

High Performance Manufactured Home Project:

Final Project Report

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Industry partners include:

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- Fleetwood Homes of Oregon, Woodburn, Oregon
- Fleetwood Homes of Idaho, Nampa, Idaho
- Golden West Homes, Albany, Oregon
- Kit Homebuilders West, Caldwell, Idaho
- Marlette Homes, Hermiston, Oregon
- Nashua Homes of Idaho, Inc., Boise, Idaho
- Palm Harbor Homes, Millersburg, Oregon
- Skyline Corporation, McMinnville, Oregon
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- Oregon Manufactured Home Association
- Northwest Housing Association

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DEFINITIONS

BPA	Bonneville Power Administration
DAPIA	Design Approval Primary Inspection Agency
DHP	Inverter-driven Ductless mini-split Heat Pump
DHW	Domestic Hot Water system
FMHCSS	Federal Manufactured Home Construction and Safety Standards
HPMH	High Performance Manufactured Home
HPWH	Heat Pump Water Heater
HUD	U.S. Department of Housing and Urban Development
IPIA	In-plant Primary Inspection Agency
MAP	Manufactured Homes Acquisition Program
MHCSS	Manufactured Housing Construction Safety Standards (aka “HUD Code”)
NEEA	Northwest Energy Efficiency Alliance
NEEM	Northwest Energy Efficiency Manufactured Housing Program
NEW	Northwest Energy Works
NPCC	NW Power Conservation Council
PNW	Pacific Northwest region – defined as Idaho, Montana, Oregon and Washington
RCDP	Residential Construction Demonstration Project
RTF	Regional Technical Forum
SEEM	Seasonal Energy and Enthalpy Model
Uo	area-weighted average hourly conductive heat loss per square foot of building envelope (per degree F delta-T)

EXECUTIVE SUMMARY

High Performance Manufactured Home Project Background

The Manufactured Home Industry in the Pacific Northwest provides a small but significant portion (10%) of new home construction. While the industry has declined substantially due to the recession and increasing competition from low cost conventional builders, manufactured homes rely heavily on electric space and water heating and therefore offer several attractive energy conservation opportunities for the Bonneville Power Administration (BPA) and its affiliated public and investor-owned utilities.

Since the 1990's, BPA has been working to improve manufactured homes through work with the Manufactured Homes Acquisition Project (MAP), support of Super Good Cents Manufactured Homes and then with continuing support of an effort with the Oregon Office of Energy on the Northwest Energy Efficiency Manufactured Housing Program (NEEM). NEEM provided a program mechanism through which to ensure that energy efficiency specifications were being met consistently by manufacturers.

Since that time, manufacturers have directly supported the maintenance of these specifications, in-plant inspections, and quality control, through a direct payment for each NEEM home manufactured in the Pacific Northwest. Since 2000, the share of energy efficient homes meeting the NEEM specification has ranged from just over 50% to about 70% of the manufactured homes produced region-wide. With the recent down-turn in the economy the percentage of NEEM certified homes has decreased, while the total number of manufactured homes built annually has also dropped in reaction to the economic crisis. In fact, because manufactured home sales depend primarily on direct financing rather than conventional mortgages, the manufactured home market was even harder hit.

The NEEM program administered by Northwest Energy Works provides a third party home certification service to over 74 utilities in the Pacific Northwest and California, with easy to verify measures, program evaluation, and program services delivered at little or no cost to the utility system. NEEM administers technical specifications, performs research and engineering analysis, implements ongoing construction quality management procedures and maintains a central database with home tracking. To insure that qualified homes are recognized in the market for their unique value, NEEM also provides utilities and home appraisers with home certification validation. Both NEEM specifications and associated Energy Star requirements are above code, i.e. more stringent than state or federal standards. NEEM also maintains its own green building specification called Eco-rated which has more stringent energy efficiency requirements and requires green attributes be included in each home.

Project Description

In 2011, BPA contracted with Northwest Energy Works (NEW) to research, develop and promote a new specification for highly energy-efficient manufactured homes. *This specification, called the High Performance Manufactured Home (HPMH), is intended to save a minimum of 50% over the current practice homes.*

In conducting this specification development project, NEW and its partners identified and explored several key factors:

- The current status of the industry, including its dramatic consolidation and retraction, along with significant changes in marketing and retailing;
- The outsized – and harmful – impact of appraisal and financing practices on energy efficiency in manufactured homes;
- The collaborative development and testing with the industry of the technologies and strategies available to build a HPMH.

This Final Project Report reviews these factors and overviews the energy saving and cost implications of a HPMH specifications.

Understandably, a sizeable portion of the report is given to review and discussion of the energy saving technologies investigated, tested, and ultimately recommended for the HPMH specification. Technologies identified and recommended meet the criteria of availability, reliability, appropriate cost, and relative ease of installation on the production line.

The HPMH Specification

The following basic technologies and manufacturing revisions were developed, pending further testing in partnership with industry, for the HPMH specification:

- Shell Modifications, including increasing insulation levels in attics (R-49), floors (R-38) and walls (R-21 + R-5 continuous) and upgrading the efficiency of windows (U=0.22);
- HVAC System Modifications built around the use of a Ductless Heat Pump with zoned supplemental heaters for extreme cold;
- Domestic Hot Water Modifications, primarily reliance on a Heat Pump Water Heater instead of traditional electric water heating;
- Lighting Modifications, increasing the use of high efficacy lamps (80% of lamps); and
- ENERGY STAR® Appliances.

These technologies and their applications are discussed at some length within the report, along with descriptions of new technology testing in partnership with industry and progress in securing regulatory approval for the proposed changes.

HPMH Package Cost Summary

Measure Category	Notes	Measure Costs
Envelope	Majority from Walls and Windows	\$ 4,277
Air Sealing & Ventilation	Whole House Exhaust Fan	\$ 50
HVAC System	DHP & Resistance Wall Heaters. (less cost of furnace and duct system)	\$ 4,701
Domestic Hot Water	Heat Pump Water Heater	\$ 1,110
Lighting	Compact and Linear Fluorescents	\$ 117
Appliances	Dishwasher & Refrigerator	\$ 62
Total		\$ 10,318

Potential Energy Savings

Energy modeling performed by Ecotope using SEEM (Simplified Energy and Enthalpy Model) found the annual potential savings of a HPMH over a typical above HUD code baseline home would be about 8,000 to 11,000 kWh for each home produced and sited.

State of the Industry

The importance of overcoming technical challenges in building a HPMH is matched by several significant industry and market issues, including:

- The appraisal and financing process for manufactured homes has become extremely difficult, exceeding even the site-built industry. Home appraisals are coming in below the invoice cost of the home in some cases. As a result, many plants are building the lowest-cost homes possible for buyers seeking to finance the home purchase, and minimum energy efficiency is increasingly common.
- Currently, the NEEM program is missing 43 percent of the potential energy conservation market as the trend continues toward sales of price sensitive homes without energy efficiency upgrades.
- The industry is looking for an innovative product to attract new customers and regain the energy efficiency leadership it enjoyed in the past.

Marketing

Despite the obstacles created by appraising practices, there are encouraging trends in the market:

- There is strong recognition of energy efficiency among manufactured home consumers.
- Retailers have highly motivated sales people who understand the importance consumers attach to energy efficiency.
- The manufactured housing industry is increasingly reliant on web based communication strategies. Websites allow customers to shop electronically, so many first interface with a retailer via the web.

Summary Conclusions

As a consequence of this study, NEW concluded:

- There is sufficient opportunity, need and benefit to justify development and implementation of a HPMH project. Indeed, consumers are beginning to request individual elements of a HPMH, necessitating new materials and training for sales teams.
- Educating retailers and consumers, and marketing the value of conservation measures effectively, will be pivotal in expanding the manufactured housing market and improving energy conservation through a HPMH.
- Unless utility programs are able to offset a significant portion of the cost to upgrade to the HPMH package (nearly \$10,000), present market conditions (particularly appraisal difficulties) suggest a two-tiered approach may be the most prudent way to promote

energy efficiency—with Energy Star being the lower tier and the new HPMH specification being the upper tier.

Recommendations

NEW recommends working with the NEEM program to take the following next steps:

- Proceed with a project to prototype construction of a HPMH at each of the manufacturing plants in the region. This is the industry’s preferred method for testing and pricing an advanced, high performance manufactured home.
- Upgrade the NEEM database system to accommodate HPMH requirements and improve reporting capabilities for utilities.
- Move forward with discussions between regional utilities and the industry to develop a workable model for regional utility collaboration that targets incentives upstream to home manufacturers in support of the HPMH.
- Establish utility measure reimbursement amounts for the HPMH to facilitate local utility programs in working with other regional stakeholders (e.g., tribes, housing authorities, weatherization agencies, Habitat for Humanity, manufactured home park owners, etc.) to sponsor pilot project opportunities to help “prime the pump” for a broader HPMH market push. Such projects can be valuable near-term opportunities to develop HPMH production and sales capability within the industry. Assisting utilities by providing program design assistance and marketing support could help maximize this approach’s impact.
- Explore with the industry to see if there is a cost effective way to develop a regional upstream incentive to capture the 43 percent of homes currently getting produced without NEEM program certification and built instead to minimum efficiency levels. Moving these homes to even the existing NEEM Energy Star efficiency level would yield significant energy savings. Such an effort also would be able to obtain home siting information, greatly reducing the number of NEEM homes that are getting sited in the region but not captured by utility programs.
- Work with regional utilities and the lending industry to explore ways to account for the value of energy efficiency options in manufactured homes.

SECTION I: PROJECT AND INDUSTRY OVERVIEW

INTRODUCTION

The Manufactured Home Industry currently represents about 10 percent of new home construction in the Northwest. The size of the manufactured housing market has dropped in the face of the recession and competition from low cost builders of conventional (“stick built”) homes, yet manufactured homes continue to offer several attractive features from an energy conservation standpoint:

- The industry is centralized in a limited number of builders, making conservation measures easy to implement;
- Energy conservation results are readily measurable for any specific dwelling unit;
- Manufactured homes are typically electrically heated, making them of great interest to regional electric utilities (Table 1 in Appendix A);
- Energy conservation initiatives in the manufactured home industry provide a useful model for similar efforts in conventional homes.

The BPA-sponsored project outlined in this report is designed to help ensure the continuation of a strong energy-efficient manufactured home program in the Pacific Northwest, and to contribute materially to broader energy conservation efforts through its development of a readily buildable highly energy-efficient home specification.

Project Overview

In May 2011, at the request of the Bonneville Power Administration (BPA), Northwest Energy Works (NEW) submitted a detailed work plan and schedule to develop a viable new specification for highly energy-efficient manufactured homes. This new specification, called the High Performance Manufactured Home (HPMH), would build upon and advance the specifications currently in effect known as NEEM: Northwest Energy Efficient Manufactured Housing Program. The HPMH home would save 50 percent over a typical HUD current practice home.

Under the BPA contract, NEW agreed to work directly with the manufactured housing industry to plan how to deliver this ambitious 50 percent energy reduction per dwelling unit throughout the BPA service region.

Achieving this target will require significant changes in construction practices and specifications in the manufactured home industry and, as the study revealed, significant interaction with the appraisers of manufactured homes. Therefore, the project considers both the technical challenges inherent in reaching this energy savings goal and the need to coordinate with existing factories and current industry leaders to address market and financing challenges.

Report Overview

The report proceeds sequentially as follows:

- Section I presents basic elements of the industry and considers its recent history and status as necessary context for the study and recommendations offered. This includes a brief review of BPA involvement in the manufactured home industry. (Data illuminating industry status will be found in Appendix A.)

- Section II reviews fundamental characteristics of the financing and appraising practices that support the industry, as these will significantly determine the ability to implement a HPMH project. (Appendix B contains results of a Home Financing Survey conducted for this project.)
- Section III illuminates, through a SWOT analysis, current marketing practices that weigh on the industry's capacity to sell a HPMH. (The outline of a strategic marketing plan can be found in Appendix C.)
- Section IV explores in detail the technical feasibility of building an HPMH and the prototyping undertaken in close collaboration with industry. (Appendix D looks at the variety of advanced technologies evaluated during this project; Appendix F reviews NEW's work with the plants to develop the HPMH measures and quality assurance processes necessary for implementation of the HPMH.)
- Section V presents Energy Use and Cost modeling for the HPMH.
- Section VI offers observations and recommendations derived from the study by NEW.

History of BPA and Utility Involvement

BPA and its partner utilities can point to strong prior and continuing efforts to improve the energy efficiency of manufactured homes. In 1992 BPA and the manufactured housing industry agreed to a single energy efficiency standard that would apply to all electrically heated homes sold in the Pacific Northwest region (PNW – Oregon, Washington, Idaho and Montana). Known as the Manufactured Housing Acquisition Program (MAP), the initiative was effective because of the cooperative agreement among all parties. Under this program, BPA and the region's major investor-owned electric utilities met most of the incremental cost associated with raising virtually all of the manufactured home production in their service areas to a regional energy efficiency standard known as Super Good Cents.

Between 1992 and 1995, approximately 50,000 homes were built under this program, with the HUD standard for overall heat loss and heating requirements exceeded by a factor of two. *The program cost utilities about \$100,000,000, and the PNW realized almost 30 average annual megawatts of savings. Given the measure's 45-year life, the program's levelized cost was about \$2.2M per aMW (Baylon, et al, 1995).*

When MAP ended in 1995, the state energy offices joined with the manufactured housing industry to operate a self-supported certification program for the industry. This new effort became known as the Northwest Energy Efficiency Manufactured Housing Program (NEEM), which adopted specifications at the MAP level of energy efficiency. Today's homes are branded as ENERGY STAR, Earth Advantage or Eco-rated (a brand developed by the NEEM program). The underlying energy efficiency specifications have been expanded to cover items like duct testing, lighting, higher efficiency equipment and better windows; the core building shell requirements remain largely unchanged.

Through NEEM the manufactured housing industry has provided a third party home certification service to utilities, with easy to verify measures, program evaluation, and program services delivered at little or no cost to the utility system. NEEM administers technical specifications, performs research and engineering analysis, implements ongoing construction quality management procedures and maintains a central database with home tracking. To insure that qualified homes are recognized in the market for their unique value, NEEM also provides

utilities with home certification validation. Both NEEM specifications and associated Energy Star requirements are above code, i.e. more stringent than state or federal standards.

NEEM is supported by 74+ utilities in the PNW and California who offer incentives for Energy Star labeled homes. For example, The Energy Trust of Oregon offers \$300 to the retailer for Energy Star labeled homes and an additional \$700 to the buyer when the home is further upgraded to Earth Advantage/Eco-rated branding. NEEM maintains a list of utilities offering rebates, which range from \$100-\$1300. Of the region's approximately 2,000 HUD homes built in 2010, some 1,100 (58% market share) were certified as Energy Star/Earth Advantage/Eco-rated.

Project Methodology

NEW and the project team relied on research and regional collaboration to complete this project:

- Literature review of building science research into energy efficient construction practices and technologies (see Appendix D);
- Extensive face-to-face interviews with representatives of all regional home manufacturers and a sampling of regional home retailers;
- Data extraction and analysis from the NEEM database at Washington State University;
- Collection of production information from the state agencies responsible for issuing HUD labels for completed homes;
- Utilization of HUD and U.S. Census Bureau reports to ascertain total shipments of manufactured homes into the Pacific Northwest;
- Researching, prototyping and testing assemblies in conjunction with industry and utility partners to prove the feasibility of available energy conservation technologies in a HPMH;
- Energy modeling and measure cost assessment with peer review and acceptance by the RTF;
- Regional utility engagement through interviews with local utility conservation staff, presentations to utilities and utility training in using the NEEM database;
- NEEM database functionality assessment and programming requirements development.

The NEEM database proved invaluable, supplying information including homes' square footage, number of sections, R-values of shell components, U-values of windows and doors, source of heating fuel type, number of homes built by each manufacturer, general geographic site location and approximate utility service area for each home, and in some cases customer information. The information for the tables in Appendix A is derived from the NEEM database.

Section II. State of the Manufactured Housing Industry

The last five years have been a critical time for the manufactured housing industry:

- Manufactured home shipments are at historic lows, a decline that tracks the recession that began in 2007 and continues today;
- Unprecedented levels of cost cutting have beset the industry, with some companies having closed or been acquired as manufacturers vie for market position and competitive edge;
- Production and marketing of very low priced homes by recession-stressed manufacturers attempting to attract buyers who otherwise might not enter the market. Typically, these homes are not energy efficient.

The scope of the industry downturn, in both absolute production and the decline in the percentage of NEEM certified homes within total production, is dramatic:

- During the last full year of the MAP program, 1994, there were 20,677 HUD code homes built by Oregon, Washington and Idaho plants. This single year of production exceeds the total number of manufactured homes (20,242) that PNW plants built in the last five years combined, a period that accords with the recession in 2007 and continues today.
- During this same period, the market share of NEEM certified homes declined from a high of 69% in 2008 to 57% in 2010, in part reflecting consumers' sensitivity to price and, as described later, the negative impacts of changes in manufactured housing appraisal standards.

Northwest Snapshot

From 2006 through 2011, plants located in Oregon, Washington and Idaho built 25,412 homes under the Housing and Urban Development Administration's (HUD) manufactured home construction standard, or "HUD Code." Of these homes, 15,235 (60%) were NEEM certified (Figure 1). (The HUD code is a federal pre-emptive, climate dependent, national building standard and quality management process for factory built manufactured homes, which allows HUD code homes to be shipped and installed across state lines.)

Noteworthy from a utility perspective is the fact that manufactured homes predominately use electricity for space heating. Seventy-eight percent of the NEEM certified homes produced in this period had electric forced air systems and 22 percent had fossil fuel furnaces. While heating system data for the nearly 9,500 non-NEEM certified homes is not readily available, a reasonable assumption is that a similar mix of electric furnace and fossil fuel heating would apply (see Appendix A, Table 1).

NEEM certified homes comprise the bulk (61 percent) of the manufactured homes sold and sited in the PNW. Approximately 43 percent are located in Washington, 36 percent in Oregon, 14 percent in Idaho and 6 percent in Montana (see Appendix A, Table 1).

