water heat

Several primary solutions are feasible across many applications/buildings

Decarbonized Fuel

Supply may be limited from less-costly sources

Renewable gas/power-to-gas (P2G) for gas customers

- Landfill gas, anaerobic digesters, gasification, synthetic gas

Biofuel or power-to-liquids (P2L) for most other customers

- Biodiesel, ethanol, synthetic fuels

Heat Pumps

Air source heat pump (ASHP)

Ground source heat pump (GSHP)

- Including GeoMicroDistric

Industrial heat

- May be more specialized (e.g., high-temp)
- May require (decarbonized) fuel, including hydrogen

High level observations

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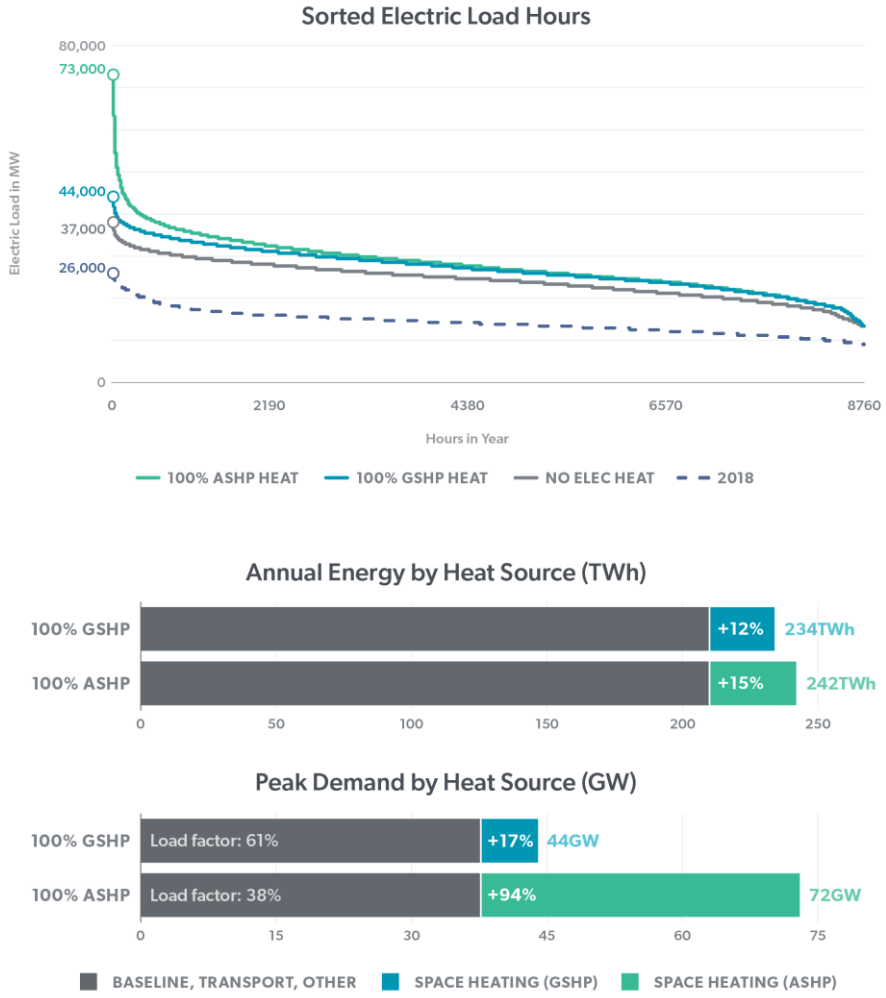
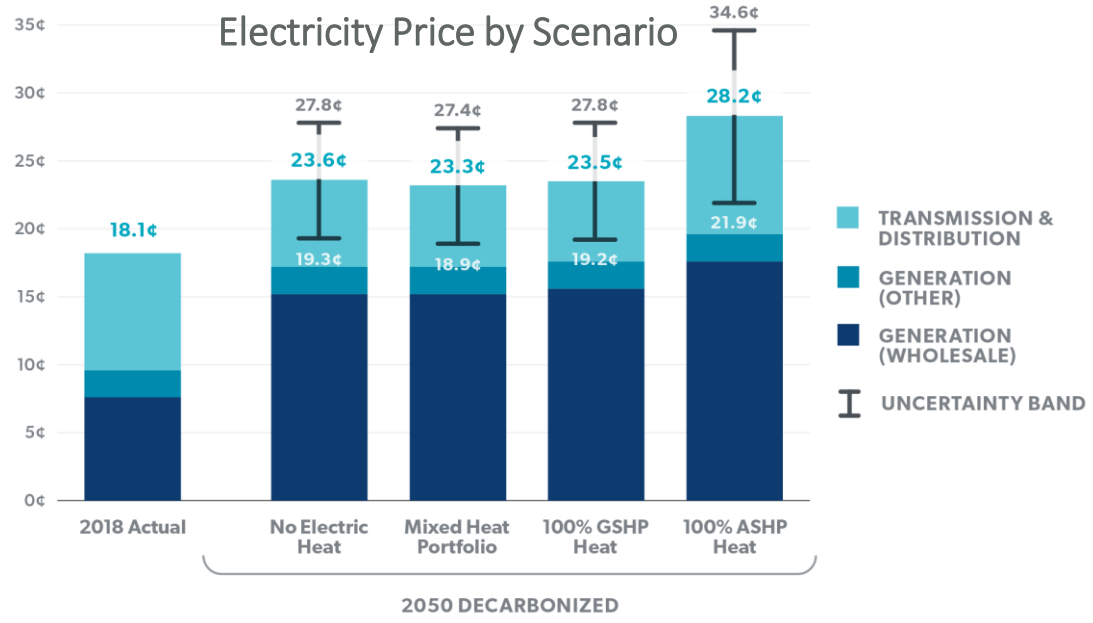
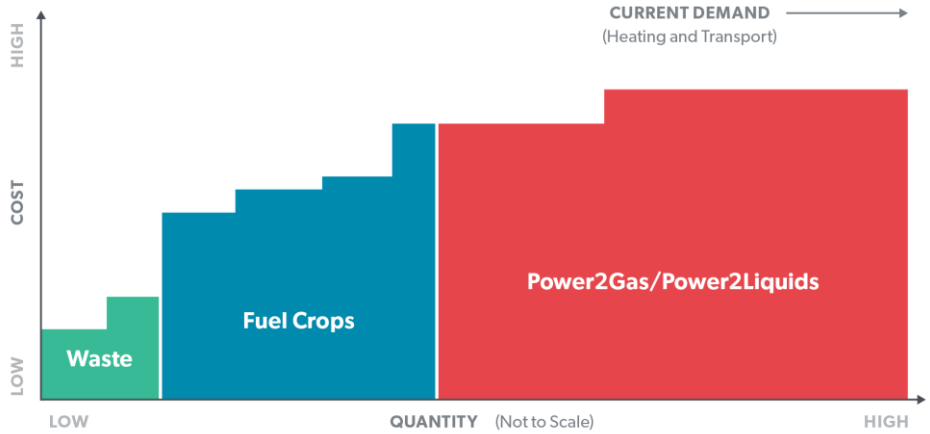
The attractiveness of electrification pathways may depend on the impact on peak electric demand

