# RI Heating Sector Transformation

## PUBLIC WORKSHOP #1

**PRESENTED TO**
RI Heating Sector Stakeholders

**PRESENTED BY**
Dean Murphy
Jurgen Weiss
Alex Stulc

December 13, 2019

THE Brattle GROUP

# 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.

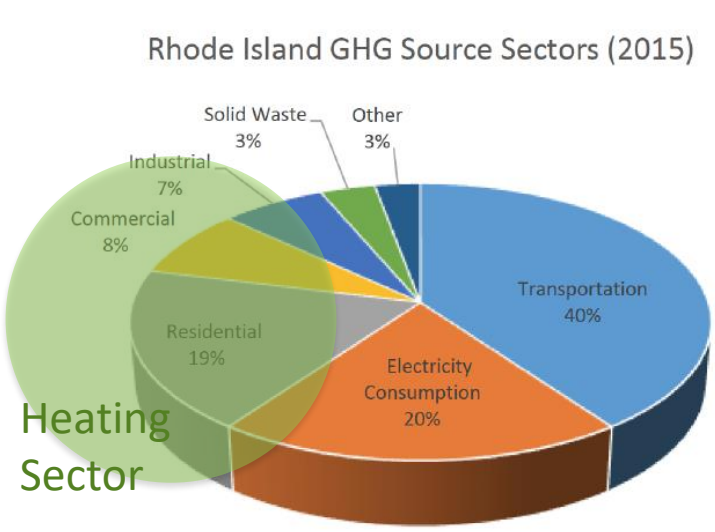
Alexcan Stulc

Adam Friedberg

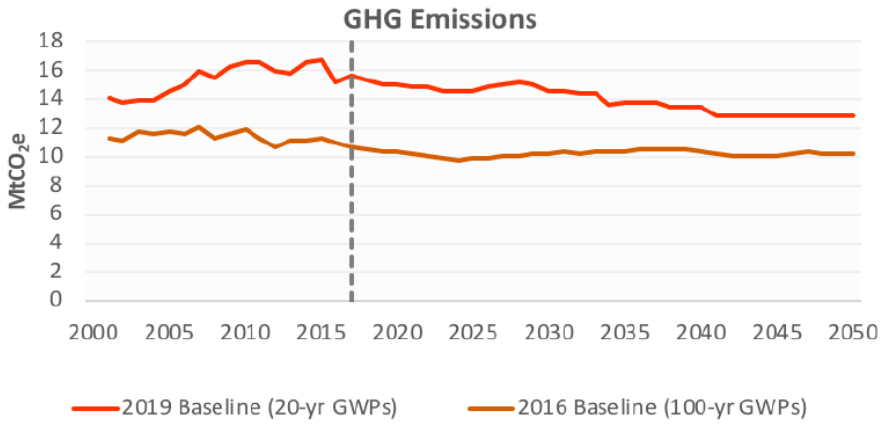
# Rhode Island Heating Sector (Transformation) Background

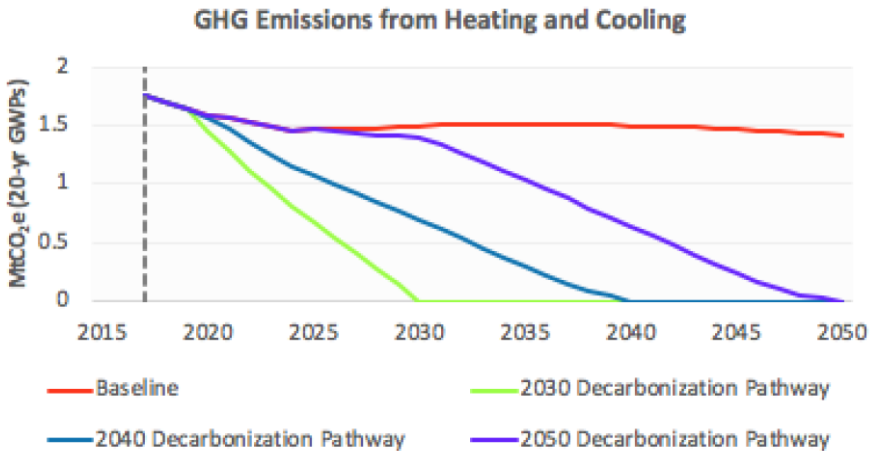
# Resilient Rhode Island Act targets 80% reductions by 2050






