Habitat Cost Effective Energy Retrofit Program
Mixed - Humid and Cold Climate

Dow Building Solutions
Michigan State University
Ferris State University
Habitat for Humanity International
Habitat for Humanity affiliates of greater Chicago area
Habitat for Humanity of Kent County
Habitat for Humanity of Michigan
Mixed – Humid (& Cold) Retrofit Case Study

OH, IN, & MI Retrofit Air Leakage Case Study
a Collaboration with Duke Energy

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Dow Building Solutions

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Professor Michigan State University
Acknowledgements

- Kate Johnson, Dow Chemical Company
- Doug Bibee, Dow Chemical Company
- Don Nelson, DR Nelson & Associates
2009 Study Details

• 15 existing homes
  – Dating between 1926 and 2001
• Michigan, Indiana, and Ohio
• Limited to air sealing and testing in one day using One/Two Component Foam
• Measurement of time/material/location
• Blower door test before and after each change
• REM/Rate calculations to estimate annual energy savings attributed to reduced air leakage
Home Selection
**Procedure**

**Visual Assessment of House**
- Potential air leakage locations within the scope of project

**Initial Blower Door Test**
- Baseline air leakage
- Negative 20, 30, 40, 50 Pa
- Identify air leakage locations

**Application of Spray Foam Sealant in First Air Leakage Location**
- Prepare location
- Foam sealant product selection
- Measure application time, amount of product used, size of air leakage location

**Repeat for up to 4 air leakage locations on the same house**

**REM/Rate Calculations**
- Energy reduction and energy cost savings attributed to sealing each air leakage location

**Gather House Info for REM/Rate**
- Measurements
- Equipment descriptions
- Characteristics

**Second Blower Door Test**
- Same conditions as initial blower door test
- Determines air leakage reduction as a result of sealing first air leakage location

**Results**
- Payback for each air sealing product at each air leakage location
Before

Sill plate & Rim Joist

Window

Rim Joist

Rim Joist on Block Wall

After
Case Study #1

Built in 1926
Take-away: Every Home is “unique” Construction

Built in 1926 with Balloon Framing

Wall cavity continuous volume space with attic and floor.
Intermediate floor framing joists are face nailed directly to the studs.
The studs are continuous from top to bottom of the building.
Air Sealing Materials

Consumer spray can

Professional gun on can foam

“DIY”

Contractor

Froth Pack Foam
Air Sealing of Rim Joist

What was done:

- 95 linear feet of rim joist
- Product used: 2.5 cans w/ gun applicator
- Labor: 1.75 hours

Initial HERS Score 190  
Initial ACH 1.3

After sealing rim joist 182  
ACH after sealing rim joist 1.1
Series of Improvements

Initial HERS Score 190  Initial ACH 1.3
after 180 after 1.0

Totals:
- Product used: 5.5 cans w/ gun applicator
- Labor: 4.3 hours
Sequence of Retrofits
Impact on Pay Back
Payback for All Cases

- Payback to air seal rim joist
- Payback on air seal measures after rim joist

- Froth Packs
- Pro and DIY Can Foam
- Pro Froth Pack
- Can Foam
- straw and applicator gun

Retrofit cost Materials and Labor (USD) vs. Years for Savings to Payback Cost
% Energy Efficiency Improvement (REM/Rate Analysis)

% EE Improvement

1 day DIY
1 day Professional Froth Pack

Retrofit cost Materials and Labor (USD)
Conclusions Air Sealing Case Study

• DIY Simple Air Sealing Can Provide very Quick Savings Payback

• % Energy Efficiency Improvement from simple one-day air sealing
  – Function of candidate home and type of improvement

• Candidate for Low Cost Prescriptive Package including Health, Safety, and Durability Measures
Gaps and Barriers

• Gaps in Energy Retrofit Market lie in understanding owner motivators, and barriers to owner investment in upgrades