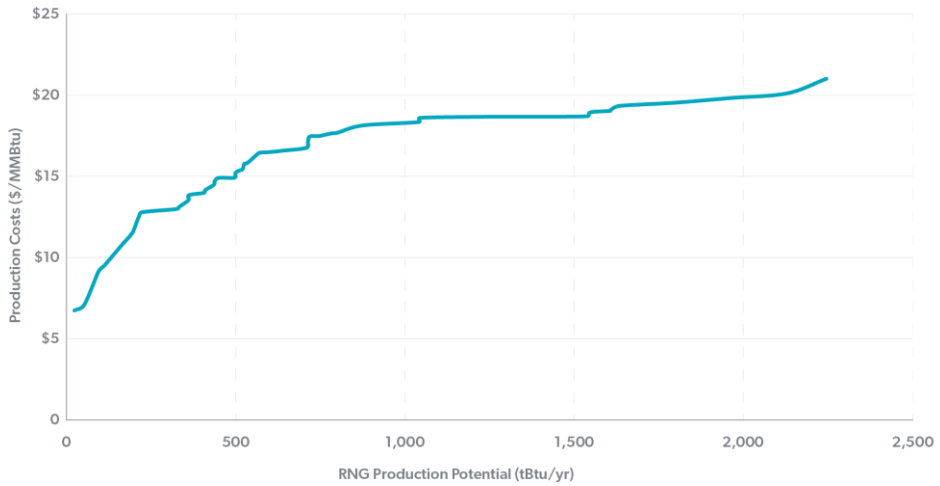


- Broad ASHP adoption could create a serious "peak issue" – unmitigated, it could materially increase electric rates (and increase the challenge of decarbonizing the electric system)



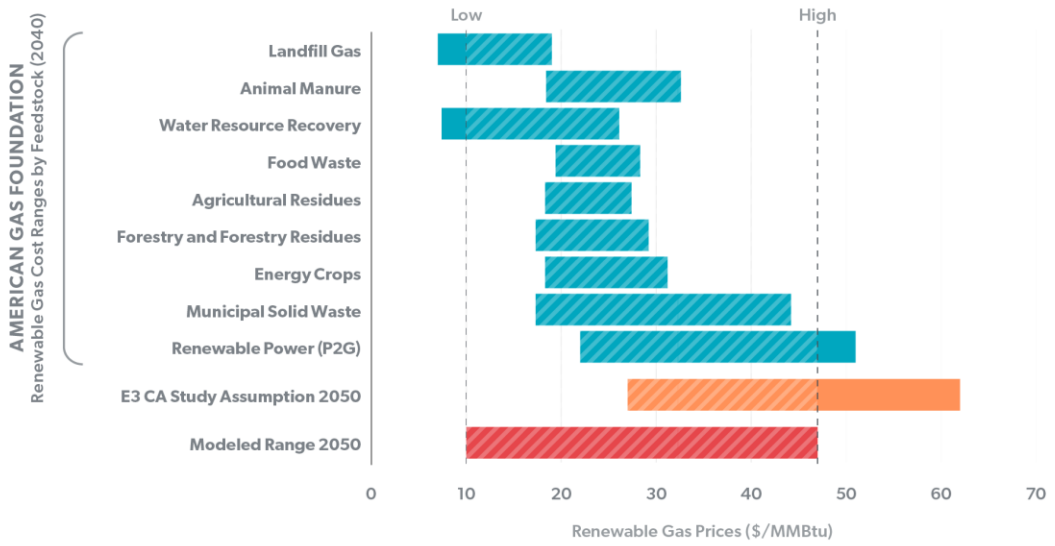
Low costs supply of RNG are likely limited, meaning that P2X likely sets price of RNG at scale



