MassCEC Clean Heating & Cooling Programs

Opportunities and Lessons Learned in Low-Carbon Heating

Massachusetts Energy Efficiency Advisory Council
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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

MA GWSA reduction targets
- 25% by 2020
- 80% by 2050

Relevant Studies

➢ 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)
- 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

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

Usage: Rebate

- Primary: 79%
- Not Primary: 21%

Usage: Survey

- Primary: 50%
- Supplemental: 25%
- A/C: 8%
- Primary: 1 zone: 17%

Offset Fuel

- Natural Gas: 39%
- Electric: 41%
- Oil: 3%
- Prop/Oth: 7%
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

<table>
<thead>
<tr>
<th>Timeline</th>
<th>May 2017 – May 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Projects</td>
<td>107</td>
</tr>
<tr>
<td>Total Awards</td>
<td>$5,995,000</td>
</tr>
<tr>
<td>Average Capacity</td>
<td>585 MBH</td>
</tr>
<tr>
<td>Cost (50th Percentile)</td>
<td>$695/MBH (heating)</td>
</tr>
<tr>
<td>Cost (25th Percentile)</td>
<td>$589/MBH (heating)</td>
</tr>
</tbody>
</table>

Project Type

- NC/Renovation: 51%
- Retrofit: 49%

Building Sector

- Comm: 34%
- Public/NP: 44%
- Aff Housing: 22%

Offset Fuel

- Natural Gas: 30%
- Electric: 63%
- Oil: 3%
- Propane/Other: 3%
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**

<table>
<thead>
<tr>
<th>Project Type</th>
<th>NC/Reno</th>
<th>Retrofit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>53%</td>
<td>47%</td>
</tr>
</tbody>
</table>

- **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)

**Offset Fuel**

- **NG**: 18%
- **Elec**: 70%
- **Oil**: 6%
- **Prop/Oth**: 6%
GSHP-Commercial Snapshot

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

Project Type:
- 30% NC/Reno
- 70% Retrofit

Building Sector:
- 50% Private
- 30% Public/NP
- 20% Affordable

Offset Fuel:
- 70% NG
- 30% 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: 86%
- Retrofit: 14%

Project Type (Comm)
- NC/Reno: 79%
- Retrofit: 21%

Offset Fuel (Res)
- Oil: 15%
- NG: 44%
- Elec: 21%
- Prop: 20%

Offset Fuel (Comm)
- Oil: 20%
- NG: 63%
- Elec: 11%
- Prop: 6%
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 (50th Percentile)
- $434/MBH (heating)

## Cost (25th Percentile)
- $356/MBH (heating)

### Project Type

- **85%**: NC/Renovation
- **15%**: Retrofit

### Offset Fuel

- **63%**: Wood
- **24%**: NG
- **8%**: Oil
- **3%**: Prop
- **2%**: Elec

## 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

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

# of Awards
- Standard: 58%
- Low-Income: 42%
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