Salt Lake City Customer Economics Analysis for Building Electrification
Completed June 2019
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  • Scenario 2: Single Family Retrofit – HPWH Replacement
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  • Scenario 4: Multifamily All-electric New Construction

• Conclusions and Next Steps
Background and Summary of Project

Salt Lake City began working with the Building Electrification Institute (BEI) in 2019 to explore opportunities to reduce greenhouse gas (GHG) emissions and air pollution through building electrification.

In 2019, BEI and its consultant, The Cadmus Group, completed this customer economics analysis to assess the costs and potential savings from installing air source heat pumps (ASHPs) and heat pump water heaters (HPWHs) in typical Salt Lake City residential buildings. The goals of these analyses were to identify the electrification upgrades that will reduce costs in Salt Lake City homes today and to help identify strategies that the City or local utilities could implement that will improve the economics of electrification upgrades in these buildings over the long-run.
The purpose of the Customer Economics Analysis was to:

- Identify building typologies and electrification upgrades with positive customer economics in Salt Lake City under current conditions.
- Help the City or local utilities prioritize strategies to improve customer economics in more building types.
- Serve as a foundation to educate and engage Salt Lake City’s building community on increasing heat pump installations.

Key research questions for the Customer Economics Analysis were:

- How do the installation, operating, and lifetime costs of electrification technologies for space heating, cooling, and water heating compare with conventional technologies?
- How long are the paybacks for selected electrification technologies and strategies?
### Customer Economics Analysis | Approach

<table>
<thead>
<tr>
<th>1) Research and validate inputs</th>
<th>2) Model energy use</th>
<th>3) Assess customer economics</th>
<th>4) Develop recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>First, the BEI team developed building upgrade scenarios and compiled installation costs for electrification equipment in typical Salt Lake City buildings and interviewed local contractors to validate these inputs.</td>
<td>The team then modeled energy use for heating, cooling, and water heating for each scenario using the U.S. Department of Energy’s Building Energy Optimization Tool (BEopt).</td>
<td>The team used the energy model outputs to assess cash flows based on the installation costs, predicted energy use, and local energy rates in order to determine lifetime costs of electrification upgrades.</td>
<td>Based on the results of the analysis, the BEI team developed recommendations for strategies that would help improve the customer economics of electrification upgrades in Salt Lake City buildings.</td>
</tr>
</tbody>
</table>

**Notes our approach:** In focusing on costs and savings, this analysis does not directly quantify some of the other benefits of electrification, such as indoor air quality, air pollution, quiet, and comfort. Additionally, while assumptions and inputs were based on extensive research and validation with stakeholders, actual costs and benefits in individual buildings are likely to vary.
### Customer Economics Analysis | Scenarios

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Single family Retrofit ASHP</th>
<th>Single family Retrofit HPWH</th>
<th>Multi-family Retrofit ASHP</th>
<th>Multifamily New Construction - All electric</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single family detached</td>
<td>Single family detached</td>
<td>4-story, 23-unit building</td>
<td>5-story, 50-unit building</td>
</tr>
<tr>
<td>Counterfactual Systems</td>
<td>Gas Furnace OR Electric Baseboard</td>
<td>Gas Water Heater OR Electric Water Heater</td>
<td>Gas Furnace OR Electric Baseboard</td>
<td>Gas Appliances</td>
</tr>
<tr>
<td>Electrification Technologies</td>
<td>Air source heat pump (ASHP) system: Ductless mini-split OR Ducted heat pump (except w/ baseboard)</td>
<td>Heat pump water heater (HPWH)</td>
<td>ASHP system: Ductless mini-split</td>
<td>Ductless mini-splits, HPWH, AND Electric range/oven</td>
</tr>
<tr>
<td>Installation Type</td>
<td>Displacement*</td>
<td>Replacement</td>
<td>Displacement* OR Replacement</td>
<td>Whole Home</td>
</tr>
<tr>
<td>Cooling Counterfactual Systems</td>
<td>Central A/C OR No A/C</td>
<td>N/A</td>
<td>Room A/C OR No A/C</td>
<td>Central A/C</td>
</tr>
<tr>
<td>Energy Efficiency/Envelope</td>
<td>Typical (Base Load) OR Efficient (Low Load)</td>
<td>N/A</td>
<td>Typical (Base Load) OR Efficient (Low Load)</td>
<td>Baseline Utah code OR tighter envelope</td>
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<tr>
<td>Solar PV</td>
<td>No PV OR With PV</td>
<td>No PV OR With PV</td>
<td>No PV OR With PV</td>
<td>No PV OR With PV</td>
</tr>
</tbody>
</table>

*Under a "displacement" scenario, the ASHP is assumed to displace a portion of the existing heating system, rather than fully replacing the system. A displacement strategy can have upsides, including lower total installation cost and redundancy of systems to ensure adequate heat on the coldest days of the year.*
## Customer Economics Analysis | Common Assumptions

### General Inputs

<table>
<thead>
<tr>
<th>Description</th>
<th>Input</th>
<th>Unit</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate</td>
<td>10%</td>
<td>%</td>
<td>Typical customer discount rate</td>
</tr>
<tr>
<td>Discount rate</td>
<td>5%</td>
<td>%</td>
<td>Low-end discount rate for sensitivity analysis</td>
</tr>
<tr>
<td>Space heating equipment lifetime</td>
<td>18</td>
<td>Years</td>
<td>Varies 15-20 years, selected 18 to simplify analysis</td>
</tr>
<tr>
<td>Water heating equipment lifetime</td>
<td>13</td>
<td>Years</td>
<td>BEOpt standard input</td>
</tr>
<tr>
<td>Fuel cost escalation - electricity</td>
<td>2.5%</td>
<td>Annual % growth</td>
<td>2019 EIA Annual Energy Outlook Reference Case – Mtn. region – nominal</td>
</tr>
<tr>
<td>Fuel cost escalation – natural gas</td>
<td>3.5%</td>
<td>Annual % growth</td>
<td>2019 EIA Annual Energy Outlook Reference Case – Mtn. region – nominal</td>
</tr>
</tbody>
</table>


### Natural Gas Rates: GS Rate

<table>
<thead>
<tr>
<th>Tier</th>
<th>Summer</th>
<th>Winter</th>
<th>Unit</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed charges</td>
<td>$6.75</td>
<td>$6.00</td>
<td>$/month</td>
<td>Dominion Energy For new constr. only</td>
</tr>
<tr>
<td>First 45 Dekatherms</td>
<td>$5.87</td>
<td>$7.13</td>
<td>$/dekatherm</td>
<td>Dominion Energy</td>
</tr>
<tr>
<td>Over 45 Dekatherms</td>
<td>$4.73</td>
<td>$5.99</td>
<td>$/dekatherm</td>
<td>Dominion Energy</td>
</tr>
</tbody>
</table>

