Decarbonization of Public Buildings in East Lansing : From Boiler to Heat Pump

EGLE
MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

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CITY OF EAST LANSING, MICHIGAN

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Why is there a need for decarbonization?

Reduce carbon emissions and promote clean energy usage

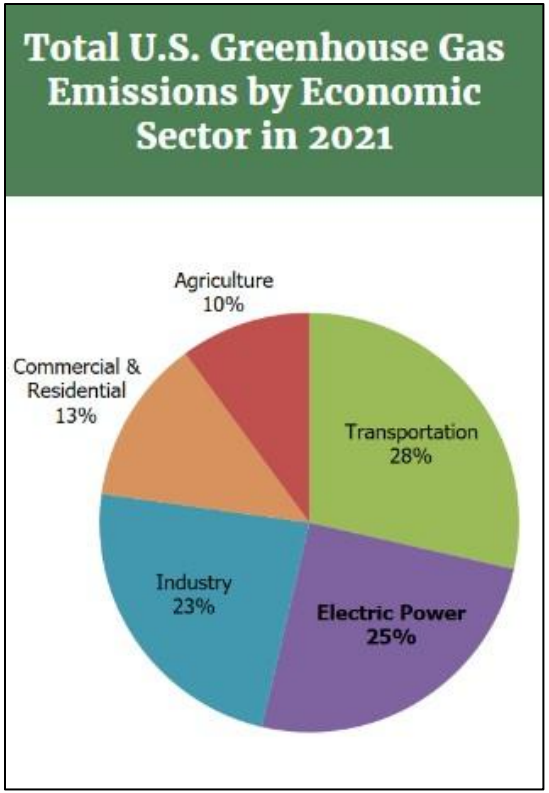
Transition from fossil fuel based systems to electrical systems

Cost-effective investments

Energy efficiency

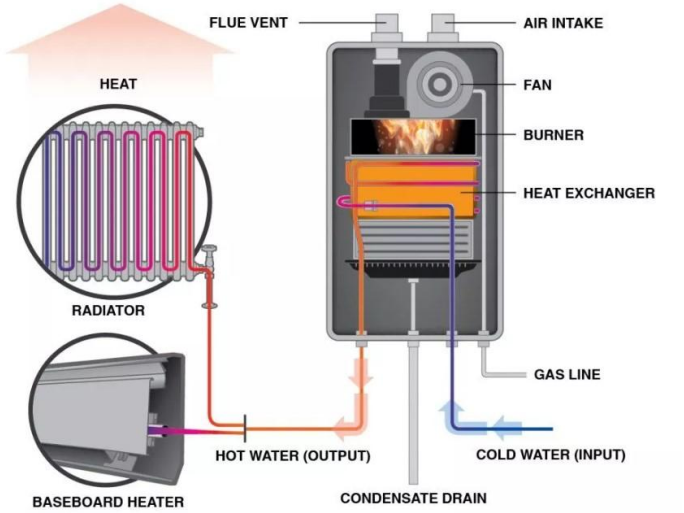
Be the leaders and set a standard for the community

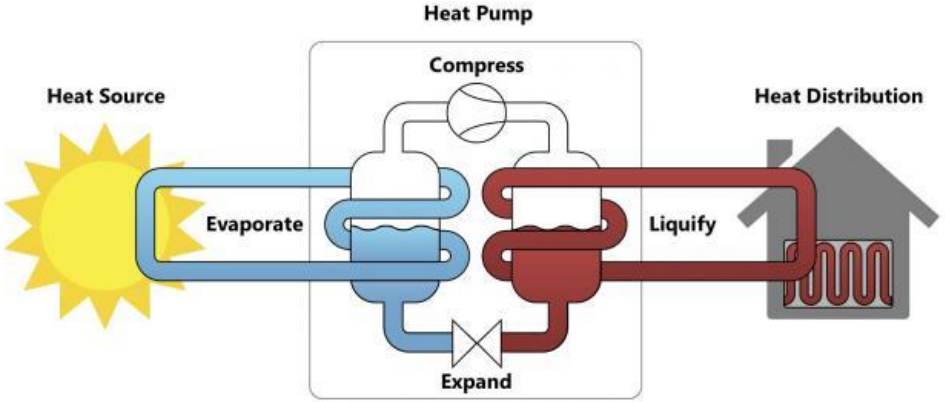
Renewable energy compatibility



Source: Sources of Greenhouse Gas Emissions | US EPA. (2015, December 29).

Why switch to electricity ?