*Other includes transmission/distribution, wastewater, agricultural, and land use/land use change/forestry



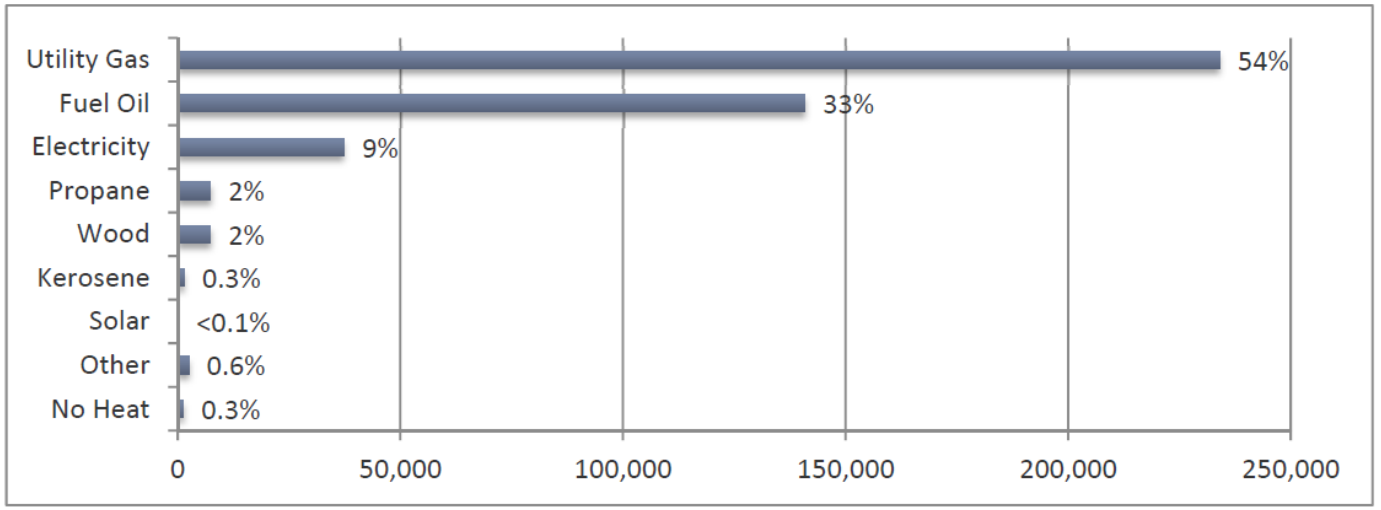



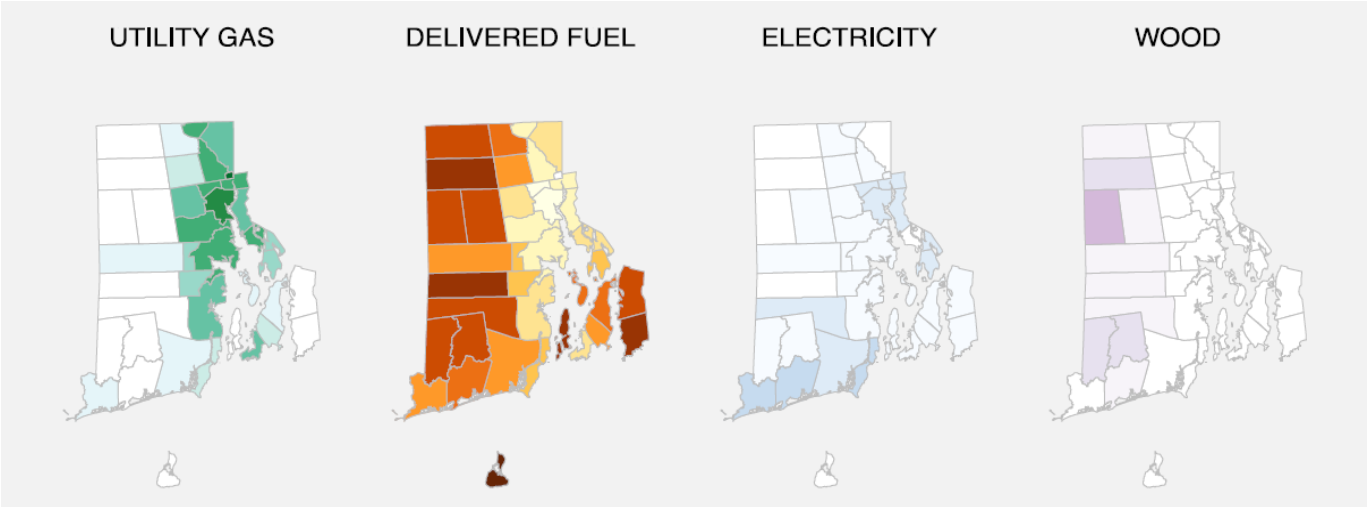

"80 by 50" likely means (near) full decarbonization of heating sector will be needed (since industrial and full transport decarbonization unlikely)

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

Confidential




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

Confidential

## Residential

| Sector | Occupancy | Estimated Households | | Percent of Group Using Each Fuel Category | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Count | % | Utility Gas | Delivered Fuel | Electricity | Wood | Solar | Other | No Heat |
| Single Family | Owned | 227,521 | 53% | 46% | 47% | 3% | 3% | 0% | 1% | 0% |
| Single Family | Rented | 32,185 | 7% | 47% | 42% | 8% | 1% | 0% | 0% | 0% |
| Multifamily | Owned | 31,575 | 7% | 69% | 22% | 10% | 0% | 0% | 0% | 0% |
| Multifamily | Rented | 141,424 | 33% | 66% | 16% | 17% | 0% | 0% | 0% | 1% |
| Total Households | | **432,705** | **100%** | **234,143** | **149,781** | **37,410** | **7,357** | **198** | **2,498** | **1,319** |
| Percent of Total | | | | **54%** | **35%** | **9%** | **2%** | **0.05%** | **0.58%** | **0.30%** |

