RI Heating Sector Transformation

PUBLIC WORKSHOP #1

PRESENTED TO
RI Heating Sector Stakeholders

PRESENTED BY
Dean Murphy
Jurgen Weiss
Alex Stulc

December 13, 2019
Agenda

Part A: Background
1. Background/Team
2. Background on RI Heating (Transformation)
3. What is heating transformation/decarbonization

Break (10 minutes)

Part B: Process and Methodology
1. Overview
2. Stakeholder Interview insights (so far)
3. Discussion/Additional Stakeholder Comments
4. Next Steps
Part A

Background
Heating Sector Transformation Project Leads

GOV
Maria Messick, Policy Advisor

OER
Nicholas Ucci, Deputy Commissioner
Dr. Carrie Gill, Power Sector Transformation
Becca Trietch, Energy Efficiency Initiatives

DPUC
Jonathan Schrag, Deputy Administrator
Ron Gerwatowski, Senior Advisor
Al Mancini, Gas Infrastructure Lead

State Project Team
Consulting Team

The Brattle Group

An economic and energy consulting firm with 11 offices in North America, Europe and Australia, with over 50 partners and 500 employees.

Dean Murphy  Jurgen Weiss

BuroHappold Engineering

An international, integrated engineering consultancy operating in 23 locations worldwide, with 60 partners and over 1,900 employees.

Alexcan Stulc  Adam Friedberg
Rhode Island Heating Sector (Transformation) Background
Resilient Rhode Island Act targets 80% reductions by 2050

“80 by 50” likely means (near) full decarbonization of heating sector will be needed (since industrial and full transport decarbonization unlikely)

Source: Deeper Decarbonization in the Ocean State: The 2019 Rhode Island GHG Reduction Study, Sept 12, 2019
Rhode Island heating sector dominated by gas and delivered fuel, with urban/rural split

Source: Meister Consultants Group, RHODE ISLAND RENEWABLE THERMAL MARKET DEVELOPMENT STRATEGY, Prepared for Rhode Island Office of Energy Resources, January 2017
A broad mix of gas and delivered fuel for both residential and commercial

<table>
<thead>
<tr>
<th>Sector</th>
<th>Occupancy</th>
<th>Estimated Households</th>
<th>Percent of Group Using Each Fuel Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Count</td>
<td>%</td>
</tr>
<tr>
<td>Single Family</td>
<td>Owned</td>
<td>227,521</td>
<td>53%</td>
</tr>
<tr>
<td>Single Family</td>
<td>Rented</td>
<td>32,185</td>
<td>7%</td>
</tr>
<tr>
<td>Multifamily</td>
<td>Owned</td>
<td>31,575</td>
<td>7%</td>
</tr>
<tr>
<td>Multifamily</td>
<td>Rented</td>
<td>141,424</td>
<td>33%</td>
</tr>
<tr>
<td>Total Households</td>
<td></td>
<td>432,705</td>
<td>100%</td>
</tr>
<tr>
<td>Percent of Total</td>
<td></td>
<td>54%</td>
<td>35%</td>
</tr>
</tbody>
</table>

Source: Meister Consultants Group, RHODE ISLAND RENEWABLE THERMAL MARKET DEVELOPMENT STRATEGY, Prepared for Rhode Island Office of Energy Resources, January 2017
Deployment rate of non-traditional heating systems in the state is low

Source: Meister Consultants Group, RHODE ISLAND RENEWABLE THERMAL MARKET DEVELOPMENT STRATEGY, Prepared for Rhode Island Office of Energy Resources, January 2017
Envisioning a decarbonized heating sector
Decarbonized buildings: Version A…

https://pxhere.com/en/photo/642739
...or Version B?

There are only a few pathways to decarbonizing the heating sector

### Space and Domestic Water Heating (Residential and Commercial)

<table>
<thead>
<tr>
<th>“Weatherization” (Reduce Energy Needs for heating)</th>
<th>(Direct) Electrification</th>
<th>Decarbonization of heating “fuels”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation</td>
<td>Ground Source Heat Pumps (GSHP)</td>
<td>Biodiesel/BioLPG</td>
</tr>
<tr>
<td>Air tightening</td>
<td>Air Source Heat Pumps (ASHP)</td>
<td>Biogas/Landfill gas</td>
</tr>
<tr>
<td>Replacement windows</td>
<td>Induction Electric Cooktops</td>
<td>Anaerobic digester gas</td>
</tr>
<tr>
<td>More efficient furnaces and boilers</td>
<td></td>
<td>Power2Gas/Power2Liquids</td>
</tr>
</tbody>
</table>

**District Heating, Mini-Districts, Individual Heating**

### Process Heat (Industrial)

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Electrification</th>
<th>Fuel Decarbonization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance, Induction, Microwave</td>
<td>Blue/Green Hydrogen</td>
<td></td>
</tr>
</tbody>
</table>
Residential buildings need to be decarbonized

Residential buildings need to be decarbonized – like this one.


