

MassCEC Clean Heating & Cooling Programs

Opportunities and Lessons Learned in Low-Carbon Heating

Massachusetts Energy Efficiency Advisory Council

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Peter McPhee
Sr. Program Director
pmcphee@masscec.com
617-315-9343



Our Mission

Grow the state's clean energy industry while helping to meet the Commonwealth's clean energy, climate and economic development goals.

INVEST

Invest in programs that increase renewable energy adoption by residents, businesses and communities.

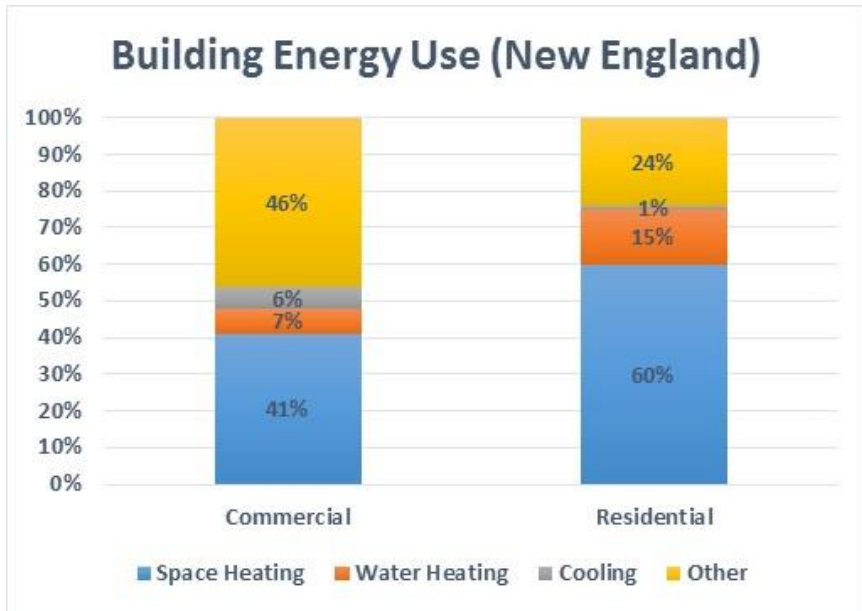
CONNECT

Connect employers, job seekers, students, communities and investors to the clean energy industry.

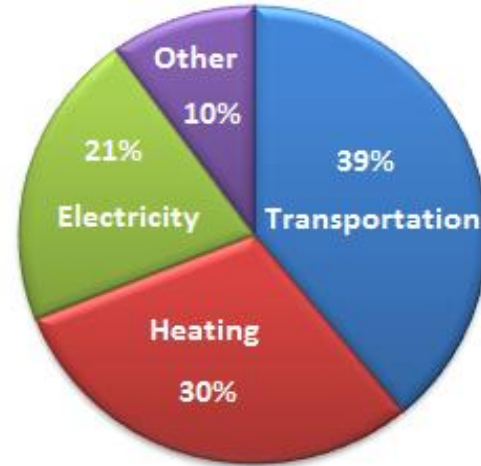
INNOVATE

Help to spur innovation through infrastructure, funding and technology development support.

Heating in MA: lots of energy, money, and carbon

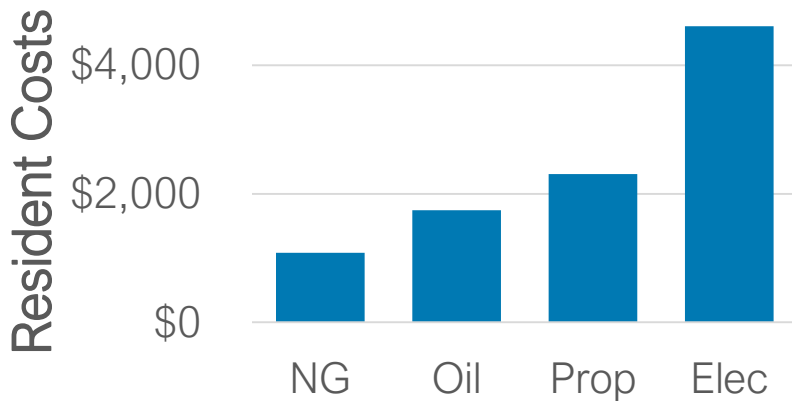


GHG Emissions (MA)



MA GWSA reduction targets

- 25% by 2020
 - 80% by 2050
 - Relevant Studies
 - Comprehensive Energy Plan (2018)
 - 2020 GWSA Progress Report (2019)
- **Broad transition to heat pumps**



