Attic Retrofits Using Nail-Base Insulated Panels

- Develop and demonstrate a roof/attic energy retrofit solution using retrofit panels for existing homes where traditional attic insulation approaches are not effective or feasible
- Monitor data to confirm acceptable moisture levels

Success Metrics: Heating and cooling energy savings of at least 10%, as well as improved comfort.
Project Overview

- **Project Purpose:** Develop, demonstrate, and assess a roof/attic energy retrofit solution using nail-base insulated panels (retrofit panels) for existing homes where traditional attic insulation approaches are not effective or feasible.

- **Technology:** Retrofit panels consist of rigid foam insulation laminated to one face of a wood structural panel. The prefabricated panels are installed above the existing roof deck during a re-roofing effort.

- **Project Goals:**
  1) Develop design details for two residential demonstration homes (one cold climate, one hot-humid climate); 2) Demonstrate the retrofit panel installations; 3) Assess energy performance, moisture performance, costs, and feedback from contractors and homeowners.

- **Scope:** This presentation summarizes the project from site assessments to installation during the winter of 2016/2017 to data collection through Feb 2018.
Hot-Humid Climate – St. Simons Island, GA
Georgia Retrofit Design

- **Ridge vent**

**Roofing:**
- Asphalt shingles
- over vent mat
- over #30 felt

**Retrofit Panel:**
- 6” thick, R-25

**Existing roof deck:**
- 1x10 boards
- over 2x6 rafters

**Eave Insulation:**
- Rigid foam board

**Existing ceiling insulation:**
- R-19 cellulose
  (not shown)

**Gable wall insulation:**
- Same insulation value as retrofit panel (not shown)
Eave Area and Attic Access
Construction – GA
Construction – GA
Construction – GA
HIRL roof mock up with ventilation mat

Figure 9. Mock-up Roof Deck Assembly and Installation of Underlayment

Figure 10. Installation of Ventilation Mat
GA Data – MC at Retrofit Panel

Takeaway: MC below 9% except one outlier
GA Data – MC at Retrofit Panel
Extended Data: Jan 2017 – Feb 2018
Note: lower graph is without the outlier

Average Sensor Values from 1/1/2017 12:00:00 AM to 2/6/2018 12:00:00 AM using daily averages

Average Sensor Values from 1/1/2017 12:00:00 AM to 2/6/2018 12:00:00 AM using daily averages
**Takeaway:** MC “after” higher than “before” but below 12% except one outlier
GA Data – MC at Existing Deck/Framing
Extended Data: Jan 2017 – Feb 2018
Note: lower graph is without the outlier
GA Data – RH Conditions

Takeaway: Attic RH (yellow) is higher for “after” summer
GA Data – RH Conditions
Extended Data: Jan 2017 – Feb 2018
Note: attic RH indicated by red line

Average Sensor Values from 1/1/2017 12:00:00 AM to 2/6/2018 12:00:00 AM using daily averages

Legend right axis
- %RH: GA indoor1
- %RH: GA indoor2
- %RH: GA rafter5
GA Data – T Conditions

Takeaway: Attic T (yellow) “after” closely tracks indoor T
GA Data – T Conditions

Extended Data: Jan 2017 – Feb 2018

Note: attic T indicated by red line
Takeaway: Attic dew point T (yellow) is somewhat lower the summer “after” installation (even though RH was higher).
GA Data – DP Conditions
Extended Data: Jan 2017 – Feb 2018
Note: attic DPT indicated by red line

Average Sensor Values from 1/1/2017 12:00:00 AM to 2/6/2018 12:00:00 AM using daily averages

Legend left axis:
- DP(°F) • GA indoor 1
- DP(°F) • GA indoor 2
- DP(°F) • GA rafter
Cold Climate – Ann Arbor, MI
Michigan Main Roof Retrofit Design

Ridge vent

Retrofit Panel:
8” thick, R-34

Roofing:
Asphalt shingles over vent mat over vapor permeable synthetic underlayment

Existing ceiling/roof deck:
2” thick fiberboard, 24” wide T&G panels, est. R-5, supported by timber frame 4”x6” rafters, 48” o.c.
Design Solution – MI

Michigan Addition Roof Retrofit Design

Ridge vent

Roofing:
Asphalt shingles over vent mat over vapor permeable synthetic underlayment

Retrofit Panel:
5” thick, R-20

Existing enclosed rafter assembly:
2x10 rafters, OSB deck, ½ drywall, R-30 fiberglass batts, 1” air space above batts, converted from vented to unvented.