### Electricity Rates: Residential Service

<table>
<thead>
<tr>
<th>Tier</th>
<th>Summer</th>
<th>Winter</th>
<th>Unit</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed charges</td>
<td>$6.00</td>
<td>$6.00</td>
<td>$/month</td>
<td>Rocky Mountain Power For new constr. only</td>
</tr>
<tr>
<td>First 400 kWh</td>
<td>$8.8</td>
<td>$8.8</td>
<td>¢/kWh</td>
<td>Rocky Mountain Power</td>
</tr>
<tr>
<td>Next 600 kWh</td>
<td>$11.5</td>
<td>$10.7</td>
<td>¢/kWh</td>
<td>Rocky Mountain Power</td>
</tr>
<tr>
<td>Above 1,000 kWh</td>
<td>$14.5</td>
<td>$14.5</td>
<td>¢/kWh</td>
<td>Rocky Mountain Power</td>
</tr>
</tbody>
</table>

Notes on rates: Assumes multifamily scenarios are individually metered at residential rates. Electricity pricing in Salt Lake City has since been updated to a two-tiered system.
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• Conclusions and Next Steps
Single Family Retrofit – ASHP Displacement | Assumptions

<table>
<thead>
<tr>
<th>Description</th>
<th>Input</th>
<th>Unit</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building size (3 Br, 2 Ba, 2-story, unfinished basement)</td>
<td>2,000</td>
<td>Sq. ft.</td>
<td>Assumption based on median SF home size in parcel database</td>
</tr>
<tr>
<td>Building age*</td>
<td>1941</td>
<td>year</td>
<td>Assumption based on median “effective year” in parcel database</td>
</tr>
<tr>
<td>Heating set point</td>
<td>76</td>
<td>°F</td>
<td>2014 Building America House Simulation Protocols</td>
</tr>
<tr>
<td>Cooling set point</td>
<td>71</td>
<td>°F</td>
<td>2014 Building America House Simulation Protocols</td>
</tr>
<tr>
<td>Water heating set point</td>
<td>125</td>
<td>°F</td>
<td>2014 Building America House Simulation Protocols</td>
</tr>
</tbody>
</table>

*Affects BEopt estimates for typical air infiltration rates, which are based on building age, building size, and local climate.

Additional Information about Building Models:

- Assumptions for typical single-family home size and year built are based on previous BEI analysis of single-family homes in Salt Lake City.
- BEopt software utilizes inputs for building size, vintage, and systems as well as local climate data to model building energy use for a variety of end uses.
- The model also accounts for heat pump performance at different outdoor temperatures.
# Single Family Retrofit – ASHP Displacement | Assumptions

## Cost and Equipment Assumptions

<table>
<thead>
<tr>
<th>Input Description</th>
<th>Counterfactual Equipment</th>
<th>Electrification Equipment</th>
<th>Notes/ Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural Gas Furnace</td>
<td>Electric Baseboard</td>
<td></td>
</tr>
<tr>
<td>System size</td>
<td>N/A</td>
<td>N/A</td>
<td>Modeled in BEopt</td>
</tr>
<tr>
<td>% Heating Load Covered</td>
<td>100%</td>
<td>100%</td>
<td>BEopt output</td>
</tr>
<tr>
<td>System efficiency</td>
<td>78% AFUE 20% duct losses</td>
<td>100%</td>
<td>BEopt defaults</td>
</tr>
<tr>
<td>Capital cost*</td>
<td>N/A</td>
<td>N/A</td>
<td>Navigant and Contractor Interviews</td>
</tr>
<tr>
<td>Available incentive</td>
<td>N/A</td>
<td>N/A</td>
<td>Rocky Mountain Power</td>
</tr>
</tbody>
</table>

*For all displacement scenarios, there is no capital cost for the counterfactual because existing heating equipment will remain in place. Electrification equipment costs are also therefore presented as total costs (as opposed to incremental costs). Additional assumptions for the capital cost range for the ductless mini-split are included in the Appendix on slide 41.
Summary of Results

Scenario 1: Gas Furnace Baseline to Ducted ASHP Displacement
- **Installation cost:** $7,000 (full cost)*
- **Operational cost:** Increase of $200 in Year 1
- **Simple Payback:** None

Scenario 2: Gas Furnace Baseline to Ductless Mini-split Displacement
- **Installation cost:** $4,950 (full cost)*
- **Operational cost:** Increase of $20 in Year 1
- **Simple Payback:** None

**Takeaway:** The economics of displacing a gas heating system with an ASHP are challenging in a typical Salt Lake City home when no other measures are included. Energy costs may increase slightly, and the installation costs of the system will not currently pay back.

*All installation costs, savings, and incentives are rounded to the nearest $10.
Summary of Results

Scenario 3
Electric Resistance Baseline to Ductless Mini-split, Displacement

- **Installation cost:** $4,950 (full cost)
  - Current incentive of $1,000 brings this cost down to $3,950
- **Operational cost:** Decrease of $760 in Year 1
- **Simple Payback:** 4 years**

**Takeaway:** The economics of displacing an electric resistance heating system with an ASHP are currently favorable in a typical Salt Lake City home, even without other measures included, and will pay for itself during the lifetime of the system.

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*All installation costs, savings, and incentives are rounded to the nearest $10.
**Simple payback does not exactly match chart payback due to rounding and assumed energy price escalations and discount rates included in the charts.*

**Scenario 3: Electric Resistance Baseline to Ductless Mini-split, Displacement (Total Cost by Year)**

- Cumulative Cost Savings (Installation cost + incremental operational cost savings)

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Key Assumptions: Baseline building assumes no existing air conditioning, solar PV, or previous envelope improvements. Retrofit scenarios assume displacement of the existing heating load (rather than full replacement), so no counterfactual heating costs are included because the existing system must stay in place. Cash flow charts assume electricity rates increase by 2.5% annually; gas rates increase by 3.5% annually; and include a 3% annual discount rate for the value of future energy savings.
Adding retrofit measures or changing current conditions could improve the economics for gas-heated single family homes. This could include:

- **Changing utility rates:** Heat pumps result in cost savings compared to gas when electricity is less than $0.094/kWh for ductless systems and $0.081/kWh for ducted systems (compared to $0.10/kWh today).

- **Increasing heat pump efficiency:** Heat pumps result in cost savings when operating above 315% efficiency. (Between 250-300% efficient is common today, but newer models may achieve higher levels).

- **Adding solar PV:** Heat pumps paired with solar PV would result in annual cost savings of $490 – $673 in Salt Lake City, but would increase installed costs.