Northwest Manufactured Home Production and NEEM Certification (all fuels)

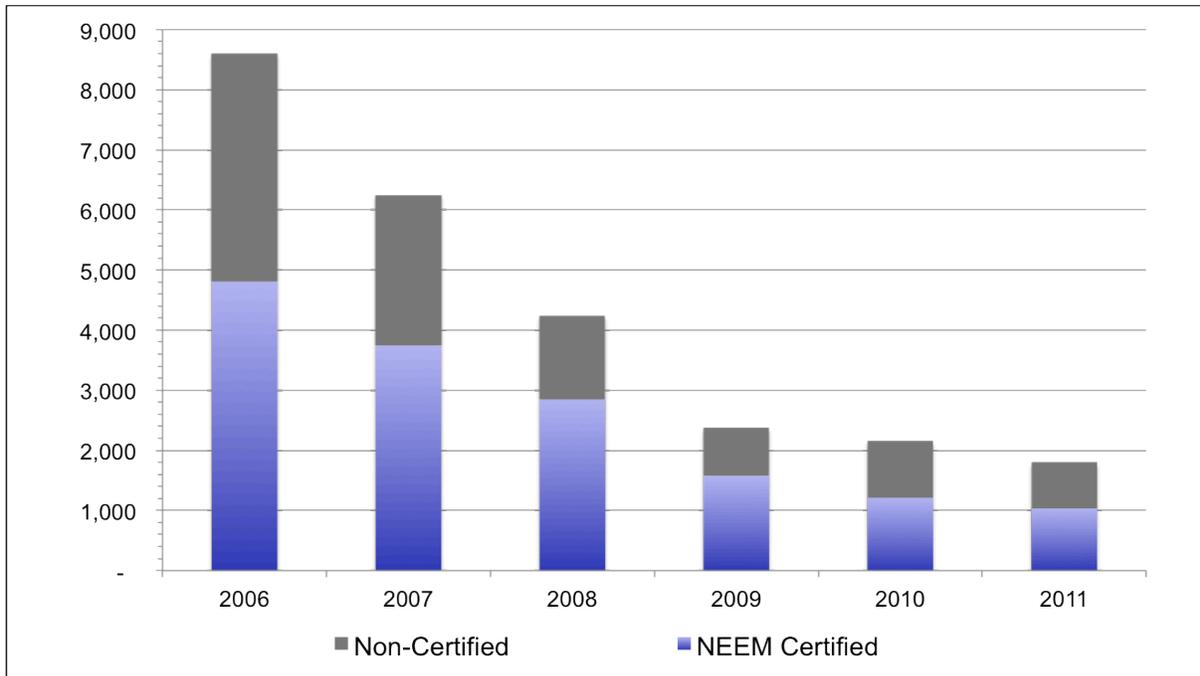


Figure 1. Production Overview: NEEM and non-NEEM manufactured homes produced 2006 to 2011

Industry Ownership Patterns

In the last five years industry ownership patterns have changed markedly through of bankruptcy filings and acquisitions. As of 2011, five national or local corporations own all the region’s plants, with two corporations owning half the plants: private equity firm Berkshire Hathaway owns two; Cavco, an Arizona company, owns three.

With fewer players in the market, coordinating an industry-wide program such as the HPMH could become far more practicable and achievable. The reduction in manufacturers means the utility system would now coordinate with only ten general managers and plants that collectively build 2,000 to 3,000 homes a year.

Factory Production Mix

Manufactured home plants understandably build the type of home they believe customers will purchase. Changing lender practices, discussed below, and the requirements of local code jurisdictions drive manufacturers to produce the flow of HUD code, modular and NEEM Energy Star homes that will meet (and ideally increase) customer demand:

- Manufactured (or “HUD code”) homes are built in the factory on a steel chassis, transported to the site and installed, with only the home installation details inspected by the local code jurisdiction. The steel frame remains under the home as part of the

foundation. The manufactured home is built to comply with the pre-emptive federal HUD home construction standard.

- A modular home is built on the same production line but is designed to meet the local building codes for where the home is to be sited, using licensed plumbers and electricians, and transported on a removable steel chassis to the site where the unit is installed on a permanent foundation and the steel chassis is removed. The modular home is inspected by the local code jurisdiction, and is considered equivalent to a site-built home upon its completion.

Since it is presently much easier to obtain financing on a modular or site-built home than a HUD code home despite significantly higher costs for a comparable modular home, the industry may be slowly moving in the direction of building modular homes just to keep the orders flowing. Modular homes represent 10-15 % of the homes currently built by Northwest manufacturers.

Current Energy Standards

Some manufacturers build a high percentage of homes to the NEEM specifications; others do not. One manufacturer includes the higher efficiency Eco-rated package in every Energy Star home ordered, while other plants present the NEEM certified home efficiency packages as upgrade options (see Appendix A, Table 2).

Relying on interview responses from factory personnel, the project team found that the region's plants are producing manufactured homes that can be classified into three levels of energy efficiency: minimum HUD thermal efficiency; somewhat thermally improved; and NEEM certified. Modular homes destined for siting in the Northwest are built with very similar energy efficiency features as NEEM homes. Using the NEEM database, industry home shipment data and the factory interview responses, NEW staff was able to utilize the production mix (excluding modular homes) to estimate the thermal performance for the weighted-average "Regional Baseline Home". For the past twenty years, the industry base unit was typically the somewhat thermally improved home, as virtually no one built homes to the minimum HUD requirements. Today's production mix has reduced the efficiency of the Regional Baseline Home. See Tables 3 & 4 in Appendix A for a more detailed presentation of the analysis.

When the baseline components are substituted for NEEM requirements in the NEEM reference model, the resulting U_o for the regional baseline home comes in at 0.0647, indicating an approximately 15 percent higher heat loss than the NEEM reference home. Several poorly performing assemblies were not de-rated, making the estimate conservative. (Minimum HUD U_o is 0.079.)

Appraisal and Financing Practices

The negative impact of financing and appraisal on energy conservation in the manufactured housing industry has been one of the major findings of this study. Recent changes to the home appraisal process, made at the national level as part of wide-ranging reform measures in home financing, have largely erased the Northwest region's long-standing practice of recognizing energy efficiency in the manufactured home valuation process. Appraisals of new manufactured homes now routinely fail to reflect the wholesale invoice cost.

As a result, buyers seeking to finance their home purchase are forced to opt for the largest, least expensively finished home possible, since the appraisal will be based on price per square foot, number of bedrooms and number of bathrooms. Resolving these issues will require managed conversations with appraisers and others in this sector.

NEW spoke on seven occasions to industry association meetings, whose membership include banks, finance companies, home retailers, material suppliers and home manufacturers, during the HPMH specification development. These industry leaders report that unless the conditions required for a favorable appraisal change, the new HPMH models will not be appraised at a level that reflects and credits the energy upgrades, severely constraining both the models' marketability and regional energy conservation efforts.

NEW staff likewise spoke to Robin LaBaron of the National Home Performance Council. He said the Council had recently developed a manufactured housing loan product for credit unions with an addendum appraisers could use to add the value of the efficiency upgrade to the total valuation of the home.

Insight into home financing and appraisal issues emerged from an in-person industry survey conducted by NEW and reported in Appendix B. The survey also revealed important characteristics of buyers and financing, including:

- Sixty-eight percent (68%) of buyers of new manufactured home pay cash for their homes, 26% mortgage their home and property, and 5% use chattel loans on the home only.
- Down payment requirements vary between 3.5% and 20%; chattel loans require a 5% to 20% down payment. The borrower's credit score determines down payment.
- Mortgage interest rates ranged between a low of 4% and a high of 6.5% (typically 5.1% to 5.4%). The interest rate for a chattel loan ranged from a low of 7% to a high 10.75% (typically 7.8% to 10.5%). The better the credit score the lower the interest rate.
- The term of mortgages typically is 25 to 30 years; chattel loans run from a low of 10 years to high of 20 years (typically 11 to 20 years).

The survey identified the leading manufactured housing lenders, Vanderbilt Mortgage and Finance, Inc. and 21st Mortgage Corporation (both owned by Berkshire Hathaway).

The survey also identified the age range of buyers (1% are 0-30 years old, 63% are 31-60 years old, and 36% are over 60 years old) and their reasons for purchase. The largest group of purchasers (49%) are replacing or upgrading their home; the next largest contingent (21%) is buying for retirement.

Given the pivotal nature of appraisal and financing on energy efficiency, NEW is recommending that BPA and NEW, with support from local electric utilities, approach the appraisal industry to explore accounting for the higher cost and greater energy efficiency of the HPMH.

Retailers' Circumstances

Retailers surveyed by NEW described notable changes in the structure and activities of their businesses, in large part reflecting the substantial changes in the industry. The changes, reported more fully in Appendix B, include:

- Reduction in marketing efforts. For instance, during the MAP period a regional marketing association called NW Pride aired regional Energy Star TV ads. Today, NW Pride no longer produces and airs TV ads.
- Transition from the once traditional local sales territory to a regional one, in part as the Internet makes it possible for buyers and sellers to connect from any location.
- Strategic modifications including re-locating businesses along major highways and resorting to large billboards to draw in passers-by.

These changes, and particularly the growing presence of the Internet in the customer/retailer relationship, have implications for the marketing of a HPMH.

Cost and Cost Differentials

Clearly a major factor in the market share of energy efficient homes sold is the cost of those homes. The Financing Survey (Appendix B) generated valuable information regarding the cost differentials among homes by size and energy efficiency level.

Manufactured homes generally serve the lower end of the housing market. They also are a common housing choice for remote locations where the cost of building a home on site becomes higher. Nineteen percent of manufactured homes sell for \$45,000 or under, 31 percent, sell for \$45,000 to \$70,000; 50 percent sell for over \$70,000.

The weighted average wholesale prices to retailers of homes and energy packages shown below do not necessarily reflect true dollar amounts because the largest retailer in the region could not provide wholesale price figures. However, NEW believes the information compares relative costs reliably:

- The survey found the average mark up on homes from the retailer to the consumer ranges from 22% to 44% and the Energy Star option appears sometimes to be passed on to the customer without mark up, or is marked up to a lesser extent than the overall home. The variability in mark up practices made it difficult to determine retail pricing for the energy packages, but a retail mark up of 15 % to 20% for the energy packages seems to be a reasonable estimate.
- The weighted average wholesale price to the retailer for a single section base home is \$29,375. The weighted average price to the retailer to add the Energy Star option is \$878. The weighted average to add Eco-rated or Earth Advantage Green option is \$1,912.
- The weighted average wholesale price to the retailer for a two-section base home is \$44,154. The weighted average price to the retailer to add Energy Star option is \$1,462. The weighted average to add Eco-rated or earth Advantage Green option is \$3,231.
- The weighted average wholesale price to the retailer for a three-section base home is \$99,034. The weighted average price to the retailer to add Energy Star option is \$1,800. The weighted average to add Eco-rated or earth Advantage Green option is \$4,868.

Section III. Marketing Practices

As will be shown below, constructing a HPMH is an achievable challenge. For the industry – and especially retailers – an equally significant challenge will be developing and implementing a viable marketing strategy for the HPMH.

To this end a NEW contractor, Russell Creative Group LLC, interpreted the findings of a survey of retailers regarding the marketing of their products. (This survey was undertaken simultaneously with a financing and appraisal survey reported above.)

The survey provided the HPMH project team a clearer picture of current marketing practices for manufactured housing in the Pacific Northwest.

- The current economic climate creates an interesting series of contrasts. Sales of new homes are down, with low-cost product driving the manufactured housing industry, *yet there is strong recognition of energy efficiency among consumers.*
- Retailers have highly motivated and capable sales people who value customer service and understand the importance consumers attach to energy efficiency.
- The manufactured housing industry is increasingly reliant on web based communication strategies in manufacturing and retailing. Websites allow customers to shop electronically, so for many their first interface with a retailer is via the web. Used wisely, the web can support education about energy efficiency beginning with the initial contact.

Retailers' responses to the survey found strong interest among consumers and retailers in energy conservation. Consequently, price is not the foremost barrier to energy efficiency – appraisal and financing practices are:

- As noted previously, appraisals consistently undervalue manufactured homes against their retail invoice, and in some cases even below to factory invoice. Energy efficiency and green construction options are not accounted for in the appraisal process. An HPMH program must address this issue proactively.
- Energy efficiency is a top-of-mind factor with most potential buyers. Most customers ask about it, and most retailers actively present it in the sales process.
- Survey respondents evidenced no consensus about the application of an incentive – factory, retailer, or customer – although most respondents want it to primarily benefit the customer. Ideally the incentive process adds value to the purchase of the manufactured home to the extent that the home buyer chooses to include the energy package in the home. It is essential the efficiency incentive be designed so its benefit can be easily, effectively and persuasively communicated by the retailer in marketing and sales activities, regardless of where the incentive is directed.
- Time may be a factor in designing the incentive. The turnaround time in construction is relatively short; the average purchase process is typically much more protracted. Any incentive program that changes frequently or runs for a limited duration will not be promoted by retailers, for fear of putting off customers.
- Retailers are craving information that will establish market differentiation from the competition. Energy efficiency and green construction will also validate the product they offer and improve market standing and perception.

Customer feedback at trade shows indicates buyers are starting to order NEEM homes with DHP units, with the units either factory installed or installed on site in DHP-ready homes. Manufacturers need immediate training on the finer points of design and installation to ensure reliable, high performance operation of these units; retailers need guidance in how to sell DHPs with confidence.

Retailers and service personnel will require training to assure correct operation and maintenance of the hybrid DHP system and similar systems.

SWOT Analysis

The table-based organizational tool called SWOT –strengths, weaknesses, opportunities, and threats – provides a simple method to compare and contrast data derived from market surveys. Conducting this exercise concisely presents relevant points in direct relationship to each other.

Utilizing the results of the marketing survey and their direct knowledge of the manufactured housing industry the Russell Creative Group LLC developed a SWOT analysis of the marketing issues facing the manufactured housing industry.

Since a SWOT process compares lists of high points, it should be revised as lessons are learned and new factors emerge. The SWOT chart for a High Performance Manufactured Home Program is presented as Table 1.

<p>Strengths</p> <ol style="list-style-type: none"> 1. Energy efficiency is top of mind with consumers. 2. Energy efficiency is a measure of value about the manufactured housing product with customers 3. High level of interest in green construction from customers 4. Interest by customers is high about new evolution of products - ductless heat pumps, heat pump water heaters, new technology glazing, insulation, windows 5. The opportunity to establish regional branding 6. Taking advantage of existing industry eco construction program 7. Going beyond existing programs, position the industry in a leadership position 8. Web based social marketing increasing program communication capabilities 9. Long running energy efficiency programs and industry participation 	<p>Weaknesses</p> <ol style="list-style-type: none"> 1. Uncertain regional housing economy creates a fragile market for manufactured homes. 2. Building and selling lower cost product 3. Post recession world unfriendly to manufactured housing product: <ol style="list-style-type: none"> a. financing options limited b. appraisals hinder home sales c. efficiency not recognized in financing and appraising process 4. Manufactured homes often are perceived as a second class housing product,
<p>Opportunities</p> <ol style="list-style-type: none"> 1. New technologies becoming available, (DHP's, HPWH's...) 2. Manufactured housing industry is a vehicle to introduce new technologies in a residential building product 3. Establish a regional marketing brand for energy efficiency 4. Reinvigorate a strong regional industry 5. Restore energy efficiency presence in appraisal and financing 6. Modify appraisals with systematic information dispersion via utility investment. 7. Reinforce energy efficiency measures in local building jurisdictions 8. Positioning a utility backed efficiency program with lending institutions 9. Re-establish manufactured housing as a viable housing product in the market, much like the MAP program <p>Certify manufactured housing industry as competitive to new IRC construction in the region</p>	<p>Threats</p> <ol style="list-style-type: none"> 1. Cost of newer technologies 2. ROI beyond initial investment for customers 3. National energy efficiency efforts not consistent with regional program goals 4. Market segregation of manufactured housing industry 5. Increasing state energy code requirements in OR & WA will require any HPMH effort to meet/exceed them to be credible 6. Due to financing obstacles, more product moving from HUD code to modular construction, increasing housing costs not otherwise necessary and diluting manufactured housing product

Table 1. SWOT analysis

Strategic Marketing Plan

Drawing on the results of the SWOT analysis, Russell Creative LLC outlined a comprehensive strategic marketing plan for a HPMH. The key elements of the plan are shown in Appendix C along with the survey instrument (see Appendix B for the survey instrument).

NEW Summary of Industry and Market Findings

Less energy efficient units gained market share in the past three years because of cost concerns and lending practices. This trend caused a drop in Energy Star market share, a drop that continues today. Indeed, entire developments are being built to minimum HUD energy standards. Reversing this trend would substantially advance energy conservation.

Despite current market conditions, it appears there is potential for a vibrant energy efficiency initiative based on managed and supportive interactions between the manufactured housing industry, retailers, customers, and the utility industry around a HPMH unit that offers 50-60% improvement in energy usage. Educating retailers and consumers, and marketing the value of conservation measures effectively, will be pivotal in expanding the manufactured housing market and improving energy conservation through a HPMH.

The retail location, the retailer, and the sales staff represent a critical linkage to the success of today's energy efficiency efforts. Marketing a HPMH will require that the value and benefits of efficiency measures and technologies be clearly integrated – and highlighted – from the initial contact to the point of sale.

Taken together, these factors argue for a new HPMH energy efficiency initiative in partnership with the manufactured home industry. Unless a utility program is able to offset the large majority of the cost to upgrade to the HPMH package, present market conditions (particularly appraisal difficulties) suggest a two-tiered approach may be the most prudent way to promote energy efficiency—with Energy Star being the lower tier and the new standard, HPMH, being the upper tier.

SECTION IV: PROJECT FEASIBILITY

Introduction

Central to consideration of creating a HPMH program with the industry is, of course, demonstrating that such a home can be built, transported and installed reliably, and then operated effectively.

To this end, NEW worked closely and collaboratively with manufacturers, BPA, its partner utilities, and NEW's contractors and partners to investigate, assemble and test available technologies to determine the potential for a HPMH. This was a joint effort to set specifications and measure achievable energy savings. The project team intentionally avoided technologies that would entail major changes in manufacturing processes. See Appendix D for specific construction details researched and evaluated by the project team when developing the HPMH Specification.

This HPMH research effort was informed by work conducted through a collaborative research project sponsored by the Building America Partnership for Improved Residential Construction. Publication of the report on this research, titled *Northwest Energy Efficient Manufactured Housing Program Specification Development*, is pending.

Researching and Testing Applicable Technologies

Three questions were posed for the initial research: (1) which measures could be built into a NEEM home to gain an additional 50 percent reduction in space conditioning, lighting and water heating energy use over the current specifications; (2) what are the challenges in building a HPMH using these technologies; and (3) what are the modeled energy savings for the new HPMH?

In response, a number of available or emerging high performance building assemblies and mechanical systems were identified and initially investigated in partnership with manufacturers. The major technologies reviewed included:

Ductless heat pump (DHP) with zonal heating in secondary zones – One- or two- head DHP systems were modeled in all of the Northwest climate zones. It was shown that DHPs could be reliably installed and commissioned on the production line, and homes with installed DHP units have successfully been transported to homebuyers' sites. With technical support from NEW, plants could design and install supplemental zonal heating systems in those homes appropriate for all PNW climates.

Heat pump water heaters (HPWH) – The project team stressed three key elements for the HPMH: exhaust air ducting, quiet operation, and defrost capability to permit operation in colder temperatures. Meeting the HPMH specification would require that HPWH equipment meet the NEEA Northern Climate Tier 2 specifications being promoted by NEEA. Appropriate products with sufficient availability are only now beginning to arrive in the market.

High performance windows (R-5) – While triple pane vinyl windows are available in the PNW, the current leading supplier of the manufactured housing window market (Kinro) is not building these R-5 windows. However, two window manufacturers supplying a small portion of the

manufactured housing industry (Cascade and Jeld-Wen) do build R-5 windows, and the project team was on hand when a full set of R-5 windows was installed in the PNNL test lab manufactured home in Richland, WA, with industry-relevant installation techniques demonstrated by the window manufacturer's representatives on site.

Improved wall assemblies – New wall assemblies with reduced thermal bridging (e.g., exterior rigid foam sheathing) were tested in the Kit Homebuilder plant in Idaho. DAPIA engineering approvals were obtained before the home was built.