Rio Villas Estates, an exciting new home development in Sacramento. Featuring all electric service, this community combines comfort and efficiency to deliver a beautiful home with excellent value.
Air source heat pumps on the outside..

Just Two Minisplits Heat and Cool the Whole House
Carter Scott has built 18 homes in Massachusetts without any heat in the bedrooms
The skeptics’ “cold bedroom” predictions were unfounded. “We have since built several houses in which the upstairs minisplit unit isn’t even being used until the outdoor temperature drops below 20 degrees,” Scott said. “Typically the response from homeowners is, ‘Wow, these houses have even indoor temperatures’ and ‘these houses are quiet.”

..and on the inside (mini-split shown, can also use existing ducts)

https://www.ductlessinduluth.com/featuredproduct.html
Even big ones…

Stilfleher, August 2008,
https://commons.wikimedia.org/wiki/File:Newport_Rhode_Island_The_Breakers_2.jpg
Even big ones...**can be electrified.**

“**Cool: Historic Newport Mansion Goes Geothermal**

The new system, which uses historic heating shafts built into the masonry of the building in the 1890s to circulate modified air to targeted areas, has proven a significant success...”

A number of commercial developments now use heat pumps

Boulder Commons, a new net-zero energy development in Boulder, Colorado, by Morgan Creek Ventures. RMI

The American Geophysical Union’s new headquarters in Washington, DC, a net-zero-energy building. Hickok Cole

Ground source heat pumps can use all sorts of “sinks”...

http://www.geowarmth.co.uk/commercial-ground-source-heat-pump-installer-case-studies
And be applied to many building types

http://www.geowarmth.co.uk/commercial-ground-source-heat-pump-installer-case-studies
At P. Franco wine bar in London, an act of culinary sorcery is about to commence. Tim Spedding, former sous chef at the Michelin-starred Clove Club, is standing in front of two induction hobs

https://www.treehugger.com/kitchen-design/professional-chefs-are-dumping-gas-induction-ranges.html
We could also replace fossil gas and oil with carbon-neutral alternatives.

Calgren Dairy Fuels in Pixley, California, captures methane that would have vented into the atmosphere. SoCalGas
Agriculture could provide a feed-stock for “bioreactors” making such fuels

Renewable natural gas' from manure and food waste to warm Vermonters;
Power2Gas ("P2G") makes synthetic methane from renewable electricity

Theoretically, hydrogen could also be made from natural gas via steam methane reforming (SMR) - how hydrogen is “made” today - and by capturing and storing the CO2.

https://www.youtube.com/watch?v=BpZV6qtl_kY
Questions?
Break (10 minutes)
Part B
Process and Methodology
Overview of Project Tasks and Methodology

RI Heat Taxonomy
Building types, end uses, heat systems, etc.; based on Meister, augmented by additional info

Create Decarbonization Pathways
Pathway specifies the Decarb Option to use for each Bldg Type/Use
Characterize on Quantitative and Qualitative dimensions. Refine.

Consider State Levers
Policies to facilitate/encourage/accelerate/force transformation

Choose Pathway(s)
Achieves milestones; may include options, multiple Pathways

[Deliverables – report, summary]

Decarb Options
Potential applications, cost and performance (estimates)

Map Decarb Options to Heat Taxonomy
E.g. 1-fam Res, Oil, no gas: GSHP 100%; or ASHP w/ backup

Eliminate strictly dominated measures
Define “rough” heating transformation pathways
Cost Estimation of pathways
Implementation issues of pathways including policy tools
Heating sector transformation raises some key questions

- How much can EE realistically achieve in existing buildings?
  - At what cost, and how quickly?

- Can ASHP deliver 100% of heat?
  - In new construction?
  - In existing structures?