## Commercial

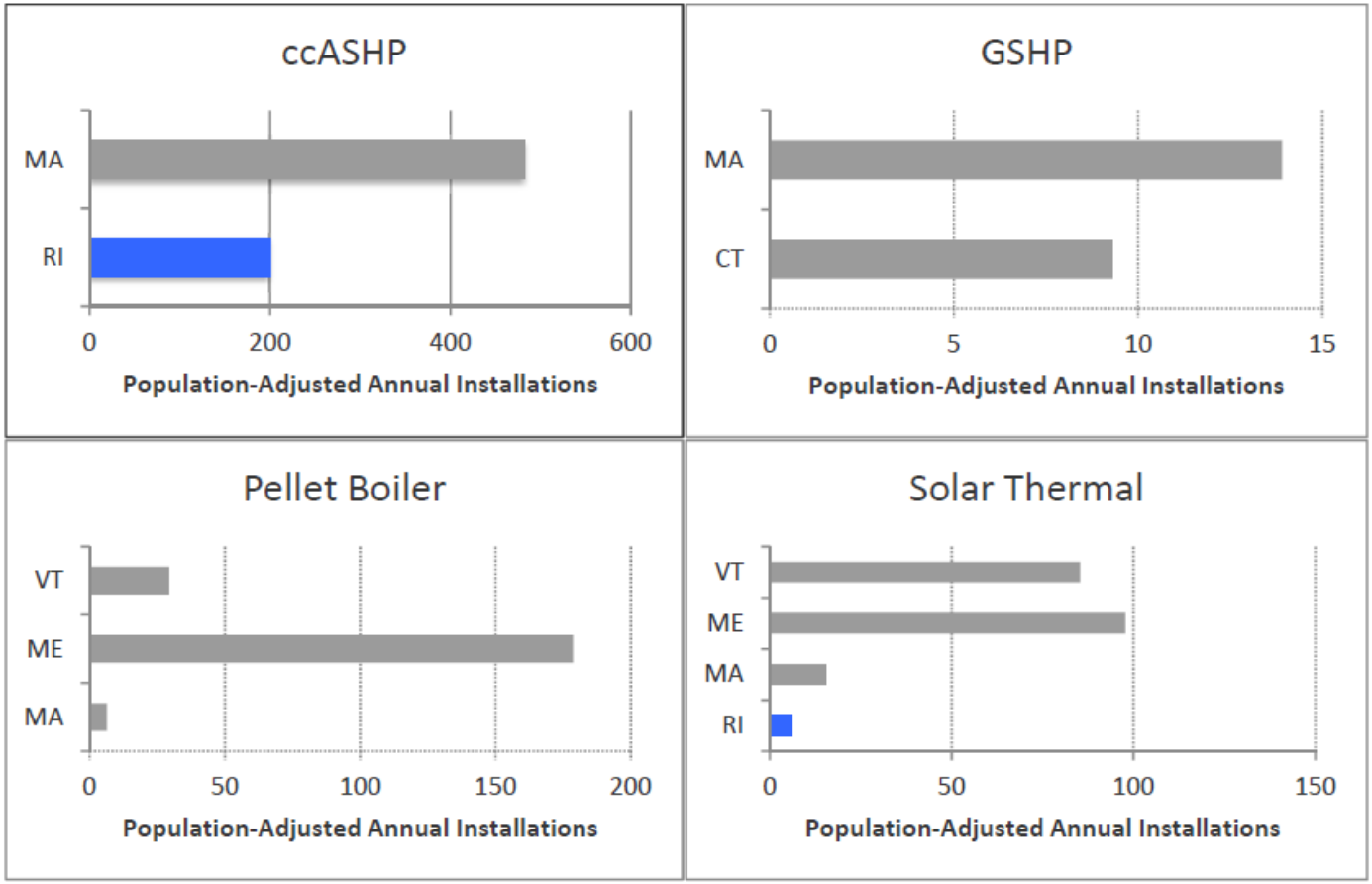
| Fuel | Buildings | | | Heated Square Footage | | |
|---|---|---|---|---|---|---|
| | Small Commercial | Large Commercial | Total | Small Commercial | Large Commercial | Total |
| Delivered Fuel | 43% | 5% | 48% | 14% | 15% | 29% |
| Utility Gas | 19% | 9% | 28% | 9% | 38% | 47% |
| Electricity | 13% | 2% | 14% | 6% | 5% | 11% |
| Wood | 6% | 1% | 6% | 2% | 1% | 2% |
| District Energy | 1% | 1% | 3% | 1% | 8% | 9% |
| Other | 1% | 0% | 1% | 0% | 1% | 1% |
| Total | **82%** | **18%** | **100%** | **32%** | **68%** | **100%** |

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



Figure 3. Annual Installations of Renewable Thermal Technologies in New England[19]