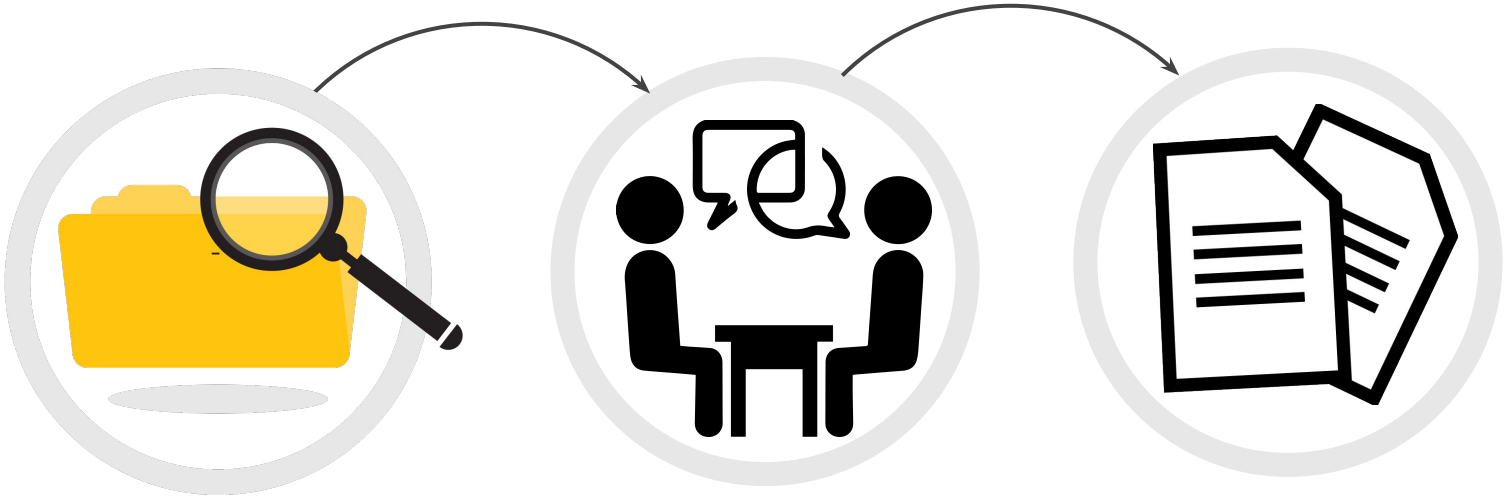




215g of CO2 per kWh

Formation of the report

Methods



Case Studies

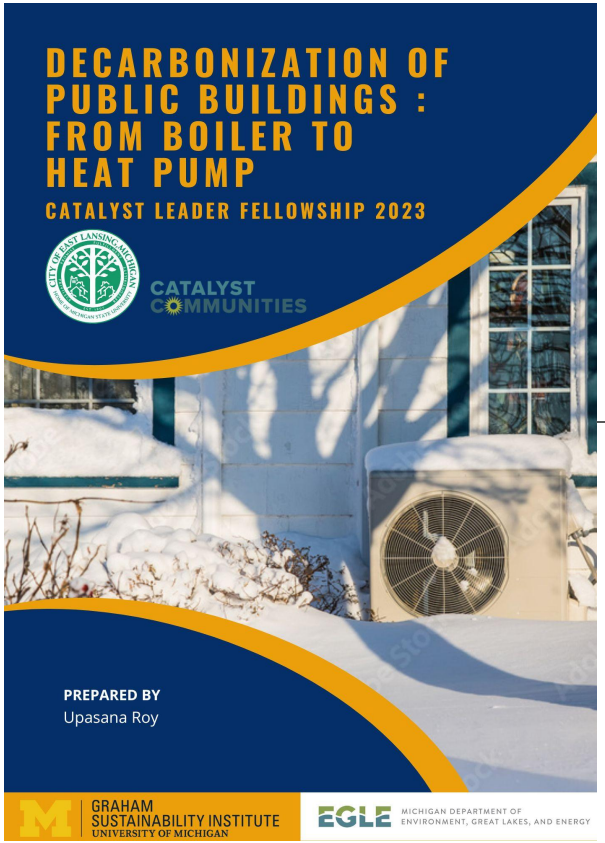
Retrofitting strategies in existing public buildings

Stakeholder Interviews

What is needed and what can be achieved

Recommendations

Site specific and general policies that should be kept in mind



Path to Decarbonization: Initiating the Conversation

Road to Electrification : Heat Pump Upgradation

Retrofit Case studies

Skokie Courthouse, Cook County, Illinois

Gillette City Hall, Campbell County, Wyoming

Stakeholder Interviews

Heat Pump factsheet

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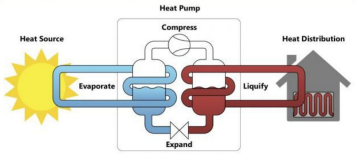
Heat Pump : Considerations for Retrofits

Introduction

A heat pump is an energy efficient heating and cooling system that can heat buildings by moving heat from outdoors to indoors (during winter) and cool buildings by moving heat from indoors to outdoors (during summer). As a heat pump moves heat rather than generating it, they have typical efficiencies between 200 and 400 percent. In addition to efficiency, a key health and safety benefit of heat pumps compared to fossil fuel-based heating is the lack of any indoor combustion emissions, such as carbon monoxide (CO), nitrogen dioxide (NO2), fine and ultrafine particles, polycyclic aromatic hydrocarbons (PAHs), and formaldehyde.