Improved attic thermal performance – New roof insulation strategies that allow for more insulation were prototyped using a high-density R-30 fiberglass batt in place of blown-in loose fill insulation in the area extending from the eave above the top wall plate (where the batt was compressed) and inward for four feet, to where the attic depth was sufficient to transition to blown-in insulation for the rest of the attic.

The investigation and testing of these products formed the basis for the HPMH Specification described in detail below.

HPMH Specification

Table 2 Presents the HPMH specification and provides a comparison between current NEEM program requirements and the High Performance Manufactured Home measures. See Appendix E for more detailed descriptions of the HPMH components.

Component	NEEM (Base)	HPMH
Ceiling	R-40	R-49 (R-45 net)
Floor	R-33	R-38
Wall	R-21	R-26 (with average of R-5 foam)
Window	U=0.35	U=0.22
Door	R-5	R-5
Duct Leakage	6% of Supply	No ducts
Target Uo	0.054	0.040
Heating System	Electric Forced Air Furnace	DHP/ Elec. Res. Hybrid Zonal
Lighting	1.4 W/ft ²	0.7 W/ft ² (most all is CFL or LED)
Infiltration	0.25 ACH (natural) / 5.0 ACH50	0.21 ACH (natural) / 4.2 ACH50
Ventilation	Whole House Fan, 32 W continuous (0.1 ACH added)	HPWH (0.14 ACH added)
DHW (EF)	0.93	2.0 (HPWH)
Appliances and Misc.	Standard refrigerator, Energy Star dishwasher	Energy Star refrigerator and dishwasher / Low-flow showerheads and faucet aerators

Table 2. Detailed HPMH Specifications

Implementing HPMH Measures

NEW worked closely with the industry to build prototype assemblies and mechanical systems on the production line. To the extent that the new practices required engineering approvals from plant DAPIA agencies, NEW provided technical assistance to facilitate these approvals. Through this process, NEW found that achieving the HPMH standard will require a comprehensive series of modifications and upgrades. All of the shell improvements and energy-efficient mechanical technologies proposed for inclusion in the HPMH package are feasible but may require significant revisions to floor plans and factory processes. Appendix F presents NEW’s work with the plants to develop the HPMH measures and quality assurance processes that will be necessary for implementation of the HPMH.

Utility Participation

Clearly, any successful HPMH initiative will be reliant on participation by the region’s utilities—both publicly-owned and investor-owned. Accordingly, NEW and BPA have sought to

engage utility representatives, kicking off the effort with a 90 minute conference with utility stakeholders on June 18, 2012 to overview the HPMH concept and invite feedback.

Approximately 45 individuals participated. The meeting presentation can be found online at: http://www.bpa.gov/Energy/N/Utilities_Sharing_EE/Energy_Smart_Awareness/pdf/HPMH_presentation_2012-06-18_final.pdf)

Utilities, NEW, and BPA will continue the dialogue initiated at the June stakeholder conference regarding technical questions and concerns about the HPMH, and in particular the proposed new heating and hot water systems.

A central finding of the study is that, with the Energy Trust of Oregon as a significant exception, utilities are not systematically entering home siting information in the NEEM database after a manufactured home is installed in their service area. Utility representatives participating in the June 18, 2012 phone conference identified inadequate communication between utility field and conservation staff to learn of new manufactured home sitings. Utilities can seek to address this issue. (As a corollary, NEW will explore potential procedures for capturing more information at the point-of-sale and/or incentives for manufactured housing manufacturers or homeowners to provide information for NEEM.)

If an HPMH initiative is launched, utilities could have significant roles in:

- Developing and adopting utility-based incentive approaches.
- Encouraging a two-tier approach that raises overall energy efficiency significantly by positioning HPMH and Energy Star homes as the preferred options, thereby raising all (or almost all) of production to at least the level of a NEEM Energy Star qualified home.
- Working with other regional stakeholders (e.g., tribes, housing authorities, weatherization agencies, Habitat for Humanity, manufactured home park owners, etc.) to sponsor pilot project opportunities to help “prime the pump” for a broader HPMH market push.
- Helping manufacturers respond to the rapidly emerging trend to ordering elements of the HPMH (especially the ductless heat pump) for installation in homes being manufactured now.

SECTION V: HPMH ENERGY USE MODELING AND COST EFFECTIVENESS

NEW and its partner, Ecotope, used the Simplified Energy and Enthalpy Model (SEEM) to predict energy consumption and used the NW Power and Conservation Council’s (NPCC) Pro-Cost model for the preliminary cost effectiveness assessment. These tools were selected because they are accepted by both the BPA and the NPCC as a means to assess energy savings and regional cost effectiveness. Broadly, this analysis produces a representative set of prototypical houses whose energy use can be estimated through simulation tools. The energy savings are then used as inputs to the Pro-Cost calculations to estimate cost effectiveness over the lifetime of the house. The results were presented to the Northwest Power and Conservation Council’s Regional Technical Forum.

Measure Costs

Table 3 presents estimated measure costs for the elements of the HPMH specification. Washington State University Energy Program’s (WSU) findings from their 2011 industry survey and market analysis project, “Cost Assessment for Manufactured Homes,” provide the basis for the estimates.

Category	Notes	2011 \$s	2006 \$s	Measure Life (yrs)	Annual O&M (2006 \$s)
Envelope	Majority from Walls and Windows	\$ 4,277	\$ 3,816	45	\$ -
Air Sealing & Ventilation	Whole House Exhaust Fan	\$ 50	\$ 45	20	\$ -
HVAC System	DHP & Resistance Wall Heaters. (less cost of furnace and duct system)	\$ 4,701	\$ 4,194	20	\$ -
Domestic Hot Water	Heat Pump Water Heater	\$ 1,110	\$ 991	15	\$ 26
Lighting	Compact and Linear Fluorescents	\$ 117	\$ 105	8	\$ (13)
Appliances	Dishwasher & Refrigerator	\$ 62	\$ 55	16	\$ -
Total		\$ 10,318	\$ 9,205		

Table 3. Measure Cost by Category

Energy Use Modeling and Benefit / Cost Analysis

Building energy use was predicted by a combination of numerical simulations and engineering calculations. SEEM (Simplified Energy and Enthalpy Model version 0.94), was used to simulate heating, cooling, ventilation, and water heating energy use. The program combines building shell characteristics, thermostat settings, occupant behavior inputs, descriptions of heating and cooling systems, and duct distribution efficiency to develop an overall estimate of energy requirements of a house.

Additionally, engineering calculations calibrated by field studies were employed to determine the energy use for lighting and water heating. Annual gross lighting savings are calculated as lighting power density (LPD) multiplied by affected floor area and annual operating hours. This method assumes all lamps in the house operate 1.5 hours per day throughout the year¹. Concurrently, the modeling accounts for heating system interactions by changing internal gains for SEEM simulations.

The weather files used in all savings simulations are composite TMY weather files corresponding to the heating and cooling climate zones assigned to each Northwest county by the Regional Technical Forum (RTF).²

The three prototype houses used in the simulations were:

924 ft², single section manufactured house

1,568 ft², double section manufactured house

2,352 ft², triple section manufactured house

These are standard analytical prototypes used by the Northwest Power and Conservation Council to develop and evaluate energy forecasts and conservation plans for the region's utilities. The energy use in the three prototypes is weighted together to create an "average" house with a floor area equal to that currently being built in the NW (1,572ft²). The weighted average creates a representative, unified estimate for energy use in manufactured houses in the region.

In all, Ecotope conducted 675 simulations with SEEM to perform the analysis. This number includes: the three prototypes; five cities comprising three heating and three cooling climate zones; a "regional baseline" performance house (a description of the Regional Baseline home is given in Section I of this report in the "Energy Standards" section); the current NEEM standard performance house; and three variations of the HPMH. Ultimately, we settled on one specification but investigated three possibilities related to HPWH installation scenario.

A HPWH compliant with the NEEA Northern Climate Spec Tier 2 was simulated. It was stipulated the tank be installed in a sound-attenuated, buffered closet which draws air from the crawl space and exhausts it outdoors. The annual HPWH energy use is based on mapping the annual crawl space air temperature profile to a COP versus temperature performance map. Water heating energy was calibrated to the equivalent of 17-18 gals per day per occupant³. The home occupancy was set at 2.2 based on a randomized survey of 2006 NEEM program houses. The baseline house gallons per day use is higher than the HPMH case because the HPMH spec calls for a 1.75 gpm showerhead while the baseline assumes the Federal maximum of 2.5 gpm.

Figure 3 presents total energy use in each of the climate types in the region for each the regional baseline home, the NEEM home and the HPMH. Figure 4 further breaks out end uses in the

¹ RTF Meeting 9/2010: <http://www.nwcouncil.org/energy/rtf/meetings/2010/09/Default.htm>

² <http://www.nwcouncil.org/energy/rtf/zones/zonemapsx.htm>

³ RTF provisionally approved savings measure: <http://www.nwcouncil.org/energy/rtf/measures/measure.asp?id=176>

home. Table 5 pulls together the information from all the modeling and analysis to present HPMH energy savings and benefit/cost ratio for the various climate zones in the region.

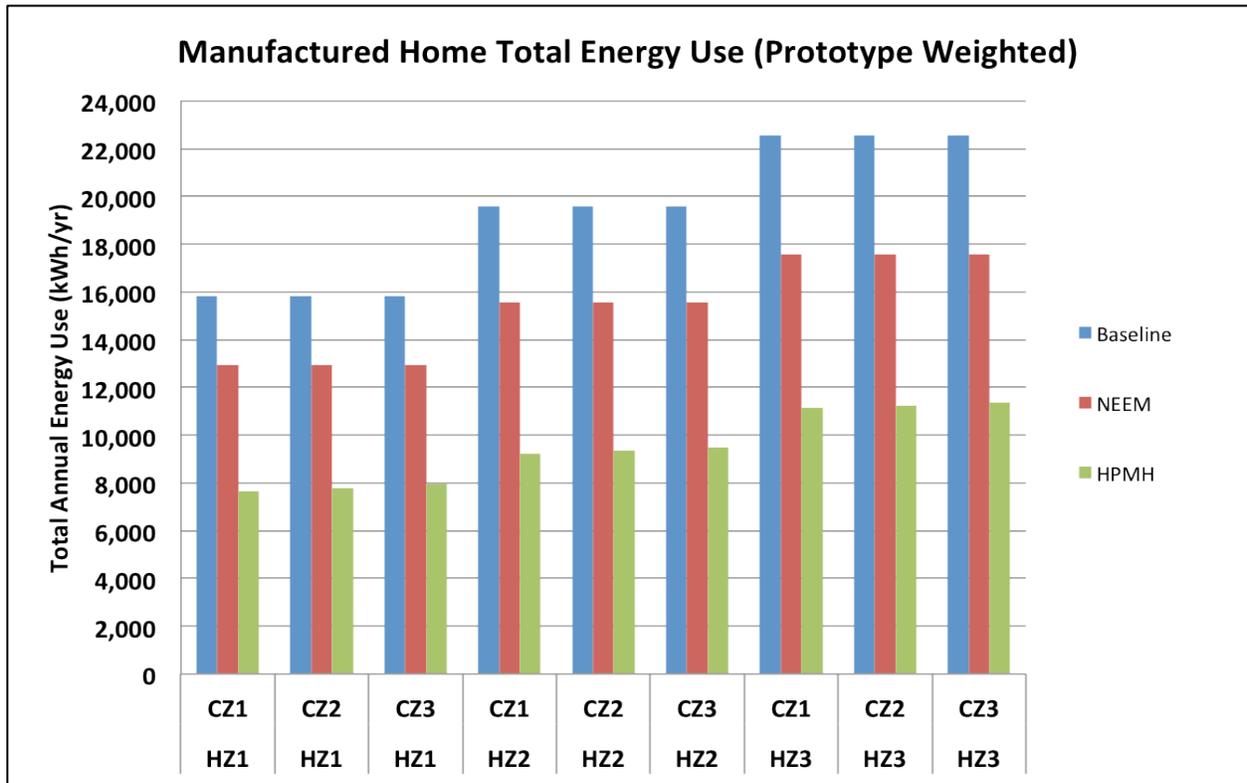


Figure 3. Manufactured Home Total Energy Use

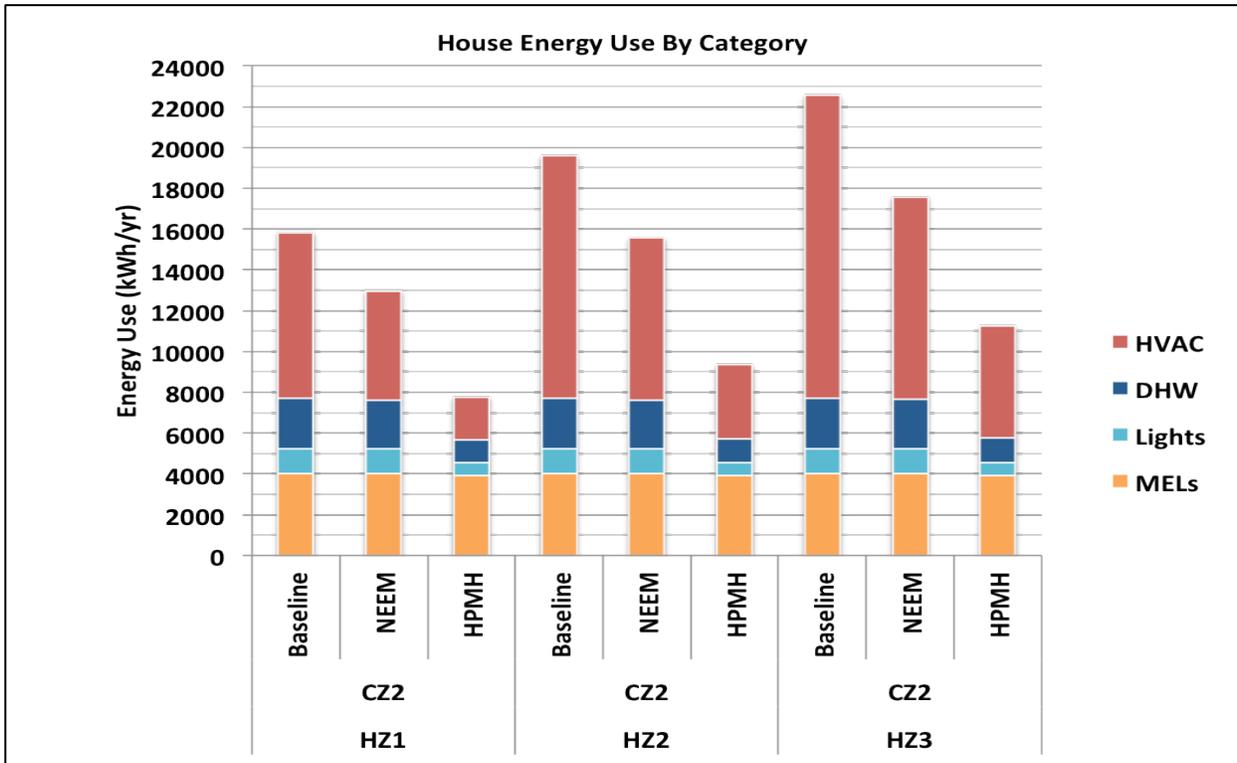


Figure 4. House Energy Use by Category

Climates		Total Annual Energy Use (kWh/yr)			Savings (kWh/yr)		(yrs)
Heating	Cooling	Regional Baseline	NEEM	HPMH	HPMH to Baseline	B/C Ratio	Measure Life
HZ1	CZ1	15,836	12,957	7,668	8,168	1.9	37
HZ1	CZ2	15,836	12,957	7,771	8,066	1.8	37
HZ1	CZ3	15,836	12,957	7,935	7,902	1.8	36
HZ2	CZ1	19,597	15,567	9,239	10,358	2.3	39
HZ2	CZ2	19,597	15,567	9,336	10,261	2.3	39
HZ2	CZ3	19,597	15,567	9,495	10,102	2.3	38
HZ3	CZ1	22,558	17,570	11,147	11,411	2.6	39
HZ3	CZ2	22,558	17,570	11,235	11,323	2.6	39
HZ3	CZ3	22,558	17,570	11,380	11,179	2.5	39

Table 4. Energy Use, Savings, and Benefit/Cost Ratio

Regional Technical Forum Approval

The project team presented its energy modeling, package cost and benefit/cost analysis to the Regional Technical Forum at the body's April and May 2012 meetings. The HPMH received Provisional UES approval, with the requirement that research be performed to confirm that the HPMH-crawlspace interactions modeling results hold up in real-world application, especially in cold climates. The full presentations made by NEW and Ecotope can be found at the following links:

http://www.nwcouncil.org/energy/rtf/meetings/2012/04/HPMH_Proposal_v4.ppt

http://www.nwcouncil.org/energy/rtf/meetings/2012/05/HPMH_Proposal_20120515_v2a.ppt

SECTION VI: RECOMMENDATIONS AND ACTION STEPS

NEW Observations

NEW observes the following regarding the key findings of this study:

- The PNW, once a leader in manufactured housing energy conservation, has lost ground to the effects of the recession and changes in manufactured home financing and appraisals.
- Electric energy savings ranging from about 8,000 kilowatt hours a year up to nearly 11,000 kilowatt hours a year over today's regional baseline home are possible using the HPMH.
- The technologies being recommended for the HPMH are available—except that a fully ducted HPWH still has not become available for the domestic market, though preliminary testing indicates its use is feasible and productive.
- The manufactured housing industry has suffered a serious decline. Manufacturers and retailers are excited about a product like the HPMH that offers distinctive selling opportunities and a chance to significantly reposition manufactured homes within the housing market.
- Manufacturers, by working collaboratively with NEW, have demonstrated their interest in prototyping and eventually marketing a HPMH. The utilities may be willing to offer HPMH incentives as a level that could make the HPMH affordable.
- The manufactured housing industry is awaiting the results of the utility system's cost-effectiveness calculations and possible incentive program.
- Marketing will be essential, with the Internet offering advantages over past techniques.
- Invaluable past experience on the part of BPA, investor owned utilities, and NEEM offers “proof of concept” for a high-level MAP-type initiative around the HPMH.
- The average package cost for the HPMH in 2006 dollars is estimated to be \$9,200.
- Costs for the energy conservation features in a HPMH, while significant, are in line with the cost of construction and offer a potential homebuyer a reasonably attractive simple payback on the investment.
- The structure of the industry, with fewer manufacturing plants building many fewer homes, makes this an ideal time to launch and manage an incentive program.

NEW Recommendations

NEW recommends moving forward into the next phases of the HPMH project, collaborating with the industry to incorporate new specifications into the NEEM program, resolve remaining technical and construction challenges, train workers to properly install new technologies, and begin to address the appraisal, financing and marketing issues that will profoundly impact the success of a HPMH project.

1. Build a prototype model home at each of the plants in the region. Prototyping a HPMH with each manufacturer will encourage them and their retailers to take ownership throughout the process of formulating new specifications.