- What **incremental** electric system upgrades would be necessary to support very large ASHP penetration?
  - What are generation (and storage) requirements, especially to cover peak heat needs?
  - What investments in the electric distribution system would need to be made that wouldn’t be made otherwise?
One very big question: What is the future of the gas distribution system?

- If heat is largely electrified, gas demand will fall dramatically
  - Is distribution system still viable at much lower volumes?
  - If not, how to “unwind” without hurting certain customers?

- Alternatives: gas system delivers decarbonized gas
  - Hydrogen or methane
    - \( \text{H}_2 \) via electrolysis (using renewable electricity) or reform natural gas to \( \text{H}_2 \) (fuel) and \( \text{CO}_2 \) (sequester)
    - Methane from biogas or synthetic methane
  - Both have potential issues:
    - Methane pathways susceptible to GHG from leaks
    - Hydrogen pathways may require upgrades to pipelines, distribution system, and end-use equipment
Some building blocks of a heating transformation strategy include:

<table>
<thead>
<tr>
<th>Identify and implement “no regret” strategies</th>
<th>Implement policies that improve incentives to align private behavior with social objectives independent of heating transformation objectives alone.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify dominant strategies/measures</td>
<td>Remove barriers and create support policies (where needed) to accelerate and scale measures that are better than all other options (for a particular building type/heating application) under reasonable assumptions about the future.</td>
</tr>
<tr>
<td>Identify dominated strategies/measures</td>
<td>Halt incentives and potentially actively discourage measures that are inferior to other approaches under reasonable assumptions about the future.</td>
</tr>
<tr>
<td>Strategies/measures that are not dominant/dominated</td>
<td>Develop measure-neutral policies that allow progress, don’t foreclose options and avoid unnecessary technology lock-in.</td>
</tr>
<tr>
<td>Improve attractiveness of “building trades”</td>
<td></td>
</tr>
<tr>
<td>Remove fossil subsidies</td>
<td></td>
</tr>
<tr>
<td>Improve retail price signals</td>
<td></td>
</tr>
<tr>
<td>Accelerate clean electricity deployment</td>
<td></td>
</tr>
<tr>
<td>Improve information about heating options</td>
<td></td>
</tr>
<tr>
<td>Stop incentives for gas water heat conversions</td>
<td></td>
</tr>
<tr>
<td>Low carbon heating fuel standards</td>
<td></td>
</tr>
<tr>
<td>Heating sector GHG caps</td>
<td></td>
</tr>
</tbody>
</table>
We have already engaged in numerous 1:1 discussions with stakeholders

<table>
<thead>
<tr>
<th>Category</th>
<th>Completed</th>
<th>Still to come</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Trades/Installers</td>
<td>RI Builders Association, GSHP installer</td>
<td>HVAC contractor</td>
</tr>
<tr>
<td>Environmental NGOs</td>
<td>CLF, Acadia Center, Green Energy Consumers Alliance</td>
<td></td>
</tr>
<tr>
<td>Technology Providers</td>
<td>Stash, Daikin</td>
<td>Mitsubishi</td>
</tr>
<tr>
<td>State Agencies</td>
<td>Efficiency Maine</td>
<td></td>
</tr>
<tr>
<td>Utilities</td>
<td>National Grid, Summit Utilities</td>
<td></td>
</tr>
<tr>
<td>Business Associations and Large Users</td>
<td>Brown University, TEC-RI/RIMA</td>
<td></td>
</tr>
<tr>
<td>Municipal Government</td>
<td>Aquidneck Planning Council</td>
<td>RI League of Cities &amp; Towns</td>
</tr>
<tr>
<td>Housing Authorities/Realtors</td>
<td>RI Housing, Providence Housing Authority, RI Association of Realtors</td>
<td></td>
</tr>
<tr>
<td>Other consultants</td>
<td>Cadmus, Synapse, Optimal Energy</td>
<td></td>
</tr>
<tr>
<td>Delivered Fuel Suppliers</td>
<td>Oil Heat Institute of RI (now EMA)</td>
<td></td>
</tr>
<tr>
<td>Environmental Justice</td>
<td></td>
<td>George Wiley Center, Center for Justice</td>
</tr>
</tbody>
</table>
Several important insights have emerged from these discussions

Don’t force single technological solution

Standardization can bring down the cost of GSHPs

High Upfront Costs are an important barrier (need financing!)