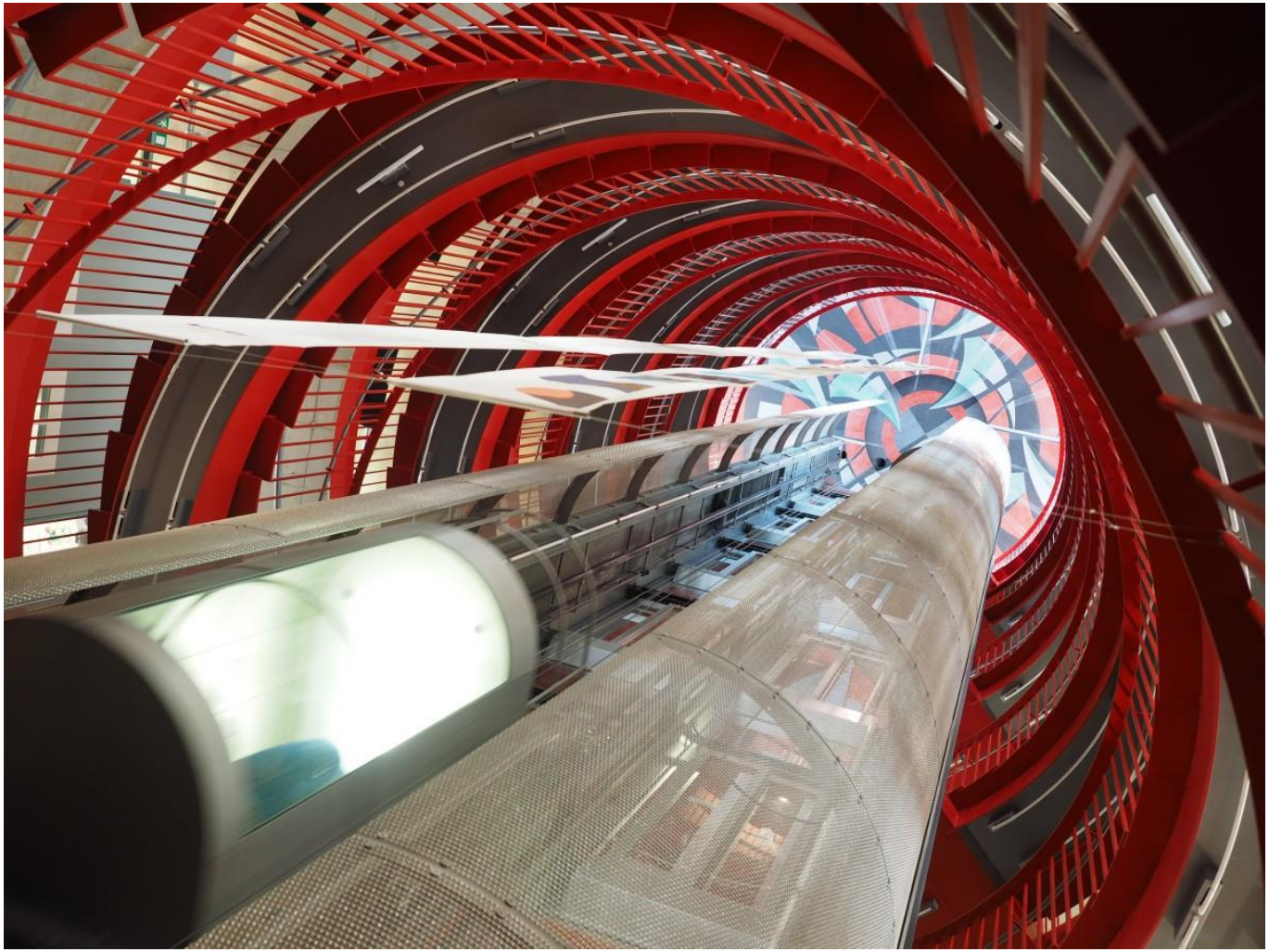



Source: Meister Consultants Group, RHODE ISLAND RENEWABLE THERMAL MARKET DEVELOPMENT STRATEGY, Prepared for Rhode Island Office of Energy Resources, January 2017

# Envisioning a decarbonized heating sector

# Decarbonized buildings: Version A…





https://pxhere.com/en/photo/642739

# …or Version B?



https://www.pxfuel.com/en/free-photo-qwpam

# There are only a few pathways to decarbonizing the heating sector



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

### "Weatherization" (Reduce Energy Needs for heating)

Insulation
Air tightening
Replacement windows
More efficient furnaces and boilers