The homes likely would be built to serve as model homes on factory or retail lots. Prototyping a new model home is the method used by industry to innovate and, more critically, accurately price a new option that involves significant production changes, like the HPMH. Absent this prototyping, no factory is likely to assume the risk of entering a HPMH into the marketplace. Prototyping is also the ideal time to instruct industry workers in installation and optimization procedures. NEW's ongoing work with NEEA's Northwest Ductless Heat Pump Project to introduce DHPs to the manufactured housing industry has confirmed the value and importance of undertaking vigorous prototyping and training when introducing significant changes to the home construction process.

2. Develop utility incentive approaches. Regional collaboration and upstream incentives likely would have significant results, but would take time to develop. Supporting local utility program development will likely move the HPMH into the market to a lesser extent, but it could be accomplished quickly. Having local utility programs in place still can have a significant impact on home buyer selection of energy efficient homes. If the HPMH is presented along side Energy Star as the new "best practice," buyers who may not have opted for Energy Star when it was the only energy upgrade on the table may now select Energy Star—just to avoid buying the bottom end product. "Ala carte" measures that add to the NEEM Energy Star home could help create market pull toward the HPMH level of performance. Specifically:
 - a. Convene discussions between regional utilities and the manufactured housing industry with the purpose of seeking a workable model for regional utility collaboration that targets incentives upstream to home manufacturers. Such an approach (inspired by the 1990's MAP program) could produce the greatest reduction to the HPMH price in the market. The expected wholesale price for the HPMH package (nearly \$10,000) is very likely beyond what utilities are able to pay as an incentive; consequently it does not stand to reason that a regional utility effort will be able to negotiate 100 percent of home production up to the HPMH specification. The HPMH might best be presented as a second efficiency tier, in addition to today's NEEM Energy Star qualified home. Negotiating 100 percent of home production up to the NEEM Energy Star specification may be possible and cost effective.
 - b. Establish HPMH utility measure reimbursement amounts to facilitate local utility programs in working with other regional stakeholders (e.g., tribes, housing authorities, weatherization agencies, Habitat for Humanity, manufactured home park owners, etc.) to sponsor pilot project opportunities to help "prime the pump" for a broader HPMH market push. Such projects can be valuable near-term opportunities to develop HPMH production and sales capability within the industry. Moving the RTF's provisional HPMH approval to active status requires field testing of some HPMH units within near future, and this incentive approach may help deliver those homes. Assisting utilities by providing program design assistance and marketing support could help maximize this approach's impact.
3. Make necessary upgrades to the NEEM database software to accommodate HPMH requirements and make possible the types of data reporting that would be wanted by utility stakeholders. Appendix E presents detailed recommendations by NEW and WSU programmers, who currently host and maintain the NEEM software.

4. Develop sales materials and training for retail sales personnel to help them understand and present the individual measures of the HPMH package to customers.
5. Convene key players to plan and initiate a process to revise the home appraisal process and lending practices to accurately attribute the value of energy efficiency features in manufactured homes and account for the operating cost savings for homeowners.

Closing

Through this study NEW and its partners confirmed the loss of market share for energy efficient manufactured homes informally observed over the last five years of working with the industry. The consequences are severe. The region as a whole is missing 43% of the potential energy conservation market as the trend toward price sensitive homes pushes out energy efficiency upgrades like NEEM Energy Star home qualification. Also, the region's utility programs have missed more than 50% of the NEEM Energy Star homes already being built and sited in the PNW region over the last five years, due in large part to the lack of coordinated and consistent utility involvement with the industry.

For an industry that has seen the loss of five regional plants during the last five years, the opportunity to develop an innovative product to attract customers and to regain energy efficiency leadership is a valuable and attractive one.

Interviews conducted by NEW for this study reveal the manufactured housing industry is awaiting the next step in the process of prototyping and pricing a High Performance Manufactured Home (HPMH).

NEW is committed to working collaboratively with all partners to make the transition to building, marketing and selling HPMH homes a smooth, cost effective, and productive one.

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APPENDIX A. State of the Industry Data

Table 1. NEEM Home Siting State and Heating Fuel Type, 2006 to 2010

(Sources: NEEM database and MHI Monthly Economic Reports)

NEEM Database Information (includes production from manufacturers no longer in operation)

	AK	AZ	CA	CO	ID	KS	MT	ND	NE	NV	OK	OR	UT	WA	WY	Grand Total
Electric Furnace	13	5	272	6	1444	1	382	1		167	4	3993	190	4653	30	11161
Heat Pump			2	1	3							13		139		158
Natural Gas Furnace	27		943	8	284		333		1	317		363	398	415	21	3110
Propane/Oil Furnace	21		4	1	2					2		3	3	7	1	44
Grand Total	61	5	1221	16	1733	1	715	1	1	486	4	4372	591	5214	52	14473

% by State 0.4% 0.0% 8.4% 0.1% 12.0% 0.0% 4.9% 0.0% 0.0% 3.4% 0.0% 30.2% 4.1% 36.0% 0.4%

Summary of NEEM Database Information

	AK	AZ	CA	CO	ID	KS	MT	ND	NE	NV	OK	OR	UT	WA	WY	Grand Total
Electric, # of Homes	13	5	274	7	1447	1	382	1	0	167	4	4006	190	4792	30	11319
Fossil Fuel, # of Homes	48	0	947	9	286	0	333	0	1	319	0	366	401	422	22	3154
Electric, %	21%	100%	22%	44%	83%	100%	53%	100%	0%	34%	100%	92%	32%	92%	58%	78%
Fossil Fuel, %	79%	0%	78%	56%	17%	0%	47%	0%	100%	66%	0%	8%	68%	8%	42%	22%

PNW Total Production 2006 to 2010, Imputed Siting States and Fuel Types

	AK	AZ	CA	CO	ID	KS	MT	ND	NE	NV	OK	OR	UT	WA	WY	Grand Total
Electric	18	7	383	10	2024	1	534	1	0	234	6	5603	266	6702	42	15831
Fossil Fuel	67	0	1324	13	400	0	466	0	1	446	0	512	561	590	31	4411

Table 2 presents production numbers for NEEM and non-NEEM manufactured homes, by manufacturing plant, for the last five years. This table shows the percentage of certified homes by plant and the total percentage of certified homes built in the region for the last five years. The total production numbers came from the State organization that issues HUD labels.

Table 2. Northwest Plants Production Volume and NEEM Program Market Share, 2006 to 2010

Manufacturer	2010			2009			2008			2007			2006		
	Total Homes	ENERGY STAR Homes	ENERGY STAR %	Total Homes	ENERGY STAR Homes	ENERGY STAR %	Total Homes	ENERGY STAR Homes	ENERGY STAR %	Total Homes	NEEM ² Homes	NEEM %	Total Homes	NEEM ² Homes	NEEM %
Manufacturer 01	462	228	49%	672	398	59%	1193	745	62%	1497	717	48%	1782	750	42%
Manufacturer 02	236	160	68%	193	158	82%	409	336	82%	407	331	81%	523	427	82%
Manufacturer 03	328	251	77%	327	302	92%	496	411	83%	627	468	75%	832	562	68%
Manufacturer 04	217	124	57%	240	139	58%	362	257	71%	510	438	86%	662	549	83%
Manufacturer 05	125	82	66%	123	78	63%	246	114	46%	395	183	46%	590	291	49%
Manufacturer 06	127	88	69%	190	135	71%	248	219	88%	423	276	65%	388	220	57%
Manufacturer 07	231	40	17%	149	37	25%	397	101	25%	546	126	23%	624	92	15%
Manufacturer 08	155	93	60%	122	61	50%	233	133	57%	416	163	39%	756	188	25%
Manufacturer 09	59	38	64%	46	37	80%	105	53	50%	215	116	54%	657	188	29%
Manufacturer 10	62	62	100%	78	78	100%	119	119	100%	199	161	81%	243	233	96%
Manufacturer 11	36	30	83%	36	35	97%	85	73	86%	181	177	98%	199	190	95%
Manufacturer 12	60	22	37%	98	31	32%	176	77	44%	220	107	49%	297	104	35%
Ended Operation	59	0	0%	103	89	86%	170	210	124%	612	481	79%	1042	1013	97%
Totals	2,157	1,218	56%	2,377	1,578	66%	4,239	2,848	67%	6,248	3,744	60%	8,595	4,807	56%

Total Production 2006 to 2010: 23,616

NEEM Certification 2006 - 2010: 14,195

NEEM Percentage 2006 - 2010: 60%

¹ This table groups NEEM-participating plants not in production after the end of 2010 as "Ended Operation." Manufacturers 11 & 12 ceased operation during 2011.

² NEEM production data for 2006 and 2007 includes both ENERGY STAR and NEEM branding, with the NEEM branding applying to those homes built to the specification formerly branded as Super Good Cents[®]

Table 3 gives an overview of the 2011 production mix of the 10 regional manufacturers, broken out by typical energy efficiency packages offered by each manufacturer. Table 3 includes the percentage of homes built to minimum HUD requirements, somewhat thermally improved HUD (an upgraded thermal shell package offered by some plants that is less than the NEEM package), HUD Energy Star, site built modular code, RV code park models. Information was gathered to the extent that it was available from manufacturers without combing through individual home files. Minimum HUD and Somewhat Thermally Improved home package information was gathered by a combination of visual inspection of each of the plants' production lines and from face to face interviews with staff. The shell components for Minimum HUD and Somewhat Thermally Improved packages are presented as installed R-values, expressed in order from the ceiling, then wall and floor. Window U-values follow and are expressed as typical averages for the series of window in use. If there is no energy package in a cell, then the plant does not build an applicable package.

Table 3. Production Mix by Manufacturer, 2011 Estimates(1/2011-7/2011)

Manufacturer	HUD Minimum Energy Pkg., %	Somewhat Thermally Improved HUD%	ESTAR HUD %	MODULAR Homes %	MODULAR ESTAR %	Park Model %	HUD Minimum. R-values (Ceiling, wall, floor, window)	Somewhat Thermally Improved HUD R-Values (Ceiling, wall, floor, window)
Manufacturer 01	0	60	40	0	0	0		40, 19,22 U-0.34
Manufacturer 02	19	0	51	0	0	30	22,11,22, U-0.30	22,21,22, U-0.30
Manufacturer 03	0	20	75	5	0	0		30,21,33, U-0.30
Manufacturer 04	75	0	21	4 (not incl. Canadian) ¹	0	0	25,11,22, U-0.34	
Manufacturer 05	0	72	19	0.25	0	8.75		40,19,33, U-0.34
Manufacturer 06	0	55	20	25	0	0		33,19,22, U-0.34
Manufacturer 07	70	9	11	5	0	5	33,11,22, U-0.60 ² or U-0.34	33,19,22, U-0.34
Manufacturer 08	0	0	80	20	0	0	Does Not Apply	Does Not Apply
Manufacturer 09	7	0	3	88-89Canada 1-2 Domestic	0	0	22,19,22, U-0.34	
Manufacturer 10	0	0	100	0	0	0	Does Not Apply	Does Not Apply

Notes: ¹This manufacturer chose not to disclose its production rates for products other than HUD and domestic modular homes.

²The windows in inventory lacked thermal performance labeling. The U-0.60 value is taken from the 1994 SGC handbook and pertains to a thermally broken aluminum frame clear dual-glazed window with 0.5 in. air space. The project team estimates the aluminum windows are used in 25% of the basic HUD homes.

For Table 4, Composite Weighted-Average Non-NEEM “Regional Baseline Home” Thermal Performance, NEW used the NEEM database and the prescriptive performance paths list in the database for each manufacturer. Table 4 presents the 2010 composite weighted-average regional baseline for non-NEEM home thermal performance. Thermal packages offered by manufacturers are listed for their non-NEEM homes. Production percentages from Table 3 were used and adjusted to reflect the mix of basic HUD homes and somewhat thermally improved homes for each manufacturer. We then multiplied the R- or U-value for each component of each package by that package’s fraction of plant production to get each manufacturer’s weighted average thermal package. Using the 2010 production numbers from Table 2 to obtain each manufacturer’s market share of non-NEEM homes, we then multiplied each manufacturer’s average thermal package component R- and U-values by the respective market share percentage to get a composite weighted average regional baseline non-NEEM thermal shell package for the industry as a whole. When the regional baseline components are substituted for NEEM program requirements in the NEEM reference model, the resulting U_o comes in at 0.0647, which reflects approximately 15 percent higher heat losses than the NEEM reference home. The actual mix of aluminum and vinyl windows used by Manufacturer 07 was not available, but the estimate presented is intended to be conservative. R-19 walls were de-rated to reflect the actual value in a 2x6 wall (R-17), but some very poorly performing assemblies (e.g., R-11 batts in 2x6 wall cavities) were not de-rated due to a lack of thermal performance data, so the weighted average non-NEEM Regional Baseline Home U_o should be considered conservative and erring toward higher apparent energy efficiency. Minimum HUD U_o is 0.079.

Table 4. Composite Weighted-Average Non-NEEM “Regional Baseline Home” Thermal Performance, Based Upon 2010 Homes Production Data

Plant Name Code ¹	Non-NEEM market share, 2010	Non-NEEM Product Mix		Minimum HUD Package. R-values (Ceiling, wall, floor, window)	Somewhat Thermally Improved Home R-Values (Ceiling, wall, floor, window)	Weighted-Average Non-NEEM “Regional Baseline Home”			
		Min. HUD %	Somewhat Thermally Improved %			Ceiling	Wall	Floor	Window
Manufacturer 01	28%	0%	100%		40, 19,22 U-0.34	40	17	22	0.34
Manufacturer 02	9%	100%	0%	22,11,22, U-0.30	22,21,22 U-0.30	22	11	22	0.30
Manufacturer 03	9%	0%	100%		30,21,33 U-0.30	30	21	33	0.30
Manufacturer 04	11%	100%	0%	25,11,22, U-0.34		25	11	22	0.34
Manufacturer 05	5%	0%	100%		40, 19, 33,U-0.34	40	17	33	0.34
Manufacturer 06	5%	0%	100%		33,19,22, U-0.34	33	17	22	0.34
Manufacturer 07	23%	89%	11%	33,11,22,U-0.60 (25%) or U-0.34 (75%)	33,19,22, U-0.34	33	11.9	22	0.40
Manufacturer 09	3%	100%	0%		22,19,22, U-0.34	22	17	22	0.34
Composite Non-NEEM “Regional Baseline Home”						32.9	14.8	23.7	0.346

Table 5 presents the NEEM approved construction energy packages being used by each plant. This information was taken from the NEEM database. All the numbered prescriptive paths in the tables below are examples of acceptable component prescriptive paths using approved ceiling, wall, and floor construction (based on the reference path in Section 1.2 of the NEEM specification). It includes a specific set(s) of energy efficiency components and measures (prescriptive standards) that each manufacturer uses to comply with NEEM program requirements.

Additional prescriptive paths have been developed for each manufacturer based on the U-factors for alternate construction, which also meet the NEEM specifications. All the numbered prescriptive paths in the tables below are examples acceptable component prescriptive paths using approved ceiling, wall, and floor construction (based on the reference path in Section 1.2 of the NEEM specification). In the table ceiling, wall and floor U factors have been converted to nominal R-values. Windows are expressed in U-factors. All homes meet or exceed the Uo of .0553. A Uo calculator is used to develop each prescriptive path using the 1,492 square foot prototype home.

Table 5. 2010 NEEM Homes: Construction Packages in Use							
Path ID by Brand by Manufacturer	Total Homes	Wall R-value	Roof R-value	Roof Insul.	Floor R-value	Floor Insul. Type	Window U-Factor
Manufacturer 01							
ECO-Rated	39						
143	35	21	40	blown	33	blanket/batt	0.32
145	4	21	40	blown	33	blanket	0.32
ENERGY STAR	189						
102	86	21	40	blown	33	blanket/batt	0.35
141	103	21	40	blown	33	blanket/batt	0.35
Manufacturer 02							
ENERGY STAR	160						
68	106	21	40	blown	33	blanket/blown	0.35
77	48	21	40	blown	33/32	blanket/batt	0.35
139	4	21	40	blown	38	blown	0.35
162	2	21	40	blown	42	blanket/blown	0.35
Manufacturer 03							
ECO-Rated	148						
145	148	21	40	blown	33	blanket	0.32
ENERGY STAR	103						
66	92	21	40	blown	33	blanket	0.35
145	11	21	40	blown	33	blanket	0.32
NEEM Park Model	1						
145	1	21	40	blown	33	blanket	0.32
Manufacturer 04							
ENERGY STAR	132						
139	81	21	40	blown	38	blown	0.35
142	14	21	40	blown	38	blown	0.33 ¹
167	37	21	40	blown	38	blown	0.35
Manufacturer 05							
ENERGY STAR	86						
71	72	21	40	blown	33/30	blanket/batt	0.35
76	9	21	38	blown	33/30	blanket/batt	0.35
102	5	21	40	blown	33	blanket/batt	0.35
Manufacturer 06							
ENERGY STAR	88						
66	46	21	40	blown	33	blanket	0.35
67	42	21	38	blown	33	blanket	0.35

Path ID by Brand by Manufacturer	Total Homes	Wall R-value	Roof R-value	Roof Insul.	Floor R-value	Floor Insul. Type	Window U-Factor
Manufacturer 07							
ENERGY STAR	40						
77	39	21	40	blown	33/32	blanket/batt	0.35
170	1	21	34	blown	33	blanket/batt	0.34 ¹
Manufacturer 08							
ENERGY STAR	93						
66	65	21	40	blown	33	blanket	0.35
75	28	21	40	blown	33	blanket	0.35
Manufacturer 09							
ENERGY STAR	38						
71	30	21	40	blown	33/30	blanket/batt	0.35
76	8	21	38	blown	33/30	blanket/batt	0.35
Manufacturer 10							
ENERGY STAR	62						
91	30	21	38/49	ovrsz batts	33	blanket	0.32
92	3	21	38/49	ovrsz batts	33	blanket	0.32
93	26	21	38	ovrsz batts	33	blanket	0.32
169	3	21	38	ovrsz batts	33	blanket	0.32

Notes: ¹Path ID 142 shows a U-0.33 window at the builder's request, to demonstrate the actual features of the home, not just the
¹Path ID 170 was a custom one-time use path limited to 13% glazing to floor area.

APPENDIX B. Retail Home Financing Survey Results Summary

Prepared for:

Bonneville Power Administration

under contract # 52578

December 5, 2011

Prepared by:

Thomas Hewes and Brady Peeks, Northwest Energy Works

Introduction

The Manufactured Home Retail Home Financing Survey was conducted in 2011 by Northwest Energy Works (NEW) for the Bonneville Power Administration. The survey was designed to support the development of a High Performance Manufactured Home (HPMH) specification to improve the energy efficiency and market performance of new Manufactured Homes (MH) built in the Pacific Northwest. This Retailer Survey helps:

- Establish baseline costs for energy related upgrades to manufactured housing;
- Determine how those costs are passed onto consumers; and

- Understand the implications for the financing of manufactured homes.

This report is based on 2011 lending practices. (Survey responses were sought for an earlier year, 2007, but retailer responses were inadequately specific.) Survey results will be found at the end of this Appendix.

General findings regarding manufactured home financing in 2011 include:

- Sixty-eight percent (68%) of new manufactured home buyers pay cash for their homes, 26% mortgage their home and property, and 5% use chattel loans on the home only.
- Down payment requirements vary between 3.5% and 20%; chattel loans require a 5% to 20% down payment. The borrower's credit score determines down payment requirements.
- Mortgage interest rates ranged between a low of 4% and a high of 6.5% (weighted average of 5.1% to 5.4%). The interest rate for a chattel loan ranged from a low of 7% to a high 10.75%. Again, the better the credit score the lower the interest rate.
- The term of mortgages is 25 to 30 years; chattel loans run from a low of 10 years to high of 20 years.