Getting heat pump installations up to scale is critical for driving down cost

If we “electrify everything,” can we really build out renewable generation fast enough?

There are huge information deficits

Weatherization may not be as cost-effective as people once thought – don’t condition incentives on it.

Must make building trades much more attractive – otherwise hard to find the labor force to implement the transformation

Electrified heat (esp. without storage) creates a huge winter electricity “peak”

Heating needs to remain affordable

Methane leaks affect both fossil and “decarbonized” gas

Gas in the home creates other problems (indoor air pollution, accident risk)

Air source heat pumps can meet 100% of a building’s heating load

Blend heating oil with bio-oil

Licensing hurdles for contractors prevent people from entering what is really a very attractive set of professions related to decarbonizing buildings

RI economy is not doing very well – be careful about energy costs

No combustion onsite for new buildings
Backup
### Table 5. Estimated Number of Rhode Island Households by Heating Fuel and Heating System

<table>
<thead>
<tr>
<th>Heating System</th>
<th>Utility Gas</th>
<th>Delivered Fuel</th>
<th>Electricity</th>
<th>Wood</th>
<th>Solar</th>
<th>Other/None</th>
<th>Total</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam or Forced Hot Water System</td>
<td>120,749</td>
<td>89,323</td>
<td>3,715</td>
<td>316</td>
<td>-</td>
<td>-</td>
<td>214,105</td>
<td>49%</td>
</tr>
<tr>
<td>Central Warm-Air Furnace</td>
<td>99,997</td>
<td>52,719</td>
<td>4,169</td>
<td>1,270</td>
<td>-</td>
<td>-</td>
<td>158,156</td>
<td>37%</td>
</tr>
<tr>
<td>Built-In Room Heater</td>
<td>9,626</td>
<td>6,554</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>16,180</td>
<td>4%</td>
</tr>
<tr>
<td>Built-In Electric Units</td>
<td>-</td>
<td>521</td>
<td>25,912</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>26,432</td>
<td>6%</td>
</tr>
<tr>
<td>Floor or Wall Pipeless Furnace</td>
<td>1,258</td>
<td>332</td>
<td>574</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2,164</td>
<td>0.5%</td>
</tr>
<tr>
<td>Room Heaters</td>
<td>-</td>
<td>332</td>
<td>1,973</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2,305</td>
<td>0.5%</td>
</tr>
<tr>
<td>Stove/Fireplace</td>
<td>556</td>
<td>-</td>
<td>5,450</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6,007</td>
<td>1.4%</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>-</td>
<td>-</td>
<td>695</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>695</td>
<td>0.2%</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>198</td>
<td>-</td>
<td>198</td>
<td>0.0%</td>
</tr>
<tr>
<td>Other Equipment</td>
<td>1,955</td>
<td>-</td>
<td>372</td>
<td>320</td>
<td>-</td>
<td>3,817</td>
<td>6,464</td>
<td>1.5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>234,143</strong></td>
<td><strong>149,781</strong></td>
<td><strong>37,410</strong></td>
<td><strong>7,357</strong></td>
<td>198</td>
<td><strong>3,817</strong></td>
<td><strong>432,705</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Meister Consultants Group, RHODE ISLAND RENEWABLE THERMAL MARKET DEVELOPMENT STRATEGY, Prepared for Rhode Island Office of Energy Resources, January 2017
Table 7. Commercial Thermal Distribution Systems

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Buildings</th>
<th>Heated Square Footage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small Commercial</td>
<td>Large Commercial</td>
</tr>
<tr>
<td>Packaged System</td>
<td>30%</td>
<td>6%</td>
</tr>
<tr>
<td>Boiler</td>
<td>22%</td>
<td>7%</td>
</tr>
<tr>
<td>Electric Resistance</td>
<td>17%</td>
<td>2%</td>
</tr>
<tr>
<td>Furnace</td>
<td>7%</td>
<td>1%</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>4%</td>
<td>0%</td>
</tr>
<tr>
<td>District Heat</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>82%</td>
<td>18%</td>
</tr>
</tbody>
</table>

Source: Meister Consultants Group, RHODE ISLAND RENEWABLE THERMAL MARKET DEVELOPMENT STRATEGY, Prepared for Rhode Island Office of Energy Resources, January 2017