MassCEC's Clean Heating & Cooling Programs

- Starting in 2013, MassCEC has worked to develop a market and industry for low carbon heating through our Clean Heating & Cooling (CH&C) Programs
 - Invested over \$60 million
 - Supported over 20,000 projects
 - Worked with over 700 businesses
- Heating electrification is a fundamental strategy in state energy and decarbonization plans
- MassCEC began phase-out of programs in 2019 due to funding constraints and incentive programs will fully end in 2020
- MassCEC is seeking to share program data, industry information/connections, program technical design, & lessons learned

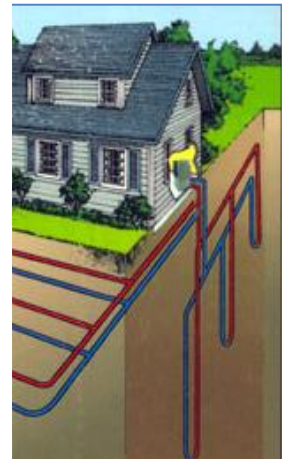
CH&C Collaboration with PAs

- CH&C Programs and PAs have had collaborative relationship since 2015
 1. Occasional presentations to PA committees
 2. Monthly check-ins with residential representatives
 3. Joint industry stakeholder forums (VRF and GSHP in July 2019)
 4. Sharing of program data and lessons learned (2019)
- Some joint consumer outreach initiatives
- MassCEC goals somewhat different than PAs
 - GHG and economic development focused
 - Longer timescales: programs target transition over decades
- Overlap in industries, technologies, customers, barriers, and energy reduction focus

MassCEC CH&C Technologies

Technologies

- Air-Source Heat Pumps
 - Mini-Splits (residential)
 - VRF (commercial)
- Central Biomass Heating
- Ground-Source Heat Pumps
- Solar Thermal
- Advanced Wood Stoves



CH&C General Lessons Learned

- Heating system replacements/fuel switching is difficult
 - Most cost-effective at end-of-life, but challenging to switch without planning ahead
 - New construction/renovation an easier opportunity
 - “Quality of heating” is very personal – this is a challenge and an opportunity
 - Design and operation of each building is different: a new heating system cannot be a plug and play solution like an electric vehicle or solar PV
- Heating system replacements are infrequent (~15 years) and building upgrades are even less frequent (30-40 years)
- Opportunity to bundle deep weatherization with heating upgrades to reduce heating system upfront costs, improve performance, and gain large savings
- Industry stakeholders consistently identify three primary hurdles to scale industry:
 1. Upfront costs
 2. Awareness of technologies
 3. Workforce challenges (e.g. forthcoming HVAC retirements)

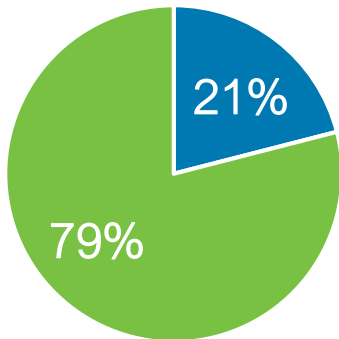
Program Takeaways

Residential ASHP Snapshot



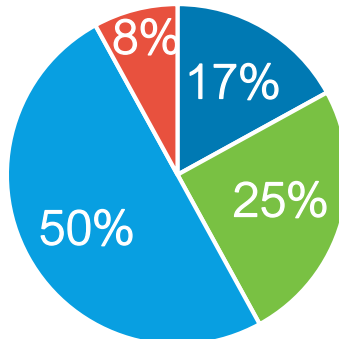
Timeline	Nov 2014 – Mar 2019
Number of Projects	20,094
Total Awards	\$28,150,681
Average Capacity	29.3 MBH
Cost (50 th Percentile)	\$325/MBH (heating)
Cost (25 th Percentile)	\$250/MBH (heating)