Lenders making loans are Vanderbilt Mortgage and Finance, Inc. and 21st Mortgage Corporation (both owned by Berkshire Hathaway), US Bank and Wells Fargo, Credit unions, and a series of other mortgage companies such as Country Place, Sterling, Triad, Guild, Land Home Financial, and Washington Federal. USDA Direct finances some homes. Of these, Vanderbilt Mortgage and Finance and 21st Century Mortgage are the major players in the manufactured housing finance industry.

Survey Methodology

NEW developed an 18-question survey instrument and selected interviewees in conjunction with Bonneville Power staff, the Oregon Manufactured Home Association, and the Northwest Housing Association. Responses to the first nine survey questions are tabulated in this report; the remaining nine questions pertain to a separate market survey discussed in Appendix C of the Final Project Report.

The nine survey questions and responses provided information about home financing options, cost data (incremental cost to retailer/to customer) and prices of existing Energy Star and Eco-rated options. Of particular interest were the types of financing being used by buyers, loan rates, and down payment requirements for the various loan products.

NEW interviewed individuals representing a cross section of business owners; leaders in the manufactured housing industry; businesses on the NEEM top ten 2010 sales list; factory-owned or corporate-affiliated retailers; and independent retailers. Retailers were located in Oregon (3), Washington (3) and Idaho (2). Montana retailers were not visited due to travel costs, small market weight and high likelihood that their situation is not much different from other rural markets in the region. Interviews typically lasted for 90 to 120 minutes.

Interviewees represented the following: opinion leaders (defined as people who sit on industry association boards) in the manufactured housing industry (3); businesses that use price point to sell (1); factory-owned or corporate-affiliated retailers (2); and independent retailers (2).

Market Characterization of Surveyed Retailers			
Retailer	Market Position	% of 2010 NEEM Sales	Number of Display Centers
Retailer 01	Price Point (Independent)	1.20	4
Retailer 02	Factory-owned	7.54	3
Retailer 03	Independent	3.43	1, strong Internet presence
Retailer 04	Opinion Leader (Independent)	1.46	2
Retailer 05	Opinion Leader (Independent)	0.69	1
Retailer 06	Opinion Leader (Independent)	1.97	2
Retailer 07	Independent	1.03	1
Retailer 08	Corporate-affiliated	0.34 (16.54 for all 10 locations)	1 (of 10 owned by the company)

Survey Interpretation

Since data for total home sales is not captured by the industry at the retailer level, NEW used NEEM program data to determine each retailer’s share of NEEM home sales during 2010, then utilized that value to assign a market weight to each respondent. For example, Retailer 02 is attributed with a market share of over 7.5 percent of NEEM sales, though the sales location where the interview was conducted represents only a fraction of that total number. We believe the centralized management structure of this retailer makes the respondent’s answers closely representative of the entire organization. This stands in contrast to how we treated Retailer 08, where individual sales locations appear to operate more autonomously.

In cases where a respondent was unable or unwilling to answer a question fully, NEW re-weighted the respondent’s market share so that non-responses would not skew the averages. The full tabulation of responses (see end of Appendix B) illustrates the degree to which non-responses and confounding factors (like whether or not NEEM certification is included in a retailer’s base pricing) can impact the weighted average of responses, with the best example being the calculated retailer markup percentages from questions Six and Seven. Here the markup for single section homes shifted from 24% to 44% and for triple section homes shifted from - 8.3% to 22%, depending upon how the responses were weighted.

With no way to determine how well the NEEM sales by retailer translate into total home sales by retailer, and given the small size of the sample, survey results should be considered anecdotal and qualitative rather than statistically accurate.

Manufactured Home Retailing Background

The market for manufactured homes has changed dramatically. In 1994 manufactured homes represented 33 percent of the total single-family market for Oregon (site built plus manufactured). For 2005 to 2010, manufactured homes were 11 percent of the total single-family market in Oregon. This trend holds true for the rest of the region as well.

This trend has had major consequences for retailers as well as manufacturers. The number of retail locations has declined as the recession and fixed business costs drove many retailers to close their doors or dramatically reduce the number of locations they operate. (The exception to this trend is a small, vertically integrated manufacturing plant that owns four retail stores and sells locally, mostly into Eastern Washington and Eastern Oregon.)

Retailers have adjusted in several ways:

- Marketing efforts have been reduced. For instance, during the MAP period a regional marketing association called NW Pride aired regional Energy Star TV ads. Today, NW Pride no longer produces and airs TV ads.
- The once traditional local sales territory is fast becoming regional, in part as the Internet makes it possible for buyers and sellers to connect from any location. Most retailers interviewed use the Internet to reach out to prospective buyers, who in turn use it to shop for lower prices and special deals. (As a result, a home sold from a retail location in Yakima could be installed in Southern Oregon, California or even Alaska.)
- Retailers are strategically re-locating their businesses along major highways and resorting to large billboards to draw in passers-by.

Taken together, these represent a major change in the retailing of manufactured homes.

Manufactured Home Financing Background

The financing of manufactured homes has an impact on energy efficiency. The percentage of NEEM-standard homes in the PNW has been falling. A factor in the decline has been the unwillingness of appraisers to accommodate the cost of a home in their appraisals (square footage dominates), disadvantaging higher cost, more efficient homes and their buyers. (See additional discussion below.)

Top NEEM retailers by sales, along with some smaller retailers, sell the Energy Star option with each home. Exceptions occur if the retailer sells a very price-sensitive, low-end line of homes, causing them to eliminate the Energy Star option to qualify the buyer for a loan.

A few retailers noted that occasionally they are being required to order factory-built homes using the modular code instead of the HUD code because of lack of HUD financing or local code restrictions. (A modular home must be built to the local site-built code and undergo local approvals, and unlike a HUD code home it is installed on a permanent foundation. A typical two-section modular home can cost \$24,000 more than a HUD code home.)

Cost Background

A major factor in the market share of energy efficient homes sold is the cost of those homes. Manufactured homes generally serve the lower end of the housing market. Nineteen percent (19%) of manufactured homes sell for \$45k or under, 31%, sell for \$45+ to \$70k; 50% sell for over \$70k.

The weighted average cost of homes and energy packages shown below should not be taken as a true dollar amounts because the largest retailer in the region could not provide their costs. (At two other retailers Energy Star comes standard and the square footage on the homes was not the same.) It does indicate how costs compare:

- The survey found the average mark up on homes from the retailer to the consumer ranges from 22% to 44% and the Energy Star option appears to be passed on to the customer without mark up, or is marked up to a lesser extent than the overall package.
- The weighted average cost to the retailer for a single section base home is \$29,375. The weighted average cost to the retailer to add the Energy Star option is \$878. The weighted average to add Eco-rated or Earth Advantage Green option is \$1,912.
- The weighted average cost to the retailer for a two-section base home is \$44,154. The weighted average cost to the retailer to add Energy Star option is \$1,462. The weighted average to add Eco-rated or earth Advantage Green option is \$3,231.
- The weighted average cost to the retailer for a three-section base home is \$99,034. The weighted average cost to the retailer to add Energy Star option is \$1,800. The weighted average to add Eco-rated or earth Advantage Green option is \$4,868.

Manufactured Home Customers

NEW also generated a substantial amount of information regarding the buyers of new manufactured homes:

- First time homebuyers represent 12% of buyers;
- Retirement Home buyers represent 21% of buyers;
- Upgrade/Replacement represent 49% of buyers;
- Second home purchasers represent 6% of buyers; and
- Rental properties represent 12% of all new manufactured homes purchased.

The typical manufactured home buyer tends to be older: 1% are 0-30 years old, 63% are 31-60 years old, and 36% are 60 and over.

Assessments and Observations

This survey continued and advanced the dialog with retailers. Accordingly, NEW was able to capture pertinent information from these conversations. Survey results plus sentiments and observations expressed by individual retailers in the interviews indicate:

- The types and costs of financing obtained by homebuyers to purchase new manufactured homes have changed little since 2007. Cash purchasers continue to comprise a large majority of buyers.
- Retailers are financially stressed because of the recession; they invariably cite customers' employment insecurity and inability to obtain adequate financing as the primary reason for the shortage of qualified buyers and the difficulty of closing home sales. These barriers have increased noticeably during the recession.
- Appraisals are not reflecting the value of energy conservation measures in homes. Appraisers adjust for square footage, number of bedrooms, and major capital improvements like garages but energy upgrade packages such as Energy Star are given no credit. Foreclosure sales undermine comparable sales data. *This finding reinforces the importance of engaging with appraisers regarding the advantages of energy efficient homes.*
- As noted, retailers vary widely in their approach to marketing energy efficiency. Some retailers surveyed sell every home with the Energy Star/Eco-rated/Earth Advantage option – this approach is common among NEEM Top 10 retailers. Similarly, retailers vary on whether they mark up or do not mark up the energy efficiency options. In part, this variation reflects the primacy of cost as a factor for manufactured home buyers.
- Manufactured home transport and installation costs are rising steadily and may become an economic issue for some new homebuyers.
- A relationship between the manufactured housing industry and local utilities remains an important factor in retailers' business plans for the future. Most retailers interviewed are aware of the NEEM Energy Star and Eco-rated Earth Advantage rebates supported by the IOUs and BPA.

NEW Conclusions

If established, the HPMH program is likely to prove attractive to new, non-traditional customers, as energy-astute buyers are drawn to consider manufactured homes.

Chattel loans are used for manufactured homes located in parks. The question is, will park homebuyers pay for upgrading to the HPMH standard? Park homebuyers may not be the consumers the HPMH program should target.

NEW recommends consideration of a second level of HPMH to meet the needs of the low-end market and park homebuyers. This Level 2 HPMH might be the existing NEEM product with a ductless heat pump. The higher HPMH level may appeal to the cash or mortgage buyer.

NEW heard repeatedly from retailers and plants that they are looking for a new product to sell, one that can appeal to those outside of the industry's traditional customer base.

Utility systems would be committing to a much smaller market if a HPMH program were initiated now, given the contraction in the industry, which would serve to mitigate risk of "breaking the bank" if the program were to enjoy greater market uptake than anticipated.

FINANCING SURVEY INSTRUMENT AND RESPONSES

Survey Instrument and Delivery Methodology

The retailer survey instrument taken to field interviews follows on the next four pages. NEW gave the survey to retailers in advance of the interview, when possible, to allow them to gather any information they might wish to share with the interviewers. NEW began the interviews by summarily presenting the survey instrument to give the people being interviewed a sense of the breadth of the questions to be asked.

NEW found that many of the interviews were greatly enhanced by engaging the retailers in general discussion after completing the survey questions and circling around to gain additional detail and clarification of information given in response to the survey. NEW then augmented the original survey responses with the retailers' additional statements from the general discussion.

HPMP Retailer Survey

1. How are home buyers financing their new home purchases today? What % are buying with cash, chattel, and conventional. How did your customers finance their new home purchases in 2010 and 2007? Please provide an approximate percentage.

	Today	2010	2007	Notes
Cash Purchase	%	%	%	
Chattel loan	%	%	%	
Conventional Financing – Bank	%	%	%	
Conv. Financing – Finance Co.	%	%	%	
Other (please describe)	%	%	%	
TOTAL (should add to 100%)				

Notes:

2. What is the down payment percentage of total sale price required today by lenders for a new home by loan type? What was it in 2010 and 2007? Please provide the standard down-payment by financing type.

	Today	2010	2007	Notes
Chattel loan	%	%	%	
Conventional Financing – Bank	%	%	%	

Notes:

3. What is the standard interest rate charged by loan type for a new home? What was it in 2010 and 2007? Please provide the standard interest rate by financing type.

	Today	2010	2007	Notes
Chattel loan	%	%	%	
Conventional Financing – Bank	%	%	%	

Notes (capture finance company names):

4. What is the standard loan term duration by loan type for a new home? What was it in 2010 and 2007?

	Today	2010	2007	Notes
Chattel loan				
Conventional Financing – Bank				

Notes:

HPMP Retailer Survey

6. What are the costs to the retailer for a new typical base-efficiency home, the Energy Star home option and the Eco-rated/Earth Advantage home option?

Home Brand:	Single	Double	Triple
Square Footage			
Typical Base Home			
Energy Star option			
Eco-rated option			

Notes:

7. What are the prices paid by the consumer for a typical new base-efficiency home, an Energy Star home and an Eco-rated home?

Home Brand:	Single	Double	Triple
Square Footage			
Typical Base Home			
Energy Star option			
Eco-rated option			

8. What percent of your customers for new homes are...

	Today	2007
First time home buyers	%	%
Retirement Home buyers (downsizing, retirement community, etc.)	%	%
An Upgrade/Replacement of their current manufactured home	%	%
A second home that will not be a primary residence (vacation home, not rented)	%	%
To use as rental property (in a park or other development)	%	%
Other:		

8a. What is the typical age range of your buyers? Circle one

Age 0-30 31-60 60 and over

9. What percent of the homes you sell are priced..

House Type	Today	2007
\$45,000 or Under	%	%
Between \$45,001-\$70,000	%	%
Above \$70,000	%	%

Notes:

10. What is the biggest hurdle for your customers to overcome in making the choice to purchase the Energy Star option? The Eco-rated or Earth Advantage options?

11. Three most common ways you reach out to customers

Three most common ways customers contact you

What do you see as promising new avenues for reaching customers?

Communication tactics –

What inspiring examples have you seen?

What needs to be avoided (e.g. balloons, embarrassing spokesperson)?

12. What are the three most common reasons for a sale to fall through?

13. Tell us about appraisals for MH.

How is the appraisal process working?

Are appraisals supporting the cost of the project?

Are appraisals crediting energy upgrades made to homes?

Are appraisals crediting other upgrade options? If so, which ones?

14. Do customers ask about energy efficiency?

15. Do you ever use energy efficiency as a selling point?

If no, why not?

16. How do you think utility incentives should be targeted? To the customer? The retailer? The factory?

17. How long from the customer's initial inquiry to purchase? From purchase to siting?

18. What would help your business?

Could anything from the energy efficiency folks help?

Summary of Responses

The following represents a summary of retailer responses to questions one through nine, with all responses reflecting 2011 data:

Question 1: How are homebuyers financing their homes? 68 % cash, 5% cash, 26% mortgages

Question 2: What do lenders require as a down payment percentage? Mortgages require a 3.5% to 20% down payment, while chattel loans require 5% to 20% down payment. The credit score determines the down payment. The better the credit score the lower the down payment.

Question 3: What is the range of typical interest rates by loan type/? The interest rate charged on a mortgage is a low of 4% to a high of 6.5%(weighted average of 5.1% to 5.4%). The interest rate charged on a chattel loan is low of 7% to a high 10.75% (weighted average 7.8% to 10.5%). The credit score determines the interest rate. The better the credit score the lower the interest rate.

Question 4: What is the standard loan duration by loan type? Loan term duration on a mortgage is a low of 25 years to high of 30 years (weighted average 25 to 30 years. Loan term duration on a chattel loan is a low of 10 years to high of 20 years (weighted average 11 to 20 years).

Question 5: Who are the primary lenders your buyers use? Lenders making loans are Vanderbilt Mortgage and Finance, Inc. and 21st Mortgage Corporation (owned by Berkshire Hathaway), US Bank and Wells Fargo, Credit unions, and a series of other mortgage companies such as Country Place, Sterling, Triad, and Guild.

Question 6: What are typical costs to the retailer for standard efficiency homes, the Energy Star package and the Eco-rated/Earth Advantage package? The weighted average cost to the retailer for a single section base home is \$29,375. The weighted average cost to the retailer to add Energy Star option is \$878. The weighted average to add Eco-rated or earth Advantage Green option is \$1912.

Question 7: (Classification of home buyers) First time home buyers represent 12% of new manufactured home buyers; Retirement Home buyers represent 21% of new manufactured home buyers; Upgrade/Replacement represent 49% of new manufactured home buyers, A second home represent 6% of new manufactured home buyers, and rental property represent 12% of new manufactured home buyers.

Question 8: Typical age of homebuyers? The typical age range of manufactured home buyers are 1% are 0-30 years old, 63% are 31-60 years old, and 36% are 60 and over.

Question 9: (Classification of price paid for homes purchased) The percent of the homes that sell for \$45k or under is 19%, sell for \$45+ to \$70k is 31% , and sell for over \$70k is 50%.

Tabulation of Survey Results

The following presents individual retailer responses to questions one through nine:

High Performance Manufactured Home Project Retailer Survey Results, Financing and Sales Questions August 31, 2011

1. How are home buyers financing their new home purchases today? What % are buying with cash, chattel, and conventional. How did your customers finance their new home purchases in 2010 and 2007? Please provide an approximate percentage.

Respondent	2011			2010			2007			Notes
	Cash %	Chattel %	Mortgage %	Cash %	Chattel %	Mortgage %	Cash %	Chattel %	Mortgage %	
1	58	21	21	70	15	15				No answer provided 10% of Mortgage figure is FHA loans
2										
3	90	2	8	90	2	8	90	2	8	
4	50	5	45	50	5	45	50	15	35	
5	90	5	5	90	5	5	50	15	35	
6	75	0	25	75	0	25				
7	25	1	74	90	0	10				
8	10	20	70							

2. What is the down payment percentage of total sale price required today by lenders for a new home by loan type? What was it in 2010 and 2007? Please provide the standard down-payment by financing type.

Respondent	2011				2010				2007			
	Chattel % Low	Chattel % High	Mortgage % Low	Mortgage % High	Chattel % Low	Chattel % High	Mortgage % Low	Mortgage % High	Chattel % Low	Chattel % High	Mortgage % Low	Mortgage % High
1	10.0%		5.0%		10.0%		5.0%					
2	5.0%	20.0%	5.0%	20.0%	5.0%	20.0%	5.0%	20.0%				
3	10.0%	20.0%	5.0%									
4	10.0%	20.0%	3.5%	20.0%	10.0%	20.0%	3.5%	20.0%	10.0%	20.0%	3.5%	20.0%
5	10.0%		10.0%		10.0%		10.0%		10.0%		10.0%	
6	10.0%		3.5%	20.0%	10.0%		3.5%	20.0%	10.0%		3.5%	20.0%
7		20.0%	5.0%									
8	10.0%		5.0%									

3. What is the standard interest rate charged by loan type for a new home? What was it in 2010 and 2007? Please provide the standard interest rate by financing type.