- **Adding air sealing and insulation:** Heat pumps paired with these energy efficiency measures could result in annual operational savings of $200 – $251, but would increase upfront costs.

- **Replacing existing A/C:** If ductless ASHPs are replacing an A/C system in the building, there would be annual cost savings of $51. There would not be savings for ducted ASHPs due to their lower efficiencies.

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**Electric Rates and Heat Pump Efficiencies Needed to Break Even with Gas Furnace**

<table>
<thead>
<tr>
<th></th>
<th>Gas Furnace</th>
<th>Ductless Mini-Split</th>
<th>Ducted ASHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per Unit</td>
<td>$0.62/Therm</td>
<td>$0.10/kWh</td>
<td>$0.10/kWh</td>
</tr>
<tr>
<td>Cost per MMBTU</td>
<td>$6.15</td>
<td>$29.31</td>
<td>$29.31</td>
</tr>
<tr>
<td>Modeled Efficiency*</td>
<td>66%</td>
<td>295%</td>
<td>255%*</td>
</tr>
<tr>
<td>Cost per delivered MMBTU</td>
<td>$9.29</td>
<td>$9.93</td>
<td>$11.49</td>
</tr>
</tbody>
</table>

**Electricity cost to break even with gas furnace**

- Gas Furnace: $0.09/kWh
- Ductless ASHP: $0.08/kWh
- Ducted ASHP: $0.08/kWh

**Efficiency to break even with gas furnace**

- Gas Furnace: 315%
- Ductless ASHP: 315%
- Ducted ASHP: 315%

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**First Year Operating Cost Comparison to Gas Furnace**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Without Measure</th>
<th>With Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductless ASHP</td>
<td>+$17</td>
<td>-$673</td>
</tr>
<tr>
<td>Ducted ASHP</td>
<td>+$200</td>
<td>-$490</td>
</tr>
<tr>
<td>Air Sealing and Insulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductless ASHP</td>
<td>+$17</td>
<td>-$251</td>
</tr>
<tr>
<td>Ducted ASHP</td>
<td>+$200</td>
<td>-$200</td>
</tr>
<tr>
<td>Replacing existing A/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductless ASHP</td>
<td>+$17</td>
<td>-$51</td>
</tr>
<tr>
<td>Ducted ASHP</td>
<td>+$200</td>
<td>+$120</td>
</tr>
</tbody>
</table>

*Ducted system includes duct losses

Note: Analysis holds electricity and natural gas prices constant for simplicity, but new tiered rates will impact the actual comparison.
Summary of Results

Scenario 4
Gas Furnace + Central A/C Baseline to Ducted ASHP Displacement w/ Weatherization
- Installation cost: $7,260 (incremental cost)*
- Operational cost: Decrease of $300 in Year 1
- Simple Payback: 24 years**

Scenario 5
Gas Furnace + Central A/C Baseline to Ductless Mini-split Displacement w/ Weatherization
- Installation cost: $5,390 (incremental cost)*
- Operational cost: Decrease of $340 in Year 1
- Simple Payback: 16 years**

Takeaway: The economics of displacing a gas heating system with an ASHP improve significantly in Salt Lake City homes when including cooling system savings and adding weatherization measures.

*All installation costs and savings are rounded to the nearest $10. Incremental costs are included for cooling systems. **Simple payback does not exactly match chart payback due to rounding and assumed energy price escalations and discount rates included in the charts.

Key Assumptions: Cash flow charts assume electricity rates increase by 2.5% annually; gas rates increase by 3.5% annually; and include a 3% annual discount rate for the value of future energy savings.
# Single Family Retrofit – ASHP Displacement | Full Results

## Results for All Modeled Scenarios (No Incentives)

<table>
<thead>
<tr>
<th>VARIATIONS</th>
<th>INSTALLATION COST</th>
<th>First year net operating savings</th>
<th>Simple Payback period**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measures - Space Heating/ Cooling</strong></td>
<td><strong>Counterfactual Heating</strong></td>
<td><strong>Counterfactual Cooling</strong></td>
<td><strong>Efficiency Measures</strong></td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Electric baseboard</td>
<td>Central A/C</td>
<td>With Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Electric baseboard</td>
<td>Central A/C</td>
<td>Without Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Electric baseboard</td>
<td>Central A/C</td>
<td>Without Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Electric baseboard</td>
<td>No A/C</td>
<td>With Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Electric baseboard</td>
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<td>With Air Sealing/Insulation</td>
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<tr>
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<td>Electric baseboard</td>
<td>No A/C</td>
<td>Without Air Sealing/Insulation</td>
</tr>
<tr>
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<td>No A/C</td>
<td>Without Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Natural gas furnace</td>
<td>Central A/C</td>
<td>Without Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Natural gas furnace</td>
<td>Central A/C</td>
<td>With Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Natural gas furnace</td>
<td>Central A/C</td>
<td>Without Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Natural gas furnace</td>
<td>Central A/C</td>
<td>With Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ducted ASHP</td>
<td>Natural gas furnace</td>
<td>Central A/C</td>
<td>With Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ducted ASHP</td>
<td>Natural gas furnace</td>
<td>Central A/C</td>
<td>Without Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ducted ASHP</td>
<td>Natural gas furnace</td>
<td>Central A/C</td>
<td>Without Air Sealing/Insulation</td>
</tr>
<tr>
<td>Ductless mini-split</td>
<td>Natural gas furnace</td>
<td>No A/C</td>
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<td>Natural gas furnace</td>
<td>No A/C</td>
<td>Without Air Sealing/Insulation</td>
</tr>
</tbody>
</table>

*All installation costs and savings are rounded to the nearest $10. Installation costs do not include incentives. Incremental costs for cooling are used when counterfactual includes a new cooling system.

**Average useful life of an ASHP is 20 years, so simple paybacks that are over 20 years will not pay back over the lifespan of the equipment.
Displacing a portion of electric resistance heating with a high efficiency ASHP will significantly reduce energy bills for a typical single family home in Salt Lake City. The operational savings from displacing a portion of the electric resistance heating system will pay back quickly in the lifetime of the equipment (4 years in the scenario presented here).

Displacing a portion of a gas heating system with an ASHP in a typical single family home, however, may slightly increase in energy bills, unless other measures included. The energy costs for high efficiency ductless heat pump systems are closer to breaking even than for ducted heat pump systems.