How does a heat pump work ?

A heat pump utilizes technology similar to that found in refrigerators and air conditioners. It extracts heat from various sources like the surrounding air, geothermal energy stored underground, water sources, or waste heat from industrial processes. By amplifying and transferring the extracted heat, it effectively meets heating requirements. Compared to traditional heating methods like boilers or electric heaters, heat pumps are significantly more efficient and cost-effective. They transfer heat rather than generating it, resulting in a higher output of heat energy relative to the electrical energy input. For instance, the coefficient of performance (COP) for a typical household heat pump is around four, indicating that the energy output is four times greater than the electrical energy consumed. This makes current models three to five times more energy-efficient than gas boilers. Heat pumps can also be integrated with other heating systems, often in hybrid configurations alongside gas systems.

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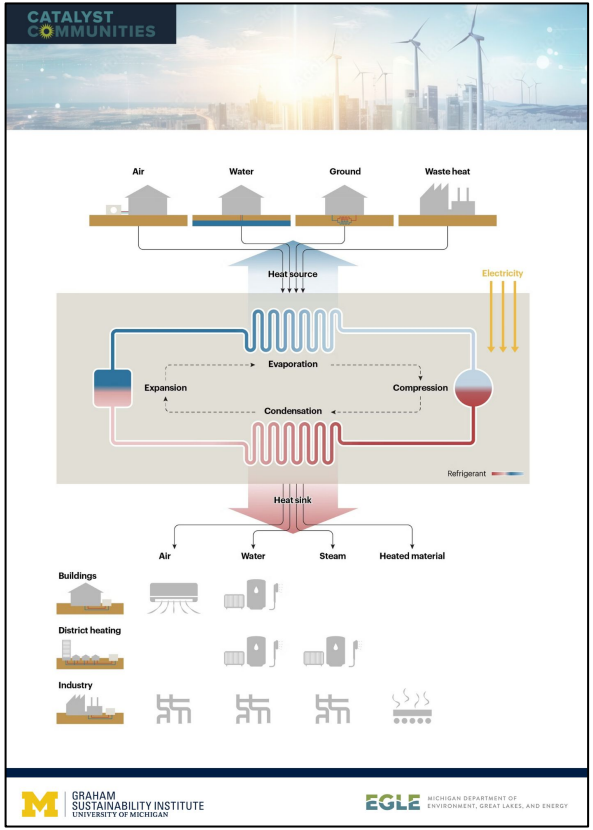

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How will transitioning to heat pumps impact the building's utility bills?

Although heat pumps may have higher upfront costs compared to conventional systems, their energy efficiency and reduced operating expenses result in long-term cost savings. Evaluation of the benefits of a heat pump system is usually done on an individual building basis. Over the lifespan of a heat pump, the energy savings can offset the initial investment, leading to lower utility bills and improved financial sustainability for public buildings. By embracing heat pump technology, buildings can not only contribute to decarbonization but also realize significant cost savings in the long run.

How is the efficiency of Heat Pumps evaluated ?

The efficiency of a heat pump depends critically on the source of the heat. In winter, the ground and external water sources typically remain warmer than the ambient air, so ground source and water-source heat pumps consume less electricity than air-source ones, yielding a higher coefficient of performance (COP).

This is particularly the case in cold climates where defrosting the outside components of air-source heat pumps can consume additional energy. However, ground source heat pumps are more expensive to install, as they require an underground heat exchanger – a deep vertical borehole or a large network of pipes buried at least one meter below the surface of the ground. Connecting a water-source heat pump to a nearby river, groundwater or wastewater can also be costly.
For these reasons, ground- and water-source heat pumps are generally less common than air-source pumps. Worldwide, almost 85% of all heat pumps sold for buildings are air-source, as they require the least effort to be installed. Many of these are air-to-air units, while in heating-dominated regions air-to-water (or hydronic) units are growing in prevalence. Ground-source heat pumps and hybrid heat pumps that combine a heat pump with another heating source, like a gas boiler, are a small portion of global sales today, but make up a substantial share of the market in some countries.