Respondent	2011				2010				2007				Notes
	Chattel % Low	Chattel % High	Mortgage % Low	Mortgage % High	Chattel % Low	Chattel % High	Mortgage % Low	Mortgage % High	Chattel % Low	Chattel % High	Mortgage % Low	Mortgage % High	
1	8.50%		6.50%										Low mortgage rate is FHA
2	7.25%	10.75%	5.50%				5.50%						
3	7.99%		4.75%		7.99%				7.99%				
4	7.00%	9.50%	4.00%	4.50%	7.00%	9.50%	5.00%	5.50%	7.00%	9.50%	5.00%	5.50%	
5	7.00%	10.00%	5.25%	6.90%	7.00%	10.00%	5.25%	6.90%					
6	10.00%		4.00%	6.00%									
7	7.50%		4.50%	4.75%									
8	10.00%		5.00%										

4. What is the standard loan term duration by loan type for a new home? What was it in 2010 and 2007?

Respondent	2011				2010				2007			
	Chattel Term Low	Chattel Term High	Mortgage Term Low	Mortgage Term High	Chattel Term Low	Chattel Term High	Mortgage Term Low	Mortgage Term High	Chattel Term Low	Chattel Term High	Mortgage Term Low	Mortgage Term High
1		20	25	30								
2		20		30								
3		20		30			20				20	
4		20		30			20				20	
5	15	20		30	15	20		30				
6	10	20		30								
7		20		30								
8		20		30								

5. Who are your customer's top 3 lenders for the homes you sell? In order 1,2,3

Respondent	Lender 1	Lender 2	Lender 3	Lender 4	Lender 5	Notes
1	US Bank	Twenty First Mort.	OSU Federal CU			1st two are chattel lenders, others are mortgages
2	Twenty First Mort.	US Bank	Sterling			
3	US Bank	Land Home Financial	Country Place	Cascade	CPM	
4	Sterling	Contry Place	Wells Fargo	Sterling		
5	US Bank	Triad	Mortgage Brokers	Washington Federal		
6	Guild Mortgage	USDA - direct				
7	Wells Fargo	Contry Place				
8	Vanderbuilt	US Bank	Triad			

6. What are the costs to the retailer for a new typical base-efficiency home, the Energy Star home option and the Eco-rated/Earth Advantage home option? Price w/ O/F freight and setup

Respondent (Mkt Share)	Single				Double				Triple				Notes
	Sq.Ft.	Base Home	Estar Option	EA/RE Option	Sq.Ft.	Base Home	Estar Option	EA/RE Option	Sq.Ft.	Base Home	Estar Option	EA/RE Option	
1. (1.2%)		24000	1200	1900		40000	1700	2400			2200	2900	
2. (7.5%)	580	35000	700	2100	1188	45000	1545	4000	2300	108000	1995	5800	
3. (3.4%)	543	21000	1200		1200	40000	1500		2400	90000	1800		
4. (1.5%)					1080	35540	1500	1850					
5. (0.7%)			1430		1296		1760		2000		1650		
6. (2.0%)	800	26000		1200	1550	53000		1800	2100	74000		2500	
7. (1.0%)	825	30000	0		1000	50000	0		2500	110000	0		Home@ome@td.wy/Estar
8. (0.3%)		27000	2000			50000	2000						
Wtd. Ave.	621	29,375	878	1,912	1,219	44,154	1,462	3,231	2,294	99,034	1,800	4,868	

7. What are the prices paid by the consumer for a typical new base-efficiency home, an Energy Star home and an Eco-rated home?

Respondent (Mkt Share)	Single				Double				Triple				Notes
	Sq.Ft.	Base Home	Estar Option	EA/RE Option	Sq.Ft.	Base Home	Estar Option	EA/RE Option	Sq.Ft.	Base Home	Estar Option	EA/RE Option	
1. (1.2%)		35000	1200	1900		65000	1700	2400			2200	2900	
2. (7.5%)			700	2100			1545	4000			1995	5800	
3. (3.4%)					1080	55000	2140	2840					Estar@omes@standard
4. (1.5%)					1296	46165	1760		2000	93297	1650		
5. (0.7%)	800	37000	1430	1200	1550	63000		1800	2100	90000		2500	
6. (2.0%)													
7. (1.0%)		39000	2000			87000	2000						No@nswer@iven
8. (0.3%)													
Wtd. Ave.	800	36,510	860	1,912	1,340	60,746	1,664	3,625	2,074	90,854	1,996	4,868	

8. What percent of your customers for new homes are... First time home buyers (FTHB), Retirement Home buyers (RHB), An Upgrade/Replacement (UPHB), A Second home (SHB), Rental property (RP) or other?

Respondent (Mkt Share)	FTHB	RHB	UPHB	SHB	RP
1. (1.2%)	5.00%	35.00%	20.00%	20.00%	20.00%
2. (7.5%)	10.00%	10.00%	80.00%		
3. (3.4%)	10.00%	25.00%	25.00%	20.00%	20.00%
4. (1.5%)		75.00%	25.00%		
5. (0.7%)	1.00%	75.00%	24.00%		
6. (2.0%)	25.00%		8.00%	8.00%	59.00%
7. (1.0%)	20.00%		80.00%		
8. (0.3%)	80.00%	10.00%	5.00%	3.00%	2.00%
Wtd. Ave.	12%	21%	49%	6%	12%

9. What is the typical age range of your buyers? Age ranges: 0-30, 31-60, 60 and over (Circle One)

Respondent (Mkt Share)	0-30%	31-60%	60%&over%	Notes
1. (1.2%)		50.00%	50.00%	Many retailers gave percentages, even though question asked for single answer
2. (7.5%)		80.00%	20.00%	
3. (3.4%)		25.00%	75.00%	This retailer broke the age categories at 50 yrs old
4. (1.5%)	0.00%	0.00%	100.00%	One answer given, presented as 100%
5. (0.7%)				Not in this early survey version
6. (2.0%)	0.00%	100.00%	0.00%	
7. (1.0%)	10.00%	89.00%	1.00%	Age categories broken at 65 yrs old
8. (0.3%)		90.00%	10.00%	
Wtd. Ave.	1%	63%	36%	

9. What percent of the homes you sell are priced... \$45k or under, \$45-60k, over \$70k?

Respondent (Mkt Share)	Today			2007			Notes
	0-\$45k	\$45-\$70k	\$70k+	0-\$45k	\$45-\$70k	\$70k+	
1. (1.2%)	10%	60%	30%				
2. (7.5%)		20%	80%		20%	80%	
3. (3.4%)	75%	20%	5%	20%	40%	40%	
4. (1.5%)		20%	80%		20%	80%	
5. (0.7%)	45%	50%	5%	25%	60%	15%	
6. (2.0%)	17%	83%					Answered with breakpoint at \$50k
7. (1.0%)	5%	25%	70%			100%	
8. (0.3%)	10%	10%	80%				
Wtd. Ave.	19%	31%	50%	6%	25%	69%	

APPENDIX C. Strategic Marketing

Introduction

Appendix C focuses primarily on the market circumstances and opportunities weighing on a new comprehensive energy efficiency effort in manufactured housing.

As with Appendix B, this Appendix relies on the results of the market survey of retailers. Readers are directed to Appendix B for a review of the creation and execution of the Survey and a copy of the survey instrument.

The purpose of the second section of the retailer survey (questions 10-18) was to gain an understanding of the day-to-day interaction with consumers, communication efforts utilized to attract customers in a quickly changing world of marketing and advertising, and the attitudes toward energy efficiency among retailers and their customers.

As in any marketing process, there are two fundamental audiences:

- Retailers, who must understand and persuasively communicate product benefits; and
- Consumers, who must receive and understand messages that support their buying decision

Through the Retailer Survey, retailers were able to explain how they currently market their business. This feedback also formed the basis for preparing a preliminary strategic marketing plan that suggests methods for bringing a new comprehensive efficiency program to the marketplace.

Findings and Conclusions

The retail location is where the impacts of financing are realized, where education of the customer about manufactured housing occurs, and where the decision on the value of options and related costs are made., Establishing the value of manufactured housing energy efficiency measures relies heavily on education and communication during the sales process. Therefore, the retail location, the retailer, and the sales staff form a critical link to the success of an energy efficiency effort.

The survey results reveal the following:

- Price is not a customer objection relating to energy efficiency. One can conclude from the survey that resource efficiency and green construction is not posing a price barrier. This is a surprising result given the average upgrade cost and is further indication of the value consumers attach to energy conservation.
- Retailers are using the Internet extensively as a primary communication tool with their customers, as lower cost web-based tools are quickly replacing traditional forms of customer outreach.
- Financing and appraisals have profound impact on retailers' ability to generate more sales activity. The appraisals consistently undervalue manufactured homes against retail

invoice, and in some cases, against factory invoice. Options, including energy efficiency and green construction, are not considered in the appraisal process.

- Energy Efficiency is a top of mind market actor. Most customers are asking for it, and most retailers present it as an active part of the sales process.
- While there is considerable length of time in the average purchase transaction from the initial customer meeting to the purchase order, the construction turnaround time is relatively short.

As regards the attitudes of retailers, we note:

- Retailers are craving information to share with potential buyers and establish market differentiation from the competition. Energy efficiency and green construction validate the products they offer. The ability to communicate these advantages effectively offers opportunities for the retailer, and for the sales associate, as they interact with potential customers.
- Retailers are excited about the potential of a product, such as an HPMH, that allows them to reverse negative stereotypes of the product they sell and regain the high ground in energy efficiency leadership.
- There is mixed reaction to the application of an incentive, whether at the factory, retailer, or the customer level. Most want it where it will benefit the customer most. It seems apparent the incentive process adds value to the purchase of the manufactured home, and that the placement of efficiency incentives should be such that the benefit is communicated through the retailer to the point of sale.

Context for Strategic Marketing

While there have been large, well-documented market shifts caused by the recession, the current economic climate offers an interesting series of contrasts:

- While the low-cost product is the current market driver in the manufactured housing industry, the recognition of energy efficiency among consumers is high.
- While the number of manufactured home builders in the region has been reduced, the remaining plants appear to have greater financial strength.
- The number of retailers has likewise dramatically reduced as a result of the recession, leaving highly motivated and capable sales people who understand the importance of energy efficiency and the value of customer service.
- Appropriate appraisals and financing for manufactured housing are challenging to secure, but overall interest rates and terms are competitive.

Nevertheless, in today's economic climate, manufactured housing is subject to ever changing financing rules and varying local enforcement of codes and zoning, diluting the pool of potential customers.

A Preliminary Strategic Marketing Plan

Market survey findings and conclusions suggest an industry ready to move ahead forcefully:

- Electronic communication technology creates new opportunities, and manufactured home retailers are engaging with them.
- Retailers are, by necessity, more entrepreneurial as factory marketing programs have scaled back.
- Utility incentive programs and associated efficiency programs have in the past proven their ability to have an impact.

Indeed, the market for manufactured housing gives signs of resurgence. Factories finally appear to be increasing seasonal production over the recent past, and consumers are out shopping.

Any HPMH marketing plan should have three objectives

1. Establish energy efficiency as a value-added measure at the manufacturer level;
2. Build a market communication strategy to increase the sales of energy-efficient products;
3. Communicate quantifiable savings to stakeholders.

The proposed marketing plan outlined here recognizes that manufactured housing is a complex product, sophisticated in its construction and complex in its installation. The plan also recognizes that while retailers are sales associates, they also must function as interior decorators, project coordinators, construction managers, and service representatives. Therefore, the marketing plan heavily stresses activities that support retailers with education, communication tools, and effective, personalized marketing to potential customers.

Eight categories of activity are identified:

1) Program Branding, Identity, and Logo - The marketing program's most important attribute will be its brand and identity. Ideally the brand will establish an emotional connection to the consumer, something they can identify with and which prompts them to evaluate the product. It should exude confidence in the product (energy efficiency), and establish a sense of market relevance and credibility.

2) Web & Social Media – One of the least costly and most effective ways of communicating today is through the web and social media. More people are getting their news and consumer information electronically, and the evolution of social media as a platform of product communication is remaking the interaction between a company or product and the consumer. The success of a HPMH campaign, and the success of the program's participants, will rest broadly on its approach to the Internet and related social media. Key aspects include:

- Program web site containing program specifications, primary program participants, information, and resources.
- Website links to participating manufacturers, who will use the location as a key marketing element.
- Links to retailers.
- Program blog. More conversational than web pages, a good blog engages potential customers and program participants.

- Facebook is a means to interact with around the program in a relaxed and informative manner.
- Twitter. Consisting of short quips, brief news items, small directives, and interesting trivia, Twitter engages quickly.
- YouTube videos - easy to create and an ideal way to engage the public and participants.
- Google Plus, Linked In, Branch Out are other sites for connecting with customers.

3) Retailer Promotion- In the case of selling a HPMH, the larger dollar investment required from the customer and the level of sophistication needed to view the value proposition favorably means informed, engaged retailers and associates are vital.

Accordingly, retailer promotion in this marketing program should entail:

- Retailer recognition and certification.
- Banner displays introducing program highlights and benefits to customers.
- Linkages back to their websites for use on printed materials.
- Virtual “walk-throughs” of a HPMH a sales person could use to take somebody through an energy efficient home.

4) Print Media – The following materials would likely be part of a strategic marketing approach:

- Program brochure.
- “Tear Sheets,” light-weight versions of brochure and program elements.
- Posters and special promotions (oversized business cards, trading cards, post cards, etc.)

5) Events & Outreach – Event opportunities are readily available. While there are no industry specific events at present, there are plenty of venues to consider – and also create – such as introductory events for new products, regional product shows, and awards events.

6) Training and Recognition - In a world where information is readily available, the interaction at the point of sale is critical. Manufactured homes are complicated, so offering a competent presentation of efficiency attributes will help promote market success. Again, training and certification will be crucial.

7) Public Relations & Outreach – A good PR team, able to match solid delivery with a sense for changing technology, is necessary.

8) Advertising – “Top of mind” is the reason for advertising; finding a cost effective way to achieve it is the challenge.

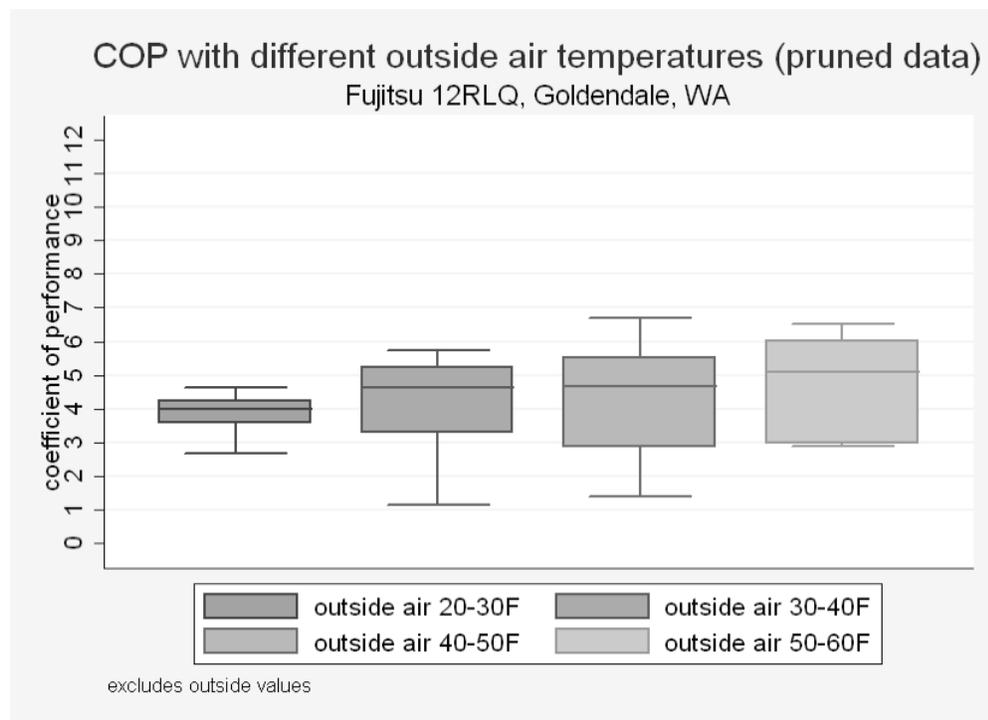
9) Utility Participation – Utility participation will be pivotal in an effective and successful energy efficiency effort in manufactured housing. Communicating regularly and effectively with utilities and their leadership must be an important, and intentional, aspect of a strategic marketing plan.

Appendix D. Related Research – Advanced Technologies for Manufactured Homes

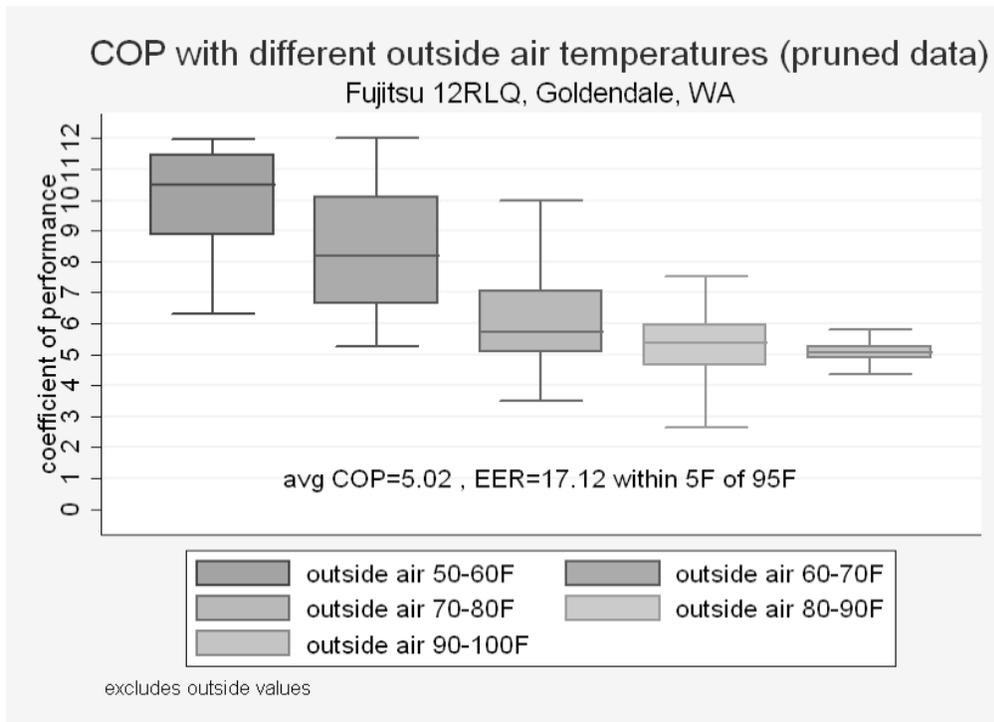
At the request of BPA, NEW identified and investigated emerging technologies and products in the energy conservation sector. This report overviews these products.

Mini-Split Ductless Heat Pump

The ductless heat pump is the most studied and available emerging technology for electric space heating in the Pacific Northwest. It combines the dual advantages of high performance at the low temperatures typical for most locations in the region with elimination of duct losses and increased infiltration characteristic of forced air systems. DHPs are a perfect match for zonal resistance electric heat, and probably have potential as an efficient complement to electric furnaces. They can be installed at the factory or on site, and will provide substantial energy savings with the documented performance shown to date.