### (Direct) Electrification

Ground Source Heat Pumps (GSHP)
Air Source Heat Pumps (ASHP)
Induction Electric Cooktops

### Decarbonization of heating "fuels"

Biodiesel/BioLPG
Biogas/Landfill gas
Anaerobic digester gas
Power2Gas/Power2Liquids

### District Heating, Mini-Districts, Individual Heating

## Process Heat (Industrial)

### Efficiency

### Electrification

Resistance, Induction, Microwave

### Fuel Decarbonization

Blue/Green Hydrogen

# Residential buildings need to be decarbonized



https://www.riverlandhomes.com/properties/rio-villas/

# Residential buildings need to be decarbonized **– like this one**.



https://www.riverlandhomes.com/properties/rio-villas/

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."

https://www.greenbuildingadvisor.com/article/just-two-minisplits-heat-and-cool-the-whole-house

https://www.greenbuildingadvisor.com/article/new-englanders-love-heat-pumps

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



https://www.ductlessinduluth.com/featuredproduct.html

# Even big ones…



Stilfehler, August 2008,
https://commons.wikimedia.org/wiki/File:Newport_Rhode_Island_The_Breakers_2.jpg

# Even big ones…**can be electrified.**



Stilfehler, August 2008, https://commons.wikimedia.org/wiki/File:Newport_Rhode_Island_The_Breakers_2.jpg

**"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…"

https://www.ecori.org/renewable-energy/2018/9/13/historic-newport-mansion-goes-geothermal

# 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

https://www.vox.com/energy-and-environment/2019/3/20/18269356/green-new-deal-building-electrification-states-cities

# 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

# But what about my gas stove…




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

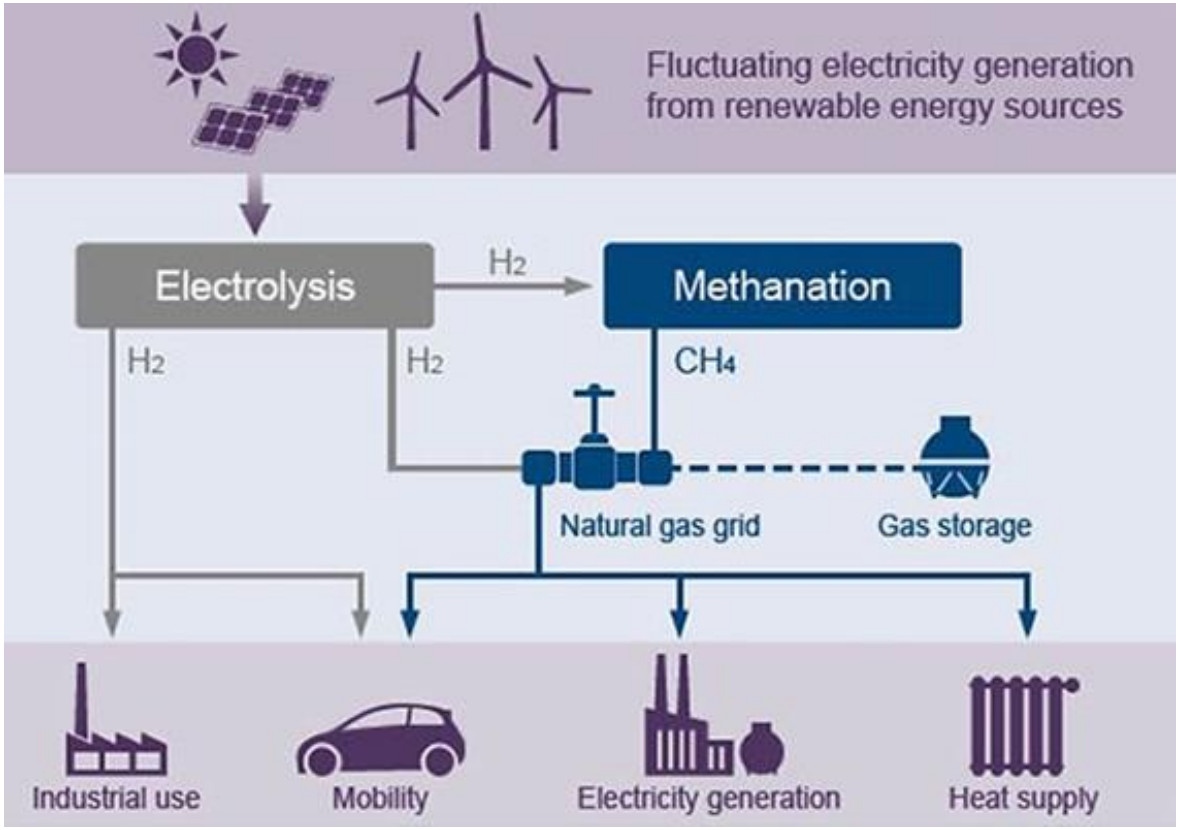
# Agriculture could provide a feed-stock for "bioreactors" making such fuels