• Matching technology with market place
  – ID and Selection of Successful Candidate Structures
“Habitat Cost Effective Energy Retrofit Program for Mixed-Humid and Cold Climate Housing Stock”
<table>
<thead>
<tr>
<th>Company</th>
<th>Skills and Focus</th>
</tr>
</thead>
</table>
| The Dow Chemical Company- Project Lead          | • Manufacturer of insulation and air sealing products  
• Recognized building science leader and provides building science and research modeling expertise  
• Elected team leader for the project  
• Global company with extensive market penetration in the U.S.  
• Leading HFH Corporate Sponsor for many years and committed to helping HFH’s global success |
| Habitat for Humanity                             | • Provides access to existing housing stock identified for energy retrofits through HFH’s local affiliates  
• Works within Gifts in Kind (GIK) program to collect materials through their GIK program and coordinate field construction deliveries and activities, professional installation where required. |
| Michigan State University                        | • Brings architectural and engineering design expertise, project management proficiency within the Construction Mgmt program.  
• Leverages MSU graduate students to support the project’s schedules, milestones, deliverables, data collection, reporting, project meetings, etc  
• Builds on existing strong Dow/MSU partnership. |
| Ferris State University                          | • HVACR engineering and building science expertise. Applied technology research and best practice development.  
• National workforce certification expertise.  
• RESNET rater abilities  
• Builds on existing HFH/FSU relationship |
| Duke Energy, DTE and Exelon                       | • Experience with a number of national energy efficiency programs with interest in exploring the deep energy retrofit market  
• Provides a utility perspective as well as utility bill acquisition, resource support on design teams |
Project Objectives

- Determine cost-effective energy efficiency retrofit solutions to meet 30% and 50% efficiency gains
- Identify technology gaps for cost effective retrofits
- Assess and classify housing stock to identify high impact archetypes to achieve economies of scale
- Clarify the existing home retrofit market potential by housing stock type and geographic area;
- Identify potential policy tools that could provide incentives for homeowners to engage in retrofits
- Develop basic retrofit design strategies
- Develop two test homes and community-scale case studies
Project Objectives

• Work with stakeholders, including homeowners, to understand obstacles, successful models, opportunities providing a pathway to the future at every stage of the project

• Develop and communicate ‘best practices’, iteratively improving them as subsequent stages of the project progresses

• Develop a training and certification framework, leveraging the ‘best practices’, market research, survey data and other lessons learned;

• Identify the need for product innovation that can address areas of need in accomplishing these deep energy retrofit products cost effectively

• Develop an expert system that enables the home owner or contractor to query the computer-based system in order to find prescriptive cost effective, energy efficient options.
Understanding the market place

- Match technical solutions with market conditions and preferences
- Identify high impact homes with high potential for ramp up
- Identify motivators of homeowners to invest in improvements
- Identify consumer or other barriers to investment in energy retrofits
Key Survey and Market Research Activities

• Market Assessment-Data Base Development-Housing Taxonomy
• Workforce Focus Groups
• Pre-retrofit and Post-retrofit Case Study Interviews
• Homeowner’s Survey-”Voice of Customer”

Michigan State University Office of Survey Research (OSR)
Building & Construction
A business group of Dow Advanced Materials Division

Retail Team
Incentives for Energy Efficient Home Improvements
US Homeowner Study
to Support Development of HomeStar Legislation

June 2010
In June 2010, a survey of consumers was fielded via the Internet to gain insights to support:

- Development of incentive plans to encourage US homeowners to make their homes more energy efficient

- Understanding of...
  - Which proposed incentive plans have the highest potential
  - Which home improvement projects consumers would be more likely to do if an incentive plan were implemented
  - How various homeowner segments would respond to differing incentive plans
  - Past incentive plan participation and drivers of potential participation in a new plan offering.

The survey focused on homeowners between the ages of 22 and 64, with 41% of the respondent base being male and 59% female. With 1,575 completed responses, the overall survey has a margin of error of +/- 2.5 at the 95% confidence level. The concept evaluation, conducted with rotation, has a margin of error of +/- 6 at the 95% confidence level.
Insights: Home Improvement Projects Related to Energy Efficiency

Without an incentive, many homeowners have either never considered or are not planning to do the types of projects targeted by the proposed incentive program. Approximately one-quarter have already insulated their attic or exterior walls, replaced their HVAC system or windows. Almost one-third have sealed gaps and cracks. 15% indicated that sealing ductwork did not apply to their home and 9% indicated that sealing gaps and cracks did not apply to their home.