There are many options to improve the economics of ASHPs in Salt Lake City’s single family homes, including changing energy rates to be more favorable for electrification, increasing the heat pump system efficiency, adding on-site solar PV, increasing air sealing and/or insulation within a home, and replacing the existing air conditioning system at the time of the retrofit.
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• Conclusions and Next Steps
## Building Energy Model Assumptions

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<thead>
<tr>
<th>Description</th>
<th>Input</th>
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<tr>
<td><strong>Building size</strong></td>
<td>2,000</td>
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</tr>
<tr>
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<tr>
<td><strong>Cooling set point</strong></td>
<td>71</td>
<td>°F</td>
<td>2014 Building America House Simulation Protocols</td>
</tr>
<tr>
<td><strong>Water heating set point</strong></td>
<td>125</td>
<td>°F</td>
<td>2014 Building America House Simulation Protocols</td>
</tr>
</tbody>
</table>

*Affects BEopt estimates for typical air infiltration rates, which are based on building age, building size, and local climate.

## Additional Information about Building Models

(Note: There are same assumptions as the single-family ASHP retrofit models)

- Assumptions for typical single-family home size and year built are based on previous BEI analysis of single-family homes in Salt Lake City.
- BEopt software utilizes inputs for building size, vintage, and systems as well as local climate data to model building energy use for a variety of end uses.
- The model also accounts for heat pump performance at different outdoor temperatures.
## Single Family Retrofit – HPWH Replacement | Assumptions

### Cost and Equipment Assumptions

<table>
<thead>
<tr>
<th>Input Description</th>
<th>Counterfactual Equipment</th>
<th>Electrification</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System size</strong></td>
<td>40 gallon</td>
<td>50 gallon</td>
<td>50 gallon</td>
</tr>
<tr>
<td><strong>System efficiency</strong></td>
<td>0.59 EF (existing)</td>
<td>0.9 EF (existing)</td>
<td>3.69 EF</td>
</tr>
<tr>
<td><strong>Capital cost</strong></td>
<td>$1,000 ($500 – equip., $500 – labor, DNV GL)</td>
<td>$1,000 ($959 – Xcel TRM)</td>
<td>Low: $1,800 Mid: $2,000 High: $2,800</td>
</tr>
<tr>
<td><strong>Available incentives</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>$400 – tier 1 $550 – tier 2 (for electric water heating customers only)</td>
</tr>
</tbody>
</table>

*Electrification equipment costs are presented here as total costs (as opposed to incremental costs).*

### Notes on Cost Assumptions:
- HPWH costs include estimated labor costs ($800-$1,800) based on local interviewees and recent research in Boulder.
- Electric panel upgrade costs are not included, as interviewees suggest they are not often needed in Salt Lake City homes.
Summary of Results

Scenario 1
Gas Water Heater Baseline to HPWH
- Installation cost: $1,000 (incremental cost)*
- Operational cost: Increase of $100 in Year 1
- Simple Payback: None

Scenario 2
Electric Resistance Water Heater Baseline to HPWH
- Installation cost: $1,000 (incremental cost)*
  - Current incentive of $500 brings this cost down to $500
- Operational cost: Decrease of $190 in Year 1
- Simple Payback with Incentive: 3 years**

Takeaway: The economics of replacing a gas water heater with a HPWH are challenging in Salt Lake City homes, but the economics of replacing an electric resistance water heater with a HPWH are favorable.

Key Assumptions: Baseline building assumes no solar PV. Cash flow charts assume electricity rates increase by 2.5% annually; gas rates increase by 3.5% annually; and include a 3% annual discount rate for the value of future energy savings.
### Counterfactual Solar PV HPWH Cost

<table>
<thead>
<tr>
<th>Counterfactual</th>
<th>Solar PV</th>
<th>HPWH Cost*</th>
<th>Incremental installed cost**</th>
<th>First year net operating savings</th>
<th>Simple Payback Period***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric resistance</td>
<td>Without PV</td>
<td>Low</td>
<td>($800)</td>
<td>$190</td>
<td>4 years</td>
</tr>
<tr>
<td>Electric resistance</td>
<td>Without PV</td>
<td>Mid</td>
<td>($1,000)</td>
<td>$190</td>
<td>5 years</td>
</tr>
<tr>
<td>Electric resistance</td>
<td>Without PV</td>
<td>High</td>
<td>($1,800)</td>
<td>$190</td>
<td>9 years</td>
</tr>
<tr>
<td>Natural gas</td>
<td>Without PV</td>
<td>Low</td>
<td>($800)</td>
<td>($100)</td>
<td>No payback</td>
</tr>
<tr>
<td>Natural gas</td>
<td>Without PV</td>
<td>Mid</td>
<td>($1,000)</td>
<td>($100)</td>
<td>No payback</td>
</tr>
<tr>
<td>Electric resistance</td>
<td>With PV</td>
<td>Low</td>
<td>($14,560)</td>
<td>$880</td>
<td>17 years</td>
</tr>
<tr>
<td>Electric resistance</td>
<td>With PV</td>
<td>Mid</td>
<td>($14,760)</td>
<td>$880</td>
<td>17 years</td>
</tr>
<tr>
<td>Natural gas</td>
<td>Without PV</td>
<td>High</td>
<td>($1,800)</td>
<td>($100)</td>
<td>No payback</td>
</tr>
<tr>
<td>Electric resistance</td>
<td>With PV</td>
<td>High</td>
<td>($15,560)</td>
<td>$880</td>
<td>18 years</td>
</tr>
<tr>
<td>Natural gas</td>
<td>With PV</td>
<td>Low</td>
<td>($14,560)</td>
<td>$590</td>
<td>25 years</td>
</tr>
<tr>
<td>Natural gas</td>
<td>With PV</td>
<td>Mid</td>
<td>($14,760)</td>
<td>$590</td>
<td>25 years</td>
</tr>
<tr>
<td>Natural gas</td>
<td>With PV</td>
<td>High</td>
<td>($15,560)</td>
<td>$590</td>
<td>26 years</td>
</tr>
</tbody>
</table>

*High, medium, and low cost estimates for HWPHs were included given the variability found in the Salt Lake City market.

**All installation costs and savings are rounded to the nearest $10. Installation costs do not include incentives. Incremental costs are calculated against a counterfactual water heating system.

***Average useful life of a HPWH is 15 years, so simple paybacks over 15 years will not pay back over the lifespan of the equipment.
Key Takeaways

• Replacing an electric resistance water heater with a high efficiency HPWH will significantly reduce residents’ energy bills for a typical single family home in Salt Lake City. The operational savings from replacing an electric resistance water heater will pay back quickly (3 years in the scenario presented here).

• Replacing a gas heating system with a high efficiency HPWH, however, will slightly increase energy bills for water heating under current conditions in a typical single family home in Salt Lake City, although there are opportunities to improve these economics.

