THERMAL ELECTRIFICATION OF LARGE BUILDINGS IN THE COMMONWEALTH

MONDAY, JUNE 29TH, 2020

BOSTON Green Ribbon COMMISSION

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AGENDA

11:00 – 11:05 AM	**INTRODUCTION** Yve Torrie, Director of Climate, Energy and Resilience, A Better City
11:05 – 11:30 AM	**REPORT SUMMARY – TECHNOLOGIES, BARRIERS, POLICY OPTIONS & STRATEGIES, & KEY TAKEAWAYS** Jeremy Koo & Ajey Pandey, Cadmus
11:30 – 11:45 AM	**CONSERVATION LAW FOUNDATION CASE STUDY: 62 SUMMER STREET, BOSTON** Brad Campbell, President, Conservation Law Foundation
11:45 – 12:00 PM	**AKELIUS CASE STUDY: CARSON TOWER, 1410 COLUMBIA RD, BOSTON** Eli Herman, Construction Manager, Akelius
12:00 – 12:25 PM	**FACILITATED Q&A** John Cleveland, Executive Director, Boston Green Ribbon Commission
12:25 – 12:30 PM	**CLOSING REMARKS** Kate Dineen, Executive Vice President, A Better City

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Ajey Pandey, Research Analyst, Cadmus
Jeremy Koo, Associate, Cadmus
Yve Torrie, Director of Climate, Energy & Resilience, A Better City

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AGENDA

- Context for Thermal Electrification
- Overview of Technologies
- Barriers to Electrification
- Policy Options and Strategies

CONTEXT

- Reducing carbon emissions from buildings is vital to the Boston and Commonwealth meeting carbon reduction goals by 2050.
- Major strategy for large building decarbonization is transitioning heating, cooling, and hot water to non-fossil fuels
    - Through **electrification** powered by renewable energy

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OVERVIEW OF TECHNOLOGIES

AIR SOURCE HEAT PUMPS (ASHP)	VARIABLE REFRIGERANT FLOW (VRF) HEAT PUMPS	GROUND SOURCE HEAT PUMPS (GSHP)
• Transfer heat from outdoor air to conditioned indoor space • Can be ductless (mini-split) or ducted (central) • Ductless systems can be certified as “cold climate” models by NEEP	• Central high-capacity heat pump system with adjustable rate of heat transfer • May have “heat recovery” feature allowing for simultaneous heating and cooling	• Transfer heat from buried ground loop to conditioned indoor space • Can use water or air distribution inside building • Requires drilling to install ground loop

NEEP: Northeast Energy Efficiency Partnership

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AIR SOURCE HEAT PUMPS

- Best fit for low- and mid-rise multifamily buildings
- Approx. $3,900+ per ton

BENEFITS	DRAWBACKS
• Individual systems allow for per-user control • Flexible installation options • Operating costs can be directly metered to occupants • Can increase flood resiliency	• Efficiency reduced by cold temperatures • Individual systems may increase maintenance requirements • Unit electric service upgrades may be required

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VRF HEAT PUMPS

- Best fit for mixed-use, office, multifamily buildings
- Approx. $8,300+ per ton

BENEFITS	DRAWBACKS
• No mechanical room required • Heat recovery improves comfort and efficiency • Multiple zones operate independently • Can increase flood resiliency	• Efficiency reduced by cold temperatures • Increases demand charges in winter • Requires replacing existing distribution systems • High volume of refrigerants required

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GROUND SOURCE HEAT PUMPS

- Best fit buildings with open space (e.g. parking lots)
- Approx. $12,000+ per ton

BENEFITS	DRAWBACKS
• Highest-efficiency option for heating and cooling • Reduced mechanical room requirements • Low maintenance costs • High ground loop lifetime • Can increase flood resiliency	• Requires space to drill boreholes for ground loop • Installed cost typically higher than other heat pump options • Distribution system modifications may be necessary in retrofit projects.