Eave Insulation
Construction – MI
Construction – MI
Construction – MI
MI Data – MC at Retrofit Panel

MC at retrofit panels
Note: 3 outliers (MI 10/11/12 S), same orientation, appears panels were wet at installation

Takeaway: MC below 10% except 3 outliers (same orientation, appears panels were wet at installation)
MI Data – MC at Retrofit Panel
Extended Data: Jan 2017 – Feb 2018
Note: lower graph is without the outliers
MI Data – RH Rafter Assembly

**RH conditions within enclosed rafter assembly**

Takeaway: RH (red) tracks indoor RH (green) and is within expected limits
MI Data – RH conditions

Takeaway: Indoor RH appears to be somewhat lower “after”
MI Data – RH conditions
Extended Data: Jan 2017 – Feb 2018

Average Sensor Values from 1/1/2017 12:00:00 AM to 2/6/2018 12:00:00 AM using daily averages

Legend right axis:
- SRH: MI indoor add L
- SRH: MI indoor tower
- SRH: MI indoor main L

Date of Activity
## House Tightness Test Results

### Blower Door Test Results

<table>
<thead>
<tr>
<th>Location</th>
<th>Test-in</th>
<th>Test-out</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan</td>
<td>9.3 ACH50</td>
<td>6.6 ACH50</td>
<td>29%</td>
</tr>
<tr>
<td>Georgia</td>
<td>17.8 ACH50</td>
<td>15.6 ACH50</td>
<td>12%*</td>
</tr>
</tbody>
</table>

*Note: if GA test-in was a more typical 8.9 ACH50 (half) at test-in, the same effort would have provided a 24% improvement.
## Energy Modeling

### Modeled Heating/Cooling Energy Savings

<table>
<thead>
<tr>
<th>Location and Run</th>
<th>Heating</th>
<th>Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI original est. (7.4 ACH50)</td>
<td>20.8%</td>
<td>13.6%</td>
</tr>
<tr>
<td>MI adjusted est. (6.6 ACH50)</td>
<td>22.9%</td>
<td>13.1%</td>
</tr>
<tr>
<td>GA original est. (14.0 ACH50)</td>
<td>13.8%</td>
<td>12.8%</td>
</tr>
<tr>
<td>GA adjusted est. (15.6 ACH50)</td>
<td>11.3%*</td>
<td>11.0%*</td>
</tr>
</tbody>
</table>

*Note: if GA had all R13 walls and R19 floors, savings would be 21.0% heating, 15.3% cooling, even at measured house leakage.

### Estimated Savings Based on Energy Bill Evaluation*

<table>
<thead>
<tr>
<th>Location</th>
<th>Heating</th>
<th>Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan</td>
<td>40%</td>
<td>17%</td>
</tr>
<tr>
<td>Georgia</td>
<td>16%</td>
<td>16%</td>
</tr>
</tbody>
</table>

*“After” data (3 months heating, 3 months cooling) compared/normalized to same period “before”.*
The house feels warmer during the winter and far less drafty.
The comfort factor has changed immensely.
The house seems quieter now, the whole place feels tightened up.
The furnace definitely ran less this winter and the bills seemed lower.
The roof is thicker, more prominent fascia, but it all looks great.
No ice damming whatsoever; we had them every other winter.
It’s a pricey retrofit but it feels like a no-brainer, our house was a particularly bad “before” case, all in all seems totally worth it.
We’re definitely pleased.
GA Homeowner Feedback Summary

- The house definitely feels warmer during the winter.
- The house feels less drafty but marginally so due to the leaky walls.
- It was very noticeable how much less the heating system ran this winter – before, during the coldest parts of the winter, the system rarely shut off and barely maintained a comfortable temperature.
- The utility bills are lower.
- Satisfied with the final appearance and overall very pleased with the results; I hope in the future to upgrade the walls, floors, and HVAC.
- The entire team did a fine job.
Key Findings

- Modeled energy savings were 23% heating, 13% cooling for MI and 11% heating and cooling for GA – an evaluation of the energy bills indicates actual savings may be considerably higher.
- Overall house tightness improved by 29% for MI and 12% for GA (very leaky walls and floors skewed results for GA).
- Monitored data collected for one winter and one summer show moisture conditions at retrofit panels and existing roof decks are well within acceptable limits. It is planned to collect data for one additional winter and summer.
- Average RH within the GA attic was higher during the summer after installation compared to the previous summer. It is planned to install an HVAC supply vent in the GA attic to help control RH.
Key Findings

- Homeowner feedback was very favorable for both sites: comfort was greatly improved; happy with the final appearance; overall pleased with the results; ice damming was eliminated in MI.
- Structural reinforcement of the existing roof assembly was minimal.
- Shingles installed over the ventilation mat looked normal (not wavy); and the ventilation gap appeared to be maintained at full depth (GA).
- Incremental installed cost ranged $8-$9/SF roof area. In addition to energy savings, the value of the demonstrated solutions includes significant improvement in comfort and durability of the roof assembly.