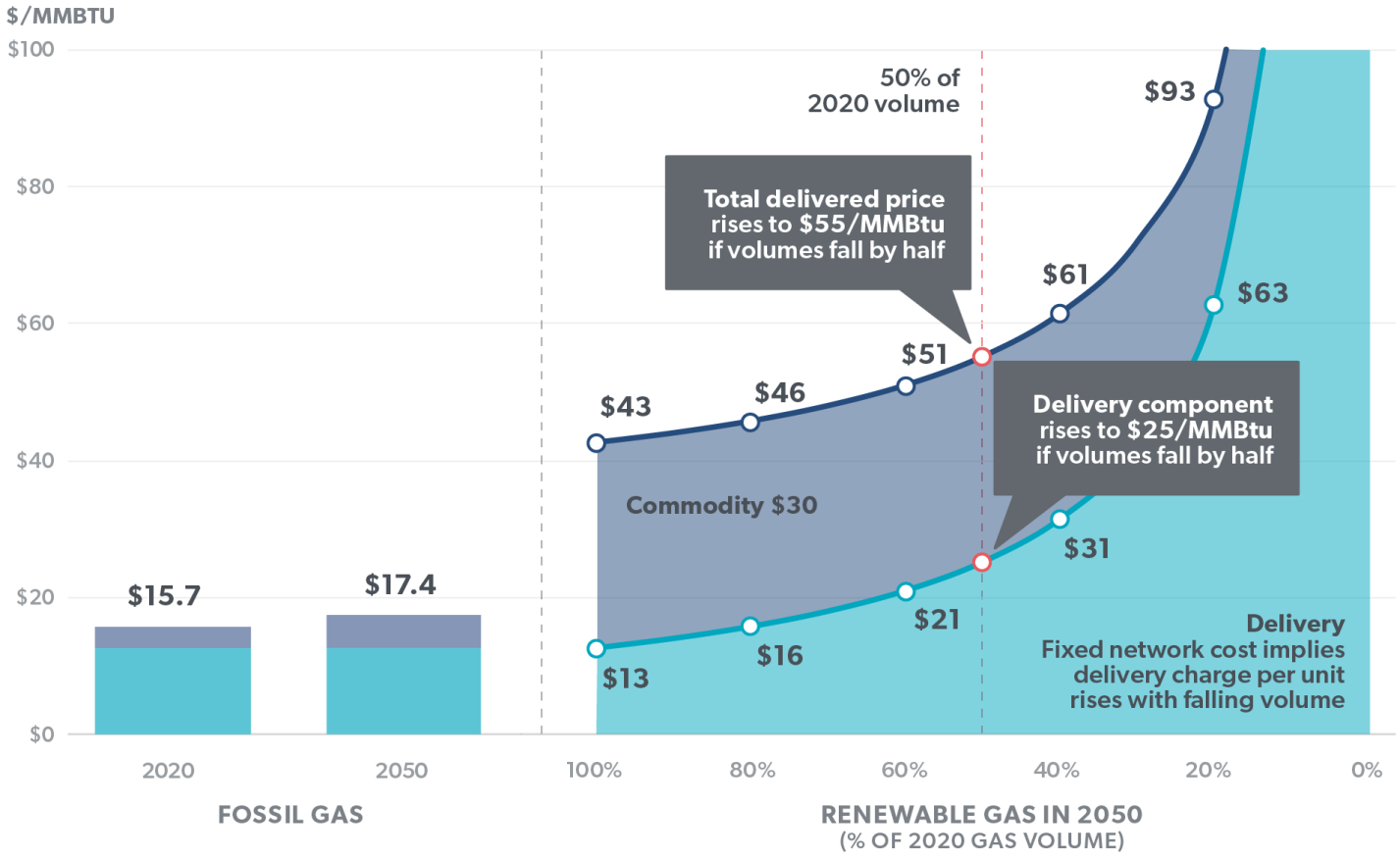


American Gas Foundation, Renewable Sources of Natural Gas, Dec 2019
(High Resource Potential Scenario)

- Low-cost pathways (fuel from waste or crops) offer limited supply – small fraction of current gas use
- Implies P2G is the "marginal" price-setting RNG
- Large uncertainty about future P2G cost, but $10-$50/MMBtu possible.
  - At low end, "everything must go right"



RNG delivered cost is vulnerable to reduced volumes



- Delivered RNG cost depends critically on overall volume; cost of delivery infrastructure is largely fixed
- A 50% volume reduction would essentially double the delivery cost (per MMBtu), further exacerbating higher RNG production cost
- Some volume reduction is likely: due to EE, partial electrification, and warmer winters