Renewable natural gas' from manure and food waste to warm Vermonters; https://vanguardrenewables.com/wp-content/uploads/2019/06/barway-5.jpg

# Power2Gas ("P2G") makes synthetic methane from renewable electricity






https://www.youtube.com/watch?v=BpZV6qtl_kY

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.

# Questions?

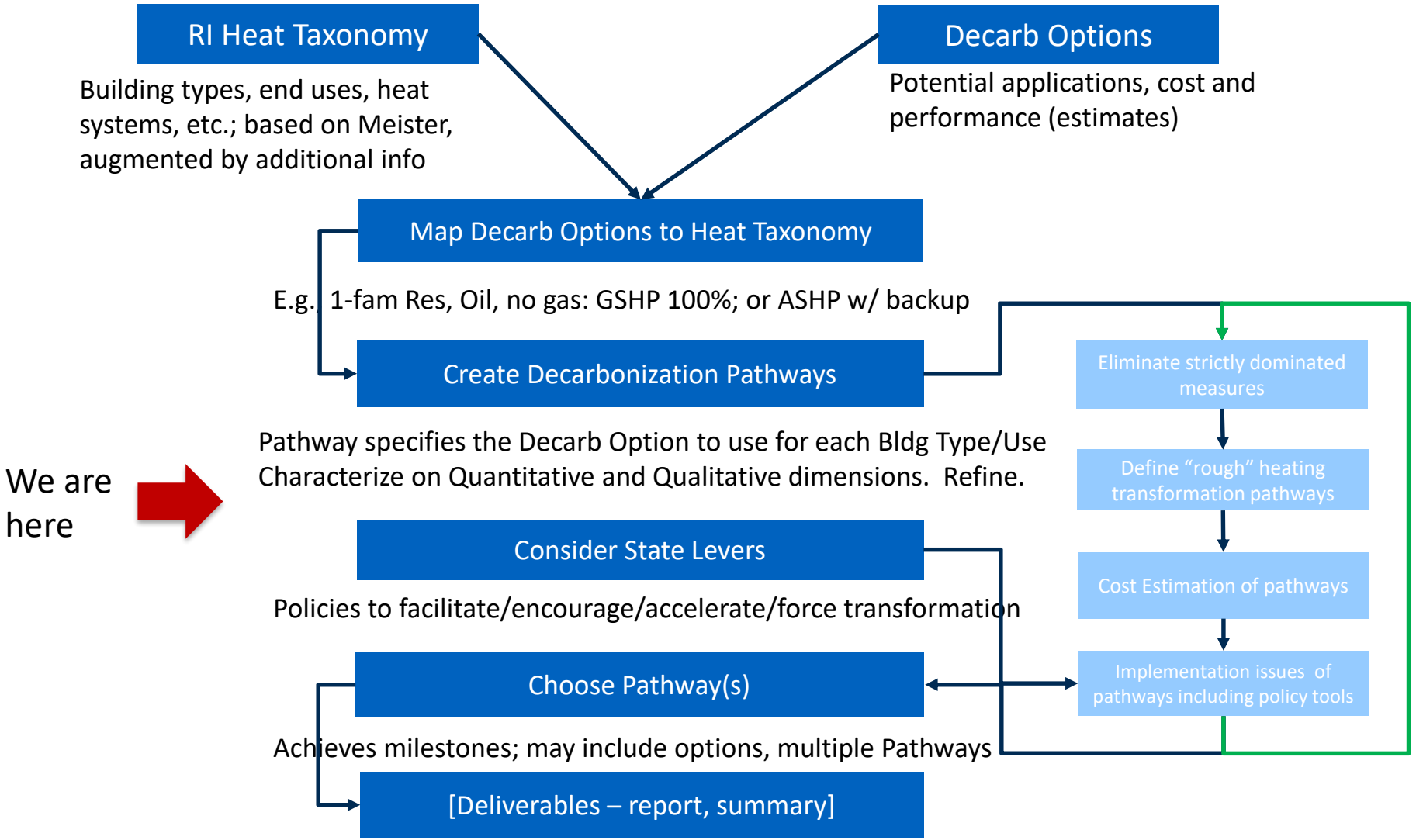
# Break (10 minutes)