Usage: Rebate



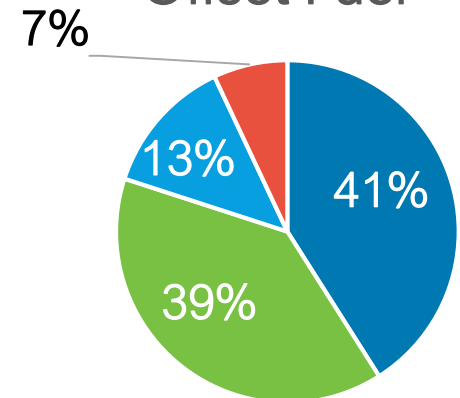
- Primary
- Not Primary

Usage: Survey



- Primary
- Supplemental
- Primary: 1 zone
- A/C

Offset Fuel



- Natural Gas
- Oil
- Electric
- Prop/Oth

Residential ASHP Takeaways

1. ASHPs represent highest potential for scalable clean heating technology
2. Technology has matured significantly, with more manufacturers and configurations
3. Strong market demand with increasing awareness
4. Robust supply chain, but constrained workforce
5. Cost-effective heating solution against oil, propane, electric
6. Opportunity to transition to low-carbon heating when adding A/C
7. Most projects still supplementary: prevalence of whole-home projects increasing
8. Some projects are high-efficiency all-electric homes

Mass Save implemented strong ASHP rebate program on Jan. 1, 2019

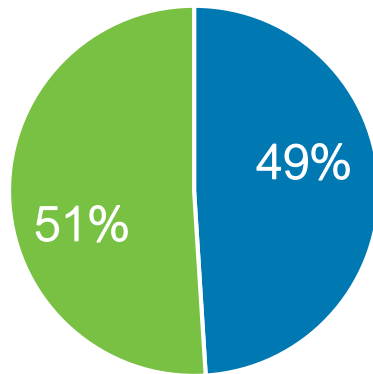
- Incentives for non-NG customers helped MassCEC justify ending program

VRF Snapshot



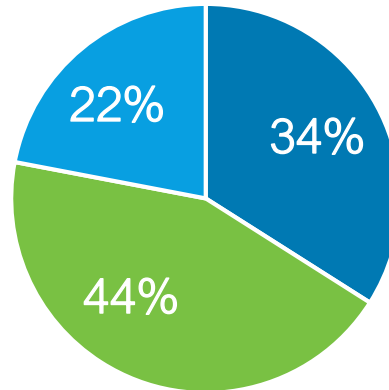
Timeline	May 2017 – May 2019
Number of Projects	107
Total Awards	\$5,995,000
Average Capacity	585 MBH
Cost (50 th Percentile)	\$695/MBH (heating)
Cost (25 th Percentile)	\$589/MBH (heating)

Project Type



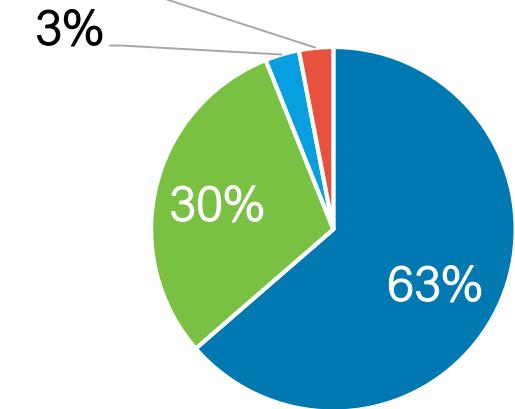
■ NC/Renovation
■ Retrofit

Building Sector



■ Comm
■ Aff Housing
■ Public/NP

Offset Fuel

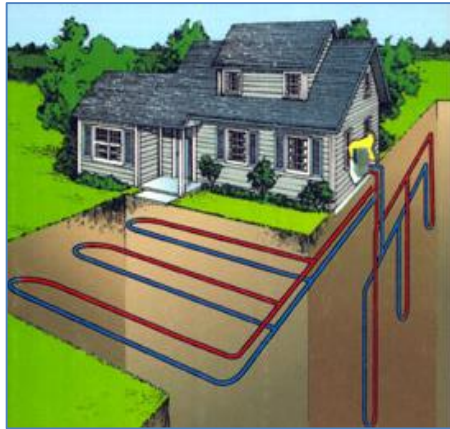


■ Natural Gas
■ Oil
■ Electric
■ Propane/Other

VRF Takeaways

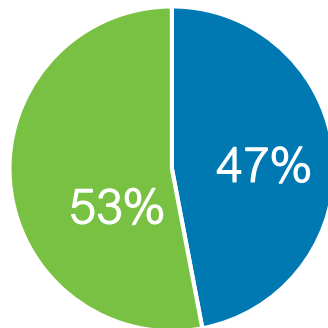
1. VRF is broadly applicable, low-carbon solution for commercial buildings in MA
2. Market demand exists today
3. VRF modelled to deliver lower heating costs than oil, propane, ER and lower cooling costs
4. Alternative is typically fossil fuel system with traditional A/C
5. VRF upfront costs sometimes lower than traditional heating and cooling systems (when distribution costs accounted for)
6. Customers motivated by cost savings, comfort improvements, and environmental benefits – additional benefits of space savings, integrated A/C, aesthetics, air quality
7. Industry supply chain is relatively advanced
8. Awareness remains low
9. Contractor experience is low