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EMERGING TECHNOLOGIES

HYDROGEN	AIR-TO-WATER HEAT PUMPS	DISTRICT GEOTHERMAL
• Potential complementary technology to heat pumps • Potential technology for combined heat & power systems • Major technology gaps exist • Infrastructure for hydrogen distribution not in Boston	• Similar technology to ASHPs • Limited availability in U.S. • Limited compatibility with existing hydronic distribution	• Potential to address many barriers to individual geothermal installations in urban context • Financing and business model for third-party geothermal network is untested

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BARRIERS

- Economics
- Policy and Regulatory
- Decision Making
- Awareness
- Technical and Building
- Workforce

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ECONOMIC BARRIERS

- Electrification technologies often have higher upfront costs than conventional fossil fuel equipment
  - Especially in retrofit applications
- Electrification may lead to increased energy costs
  - Cooling savings may be achieved
  - High cost of electricity vs. low cost of fossil fuels may increase heating costs
- Incremental costs can be reduced for new construction and renovations

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POLICY AND REGULATORY BARRIERS

- MA's new statewide energy efficiency targets allow fuel switching where cost-effective
- By existing metrics, switching from gas to electric faces challenges in achieving cost effectiveness, reducing incentive potential for thermal electrification
- Non-energy benefits of electrification are not valued enough in regulatory structures to compensate

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DECISION MAKING BARRIERS

- Some building owners have goals that disincentivize electrification
- Leasing structures can also lead to split incentives between building owners and tenants

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AWARENESS BARRIERS

- Building practitioners have low familiarity and experience with thermal electrification
- Building owners are often unaware thermal electrification is an option
- When an HVAC system breaks down, building managers typically seek like-for-like replacements

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WORKFORCE BARRIERS

- HVAC contractors are less familiar with installation, maintenance, and incentives for thermal electrification
- Maintenance staff will need to be re-trained when switching to thermal electrification technologies

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POLICY OPTIONS AND STRATEGIES

	FINANCIAL RISK REDUCTION STRATEGIES	INCENTIVES AND RATE STRUCTURES	CODES, STANDARDS, AND MANDATES	OTHER POLICIES/STRATEGIES
POLICY AND REGULATORY		x		
ECONOMICS	x	x	x	
DECISION MAKING	x		x	
AWARENESS	x			
TECHNICAL AND BUILDING				x
WORKFORCE				x

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POLICY OPTIONS AND STRATEGIES

- Financial Risk Reduction:
  - Use advanced metering data to improve building performance data quality
  - Promote standardization of thermal electrification projects for lending, installation, quality control
  - Implement green leasing strategies, third-party ownership models for renewable thermal
  - Support green banks and beneficial financing for sustainability projects

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POLICY OPTIONS AND STRATEGIES

- Incentives and Rate Structures:
  - Increase and streamline utility incentives for thermal electrification
  - Adjust utility rate structures for electricity and gas
- Codes, Standards, and Mandates:
  - Building codes and zoning reforms
  - Building energy and emissions performance strategies
  - Minimum renting standards for building performance
  - Natural gas restrictions
- Other Policies
  - Manufacturer partnerships
  - Workforce training

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CASE STUDIES

- A GSHP project in an **existing historic** municipal building of 14,000 square feet with occupants relocated during construction
- A VRF project in an **existing commercial office** building of 22,000 square feet with occupants relocated during construction
- A VRF project in an **existing commercial office** building of 71,000 square feet over four floors with occupants present during construction.
- A VRF project in an **existing multifamily residential** building of 153 units with occupants present during partial construction and individual units converted when tenants allow contractors into their units or upon turnover
- A GSHP project in a **newly constructed higher education** building of 345,000 square feet over 19 stories

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CASE STUDIES

TECHNOLOGY	BUILDING TYPE	SIZE	APPLICATION
GSHP	Historical Renovation	14,000 sf	Municipal
GSHP	New Construction	345,000 sf	Higher education
VRF	**Phased Renovation**	**22,000 sf**	**Commercial office**
VRF	**Phased Renovation**	**153 units**	**Multifamily residential**
VRF	Displacement Renovation	71,000 sf	Commercial office

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CONCLUSION

- Thermal electrification technology is widely available and is being installed
- Installation can be technically feasible in select circumstances
  - End of life (EOL) replacement
  - Major renovation
  - New construction

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CONCLUSION

- Electrification faces challenges, including:
  - High upfront costs
  - Policy and regulatory barriers to incentives and rebates
  - Split-incentive barriers between tenants and building owners
- Adoption is accelerating
  - Required scale of adoption for decarbonization will require more incentives, policies, and mandates

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