Basic Results

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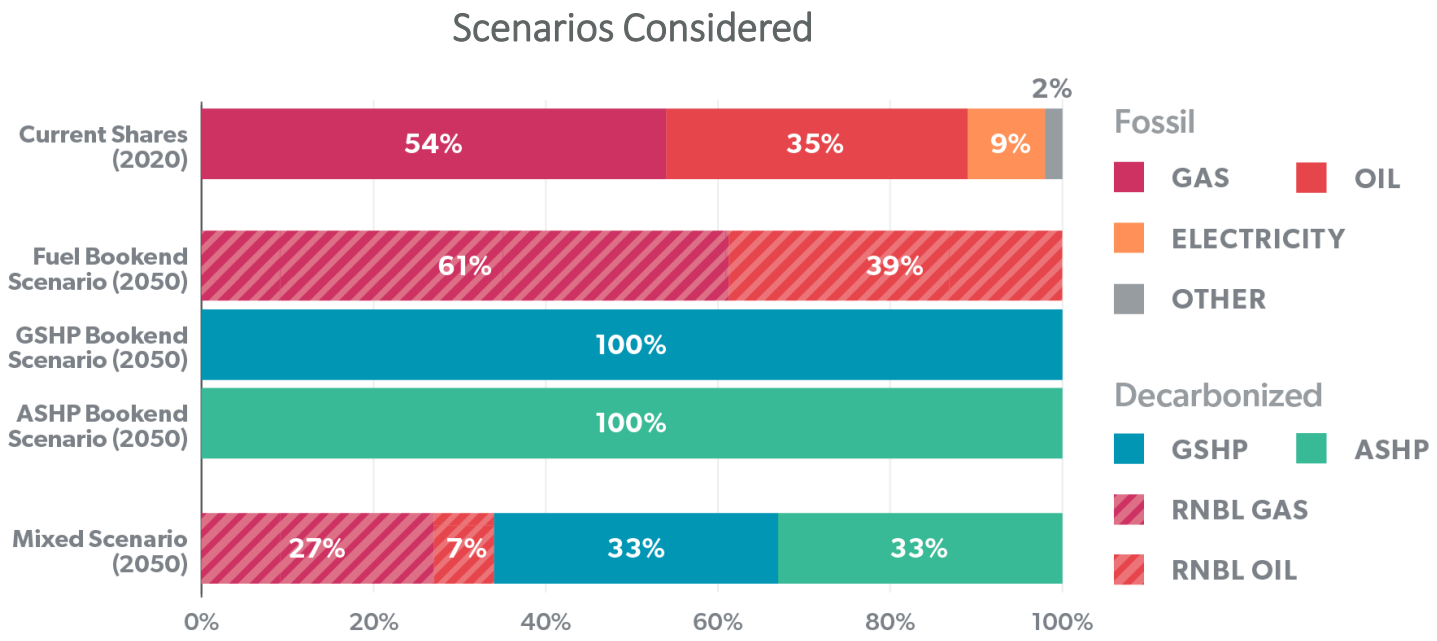
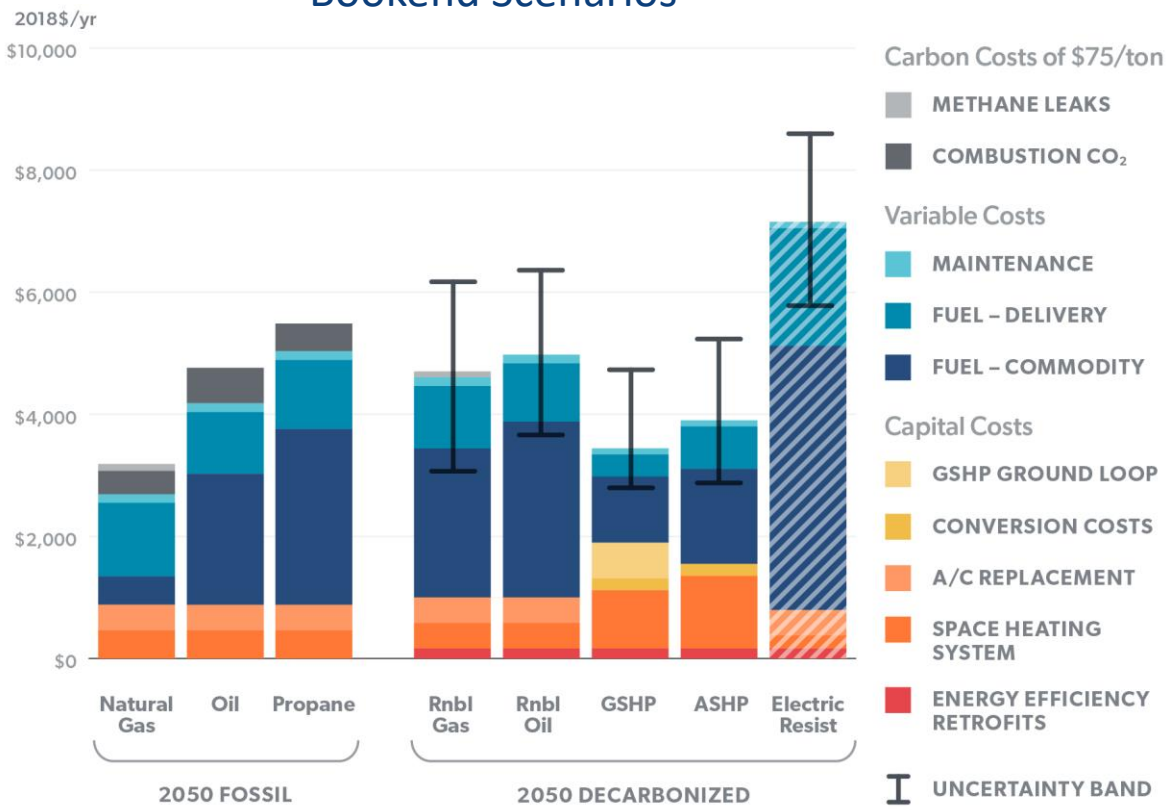
Study compares annualized heating costs of heating decarbonization options, under several scenarios



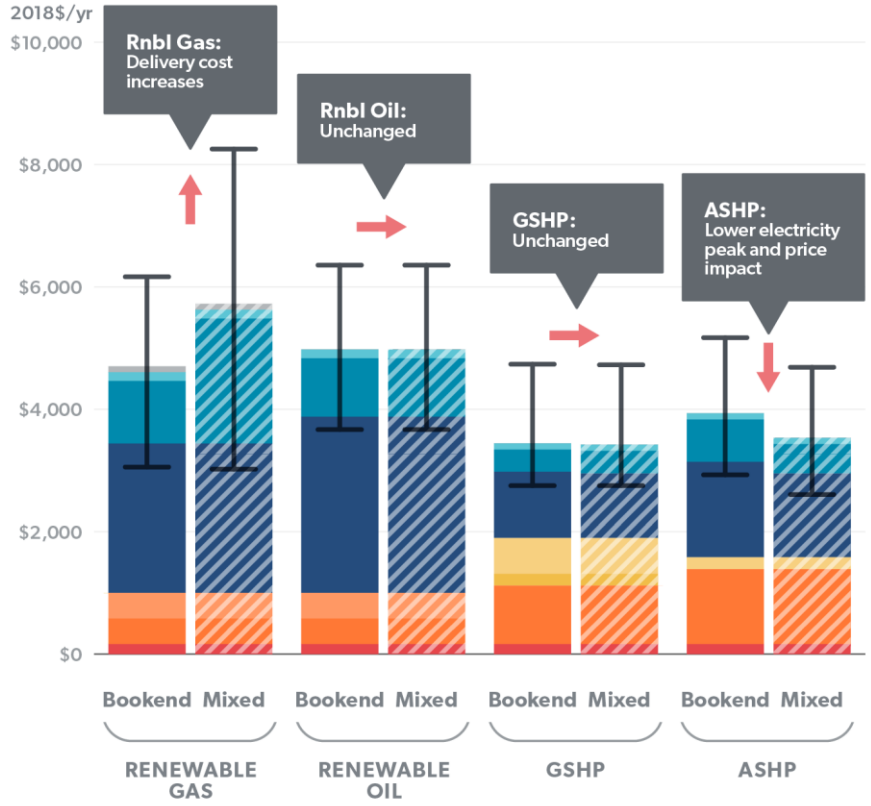
- Developed both “bookend” and “mixed adoption” scenarios to understand indirect impact of widespread single technology adoption on
  - Price of electricity
  - Delivered cost of RNG
- Applied to “typical” existing singly family detached house
- Explored impact of larger buildings

Conclusion: there is no one technology that is clearly cheaper or better than the others

Bookend Scenarios



Mixed versus Bookend Scenarios



- Cost is likely to increase for current natural gas customers; potentially similar for oil, propane customers.
- "Mixed" scenario makes RNG more costly (higher gas delivery cost) and ASHP less costly (lower electricity price)

Besides quantitative issues, there are also a number of qualitative implementation barriers to consider