• There are many options to improve the economics of HPWHs in Salt Lake City’s single family homes, which include changing energy rates to be more favorable to electrification, increasing HPWH system efficiency, adding on-site solar PV, and/or including a HPWH as part of a broader package of measures.
Table of Contents

• Customer Economics Analysis Overview
  • Scenario 1: Single Family Retrofit – ASHP Displacement
  • Scenario 2: Single Family Retrofit – HPWH Replacement
  • Scenario 3: Multifamily Retrofit – ASHP Replacement and Displacement
  • Scenario 4: Multifamily All-electric New Construction

• Conclusions and Next Steps
**Multifamily ASHP Displacement & Replacement | Assumptions**

### Building Energy Model Assumptions

<table>
<thead>
<tr>
<th>Description</th>
<th>Input</th>
<th>Unit</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building size</strong></td>
<td>33,700, ~950</td>
<td>Sq. ft.</td>
<td>DOE Midrise Apartment Reference Building</td>
</tr>
<tr>
<td>(23 units, 4 stories)</td>
<td>ft² per unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Building age</strong></td>
<td>1970</td>
<td>years</td>
<td>Assumption, based on Census data</td>
</tr>
<tr>
<td><strong>Heating set point</strong></td>
<td>76</td>
<td>°F</td>
<td>2014 Building America Housing Simulation Protocols</td>
</tr>
<tr>
<td><strong>Cooling set point</strong></td>
<td>71</td>
<td>°F</td>
<td>2014 Building America Housing Simulation Protocols</td>
</tr>
<tr>
<td><strong>Water heating set point</strong></td>
<td>125</td>
<td>°F</td>
<td>2014 Building America House Simulation Protocols</td>
</tr>
</tbody>
</table>

*Additional Information about Building Models:*

- Assumptions for typical multifamily size and year built are based on previous BEI analysis of multifamily buildings in Salt Lake City.
  - Most existing multifamily buildings in Salt Lake City were built between 1960 and 1999 and are a range of different sizes.

- BEopt software utilizes inputs for building size, vintage, and systems as well as local climate data to model building energy use for a variety of end uses.

- The model also accounts for heat pump performance at different outdoor temperatures.

---

*Affects BEopt estimates for typical air infiltration rates, which are based on building age, building size, and local climate.*
## Multifamily ASHP Displacement & Replacement | Assumptions

### Cost and Equipment Assumptions

<table>
<thead>
<tr>
<th>Input Description</th>
<th>Counterfactual Equipment</th>
<th>Electrification Equipment</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System size</strong></td>
<td>Gas Furnace N/A</td>
<td>Ductless mini-split – 1 zone displacement 1.25 ton 1 ton – w envelope measures</td>
<td>Modeled in BEopt</td>
</tr>
<tr>
<td></td>
<td>Electric Baseboard N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Heating load coverage</strong></td>
<td>100%</td>
<td>80% (Displacement)</td>
<td>BEopt outputs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100% (Full Replacement)</td>
<td></td>
</tr>
<tr>
<td><strong>System efficiency</strong></td>
<td>78% AFUE</td>
<td>9.6 HSPF, 18 SEER (non-cold climate)</td>
<td>BEopt defaults</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.3 HSPF, 20 SEER (cold climate)</td>
<td></td>
</tr>
<tr>
<td><strong>Capital cost</strong></td>
<td>$1,934/unit For replacement variation</td>
<td>$3,957 – 1.25 ton $3,860 – 1 ton (single zone, non-cold climate)</td>
<td>Navigant report, unable to verify with local contractors</td>
</tr>
<tr>
<td></td>
<td>(Doesn’t model costs in replacement variation, not typically replaced)</td>
<td>$5,577 – 1.5 ton $4,989 – 1.25 ton (multi-zone, cold climate)</td>
<td></td>
</tr>
<tr>
<td><strong>Available incentive</strong></td>
<td>N/A</td>
<td>$0.25/kWh (up to 70% of total project costs, market rate)</td>
<td>Rocky Mountain Power</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0.30/kWh (up to 100% total project costs, low income)</td>
<td></td>
</tr>
</tbody>
</table>

* Electrification equipment costs are presented as total costs (as opposed to incremental costs). Heat pump cost assumptions do not currently assume any economies of scale for installation costs, which may be possible in multi-family settings.
Summary of Results

Scenario 1
Gas Furnace Baseline to Ductless Mini-split, Displacement
- Installation cost: $3,960/unit (full cost)*
- Operational cost: Increase of $10/unit in Year 1
- Simple Payback: None

Scenario 2
Gas Furnace Baseline to Ductless Mini-split, Full Replacement
- Installation cost: $3,640/unit (incremental cost)*
- Operational cost: Increase of $10/unit in Year 1
- Simple Payback: None

Takeaway: Displacing or replacing a gas heating system with an ASHP could result in breakeven or slightly increased energy costs in a typical multifamily building if no other measures are included.

*All installation costs and savings are rounded to the nearest $10.

Key Assumptions: Baseline building assumes no existing air conditioning, previous envelope improvements, or solar PV. Cash flow charts assume electricity rates increase by 2.5% annually; gas rates increase by 3.5% annually; and include a 3% annual discount rate for the value of future energy savings.
### Scenario 3
Gas Furnace + Room A/C Baseline to Ductless Mini-split, Displacement
- **Installation cost:** $3,460/unit (full cost)*
- **Operational cost:** Decrease of $100/unit in Year 1
- **Simple Payback:** 35 years**

### Scenario 4
Gas Furnace + Room A/C Baseline to Ductless Mini-split, Full Replacement
- **Installation cost:** $3,140/unit (incremental cost)*
- **Operational cost:** Decrease of $110/unit in Year 1
- **Simple Payback:** 29 years**

**Takeaway:** When displacing or replacing a gas heating system with an ASHP, including cooling system savings can generate energy cost savings, although may not be sufficient to pay back over the lifetime of the equipment.

---

*All installation costs and savings are rounded to the nearest $10.
**Simple payback does not exactly match chart payback due to rounding and assumed energy price escalations and discount rates. Average useful life of an ASHP is 20 years, so paybacks over 20 years will not pay back over the lifespan of the equipment.

---

**Key Assumptions:** Baseline building assumes no previous envelope improvements or solar PV. Cash flow charts assume electricity rates increase by 2.5% annually; gas rates increase by 3.5% annually; and include a 3% annual discount rate for the value of future energy savings.
Summary of Results

Scenario 5: Electric Resistance to Ductless Mini-split, Displacement
- Installation cost: $3,960/unit (full cost)*
  - Current incentive of $840 brings cost to $3,120
- Operational cost: Decrease of $190/unit in Year 1
- Simple Payback with Incentive: 16 years**

Scenario 6: Electric Resistance to Ductless Mini-split, Full Replacement
- Installation cost: $5,570/unit (incremental cost)*
  - Current incentive of $960 brings cost to $4,610
- Operational cost: Decrease of $250/unit in Year 1
- Simple Payback: 18 years**

Takeaway: Displacing or replacing an electric resistance heating system with an ASHP will result in significant cost savings in a typical multifamily building, even with no other measures included.