GSHP-Residential Snapshot

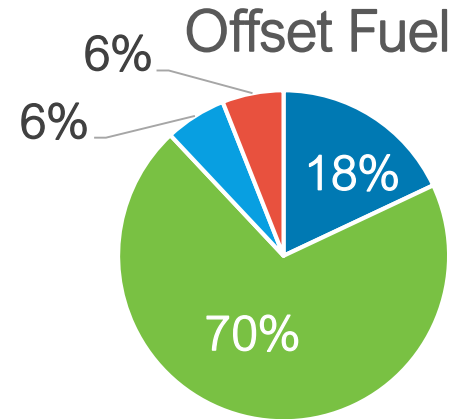


Timeline	Nov 2014 – Present
Number of Projects	414
Total Awards	\$4,006,009
Average Capacity	60.6 MBH
Cost (50 th Percentile)	\$866/MBH (heating)
Cost (25 th Percentile)	\$714/MBH (heating)

Project Type

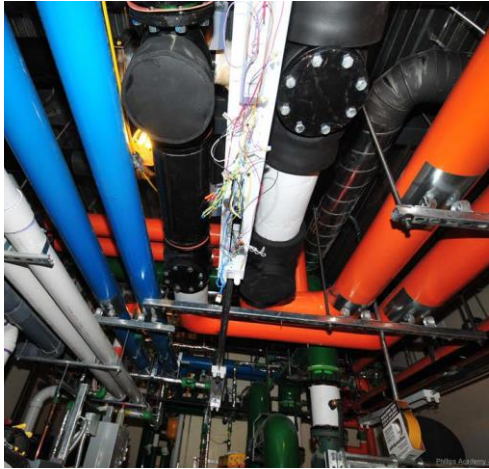


■ NC/Reno
■ Retrofit



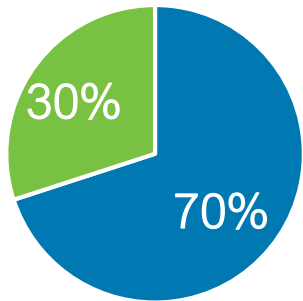
■ NG ■ Oil
■ Elec ■ Prop/Oth

GSHP-Commercial Snapshot



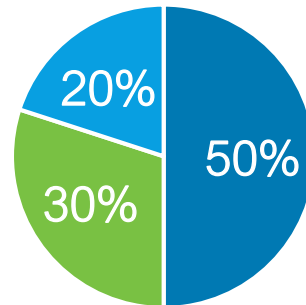
Timeline	Sept 2013 – June 2019
Number of Projects	16
Total Awards	\$1,714,000
Average Capacity	1,900 MBH
Cost (50 th Percentile)	\$998/MBH (heating)
Cost (25 th Percentile)	\$817/MBH (heating)

Project Type



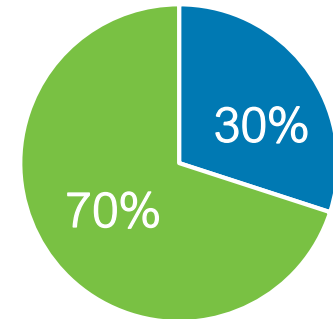
- NC/Reno
- Retrofit

Building Sector



- Private
- Affordable
- Public/NP

Offset Fuel



- NG
- Oil

GSHP Takeaways

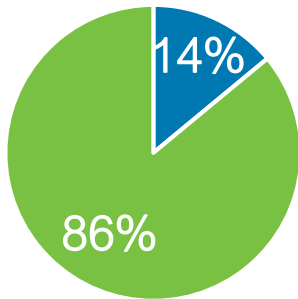
1. Existing market demand
2. Technology is highly efficient – lowest total carbon impact of CH&C techs
3. Operational costs competitive with natural gas, significantly cheaper than oil, propane, electric resistance
4. GSHP are part long-term asset (loop field at 50-100 years) and part heat pump technology (20 - 25 years)
5. Installations are complex and costs are high due to drilling, but offer high efficiency operation
6. Awareness remains low
7. Contractors mostly consolidated to smaller number of experienced firms
8. Significant efforts underway in NY to reduce cost of GSHP installations
9. GSHP sometimes competitive with whole-home ASHP (after federal tax credit)