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Steps required while considering heat pump installation and whom to contact according to heat pump type

Steps for heat pump installation	Whom to Contact	Heat pump type
Sizing and heat pump system design		
On-site assessment of existing heating infrastructure and property insulation	General construction worker, heat pump installer	All
Heat losses and heating load calculations	Heat pump installer	All
Design, choice of materials and system layout	Heat pump installer	All
Pressure drop calculations, thermal conductivity assessment	Heat pump installer	All
Installation		
Trenching and drilling	Certified drilling professional	Ground-source
Pipe joining and plumbing	Plumber, pipefitter, heat pump installer	All
Handling refrigerants	Heat pump installer with F-gas certification Heat pump installer qualified to handle flammable materials	Systems with onsite F-gas refrigerant handling Systems with on-site hydrocarbon refrigerant handling
Electrical work		
Electrical wiring	Electrician, heat pump installer	All
System configuration		
Final system setup, refrigerant gas stabilization	Heat pump installer	All

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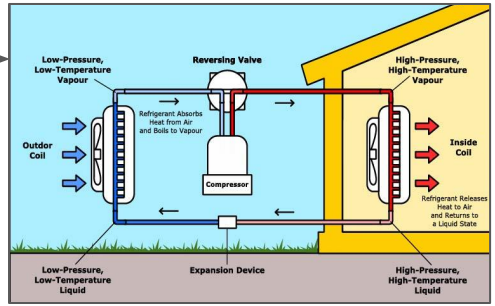
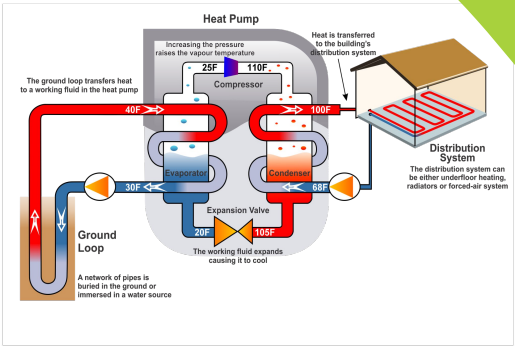
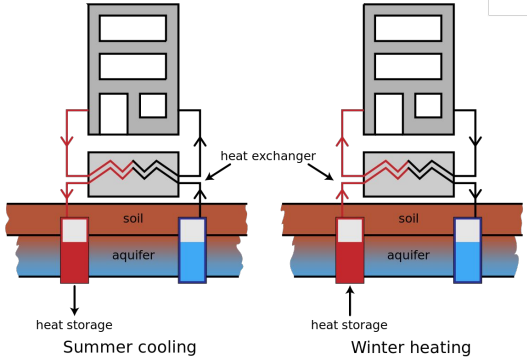
Potential Retrofitting Strategies of Hannah Community Center at East Lansing

1. **Envelope treatments**
2. **Schedules**
3. **Variable Volume Pumps**
4. **Energy Recovery**

Current boilers have 2-3 years left of use







Design Based

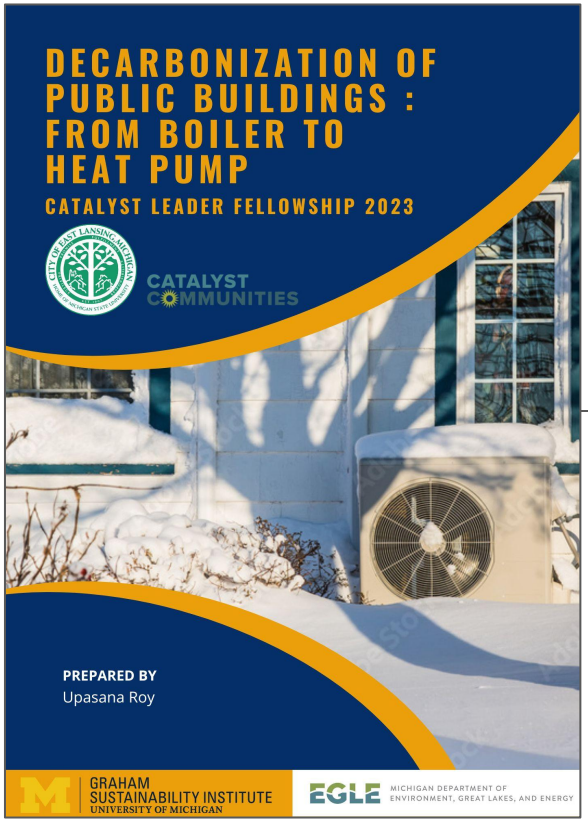
- System Upgradation
- Electrical capacity
- Lower Heating Hot Water Temperature

Moving Forward

Policy Based

- Integrate renewable energy sources
- Capitalize on available incentives
- Align decarbonization regulatory work across State and Local Agencies

Community Deliverable



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Questions ?