Key Assumptions: Baseline building assumes no existing air conditioning, previous envelope improvements, or solar PV. Cash flow charts assume electricity rates increase by 2.5% annually; gas rates increase by 3.5% annually; and include a 3% annual discount rate for the value of future energy savings.

*All installation costs and savings are rounded to the nearest $10. Displacement scenarios use full installation cost because the existing system must stay in place.
** Simple payback does not exactly match chart payback due to rounding and assumed energy price escalations and discount rates.
## Results for All Modeled Scenarios (Including Current Incentives)

<table>
<thead>
<tr>
<th>Measures - Space Heating/ Cooling</th>
<th>Counterfactual: Space Heating</th>
<th>Counterfactual: Space Cooling</th>
<th>Efficiency Measures</th>
<th>Solar PV</th>
<th>Incremental installed costs (w/ incentive)*</th>
<th>First year net operating savings</th>
<th>Simple Payback Period**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement DMSHP Electric baseboard</td>
<td>Room A/C</td>
<td>Without EE</td>
<td>Without PV</td>
<td>($2,770)</td>
<td>$300</td>
<td>9 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>Room A/C</td>
<td>Without EE</td>
<td>Without PV</td>
<td>($4,240)</td>
<td>$370</td>
<td>11 years</td>
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</tr>
<tr>
<td>Displacement DMSHP Electric baseboard</td>
<td>Room A/C</td>
<td>With EE</td>
<td>Without PV</td>
<td>($4,780)</td>
<td>$390</td>
<td>12 years</td>
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<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>Room A/C</td>
<td>With EE</td>
<td>Without PV</td>
<td>($5,820)</td>
<td>$430</td>
<td>14 years</td>
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</tr>
<tr>
<td>Displacement DMSHP Electric baseboard</td>
<td>No A/C</td>
<td>Without EE</td>
<td>Without PV</td>
<td>($3,120)</td>
<td>$190</td>
<td>16 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>No A/C</td>
<td>Without EE</td>
<td>Without PV</td>
<td>($4,610)</td>
<td>$250</td>
<td>18 years</td>
<td></td>
</tr>
<tr>
<td>Displacement DMSHP Electric baseboard</td>
<td>No A/C</td>
<td>With EE</td>
<td>Without PV</td>
<td>($5,140)</td>
<td>$270</td>
<td>19 years</td>
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<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>No A/C</td>
<td>With EE</td>
<td>Without PV</td>
<td>($5,140)</td>
<td>$270</td>
<td>19 years</td>
<td></td>
</tr>
<tr>
<td>Displacement DMSHP Electric baseboard</td>
<td>Room A/C</td>
<td>Without EE</td>
<td>With PV</td>
<td>($2,770)</td>
<td>$150</td>
<td>18 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>Room A/C</td>
<td>Without EE</td>
<td>With PV</td>
<td>($4,240)</td>
<td>$220</td>
<td>19 years</td>
<td></td>
</tr>
<tr>
<td>Displacement DMSHP Electric baseboard</td>
<td>Room A/C</td>
<td>With EE</td>
<td>With PV</td>
<td>($4,780)</td>
<td>$240</td>
<td>20 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>No A/C</td>
<td>With EE</td>
<td>Without PV</td>
<td>($6,210)</td>
<td>$300</td>
<td>21 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>Room A/C</td>
<td>With EE</td>
<td>With PV</td>
<td>($5,820)</td>
<td>$280</td>
<td>21 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>Room A/C</td>
<td>Without EE</td>
<td>Without PV</td>
<td>($3,140)</td>
<td>$170</td>
<td>29 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Gas furnace</td>
<td>Room A/C</td>
<td>With EE</td>
<td>Without PV</td>
<td>($4,860)</td>
<td>$100</td>
<td>35 years</td>
<td></td>
</tr>
<tr>
<td>Displacement DMSHP Gas furnace</td>
<td>Room A/C</td>
<td>Without EE</td>
<td>Without PV</td>
<td>($3,460)</td>
<td>$160</td>
<td>35 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Gas furnace</td>
<td>Room A/C</td>
<td>With EE</td>
<td>Without PV</td>
<td>($5,660)</td>
<td>$110</td>
<td>29 years</td>
<td></td>
</tr>
<tr>
<td>Displacement DMSHP Gas furnace</td>
<td>Room A/C</td>
<td>Without EE</td>
<td>With PV</td>
<td>($6,210)</td>
<td>$160</td>
<td>35 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>No A/C</td>
<td>With EE</td>
<td>With PV</td>
<td>($5,140)</td>
<td>$160</td>
<td>39 years</td>
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<tr>
<td>Displacement DMSHP Electric baseboard</td>
<td>No A/C</td>
<td>Without EE</td>
<td>With PV</td>
<td>($4,610)</td>
<td>$100</td>
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<tr>
<td>Replacement DMSHP Electric baseboard</td>
<td>No A/C</td>
<td>Without EE</td>
<td>With PV</td>
<td>($3,120)</td>
<td>$40</td>
<td>78 years</td>
<td></td>
</tr>
<tr>
<td>Displacement DMSHP Gas furnace</td>
<td>No A/C</td>
<td>With EE</td>
<td>Without PV</td>
<td>($5,360)</td>
<td>$40</td>
<td>134 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Gas furnace</td>
<td>No A/C</td>
<td>With EE</td>
<td>Without PV</td>
<td>($6,160)</td>
<td>$40</td>
<td>154 years</td>
<td></td>
</tr>
<tr>
<td>Displacement DMSHP Gas furnace</td>
<td>Room A/C</td>
<td>With EE</td>
<td>With PV</td>
<td>($4,860)</td>
<td>$20</td>
<td>243 years</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Gas furnace</td>
<td>Room A/C</td>
<td>With EE</td>
<td>With PV</td>
<td>($5,660)</td>
<td>$10</td>
<td>566 years</td>
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</tr>
<tr>
<td>Replacement DMSHP Gas furnace</td>
<td>Room A/C</td>
<td>Without EE</td>
<td>With PV</td>
<td>($3,140)</td>
<td>$10</td>
<td>No Payback</td>
<td></td>
</tr>
<tr>
<td>Displacement DMSHP Gas furnace</td>
<td>Room A/C</td>
<td>Without EE</td>
<td>With PV</td>
<td>($3,460)</td>
<td>$10</td>
<td>No Payback</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Gas furnace</td>
<td>No A/C</td>
<td>Without EE</td>
<td>Without PV</td>
<td>($3,640)</td>
<td>$10</td>
<td>No Payback</td>
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</tr>
<tr>
<td>Displacement DMSHP Gas furnace</td>
<td>No A/C</td>
<td>Without EE</td>
<td>Without PV</td>
<td>($3,960)</td>
<td>$10</td>
<td>No Payback</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Gas furnace</td>
<td>No A/C</td>
<td>Without EE</td>
<td>Without PV</td>
<td>($3,640)</td>
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</tr>
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<td>Replacement DMSHP Gas furnace</td>
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<td>With EE</td>
<td>With PV</td>
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<td>$10</td>
<td>No Payback</td>
<td></td>
</tr>
<tr>
<td>Displacement DMSHP Gas furnace</td>
<td>No A/C</td>
<td>With EE</td>
<td>With PV</td>
<td>($3,360)</td>
<td>$10</td>
<td>No Payback</td>
<td></td>
</tr>
<tr>
<td>Replacement DMSHP Gas furnace</td>
<td>No A/C</td>
<td>With EE</td>
<td>With PV</td>
<td>($3,160)</td>
<td>$10</td>
<td>No Payback</td>
<td></td>
</tr>
</tbody>
</table>