Mini-Split Ductless Heat Pump Bench Test Results for Heating (Davis, 2009)



Mini-Split Ductless Heat Pump Bench Test Results for Cooling (Davis, 2009)

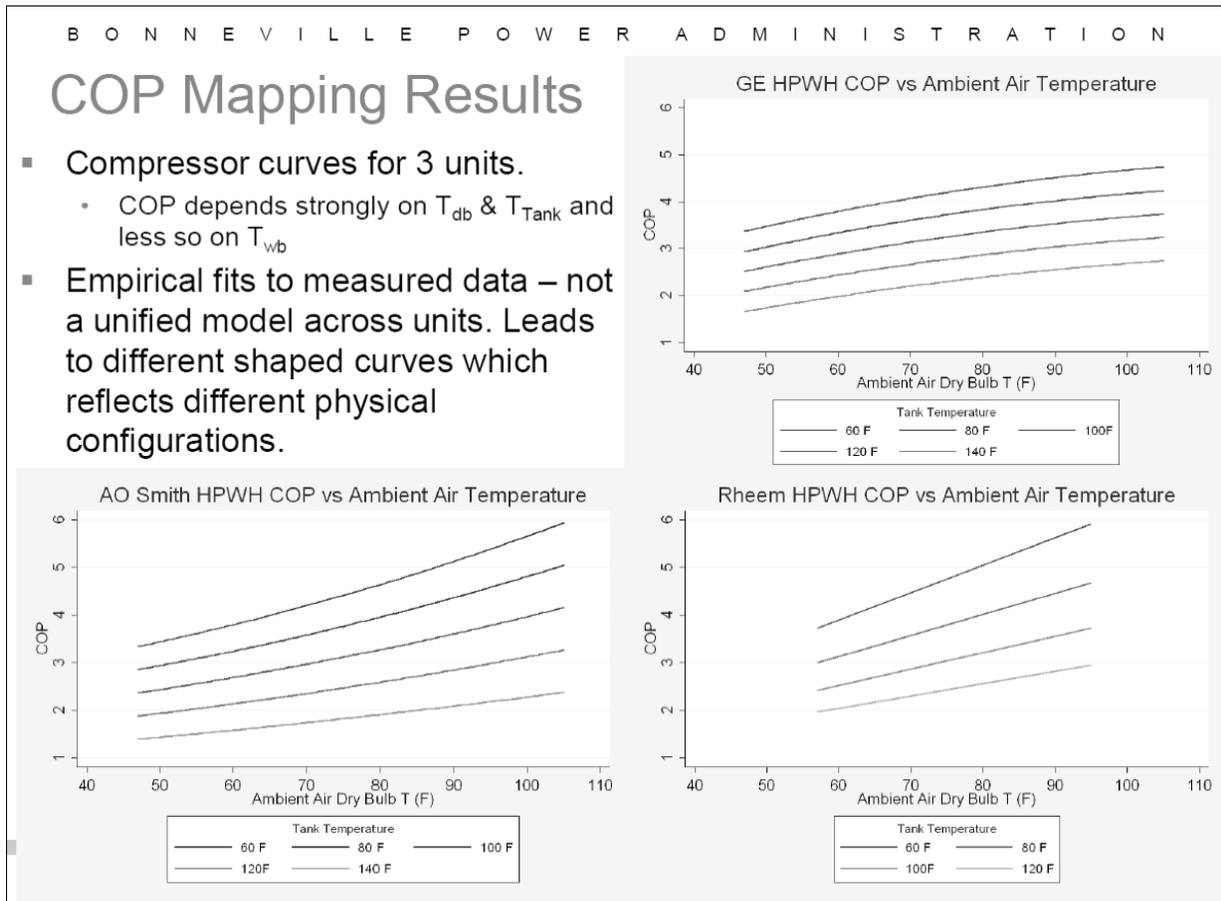
A report prepared by Ecotope Inc., *Ductless Heat Pump Impact & Process Evaluation: Lab-Testing Report (July 2011)*, found that data collected in the field matched data collected in the lab and that mini-split heat pumps deliver good performance when the outdoor temperature is low. The same report found the two DHP models tested (the Fujitsu 12RLS and Mitsubishi FE12NA) demonstrated “high performance”, suitable in both retrofits and in new homes.

Given the volume of positive performance data that has accumulated over the last 3-4 decades, marketing of DHPs now seems to be the primary obstacle to their installation. Further discussion with utilities, manufacturers, contractors, A/C vendors, big-box retailers such as Lowe’s or Home Depot, and regulatory or other state and federal organizations to disseminate DHP information and to encourage incorporation of the technology seems to be warranted.

HPWH

At present HPWHs are available in two forms, integrated units and add-on units. The majority of recent research on HPWH focuses on integrated units. Electric-resistance water heaters operate on COP of 1, while the average conventional HPWH is rated 2, topping out at 2.3. Initial test results from CO₂- refrigerant split-system models show a potential COP of 3.6-4, but these are far too expensive (\$9,000 retail) to be cost effective; hence they are not imported into this country.

The accompanying slide is taken from a presentation by BPA at the first regional Heat Pump Water Heater Consortium meeting sponsored by the Northwest Energy Efficiency Alliance. Note that the performance at higher water temperatures is limited to the 2 COP range. BPA lab tests for integrated HPWH are available at: http://www.bpa.gov/energy/n/emerging_technology/HPWH.cfm.



Altherma, a split-system manufactured by Daikin, combines space and water heating. These systems are very expensive and handicap water heating by adding two additional heat exchanges. In addition, the control logic is optimized for space heat rather than water heating.

The integrated HPWHs currently available in the U.S. take heat from the space in which they are located, usually a conditioned space or a buffer space. This reduces the unit efficiency by the impact on the space heat as is shown by the spreadsheet by Ben Larson and Adam Hadley found at this

link: http://www.nwcouncil.org/energy/rtf/measures/res/Res_HPWH_v1_2.xlsm. A promising step forward is a split system using R410A with a variable speed compressor that condenses the refrigerant in a coil in the hot water tank. Such a system would not

impact interior space heat and would have efficiencies comparable to ductless heat pumps.

Improved ceiling/floor trusses, Foam Sheathing/Adhesives

The ARIES Collaborative reported on the advanced envelope research effort in *Advanced Envelope Research for Factory Built Housing, Phase 2: Design and Development*. The report compares three envelope systems for manufactured housing, SIPs (Structural Insulated Panels), Stud walls with structural insulative sheathing, and Flash-and-batt wall construction. The three systems naturally have different strengths and weaknesses. SIPs have high insulation capacity, offer excellent structural support & stability, greater durability, air-tightness, and a non-toxic manufacturing environment; conversely they are considerably more expensive, require greater capital investment, and require greater time and attention to manufacture.

Stud walls with structural insulative sheathing, such as expanded polystyrene (EPS) and extruded polystyrene (XPS), are the least expensive and most versatile in terms of manufacturing and installation but yield the lowest energy savings. They use Advanced Framing⁴ and a combination of fiberglass batt and EPS/XPS.

Flash-and-batt wall construction employs both fiberglass insulation and closed-cell polyurethane spray foam. This system offers a high R-value (higher than stud walls with insulative sheathing, lower than SIPS) and delivers lower air infiltration and a vapor barrier at a reasonable cost. However, the spray in foam is toxic and necessitates strict adherence to plant protocols for both personal safety and for a smooth & efficient manufacturing process. Protocols may include protective gear for workers and restrictive positioning when applying the foam. In addition, the equipment requires significant capital investment and frequent maintenance.

The flash and batt construction can also be used on ceilings and has possible application to floor insulation. All of the considerations listed above in regard to walls apply equally to ceilings and floors. Ceiling trusses are currently attached to the ceiling drywall with spray foam adhesive. It is possible that urethane, which is highly adhesive, could serve a dual purpose as both adhesive and insulation in a flash and batt or flash and loose fill insulation system.

⁴ 24-inch centers with single top plates, two stud corners, no jack studs, no cripples, single headers and in many cases no headers at all.

Another possibility is to use spray foam or a formed foam block to increase insulation at the ceiling's weakest thermal point which is at the sloped edge of the truss where it joins the wall assembly. This would raise the overall insulation value of the ceiling by substantially increasing the insulative value of the edge.

Floor systems would appear to benefit most from use of SIP construction, because insulation is integrated with the structure. It could possibly allow reduction of I beam dimension and increase design flexibility. In the near term, manufactured homes could make use of flash and batt to great advantage to increase floor insulation values.

Advanced windows on manufactured homes

Windows remain the thermal weak point in walls. In a typical manufactured home the nominal wall is R19, while the typical window is R1.5 to R2.8. As the other envelope components become more efficient, it is imperative to increase the thermal efficiency of windows. Technology has evolved where windows are now available in the R5 range. The High Performance Manufactured Homes specification dictates U-.22 triple paned windows. A substantial jump, but considering some manufacturers offer windows rated at U- .16, this is an appropriate time to advance.

To assist this transition to a higher efficiency level, U.S. DOE is providing assistance to builders who buy window packages. Details can be found at <http://www1.eere.energy.gov/buildings/windowsvolumepurchase/>.

Appendix E. Database Improvement Recommendations

Prepared for:

Bonneville Power Administration

contract # 52578

February 9, 2012

Prepared by:

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Introduction

The Northwest Energy Efficient Manufactured Program (NEEM), administered by Northwest Energy Works, Inc. (NEW), is the mechanism with which the northwest's manufactured home industry builds and markets energy efficient homes. Every plant that ships homes into the four northwest states of Oregon, Washington, Idaho and Montana participates in the NEEM program. Multiple independent field-based evaluations of NEEM home performance over the past fifteen years have found high levels of compliance with program specifications, and continued improvements to the program are reflected in improved findings in more recent field studies. The Regional Technical Forum has created deemed measures for NEEM homes, and over seventy utilities in the region promote the NEEM program by offering incentives for the purchase (and in some cases, the sale) of NEEM-certified homes. The program has been marketed in the past under the Super Good Cents and Natural Choice brands, and today NEEM homes are branded ENERGY STAR[®], with several plants also co-branding "green" homes with the NEEM-supported Eco-rated[™] label.

The NEEM program delivers high quality energy savings measures (homes) to the region's utilities. The industry supports the program through fees paid for each NEEM-certified home produced. NEW participates in USDOE's Building America Program as a member of the Partnership for Improvements in Residential Construction (BA-PIRC) research team to bring technical support to the NEEM program. NEW also pursues grant opportunities to perform research that supports energy efficiency improvements in manufactured housing. The multiple funding sources and ongoing product and process improvement has enabled the NEEM program to build a strong partnership with the manufactured housing industry over the past fifteen plus years.

Utility Services

The NEEM program's primary services to utilities are as follows:

1. Home documentation. The primary way the NEEM program interacts with utilities is through the documentation generated by the program's database system. Plants submit

information about the homes being built to NEEM's central web-connected home certification and tracking system. The system generates certification documentation for each home, including a compliance certificate page and a utility incentive application page. The utility incentive application will include utility contact information, if home siting information entered by the plant accurately identifies the serving electric and/or gas utility.

2. **Due diligence.** The system has three user groups: HUD code plants, NEEM program staff and utilities. Each user group has its own appropriate set of permissions. Utilities can log in to the system and perform several actions. The most common is to confirm that a home truly is a NEEM-certified home. A utility is allowed to enter a home serial number to pull up the home's record, if the information entered corresponds to a valid record. The utility then can input siting information and confirm that the home is in the utility's service territory. The system then delivers a transaction confirmation that shows the utility performed due diligence, and the system "locks" the home data to prevent another utility from claiming the home in the future (in case the home is re-located).
3. **Market engagement.** A utility also can input their own incentives, along with active dates for the NEEM certification measure and for other residential measures supported by the utility. Then, whenever a home's certification documents are able to identify the utility, the utility's incentive information also will be included. This feature, when combined with a manufacturer's ability to identify in the database additional energy efficiency measures installed in the home (e.g., CFL lighting, clothes washer, etc.), provides the ability to identify and promote comprehensive energy efficiency "packages" that go beyond the basic NEEM home certification. This feature could prove useful if utilities wish to promote a high performance manufactured home package that includes NEEM certification plus one or more items from a list of possible additional upgrades.
4. **Technical support.** The NEEM program staff provides problem home assessment services, including utility bill analysis and onsite home testing and problem-solving. The NEEM team has a very good track record identifying problems and finding workable solutions to correct home performance issues. Utilities, homeowners, factories and retailers may request these services from NEEM.

Program Limitations

The NEEM program is a factory-based certification program that ensures homes leaving factories meet program specifications. Periodic field studies confirm adequate care is being taken during setup to deliver homes that meet NEEM onsite performance specifications. This factory focus has helped make the NEEM program the most successful above-code program in the entire industry. Unfortunately, technical success does not necessarily yield the best information for parties like utilities who are interested in knowing if a NEEM home gets sited in their utility's service territory. Plants often do not include home siting information when they enter a new home into the NEEM database system. NEEM program staff has worked with the plants for many years in an effort to collect the best possible siting information, without great success. In many cases, the home retailer or developer does not have an address for the property at the time the home is ordered from the factory. Retailers usually pursue permits, address designations and site preparation work while the home is

being built at the plant. The home address may not be communicated back to the factory until after the home is built.

Obtaining home siting information often involves pulling home warrantee and service files generated when the factory and retailer work together to finalize the home's setup. The NEEM program has paid the plants to have an employee gather siting information for the homes selected for random testing as part of periodic program field studies. Unless utilities come together to fund an effort to work closely with the industry as they did under the MAP program of the early 1990's, the NEEM program is not likely to be able to afford to generate the kind of high quality home siting information that would allow utilities to search for homes that likely are located in their service territory but haven't had an incentive application submitted by the homeowner.

The NEEM program is making an effort to make some marginal improvements to the quality of home siting data in the system by reaching out to utilities to encourage their use of the NEEM database system to perform due diligence by confirming homes in the database and entering siting information. NEEM has created login accounts for all of the utilities currently offering incentives on NEEM-certified homes and plans to conduct database user training with those utilities to help them get started with the system.

When the database first came online, NEEM staff spoke with BPA about the documentation the database system would be capable of generating. NEEM recommended that BPA's implementation manual include instructions to guide utilities in using the NEEM database to confirm homes and that the system confirmation receipt be the item for BPA auditors looked for in utility records, not just the home certificate. The Energy Trust of Oregon confirms each home in the NEEM system before paying incentives. If BPA required the same effort of its member utilities, there would be much more home siting data coming into the NEEM system. Building strong utility-retailer relationships can be helpful for locating the NEEM homes in a particular utility area.

NEEM Home Certification and Tracking System

The NEEM program database application allows over seventy regional utilities to participate in the nation's premier new construction energy efficient manufactured home program at low to no administrative cost. The NEEM database system in use today represents the third evolution of how data is collected and managed within the NEEM program. During the first years of the NEEM program, each participating state agency maintained its own database to track homes built by its in-state plants. In 2000, the NEEM program brought online a region-wide web-facing application and database to facilitate real-time data collection, provide better quality home certification process for the plants and improve NEEM program reporting capabilities. Today's system, brought online in 2005, is a SQL database with a web-facing user frontend application written in ColdFusion.

The NEEM database system is fully functional for plants and utility users, but its program administration functions were never completely implemented, due to the loss of the programming team in a round of state budget cuts. During their final days on the project, the programmers were able to build a system backend tool using Microsoft Access, which allows the NEEM staff to perform system maintenance. The database and web hosting moved to WSU in late 2009 when the Oregon Department of Energy ceased administering the NEEM program. Since that time, NEEM staff has had to relay NEEM database maintenance requests

to WSU for implementation. The database reports also did not get completed and made web-accessible, so the loss of direct backend access has made it more difficult for NEEM staff to generate reports, especially custom queries—with utility programs being the primary requestors of such information.

While the NEEM database system is stable and reliably performing its primary functions of generating home certification documentation and tracking homes, its web application is written in a language that currently is falling out of use in favor of the ASP.NET platform. This means that in the future, the current NEEM database system could become increasingly difficult to support. In the shorter term, the NEEM application is the last one hosted by WSU that uses ColdFusion, and the NEEM program will need to either pay the entire cost of licensing the software or find another host for the system. It is not clear whether NEEM or WSU staff would be allowed direct access to the system backend if it is hosted with an outside vendor.

Next Steps for the NEEM Database

As part of NEW's High Performance Manufactured Home Project with BPA, WSU was asked to prepare recommendations regarding maintaining and upgrading the NEEM database system to ensure its ability to support utility programs, both those in place today and potential future programs with greater need for home information from the NEEM database. WSU looked at three possible courses of action, based upon direction developed at a database review session attended by BPA, NEW and WSU.

1. The first option involves leaving the NEEM application as it is and making any desired improvements to the ColdFusion code. WSU estimates that significant changes to the system would be more costly than if programmed in ASP.NET. This option may result in a system with limited long-term viability, as the Cold Fusion platform is losing popularity among programmers.
2. The second option involves leaving the NEEM application as it is but making changes by writing new modules in ASP.NET. Any new code developed would be written with the intent of it functioning as part of an eventual complete re-write of the application into ASP.NET. This option likely would prove a bit more cumbersome for development, as it would not be a clean “ground up” programming effort, and it would spread system operations across two applications. However, since the entire application would not be written at one time, the approach could prove desirable from a cash flow standpoint.
3. The third option involves using the existing application as a guide and completely rebuilding it in ASP.NET. This approach likely would prove to have the lowest overall project cost in the long run and represents the typical software development process. However, the NEEM program does not have the funds to support such an effort at this time.

WSU estimates that they could develop an ASP.NET web-facing “helper” application that would handle the current backend functions and deliver some key new functionality to the database system and make some minor improvements to the ColdFusion application for less than \$90,000. For just under \$170,000, WSU estimates that they could develop a completely new NEEM application in ASP.NET.

Recommendations

NEW recognizes the need to maintain uninterrupted program operation for its participating manufacturers. This is the primary function of the database system. To accomplish this, NEW worked with WSU to develop requirements for a new, rewritten application, so that there is a plan in place to guide subsequent programming efforts (see Exhibit 1 to this Appendix). Then NEW would like to begin by building some of the existing system's most vulnerable functions in ASP.NET code. In particular, adding new construction paths for manufacturers, editing home records, and exporting data for creating reports are all functions that require backend database access that might not be readily available should WSU cease hosting the application due to their no longer maintaining ColdFusion licensing and support.

NEW recommends that BPA permit the HPMH project to focus some of the effort for overall system requirements development toward coding the first of the backend functions in ASP.NET. The current project budget should allow for some significant progress to be made and bring usable code online. Given the discussions and progress made through the HPMH project to date, NEW believes that the existing NEEM database can perform a better-than-expected job of serving as a guide for future system development, which should lessen the difficulty of developing and documenting system requirements.

Developing the initial ASP.NET code for back-end functions is a first step toward modernizing the NEEM database application in a way that does not restrict future choices for further database development. This new code would improve the NEEM program's ability to access data and service its core customers. Utilities would benefit from the initial programming work through NEEM's improved ability to generate custom reports, for example a regional utility siting report.

NEW recommends that BPA, other regional utilities and public benefit charge administrators step up to support modernizing the NEEM database system to ensure the program is able to continue providing high quality energy efficiency measures, measure validation and reporting. The NEEM program has provided utilities easily identifiable energy savings without charge for over fifteen years. BPA is taking the first steps in this regard through its support of database requirements development as part of the High Performance Manufactured Home Project, but it will take more help to fund programming, since the NEEM program does not have surplus funds at this time.