Solar Hot Water Snapshot



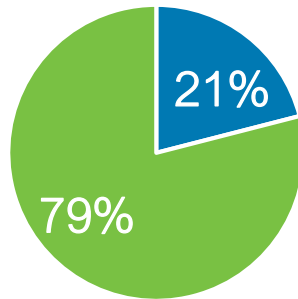
Timeline	April 2011– Present
Number of Projects (Res)	1,314
Number of Projects (Comm)	123
Total Awards	\$6,974,584
Average Cost per Collector	\$4,700

Project Type
(Res)



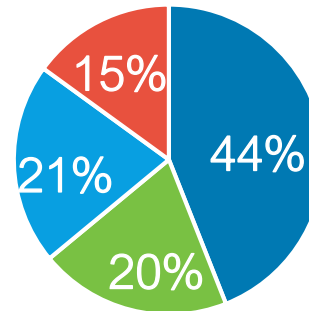
- NC/Reno
- Retrofit

Project Type
(Comm)



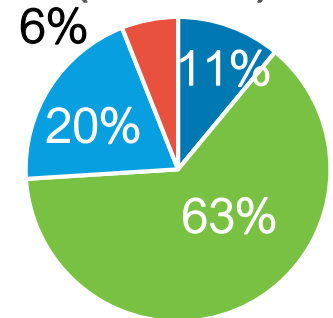
- NC/Reno
- Retrofit

Offset Fuel
(Res)



- Oil
- Elec
- NG
- Prop

Offset Fuel
(Comm)



- Oil
- Elec
- NG
- Prop

Solar Hot Water Takeaways

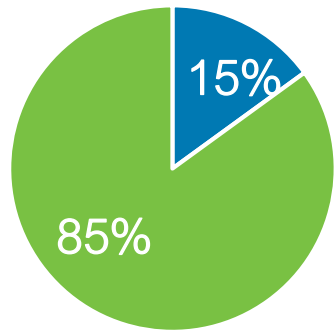
1. Existing market demand for one of the only low-carbon hot water solutions
2. Cost-effective against oil, propane, electric resistance water heating. Marginal against natural gas.
3. DHW becomes larger proportion of load as homes become tighter
4. Contractors are mostly consolidated to small number of experienced firms
5. Project costs and volume have stayed relatively constant over past several years
6. More energy per square foot than solar PV

Modern Wood Heat-Res Snapshot

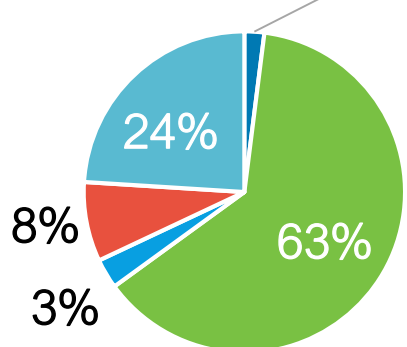


Timeline	Nov 2014 – Present
Number of Projects	117
Total Awards	\$1,633,595
Average Capacity	64.21 MBH
Cost (50 th Percentile)	\$434/MBH (heating)
Cost (25 th Percentile)	\$356/MBH (heating)

Project Type



Offset Fuel



Takeaways:

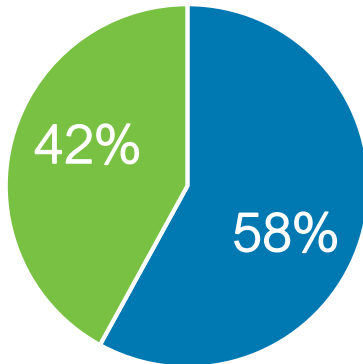
1. Wood is cheapest delivered fuel
2. Fuel price very stable
3. Clean burning, high satisfaction, fully automated
4. Local, sustainable fuel supply chain
5. MassCEC supported 12 commercial projects: very cost-effective

Woodstove Change-Out Snapshot



Timeline	2012– Present
Number of Projects	2564
Total Awards	\$3,936,507
2019 Average Costs	\$4,234,31
2019 Average Rebate Standard	\$1,328
2019 Average Rebate LI	\$2,738

of Awards



■ Standard ■ Low-Income

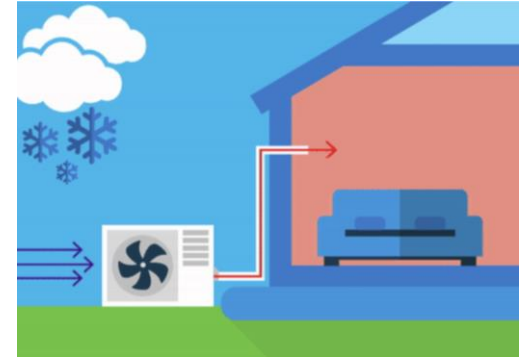
Takeaways:

1. Most stoves displace fossil fuel heating
2. Cheaper operational costs than oil, propane, electric resistance
3. Woodstove usage higher for lower income, rural households

Targeted Clean Heating Initiatives: 2020

Whole-Home ASHP Pilot: “the heating system of 2030”

- Identify cost-effective, replicable designs for whole-home heat pump implementation
 - New construction: no fossil fuels
 - Retrofit: system serves 100% of heat load, must replace NG



HeatSmart Mass:

- Generate local scaling of CH&C adoption
- Pilot energy solutions and business models
- Communities partner, select technologies, and dedicate team of volunteers

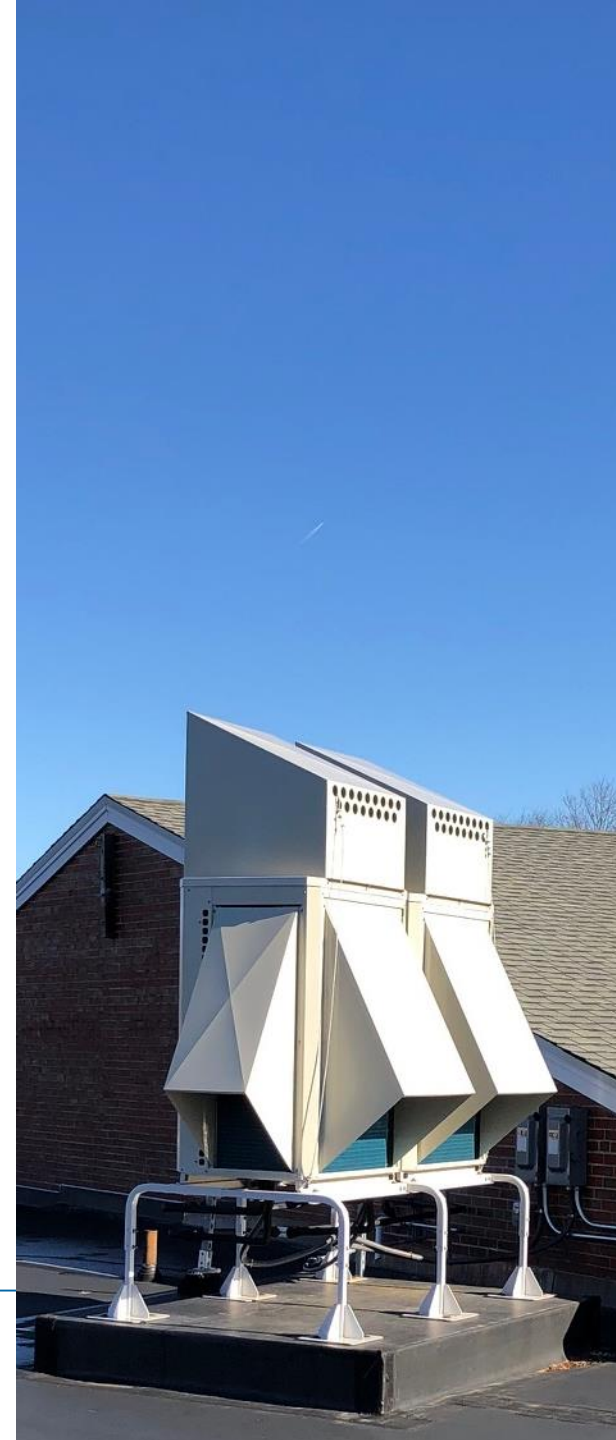
Clean Energy Lives Here:

- Public awareness and education campaign
- Supporting consumers in planning for home decarbonization
- Aiming for larger coalition campaign in 2021



Conclusions

- CH&C technologies offer solution for decarbonizing enormous chunk of MA energy usage
- Technologies are relatively mature and industry is prepared for growth
- Market demand exists today and is growing
- Hurdles remain for broad scaling:
 1. Costs
 2. Awareness
 3. Workforce
 4. Technological refinement
- Continued need for state or utility support in order to scale industries in line with state ambitions



Thank you