Approach	Challenge
GSHP (some ASHP)	High Initial Cost
GSHP	Installation Constraints
ASHP, GSHP	Market Maturity
GSHP (some ASHP), Energy Efficiency	Split Incentives
Renewable Gas	Methane Leakage
Renewable Gas	Indoor Air Quality
Renewable Gas	Effects of Gas Leaks (Safety)
Renewable Fuels	GHG Reductions
Deep Retrofits	Cost, Implementation, Disruption

- Each of the core solutions (EE, ASHPs, GSHPs, RNG) faces its own implementation challenges
- Given that there are no "blanket" winners based on "typical" cost, two important conclusions
  - The "best" solution is likely a function of specific context
  - Task of overall heating decarbonization means moving on several parallel paths, removing barriers, creating technology neutral insurance measures, and incentivizing the scaling of "all of the above"

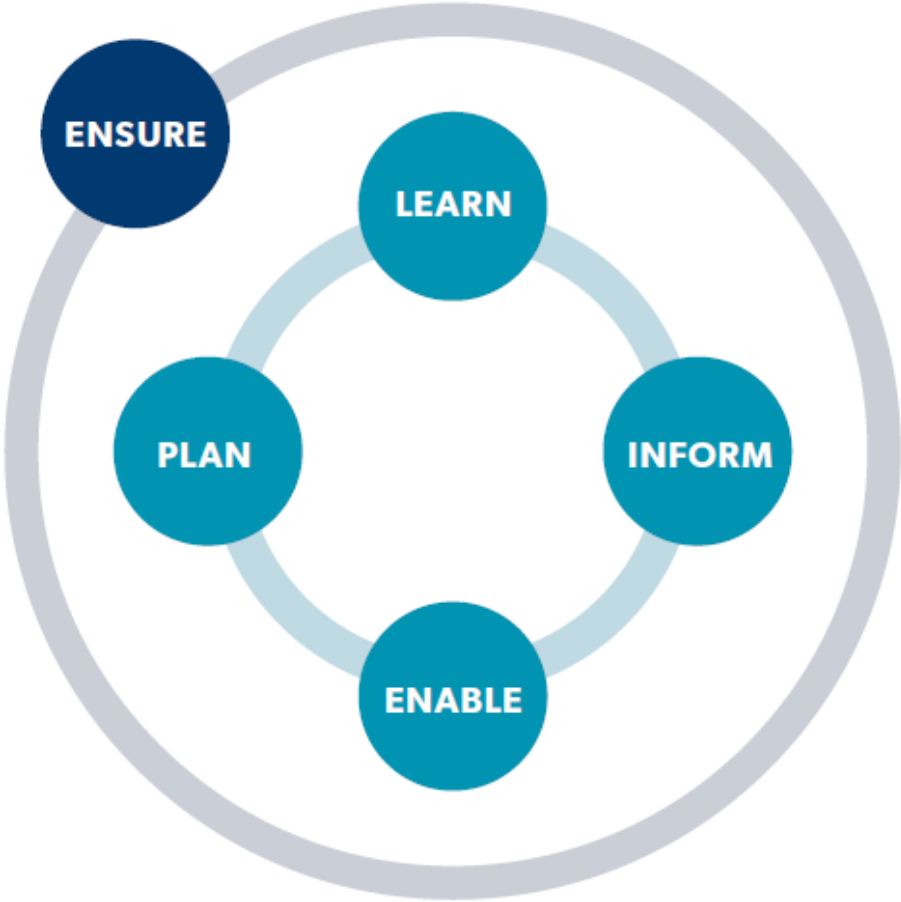
The core conclusion that there is at present no clear "winner" leads to several general policy themes

Some of the policy themes that emerge from the combination of the fact that there is no clear winner and that investments in heating infrastructure are relatively infrequent and long-lived are:

- **Ensure progress**: Implement policies that guarantee emissions reductions independent of which technology is adopted
- **Take advantage of "natural" investment opportunities**: Focus incentives on "incidents" of intervention/investment: Equipment replacement, major home renovations, grid mod, gas system upgrades/replacements
- **Expand planning horizons and explore future proofing**: Include 2050 in planning to assess long-term viability of investments
- **Implement No Regrets policies**, but also do enough to **maintain options**
- **Plan for contingencies:** What if the gas volume drops below some threshold?
- **Learn and get ready:** Gather information and ramp up capabilities to deploy at larger scale

A Policy Framework for the next decade includes five elements

Ensure	Increase efficiency and reduce carbon content of all fuels to zero over time – ensures progress no matter which technologies are used
Learn	Data collection, R&D, pilot projects to understand technologies, infrastructure, and customers
Inform	Educate stakeholders – customers, installers, policymakers – about pros and cons of options, system interactions, etc.
Enable	Facilitate deployment with incentives; target natural investment opportunities; align regulations, rules, and codes; expand workforce
Plan	Expand planning horizon; develop long-term, high-level contingency plans now (do not commit yet) and use to guide near-term policy