<table>
<thead>
<tr>
<th>Energy Efficiency Project Disposition</th>
<th>Never considered</th>
<th>Not planning</th>
<th>Plan next 12 mos</th>
<th>Plan next 24 mos</th>
<th>Completed &lt;12 mos</th>
<th>Completed &gt;12 mos</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add insulation to the attic</td>
<td>22%</td>
<td>20%</td>
<td>12%</td>
<td>3%</td>
<td>6%</td>
<td>16%</td>
<td>18%</td>
</tr>
<tr>
<td>Insulate a basement</td>
<td>24%</td>
<td>10%</td>
<td>7%</td>
<td>4%</td>
<td>3%</td>
<td>8%</td>
<td>44%</td>
</tr>
<tr>
<td>Insulate a crawl space under the house</td>
<td>13%</td>
<td>9%</td>
<td>8%</td>
<td>5%</td>
<td>4%</td>
<td>8%</td>
<td>48%</td>
</tr>
<tr>
<td>Insulate exterior walls</td>
<td>32%</td>
<td>17%</td>
<td>9%</td>
<td>1%</td>
<td>4%</td>
<td>18%</td>
<td>19%</td>
</tr>
<tr>
<td>Replace a heating and/or air conditioning system</td>
<td>22%</td>
<td>21%</td>
<td>10%</td>
<td>8%</td>
<td>4%</td>
<td>22%</td>
<td>13%</td>
</tr>
<tr>
<td>Replace windows</td>
<td>17%</td>
<td>27%</td>
<td>10%</td>
<td>8%</td>
<td>6%</td>
<td>23%</td>
<td>8%</td>
</tr>
<tr>
<td>Seal ductwork to stop air leakage</td>
<td>28%</td>
<td>17%</td>
<td>10%</td>
<td>6%</td>
<td>8%</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Seal the gaps and cracks that allow conditioned air to escape and outdoor air to enter the home</td>
<td>16%</td>
<td>21%</td>
<td>18%</td>
<td>6%</td>
<td>14%</td>
<td>17%</td>
<td>9%</td>
</tr>
</tbody>
</table>

Home Energy Efficiency Incentives 2010

DOW RESTRICTED - For internal use only
Technical studies

Incorporate individual measures:
- air sealing
- Insulation
- replace components
- solar components

Evaluate energy efficiency
Determine ‘best practices’ for Community Homes - Pilot

Select test homes with diverse age and building style

Test Homes (2) (TASK 8)
Test House A
Test House B

Select community scale- pilot homes with diverse age and building style

Community Scale – Pilot Homes (10 in base year in Cold Climate Zone) (TASK 9)
1. **Select Case Study Homes with HFH**
   - Use procedures for home characteristics studies (TASK 6,7 +)
   - Select 10 community scale pilot homes from 2 climate zones
   - Start initial building information gathering

2. **Gather + Report on Existing Case Study Info**
   - Obtain:
     - Property information + legal description
     - Field measurement + condition assessment
     - Utility metering information
     - Home classification characterization
     - MSU OSR to conduct homeowner use and attitudinal pre-retrofit survey (program qualification)

3. **Develop Baseline Case Study Documentation**
   - Develop baseline case study documents, including plans, reports, energy use computer simulation of existing home
   - Conduct an environmental assessment with consulting testing firm for lead, asbestos, mold + other contaminants
   - Conduct risk assessment of study home

4. **Analyze Existing Building Data**
   - Analyze existing information for retrofit opportunities
   - Conduct energy simulation of alternative
   - Propose retrofit solutions

5. **Review Solutions**
   - Submit to Case Study Task Force for review + revisions
   - Revise per review
   - Prepare final existing building report
   - Obtain acceptance of report + retrofit solutions from Case Study Task Force + Research Design Team

6. **Consult with HF Affiliates**
   - Prepare design solution documents
   - Prepare instrumentation + data collection plans
   - Prepare overall construction management and quality oversight plan

7. **Set up/Train**
   - Conduct field training with HFH as needed
   - Implement instrumentation + data collection plan
   - Install data collection equipment
   - Implement overall construction project mgmt + quality oversight plan

8. **Implement Construction (HFH)**
   - Provide quality control + data collection during construction (Research Team)
   - Conduct periodic field observation
   - Provide written + photo records
   - Collect cost data

9. **Assist with Commissioning + Start-up**
   - Conduct post retrofit user survey
   - Complete homeowners’ education and manual
   - Provide commissioning + startup assistance for homeowner

10. **Conduct Post-Construction Activities**
    - Research Team will:
      - Collect energy data
      - Monitor data recording systems
      - Troubleshoot equipment issues

11. **Prepare Data Report**
    - Include data on instrumentation, metering data, climate data, cost information, labor, etc

12. **Analyze Data**
    - Include cost analysis, life cycle cost effectiveness, savings, energy analysis and analysis versus computer energy simulation

13. **Develop Case Study Report**
    - Include:
      - Data and analysis reporting
      - Results
      - Recommendations from case studies
      - Develop case study conclusions

End TASK 9
Start TASK 9

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End TASK 9
Synthesis Activities

- Synthesis of case studies
- Aggregate case study project reports
- Develop overall conclusions
- Identify prescriptive packages
- Identify best practices
Synthesis Activities

• Develop contractor/installer industry documents, details, specifications
• Develop workforce skills training
• Develop expert system development team
Closing the gaps

• Identify best practices and most effective technical strategies matched to high impact archetypes
• Foster community scale implemented based on consumer motivations
• Develop consistent SOP and processes for large scale implementation
• Develop work force skill standard certification for training
Q and A