Passive House Multifamily - MN CARD Grant

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This research is funded by the MN Department of Commerce CARD program and has 3 main objectives. 1) Determine the feasibility, cost effectiveness, and energy/carbon savings potential of Passive House certification for multifamily buildings in Minnesota using modeling and existing monitoring data from recently completed, regional examples. 2) Use surveys and market studies to understand the drivers and barriers related to multifamily Passive House adoption in Minnesota and identify the most promising market segments for CIPs to target. 3) Provide guidance on how best to structure CIPs targeted at multifamily Passive House construction to maximize awarded energy savings and market uptake.

Funders: Minnesota Department of Commerce.
3 buildings scales

A. SMALL MULTIFAMILY
TEWA LINDA
Envelope Area 14,107
tCFA 8,596
Dwelling Units 6
Bedrooms 18

B. MEDIUM MULTIFAMILY
SOLSTICE APARTMENTS
Envelope Area 21,103
CFA 17,880
Dwelling Units 23
Bedrooms 23

C. LARGE MULTIFAMILY
HOOK & LADDER
Envelope Area 56,200
CFA 53,167
Dwelling Units 59
Bedrooms 97

3 climates

7 NORTH
BEMIDJI MUNICIPAL AIRPORT

6A CENTRAL
Minneapolis - St. Paul Intl Airport

6A SOUTH
Albert Lea (AVCON)

These cities were chosen to study three different regions that represent a good cross-section of Minnesota.

Bemidji in the north, is located in climate zone 7, and the city is surrounded by lakes and forestland.

Minneapolis and St. Paul are located in climate zone 6A along the Mississippi River and network of lakes, and it represents the largest city of the three examples.

Albert Lea in the south, is located in the climate zone 6A, and is located between lakes and farmland.
## BASELINE COMMERCIAL CODE
ASHRAE 90.1 2019 W/ MIN AMENDMENTS

<table>
<thead>
<tr>
<th></th>
<th>GAS</th>
<th>ELECTRIC RESISTANCE</th>
<th>ELECTRIC ASHP</th>
<th>PHIIUS+ 2021</th>
<th>PERFORMANCE BASED (VARIES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof (whole wall)</td>
<td>R30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slab</td>
<td>R29 + 3.8x3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windows</td>
<td>U-0.43/0.37 (operable), U-0.36/0.29 (fixed) + shading 0.75, no interior blinds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doors</td>
<td>Uw 0.77 (R1.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Sealing</td>
<td>0.31 cfm/SF @50 Pa (3 ACH50)</td>
<td></td>
<td></td>
<td></td>
<td>0.6 cfm/SF @50 Pa</td>
</tr>
<tr>
<td>Heating</td>
<td>0 AFUE Gas Furnace</td>
<td></td>
<td></td>
<td>Air Source Heat Pump COP 3.4 @ 47F / 2.2 @ 17F</td>
<td>Air to Air Heat Pump 20,000 BTU/h Heating COP 3.17 @ 47F / 2.47 @ 17F</td>
</tr>
<tr>
<td>Cooling</td>
<td>Electric AC</td>
<td></td>
<td></td>
<td></td>
<td>Air to Air Heat Pump 16,000 BTU/h 20 SEER</td>
</tr>
<tr>
<td>Ventilation</td>
<td>Balanced, No Recovery</td>
<td></td>
<td></td>
<td></td>
<td>Energy Recovery Ventilator 3RE I/ERU I/E 1.0 W/cm²</td>
</tr>
<tr>
<td>DHW</td>
<td>Standard Natural Gas 0.69 EF</td>
<td></td>
<td></td>
<td>Electric Heat Pump 4.07 U/F</td>
<td>72 ga. tank</td>
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<tr>
<td>Lighting &amp; Power</td>
<td>75% LED, Utility Baseline Appliances</td>
<td></td>
<td></td>
<td>100% LED, Median Energy Star Apps.</td>
<td></td>
</tr>
<tr>
<td>Thermal Bridging</td>
<td>Not Included in Baseline Models</td>
<td></td>
<td></td>
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</tbody>
</table>

## annual site energy use comparison | medium multifamily

**BEMIDJI (7A)**
66% - 34% savings

**MINNEAPOLIS ST PAUL (6A)**
64% - 33% savings

**ALBERT LEA (6A)**
60% - 29% savings
modeled to actual consumption - verdant

WUFI EUI (with parking garage): 23.5 kBTU/sf/yr

Measured EUI (with parking garage): 29.6 kBTU/sf/yr

80% Modeled vs. Actual
(Measured data is most recent 12 months, but has not been weather-normalized yet)

utility bills - verdant

yearly total = $98,980

Since gas is a cheaper energy source and PH buildings mostly save gas, we can’t expect 50% energy cost savings to match the 50% reduction in energy consumption.
## Construction Costs — Minnesota Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Location</th>
<th># Units</th>
<th>Floor Area (gross)</th>
<th>Construction Cost</th>
<th>Cost Year</th>
<th>Cost/sf</th>
<th>Cost/unit</th>
<th>Incremental Above</th>
<th>Incremental Below</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hook &amp; Ladder</td>
<td>Minneapolis, MN</td>
<td>59</td>
<td>73,000</td>
<td>$10,350,360</td>
<td>2017</td>
<td>$242</td>
<td>$175,430</td>
<td>13.0%</td>
<td></td>
<td>Energy Star</td>
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<tr>
<td>Verdant</td>
<td>Saint Paul, MN</td>
<td>82</td>
<td>123,137</td>
<td>$19,456,650</td>
<td>2021</td>
<td>$258</td>
<td>$237,276</td>
<td>12.0%</td>
<td></td>
<td>Green Communities</td>
</tr>
<tr>
<td>Hillcrest Village</td>
<td>Northfield, MN</td>
<td>17</td>
<td>17,074</td>
<td>$4,069,500</td>
<td>2022</td>
<td>$230</td>
<td>$239,382</td>
<td>7.0%</td>
<td></td>
<td>Standard Construction</td>
</tr>
<tr>
<td>Solstice</td>
<td>Minneapolis, MN</td>
<td>23</td>
<td>18,960</td>
<td>$6,138,000</td>
<td>2023</td>
<td>$324</td>
<td>$266,870</td>
<td>7.5%</td>
<td></td>
<td>Energy Star</td>
</tr>
</tbody>
</table>

## Incremental Construction Costs

**Typical Incremental Cost in MN:** 7-13%, **MN average 10%**