Thank you

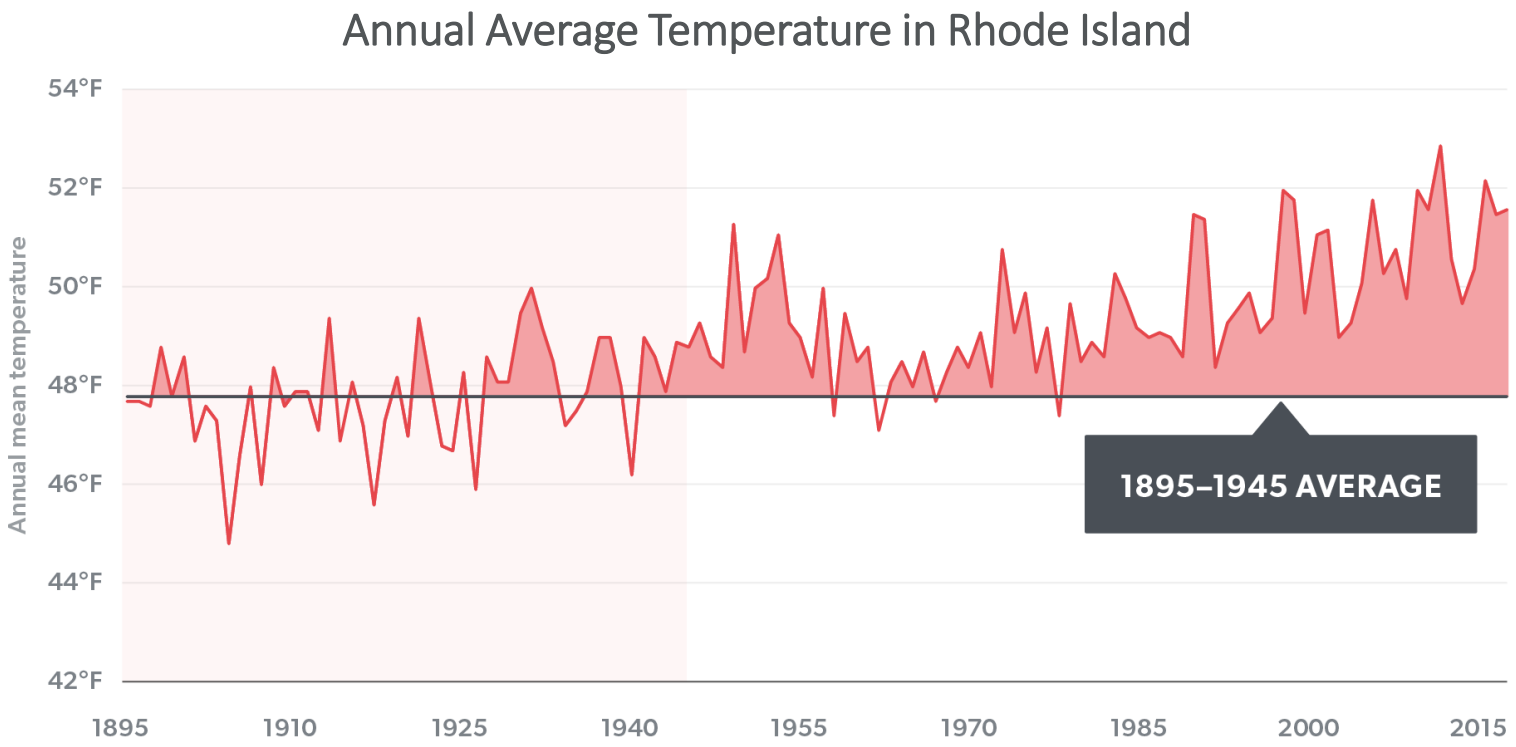
More information about the project as well as the full report and technical appendix are available at:

https://www.brattle.com/reports/heating-sector-transformation-in-rhode-island

http://www.energy.ri.gov/HST/

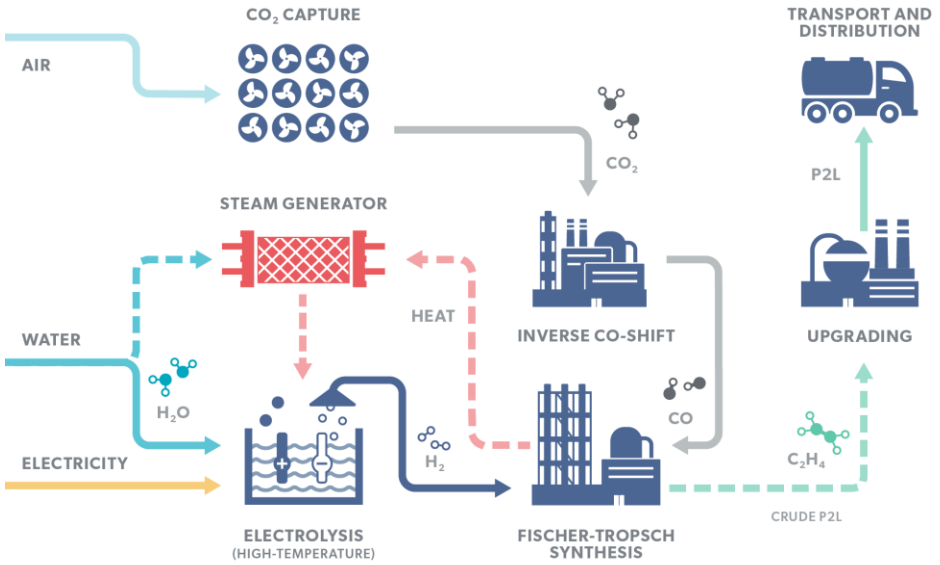
Additional Information

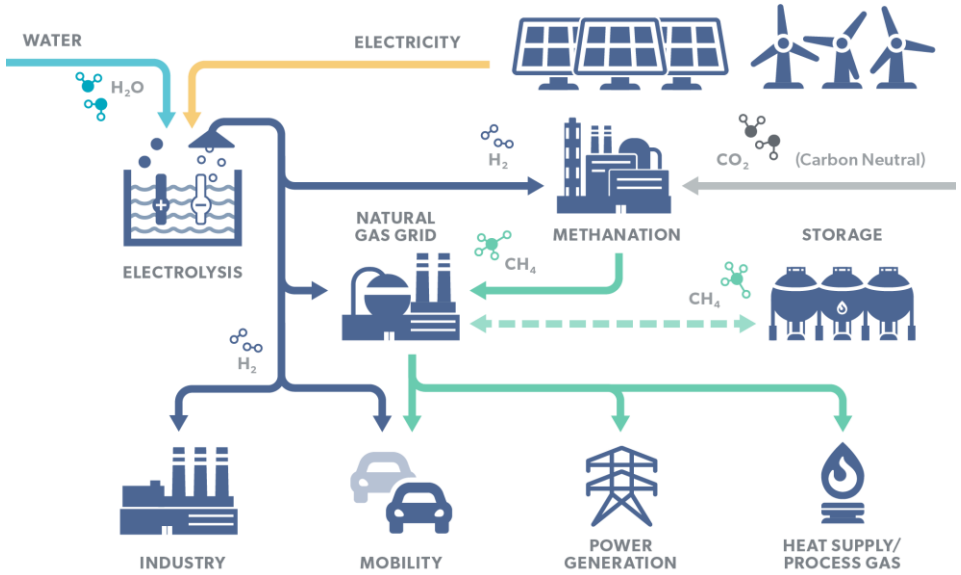
Even with rising temperatures, heating is still necessary, and peak heat needs may not decrease



- Mean annual temperatures in RI have already increased substantially and are expected to continue to increase
  - This is also true in winter (due to moderating effect of Atlantic Ocean)
- But extremes are also expected to increase, so peak heating conditions may stay the same or worsen
  - Polar Vortex!