*All installation cost and savings are rounded to the nearest $10. Full replacement scenarios include incremental costs against counterfactual heating and cooling systems. Displacement scenarios include full installation costs because the existing system must stay in place. Costs include Rocky Mountain Power and Dominion incentives current to the tie of this analysis, although these incentives have likely since changed.

**Average useful life of an ASHP is 20 years, so simple paybacks that are over 20 years will not pay back over the lifespan of the equipment.
Displacing or replacing an electric resistance heating system with a high efficiency ASHP system will result in significant energy cost savings that will pay back over the lifetime of the equipment in a typical Salt Lake City multifamily building.

Displacing or replacing both a gas heating system and room air conditioning with a high efficiency ASHP will result in energy cost savings that can come close to paying back over the lifetime of the equipment in a typical multifamily building.

Displacing or replacing a gas heating system alone, without addressing cooling, may result in a slight energy cost increase in a typical multifamily building, although it is close to breaking even. However, providing reliable cooling will become increasingly important as temperatures rise due to climate change, making ASHP systems even more attractive as a strategy for improving health and resiliency.

There are many options to improve the economics of installing an ASHP system in Salt Lake City multifamily buildings, which include changing energy rates to be more favorable to electrification, increasing the heat pump system efficiency, adding solar PV, and increasing air sealing and/or insulation.
Table of Contents

- Customer Economics Analysis Overview
  - Scenario 1: Single Family Retrofit – ASHP Displacement
  - Scenario 2: Single Family Retrofit – HPWH Replacement
  - Scenario 3: Multifamily Retrofit – ASHP Replacement and Displacement
  - **Scenario 4: Multifamily All-electric New Construction**

- Conclusions and Next Steps
Multifamily All-electric New Construction | Assumptions

Relevant Findings from BEI’s Building and Housing Stock Analysis for Salt Lake City

- Salt Lake City is experiencing an increase in multifamily new construction.
- Many of these buildings are larger than Salt Lake City’s average multifamily building size.
- Nearly 80% of the multifamily buildings constructed after 2010 had more than 50 units.
Building Energy Model Assumptions

<table>
<thead>
<tr>
<th>Description</th>
<th>Input</th>
<th>Unit</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building size</strong></td>
<td>47,500, ~950 ft² per unit</td>
<td>Sq. ft.</td>
<td>Modeled in BEopt</td>
</tr>
<tr>
<td>(50 units (1 BR), 5 stories)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Heating set point</strong></td>
<td>76</td>
<td>°F</td>
<td>2014 Building America Housing Simulation Protocols</td>
</tr>
<tr>
<td><strong>Cooling set point</strong></td>
<td>71</td>
<td>°F</td>
<td>2014 Building America Housing Simulation Protocols</td>
</tr>
<tr>
<td><strong>Water heating set point</strong></td>
<td>125</td>
<td>°F</td>
<td>2014 Building America House Simulation Protocols</td>
</tr>
</tbody>
</table>

**Additional Information about Building Models:**

- Assumptions for typical new multifamily building are based on previous BEI analysis of multifamily buildings in Salt Lake City.
- BEopt software utilizes inputs for building size, vintage, and systems as well as local climate data to model building energy use for a variety of end uses.
- The model also accounts for heat pump performance at different outdoor temperatures.
# Multifamily All-electric New Construction | Assumptions

## Heating & Cooling Equipment and Cost Assumptions

<table>
<thead>
<tr>
<th>Input Description</th>
<th>Counterfactual Equipment</th>
<th>Electrification Equipment</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System info</strong></td>
<td>Gas Furnace</td>
<td>Ductless mini-split</td>
<td>BEOpt outputs</td>
</tr>
<tr>
<td></td>
<td>Central A/C</td>
<td>Air Exchange</td>
<td></td>
</tr>
<tr>
<td>10 kbtu</td>
<td>0.6 ton</td>
<td>0.75 ton</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Air exchange - Air King</td>
<td>0.5 ton – w envelope</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BFQ80</td>
<td>measures</td>
<td></td>
</tr>
<tr>
<td>System efficiency</td>
<td>80% AFUE</td>
<td>Panasonic FV-08VKS3</td>
<td>BEOpt defaults</td>
</tr>
<tr>
<td></td>
<td>14 SEER</td>
<td>Exhaust Fan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 HSPF, 22 SEER</td>
<td>(cold climate)</td>
<td></td>
</tr>
<tr>
<td>Capital cost</td>
<td>$7,995</td>
<td>$7,115</td>
<td>Local Developer</td>
</tr>
<tr>
<td></td>
<td>$60</td>
<td>$130</td>
<td></td>
</tr>
<tr>
<td>Available incentive</td>
<td>N/A</td>
<td>N/A</td>
<td>Rocky Mountain Power</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

**Rationale for selecting Ductless Mini-splits:**

These systems can require less space than ducted central systems, which is a consideration for developers.