NEW expects that other organizations would be interested in joining the effort. In the past, the Energy Trust of Oregon has expressed willingness to help fund improvements to the NEEM database application, especially to the extent that those improvements result in improved data access for their program staff. NEW recommends that BPA help assemble a group of IOUs to discuss the opportunity to assist the NEEM program's database modernization work and leverage BPA's current funding that is helping to launch the effort.

Exhibit to Appendix E

Software Requirements Specification
Version 1.4
August 10, 2012

Northwest Energy-Efficient Manufactured Home Program™ (NEEM)
Home Certification and Tracking System

Chris Fuess

Submitted in partial fulfillment
Of the requirements of
Northwest Energy Works

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1.0. Purpose

1.1. Introduction

This Software Requirements Specification provides a complete description of all the functions and specifications of the Northwest Energy-Efficient Manufactured Home Program (NEEM) Home Certification and Tracking System.

The expected audience of this document is the staff of Northwest Energy Works, home manufacturers, utilities who will use this system, and the developers.

1.2. Scope

The Northwest Energy-Efficient Manufactured Home Program (NEEM) Home Certification and Tracking System (HCTS) is designed to run on the WSU Energy Program web server and to allow users to track the construction and siting of manufactured homes. The data is held in a Microsoft SQLServer2008 database server also at the WSU Energy Program.

2.0. Overall description of proposed work

The HCTS currently resides on the WSUEP web servers. The application currently allows for the tracking of manufactured homes built in the NW region and sited throughout the western United States. This system will be completely web-based, an Internet connection is necessary to access the system; the old system had an Access front end that allowed administration but only to onsite employees. HCTS which is currently running on the WSU web server was developed as a ColdFusion application which as a programming language is not as prevalent as it was 10 years ago. ColdFusion lacks plugins, does not have a very strong ecosystem, and will be hard to find developers who still use it. The language lacks structure and code is repeated in many places making maintenance difficult. Therefore, new features would be developed with ASP.Net, which is a current web technology and will be able to be maintained into the future.

The HCTS web site will continue to be operated from the WSUEP server. When a user connects to the Web Server, existing features will still utilize the existing ColdFusion codebase in order to leverage the work that was already done. New features will be written in ASP.Net. Both systems will access and store data in the NEEM SQLServer database.

2.1. Use cases

The system will be expanded to allow NEEM Staff, Home Manufacturers, and Utilities to find, view, add, edit, and delete data.

2.1.1. Use Case: Enter a Home

Brief Description:

Users will want to be able to enter new homes into the system as they are built.

- Manufacturers and Staff will be able to enter new homes into the system – selecting the energy efficiency brand for the home and a valid builder option package, called a Path, for the brand and heating system selected.

2.1.2. Use Case: Find a Home

Brief Description:

Users will want to be able to search for a specific home in the system.

- Staff will be able to do wildcard searches and will be able to edit all the info about a home in the system.
- Manufacturers will be able to find their own homes and edit them for a limited time.
- Utilities will be able to search and claim homes – with serial number format used by manufacturers so utility can find them more easily.

2.1.3. Use Case: Edit Home

Brief Description:

Edit home record

1. Staff will be able to edit anything about a home. They will also be able to delete a home.
2. Manufacturer will be able to modify some fields of a home or to delete it for a limited time. They will also be able to enter siting information for a home at any time.
3. The way homes are marked deleted will be changed. A new field to the database for that purpose will be added instead of appending a "D" to the serial number. The ColdFusion code will be modified to make use of the new field.

2.1.4. Use Case: Utility Home Confirmation

Brief Description:

Utilities will claim a home

- Utilities will be able to mark homes as being in their service territory and that an incentive has been processed for the home. The system will generate a transaction record for the action and will “lock” the home record to notify any subsequent utility accessing the record that the home already has had an incentive processed and by which utility.

2.1.5. Use Case: Generate Reports

Brief Description:

Staff will be able to generate reports, essentially data dumps of the entire database, so they can create custom reports for their users. Here are some examples they would be able to provide:

- Report of retailers: home sales activity, retailers located in or near a utility’s service territory, homes with missing siting information.
- Compare what got built vs. what utilities claimed.
- Home siting with potential serving utility, missing or incomplete address information.
- EPA quarterly ENERGY STAR[®] homes reporting.

2.1.6. Use Case: System maintenance

Brief description:

Staff will want administrate users and options available in the system.

- Staff will develop new brands and new paths, specific to a particular construction method employed by a manufacturer, using software and analysis tools not part of the system. The requirements for a given brand or path will be entered into the system, and paths assigned (made available) to the appropriate manufacturer(s).
- Add/Update/Delete manufacturers
- Add/Update/Delete retailers
- Add/Update/Delete utilities
- Add/Update/Delete system users (data and passwords)
- Add/Update/Delete heating system types

3.0. Existing Functionality

The HCTS existing code base is utilizing the ColdFusion scripting language to access and present the data on the web. Existing pages will be largely left unchanged except to compensate for changes in the database structure. The following documents the existing functionality of the site and is listed here for reference.

3.1. Existing Use cases

3.1.1. Add Home

Brief Description:

Some of the data points entered are Serial Number, Retailer, Heating System, Path (option package), Floor Area, Glazing Area, etc.

- Manufacturers can add a new home to their home list in the system.
- Admins can add a home to any manufacturer.

3.1.2 Edit/Print/Delete Home

Brief Description:

Users can search for a home by Serial Number, Retailer, Manufacturer or Date Range to get a list of matching homes. Home info is not currently editable, but Siting and Appliance info can be added.

- This feature is available to Admin, Manufacturer, and State Users.
- Manufacturers and Admins can print certificates of compliance

3.1.3. Add/Assign/Edit Retailer

Brief Description:

Users can add & edit basic retailer information. Retailers can be assigned to manufacturers.

- Admins can Add, Edit, and Assign retailers
- Manufacturers can only Assign retailers

3.1.4. Assign Paths to Manufacturer

Brief Description:

Admin users can select a manufacturer and then assign a predefined path, option package, to them:

3.1.5. Edit Manufacturer**Brief Description:**

Users can edit the basic info pertaining to manufacturers:

- Admin and State users can edit multiple manufactures.
- Manufacturers can only edit their own data.

3.1.6. Incentive Maintenance**Brief Description:**

Utility users can add and edit incentive programs. Utilities can then search for homes and approve incentives for particular homes.

3.1.7 Reports**Brief Description:**

On screen reports can be generated. Report information is restricted depending on user access level. The following lists of reports are currently available.

1. Paths by grouped by Manufacturer
2. Certified and Deleted Homes Report
3. Certified Home Summary Report
4. Manufacturer List Report
5. Retailer List Report

Appendix F. HPMH Measure Development and Anticipated Quality Management Implications

Shell Modifications

The duct system removed from the floor

Removing the duct system will allow about 25 percent more insulation in the floor.

Rigid insulation on the exterior of the wall structure behind the siding

R-5 foam sheathing will be installed on the exterior walls ($\frac{3}{4}$ in. thick), resulting in approximately a 25-percent reduction in the overall heat conductivity of the wall system. R-5 foam sheathing was provided by the HPMH project and installed in the plant on a demonstration home, with NEW staff on hand to monitor both the time implications for the added process and any potential impacts on building durability or measure effectiveness. Construction job processes were monitored in the plants to ensure buildability. NEW inspected the home once it was set up on site and found no sign of siding movement, damage to windows or unusual drywall cracking.



Photo 1. Rigid foam sheathing on walls

Triple glazed windows

Windows incorporating modern low-E coatings and standard vinyl frame design with a U-value of 0.20 were installed in a Lab Home at PNNL in Richland, WA. The windows were able to replace the existing window packages without significant design impacts in the PNNL lab home. Air tightness tests and light levels were monitored before and after window installation. NEW participated with the window manufacturer's installation experts and PNNL staff in determining the window installation process most appropriate to the manufactured home construction type, and in developing elements of the window experiment plan.

Increased ceiling thermal performance

Insulation was prototyped and costs analyzed to modify the ceiling insulation detail for conventional trusses, increase the truss heel dimension to approximately eight inches, or use

hinged trusses to gain higher heel heights without increasing the overall transport height of the home.

Overall Uo reduction

The combined impact of the changes to the thermal envelope described above would improve the overall Uo of the home from the current NEEM specification of about 0.054 to a level of about 0.040. This represents a reduction in heat-loss rate over the current national northern tier HUD standard (Uo =0.079) by nearly a factor of two.

HVAC System Modifications

The typical electric forced-air furnace and duct system will be eliminated from the home altogether, a fundamental change to the heating system, and be replaced by an alternative DHP-based HVAC system. The proposed system is called a hybrid DHP zonal electric heating system, because the DHP is combined with electric wall heaters or electric baseboard units located throughout the home. In the prototype homes the zonal electric backup units were Cadet® heaters (a local producer), but any comparable product could be used.



Photo 2. DHP compressor being installed in the plant

Electric resistance heaters *back up* the primary DHP heating system. The high efficiency DHP is located in the central living area and sized with sufficient capacity to meet the entire home's cooling and heating load under most conditions when interior doors are left open. The DHP includes one or two wall-mounted indoor heads in the central space that operate nearly continuously, adjusting fan speed in proportion to the amount of heating or cooling being performed by the unit.



Photo 3. DHP indoor head installed in plant

The continuous operation of the indoor head blower thoroughly mixes the room air throughout the house, ensuring the air gets turned over and conditioned by the DHP. Remote rooms will be conditioned indirectly most of the time, with the back-up electric resistance wall heaters supplementing as needed in extreme conditions. The use of a zone heating system of this type eliminates numerous thermal envelope penetrations and is expected to reduce the building's air leakage rate considerably, even over the relatively tight duct systems used in typical NEEM homes.

NEEM plants would set the wholesale option price for the new heating system, and it may differ for different floor plans and climate zones.

Experience with the first prototype hybrid zonal systems in homes currently placed at retail display centers indicates that more work may be needed to help improve cooling performance in secondary zones. Adding ceiling paddle fans in key secondary zones may be an important part of the hybrid zonal system, especially in larger homes and in locations with significant cooling loads. More research and testing is needed in this area.

Domestic Hot Water Modifications

The use of a heat pump water heater (HPWH) will significantly improve the efficiency of the domestic hot water system. Several products have been demonstrated in the Pacific Northwest over the last two years, and several units have shown good performance characteristics in both lab tests and home installations. One product, AirGenerate, was recently approved as the first HPWH compliant with the NEEA Northern Climate Spec Tier 2.

To enhance the efficiency of this system, a hot water conservation package —low flow showerheads, faucet aerators, and water conserving appliances – will be added. Given current regional laboratory results and field performance, a 50 percent reduction in the energy requirements for DHW over the base home was found as a result of the NEEM modeling.

The project team identified three approaches to incorporating the HPWH into homes:

- In design option 1, the HPWH would be designed to draw air from the house crawlspace, transfer its heat into the domestic hot water tank and then exhaust the resultant cool air to the outside. There would be no impact on indoor air temperature or home ventilation systems. This option has been presented by one plant's DAPIA to HUD, and HUD has ruled that a plant wishing to use this approach would need to submit a request for an alternate construction letter of approval, which could be used for all homes.
- Design option 2 utilizes the HPWH as the central component in a heat recovery ventilation system for the home, operating intermittently at up to 300 cfm, according to the hot water demands of the occupants. If the interior-coupled system is used the overall ventilation rates provided by the heat pump water heater could exceed the current NEEM and HUD standards by about 20 percent. HPWH run times could also obviate the need for a whole-house ventilation system and timers or other controls, though this strategy could be in conflict with HUD standards. The spot ventilators (bath and range hood fans) currently used in the NEEM homes would still be required as part of the ventilation system. Since the HPWH will be moving more air when it runs than the conventional whole house ventilation fan, fresh air make-up may need to be provided via dampered air inlets, possibly located in the bedroom and water heater closets. This option has not been presented to any DAPIA firm, as the project team is concerned about comfort issues

arising from the introduction of so much make-up air into bedrooms—zones that are intended largely to be indirectly conditioned by a DHP in the home’s main zone.

- Design option 3 relies on a heat recovery approach that fits the AirGenerate HPWH with a restrictor that reduces airflow rate to 175 cfm, the minimum airflow lab testing has shown will not significantly affect the HPWH unit’s performance. The 175 cfm HPWH airflow, coupled with a Panasonic Whispergreen® whole house fan located in the master bathroom, would meet the required HUD ventilation rate when set to provide 30 cfm continuously and to increase to 80 cfm with an occupancy sensor. The Whispergreen/AirGenerate/175cfm option is in the process of being reviewed by the DAPIA for prototyping by one manufacturer. Pressure diagnostic testing of a prototype home could help determine whether fresh make-up air will be required.

Lighting Modifications

Essentially 90 percent of all lamps will require high efficacy bulbs. (Eco-rated home certification, which is a green home brand developed by the NEEM home program, now requires 50% CFLs or equivalent.) Use of modern LED lighting for accent application is anticipated. This specification would reduce the power required by the lighting system by more than 50 percent.

Appliances and Plug Load Modifications

Plug loads and appliances are the most difficult areas to address. The HPMH specification calls for high-performance Energy Star (or Energy Star Plus) appliances to be provided as part of the home package when a customer purchases new appliances with the home. These would include the refrigerator and dishwasher. Homes that receive NEEM program Eco-rated certification already have to meet this requirement. We include these products in the HPMH package so that both the hot water savings and energy savings associated with these efficient appliances are included as part of the complete energy efficient package.

Quality Control and Quality Assurance for the HPMH

Just as site built homes are constructed according to a specific building code to insure proper design and safety, today’s manufactured homes are constructed in accordance with the Manufactured Housing Construction Safety Standard, the “HUD Code.” The United States Congress laid the foundation for the HUD Code in the National Manufactured Home Construction and Safety Standards Act of 1974 by directing the Secretary of U.S. Department of Housing and Urban Development to establish appropriate manufactured home construction and safety standards that “...meet the highest standards of protection, taking into account the importance of safety and quality construction.”

The HUD Code is unique since it is specifically designed for compatibility with the factory production process. Performance standards for heating, plumbing, air conditioning, thermal and electrical systems are set in the code.

In addition, performance requirements are established for structural design, construction, fire safety, energy efficiency, and transportation from the factory to the customer’s home site. Manufactured homes are constructed with virtually the same materials used in site-built homes. However, in contrast to traditional site-building techniques, manufactured homes have the

advantage of using engineered design applications and cost-efficient assembly line techniques to produce each home.

The HUD enforcement system begins with oversight by the Design Approval Primary Inspection Agency (DAPIA). The DAPIA (a third party inspection agency) must: approve the engineering design of the home; approve the manufacturer's quality assurance manual for its plant; and coordinate with the other third-party inspection agency, known as the IPIA

The Production Inspection Primary Inspection Agency (IPIA) has the responsibility to make sure the production facility programs and procedures are in accordance with the DAPIA approved quality assurance manual; and, it conducts inspections of homes produced in the factory to assure conformance with the approved design. The IPIA inspector checks each phase of construction, and verifies that the manufacturer's own in-plant inspection and quality control processes are being followed.

The High Performance Manufactured Home (HPMH) must undergo the same approval process as a HUD code home. Individual plants will submit upgrade energy measures and their corresponding designs for DAPIA approval. Once the measures are approved they will be included in each plant's DAPIA manual. Then the IPIA is required to inspect the home to the HPMH spec that has been previously entered into the DAPIA manual for that plant.

Each factory would then be certified by NEEM to build the HPMH. Staff training at each workstation would be given as well as in-plant monitoring of at least the first two completed homes. Drawings and specification language will be developed for each of the final measures to be included in the HPMH package and added to the NEEM In-Plant Inspection Manual.

The NEEM inspectors, along with representatives from relevant material and equipment suppliers, will provide in plant training on at least the first two houses built by each plant. Once each plant demonstrates its ability to build to the HPMH specifications under the plant's quality control processes, the HPMH measures will become part of the NEEM quarterly plant inspection process. Special consideration and effort will be given to the DHP design and installation process as well as the HPWH design and installation. As of the writing of this final report no HPWH has been approved in the USA by UL or HUD for ducting outside air to and from the condenser coil.

The project team worked with several regional plants to demonstrate HPMH measures and secure approval through the DAPIA and IPIA process. There are no outstanding technical or regulatory issues on the shell measures. Several plants have installed R-5 foam over exterior sheathing or removed in-floor ducts and installed the hybrid ductless heat pump system with DAPIA and IPIA approval. The DHP equipment has been approved for installation through one plant's DAPIA, but obtaining HUD listing on the DHP equipment may prove necessary as this option gets used more broadly. Table 1 presents the measures for the HPMH and the Quality Control/Quality Assurance (QA/QC) procedures for each measure.

Table 1. Plant Design Approval Implications and Quality Management Procedures

Component	Measures for the HPMH	Status of DAPIA approval	HPMH QC (Performed by NEEM Program or Field Study Team)	Outstanding Issues & Next Steps
Ceiling	R-49+ (R-45 net, due to depth limits at truss heel)	DAPIA would need to call out compressed or dense packed insulation.	Training on two homes from each factory. Quarterly plant inspection.	Higher heel heights could cause transportation issues. Prototype more options for sidewall area (e.g., dense pack cellulose, foam)
Floor	R-38 (remove ducts)	No HUD approval needed	Training on two homes from each factory. Quarterly plant inspection.	No issues
Wall	R-26 (R-21 plus R-5 foam)	DAPIA approval obtained	Training on two homes from each factory. Quarterly plant inspection. Random field study.	Prototype other options (e.g., staggered wall framing)
Window	U=0.22	No HUD approval needed	Training, confirm products. Quarterly plant inspection. Random field study.	No issues
Door	R-5	No change	Quarterly plant inspection.	No issues
Target Uo	0.040	No HUD approval needed (DAPIA pkg. will incl. each shell measure)	HPMH path development with plant staff. Quarterly plant inspection. Field study data analysis.	No issues
Heating System	DHP/ Electric Resistance Zonal Heaters	DAPIA approval obtained for prototype homes. HUD listing of equipment may be necessary.	Training on 1 st four homes. Quarterly plant inspection. Random field study.	If DHP is delayed and the production line pushes the home “out the door,” home will get red tagged by IPIA if zonal backup system cannot supply design heating load by itself. Repeated red tags can result in fines for the plant.
Lighting	0.7 W/sf (most all is CFL or LED)	No HUD approval needed	Training, check products. First home inspected. Quarterly plant inspection.	No issues: lighting products already part of Eco-rated homes
Infiltration	0.21 ACH (natural)	Does Not Apply	Training, field test two homes from each factory. Quarterly plant inspection. Random field testing.	No issues: plant inspection process already covers infiltration areas
Domestic Hot Water	HPWH 2.0 ef (assuming Air Generate 66 gal or equal)	Sent to DAPIA and HUD for approval. HUD wants a plant to request an Alternate Construction Letter. HUD listing of equipment may be necessary.	Training on four homes from each factory. Quarterly plant inspection. Random field testing.	HUD ruling requires alternate construction letter for each home if the HPWH is to use crawlspace air. No HPWH available with HUD or UL ducted intake. Homes may be too tight to allow HPWH use of indoor air without having make-up air.
Appliances	EStar Dish, ref., washer (Includes low flow faucets, showerheads)	No HUD approval needed	Quarterly plant inspection.	No issues: water savings products already part of Eco-rated homes, DW already required

BONNEVILLE POWER ADMINISTRATION

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