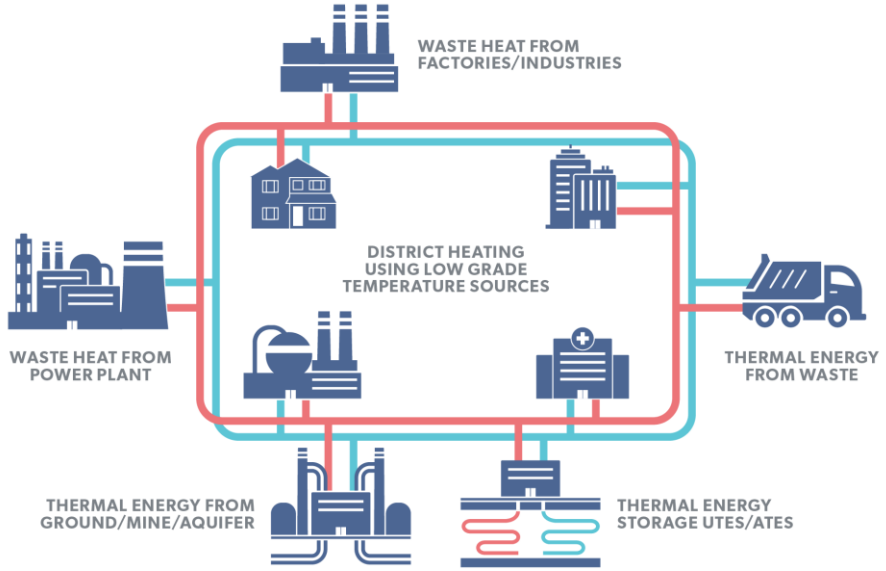
P2X pathways will likely be required “at the margin” to develop drop-in substitute fuels

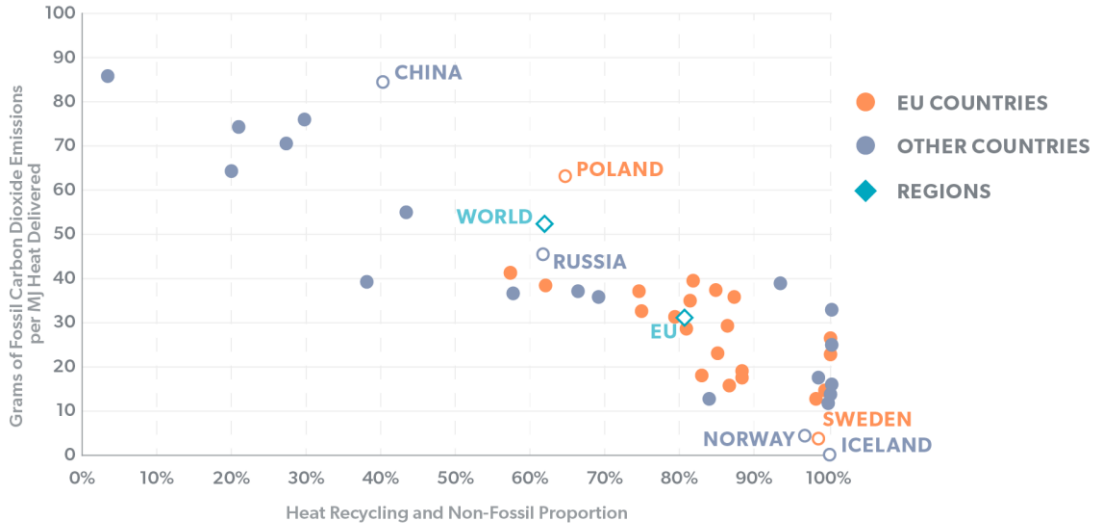




- Power2Gas and Power2Liquids pathways could provide (almost) fully decarbonized replacement fuels for natural gas and heating oil, at scale
  - More costly, relative to current fossil fuels (especially natural gas)
  - P2G still suffers from potential methane leak issues

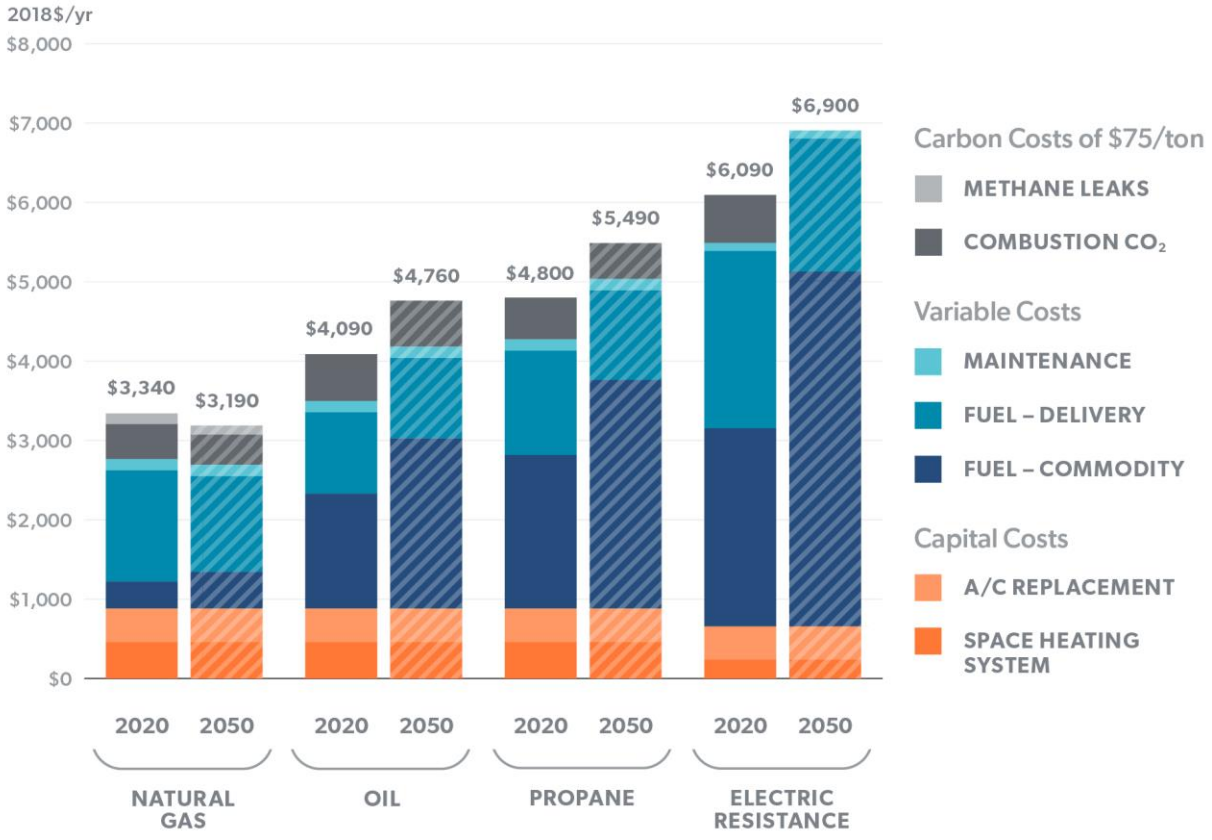
District heating approaches could provide a centralized alternative to decarbonizing individual buildings