# Part B

# Process and Methodology

# Overview of Project Tasks and Methodology





# 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 <u>decarbonized</u> gas
  - Hydrogen or methane
    - $H_2$ via electrolysis (using renewable electricity) or reform natural gas to $H_2$ (fuel) and $CO_2$ (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:



| | | |
|---|---|---|
| Identify and implement "no regret" strategies | Implement policies that improve incentives to align private behavior with social objectives independent of heating transformation objectives alone. | Improve attractiveness of "building trades"<br>Remove fossil subsidies<br>Improve retail price signals |
| Identify dominant strategies/measures | 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. | Accelerate clean electricity deployment<br>Improve information about heating options |
| Identify dominated strategies/measures | Halt incentives and potentially actively discourage measures that are inferior to other approaches under reasonable assumptions about the future. | Stop incentives for gas water heat conversions |
| Strategies/measures that are not dominant/dominated | Develop measure-neutral policies that allow progress, don't foreclose options and avoid unnecessary technology lock-in. | Low carbon heating fuel standards<br>Heating sector GHG caps |

# We have already engaged in numerous 1:1 discussions with stakeholders



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

# Several important insights have emerged from these discussions



Don't force single technological solution

Don't see how you can do it without district heat

Standardization can bring down the cost of GSHPs

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

No combustion onsite for new buildings

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

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

Methane leaks affect both fossil and "decarbonized" gas

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

Air source heat pumps <u>can</u> 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

# Backup

Table 5. Estimated Number of Rhode Island Households by Heating Fuel and Heating System

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

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

| Fuel | Buildings | | | Heated Square Footage | | |
|---|---|---|---|---|---|---|
| | Small Commercial | Large Commercial | Total | Small Commercial | Large Commercial | Total |
| Packaged System | 30% | 6% | 37% | 12% | 22% | 34% |
| Boiler | 22% | 7% | 28% | 9% | 30% | 39% |
| Electric Resistance | 17% | 2% | 19% | 5% | 3% | 8% |
| Furnace | 7% | 1% | 8% | 2% | 2% | 5% |
| Heat Pump | 4% | 0% | 4% | 3% | 2% | 5% |
| District Heat | 1% | 1% | 3% | 1% | 8% | 9% |
| Other | 1% | 0% | 1% | 0% | 0% | 0% |
| Total | **82%** | **18%** | **100%** | **32%** | **68%** | **100%** |

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