For additional information on all-electric construction from Giv Group/Pragmatists for Clean Air: [https://pragmatistsforcleanair.org/resources/item/40-case-study-diamond-rail-all-electric-vs-typical](https://pragmatistsforcleanair.org/resources/item/40-case-study-diamond-rail-all-electric-vs-typical)
# Multifamily All-electric New Construction | Assumptions

## Water Heating Equipment and Cost Assumptions

<table>
<thead>
<tr>
<th>Input Description</th>
<th>Counterfactual Equipment</th>
<th>Electrification Equipment</th>
<th>Notes/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>System size</td>
<td>Gas water heater</td>
<td>Heat pump water heater</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40 gallon</td>
<td>50 gallon</td>
<td>BEopt defaults</td>
</tr>
<tr>
<td>System efficiency</td>
<td>0.61 EF</td>
<td>3.55 UEF</td>
<td>BEopt defaults</td>
</tr>
<tr>
<td>Capital cost</td>
<td>$625</td>
<td>$1870 total</td>
<td>Local Developers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1300 equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$220 louvered doors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$350 additional installation labor and parts cost</td>
<td></td>
</tr>
</tbody>
</table>

### Notes on Assumptions:

- This analysis uses retail costs for equipment and factors in additional installation costs for HPWH based on local interviews.
- HPWHs were selected over electric tankless water heaters because they have higher efficiencies and lower peak demand.
- HPWHs can have long recovery times, which often requires larger storage compared to gas water heaters.
Multifamily All-electric New Construction | Results

**Results**

- All-electric new construction avoids $1,600 per unit compared to mixed fuel new construction.
- All-electric new construction also results in $100 in operational cost-savings in Year 1.

**New Construction with Ductless Mini-split + HPWH (Savings by Year)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Installation Savings</th>
<th>Cumulative Cost Savings (Installation cost + incremental operational cost savings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>1</td>
<td>$810</td>
<td>$810</td>
</tr>
<tr>
<td>2</td>
<td>$2,925</td>
<td>$2,925</td>
</tr>
<tr>
<td>3</td>
<td>($1,095)</td>
<td>($1,095)</td>
</tr>
<tr>
<td>4</td>
<td>($857)</td>
<td>($857)</td>
</tr>
<tr>
<td>5</td>
<td>($1,000)</td>
<td>($1,000)</td>
</tr>
<tr>
<td>6</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>7</td>
<td>$500</td>
<td>$500</td>
</tr>
<tr>
<td>8</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td>9</td>
<td>$1,500</td>
<td>$1,500</td>
</tr>
<tr>
<td>10</td>
<td>$2,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>11</td>
<td>$2,500</td>
<td>$2,500</td>
</tr>
<tr>
<td>12</td>
<td>$3,000</td>
<td>$3,000</td>
</tr>
<tr>
<td>13</td>
<td>$3,500</td>
<td>$3,500</td>
</tr>
<tr>
<td>14</td>
<td>$4,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>15</td>
<td>$4,500</td>
<td>$4,500</td>
</tr>
</tbody>
</table>

**Net upfront cost savings by cost type for Baseline Variation (Per unit. Positive = savings in all-electric case)**

- **Space heating**: $810
- **Water heating**: ($1,095)
- **Electrical**: ($857)
- **Envelope measures**: ($1,000)
- **Gas connection costs**: $2,925
- **Incentive**: $636
There has been a rapid increase in new construction on the Wasatch Front, and all-electric new construction will be critical to lowering emissions, improving air quality, and preventing future gas infrastructure build-out in the coming years.

Multifamily all-electric new construction in Salt Lake City has lower installed costs compared to a mixed fuel building today. This is a result of avoided gas infrastructure costs as well as cost-savings come from only installing one heating and cooling system instead of two.

Multifamily all-electric new construction also has lower operating costs compared to a mixed fuel building today, which is largely the result of avoided monthly fixed costs for gas service in all-electric multifamily construction.
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  • Scenario 4: Multifamily All-electric New Construction

• Conclusions and Next Steps
Final Takeaways

- **All-electric multifamily new construction has both lower installed costs and lower operating costs** in Salt Lake City compared to a mixed fuel building today. Building all-electric will also avoid the build-out of additional gas infrastructure across the city.

- **Replacing or displacing electric resistance technologies with ASHP and HPWH systems is currently very cost-effective** for typical single family and multifamily buildings in Salt Lake City.

- **The results for replacing or displacing gas appliances with ASHP and HPWH systems are more mixed.** Some scenarios reduce energy costs or are close to breaking even, particularly when replacing both the heating and cooling system at the same time. However, other retrofit scenarios can result in slight increases in energy costs under today’s conditions for both single family and multifamily buildings.

- **There are many options that would help improve the economics of electrification upgrades in Salt Lake City**, including changing energy rates to be more favorable for electrification, increasing the heat pump system efficiency, adding solar PV, increasing air sealing and/or insulation within a home, and replacing the existing air conditioning system at the time of the retrofit.
Appendix

- Abbreviations
- Additional Cost Assumptions
Abbreviations

- AFUE: Annual Fuel Utilization Efficiency
- A/C: Air Conditioner
- ASHP: Air-source heat pump
- BEOpt: Building Energy Optimization Tool
- BR: Bedroom
- DMSHP: Ductless mini-split heat pump
- DOE: US Department of Energy
- EE: Energy Efficiency
- EER: Energy Efficiency Ratio
- EF: Efficiency Rating
- GS Rate: General Service Rate
- HH: Household
- HPWH: Heat Pump Water Heater
- HVAC: Heating, Ventilation, and Air Conditioning
- ICAST: International Center for Appropriate & Sustainable Technologies
- PV: Photovoltaic (Solar)
- RMP: Rocky Mountain Power
- SEER: Seasonal Energy Efficiency Ratio
- SF: Single Family Home
- UEF: Uniform Energy Factor
### Additional Cost Assumptions for Ductless Mini-splits

<table>
<thead>
<tr>
<th>Cost element</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost elements</strong></td>
<td></td>
</tr>
<tr>
<td>Non-equipment (labor, materials, other)</td>
<td>$1,751</td>
</tr>
<tr>
<td>Typical contractor equipment mark-up</td>
<td>$875</td>
</tr>
<tr>
<td><strong>Potential additional costs</strong></td>
<td></td>
</tr>
<tr>
<td>Each additional zone</td>
<td>$887-974</td>
</tr>
<tr>
<td>Exterior wall-mounted</td>
<td>$1,000</td>
</tr>
<tr>
<td>Roof-mounted</td>
<td>$400</td>
</tr>
<tr>
<td>Brick exterior wall</td>
<td>$260</td>
</tr>
<tr>
<td>Electric panel upgrade</td>
<td>$1,000-$3,800</td>
</tr>
</tbody>
</table>

#### Sample ranges of total Installed costs

| Single zone | $3,643 - $5,256 |

### Background on Additional Cost Assumptions:

- In 2018, Navigant conducted an extensive study via contractor surveys and web scraping on ductless ASHP costs in MA that estimated non-equipment costs and equipment costs by efficiency level.
- Costs vary substantially by size, number of zones, efficiency level, whether it is a cold climate heat pump, as well as building type and installation context.
- Electric panel cost range quoted from Building Decarbonization Coalition, though are not included in the analysis based on local interviews suggesting they are not typically needed in Salt Lake City homes.
- Costs were validated with local contractors to be in a similar range for a 1.5 ton single zone ductless system: $4,500-$5,400.