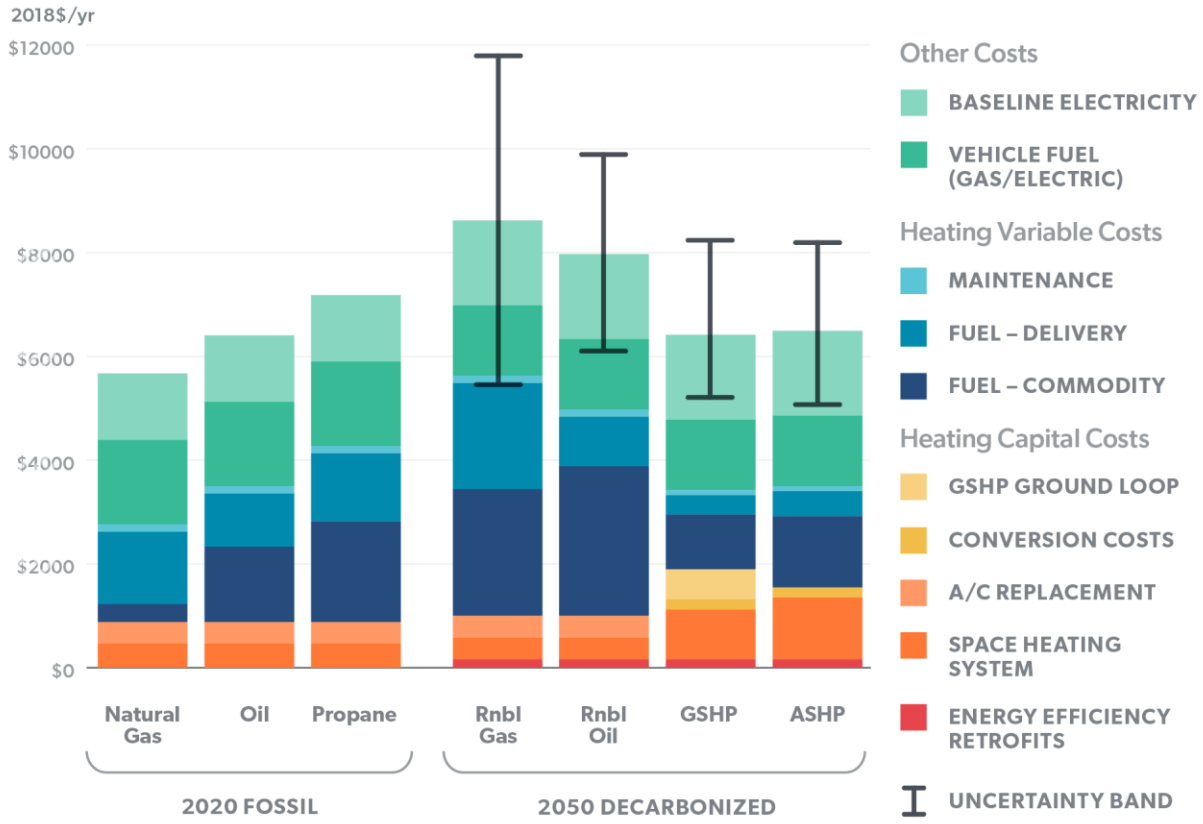
- Some Scandinavian countries have achieved very low carbon district heating systems
- GeoMicroDistricts may be one approach to lower (and spread) the cost of GSHPs, which also avoid peak-related issues of ASHPs
  - Use shared geothermal loops and load diversity to reduce costs of GSHP systems, relative to stand-alone systems for individual buildings

Future annual heating costs (e.g., 2050) are relevant
For fossil fuels, they may be modestly higher than now



- Fossil fuel costs are projected to increase modestly, making 2050 fossil heating costs somewhat higher than today (in real terms)
- But gas prices will likely stay low, and better furnace efficiency could offset natural gas price increases
- Building efficiency upgrades to reduce overall heat needs would further mitigate fuel price increases
- Warmer average winters would also mitigate, even if peak gets colder

Overall impact of heating decarbonization could be mitigated (somewhat) by decarbonization impacts on energy "wallet"



- Baseline electricity and transportation energy costs are added to heating costs
- Widespread ASHP adoption (bookend case) would make baseline and EV electricity uses more expensive; mitigated in mixed scenario
- EV related savings mitigate cost increases somewhat
  - Impact not as strong as initially expected, after adjusting for gas tax equivalent in EV world
- Must recognize that this does not mean nobody will pay more
  - Particularly important to look at impact on low income populations

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- Distributed Energy Resources
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- Electricity Market Modeling & Resource Planning
- Electrification & Growth Opportunities
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- Gas/Electric Coordination
- Market Design
- Natural Gas & Petroleum
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