

Market Analysis for Zero Net Energy Manufactured Home Replacements in Delaware

**PREPARED FOR
DELAWARE SUSTAINABLE ENERGY UTILITY**

**PREPARED BY
VERMONT ENERGY INVESTMENT CORPORATION**



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Executive Summary

The need for affordable housing is as acute in Delaware as any other part of the United States. Housing affordability must include energy affordability, and for many Delawareans who have purchased mobile homes or manufactured homes, the benefits of low upfront purchase costs are degraded by high energy costs for decades. Mobile and manufactured homes have higher energy costs, and these costs often end up being a public cost as part of the Low-Income Home Energy Assistance Program (LIHEAP). There is now an alternative to mobile and manufactured homes, one that fits the footprint as a traditional manufactured home but which has energy characteristics that make it affordable for the long-term: a Zero Net Energy Manufactured Home Replacement (ZNE MH).

The Delaware Sustainable Energy Utility (Delaware SEU) commissioned Vermont Energy Investment Corporation (VEIC) to assess the feasibility of bringing these homes to Delaware with the assessment structured in two phases:

Phase 1 – Provide analysis, using secondary data sources, that identifies and characterizes potential market(s) for ZNE MH and initial feasibility based on customer cashflow. Phase 1 analysis will provide the basis on which the Delaware SEU can decide whether Phase 2, pilot program design, should proceed.

Phase 2 – Provide pilot program design, including

- Refinement and final identification of the pilot program market, with determination of pilot market size characteristics with a focus on supporting low- and moderate-income participants
- ZNE MH technical specifications optimized for Delaware climate and cost effectiveness
- Identification of the supply and delivery chain
- Creation of the customer economic model
- Determination of program eligibility, partners, incentives, and other resources
- Development of an evaluation plan to verify pilot effectiveness

Phase 2 analysis will provide the basis on which the Delaware SEU can decide whether a pilot program should be implemented.

VEIC reviewed and analyzed federal codes and standards, Delaware regulations and policies, manufactured housing characteristics, housing needs in Delaware, occupant income demographics, available financing for factory-built homes, and manufactured home market sectors in order to characterize potential markets. VEIC also prepared a cost-benefit analysis, with a summary of non-energy benefits and a cashflow analysis of estimated housing and energy costs and savings to derive the net present value of lifetime housing and energy costs.

Based on this analysis, VEIC concludes that:

- There is need for more energy-efficient, resilient, and affordable housing in Delaware.
- The barriers to effecting change in manufactured home financing in the short term create a positive impetus to look at modular housing, sited on owned land or land leased with secure long-term tenure.
- Such modular housing, built and sited to ZNE MH standards, can reduce the net present value of housing and energy costs over a 30-year period by up to 11 percent, compared to manufactured homes built to the HUD standard.
- When compared to a new manufactured home built to HUD standards, the ZNE MH provides positive cashflow of \$200 - \$300 per month, starting in the first year, and continuing throughout a full 30-year period.
- There is sufficient market to create a ZNE MH pilot program, and sufficient market in the long-term to justify the costs of a pilot program.
- The market of a pilot program would involve new purchases of homes on owned land or on land that is deeded by land trusts for very long-term tenures. This would preclude the pilot work in large manufactured home communities on leased land that are found throughout Delaware most common around Delaware's shore.
- The role that land trusts can play in transforming manufactured home parks to zero net energy communities can be catalytic, the type of change that could draw new sources of funds to the table.

VEIC recommends moving to Phase 2, pilot program design, during which the following would be accomplished to provide the basis for a decision on whether to implement a pilot:

- Establish working group of designated DE SEU Energy Program Committee members and external stakeholders for feedback on program design during Phase 2
- Work with regional modular home manufacturers to revise open-source ZNE MH plans for Delaware's climate
- Estimate ZNE MH costs, based on Delaware's climate, production costs, and siting costs
- Define potential ownership models
- Investigate funding and financing sources for pilot project, with the objective of sustainability of funding and financing for long-term market development
- Compare costs and benefits of ZNE MH to those of site-built homes
- Document pilot design, including number and location of homes, program partners, incentives and financing, program budget, performance metrics and savings verification

Introduction

The American Dream: a home of one's own. For significant portions of any U.S. population, this dream can be achieved with a manufactured home—whether rented or owned, whether on one's own plot of land, in a park, or in a community. With purchase prices that are often less than half the cost of an average site-built home, manufactured homes offer affordable housing for many, especially in rural areas. These homes, the older ones of which have traditionally been called *mobile homes*, readily fill a housing need for low- and moderate-income Delawareans.

Although the initial price might make this option seem affordable, other costs associated with these structures, especially the costs of energy, contribute to the hidden high cost of living across the full tenure of renting or owning. Most manufactured homes, especially older units, have significantly higher energy costs than other types of housing. The thermal properties, including poor air-sealing and insufficient insulation, lead to heating and cooling costs that raise the overall cost of occupancy, significantly burdening low- and moderate-income residents.

Residents of manufactured homes spend nearly twice as much on energy per square foot of living space as do residents of site-built homes. Monthly utility bills of \$500 or more during summer and winter utility peak periods are not unusual. That amount places a significantly higher energy burden on many residents.¹ This is especially true for homes manufactured prior to 1976 when the U.S. Department of Housing and Urban Development (HUD) implemented its code regulating construction quality and safety of manufactured housing.

There are alternatives to baseline code construction of manufactured homes, including high-performance factory-built homes that offer their occupants affordable living and are resilient against extreme weather. One of the latest designs is a high-performance modular home that fits onto the footprint of a mobile or manufactured home. These homes have a much lower cost and can be completed quickly, compared to site-built housing, and are designed to fit the footprint used in mobile home parks. They were created in Vermont, after Tropical Storm Irene disproportionately destroyed a large number of manufactured homes. The Zero Net Energy Manufactured Home (ZNE MH) is designed for long-term affordability. It has a higher upfront cost, but it drastically reduces energy costs. Occupants can obtain additional long-term savings by being able to finance with conventional mortgage financing, rather than high-cost personal property financing.

Energy Burden

Household energy costs divided by household income. Energy burdens for low-income households in the United States are, on average, twice as high as those for all US households.

¹ “How To Eliminate the Worst Housing Stock in Appalachia,” Frontier Housing, 2012, <http://www.frontierhousing.org/mhdr/docs/EliminateWorstHousingUSHandout0909b.pdf>.



Purpose of Study

The goal of this study, which is the first phase of a two-part effort, is to evaluate the feasibility of a manufactured home replacement program with Zero Net Energy Homes (ZNE MH) in Delaware. The study has determined market opportunities and marketplace barriers, via a review of secondary data on existing housing stock. The study cites details of market size, average energy use, home ownership, and income demographics; and estimates the long-term costs and benefits of the ZNE MH in the Delaware climate. The study has been informed by the engagement of key stakeholders on the potential for catalyzing the entry of these homes into the market.

Based on the results of this analysis, the Delaware Sustainable Energy Utility (DE SEU) will consider proceeding to Phase 2, design of program pilot. Key areas of focus during the program pilot design phase will include:

- Refinement and final identification of the pilot program market, with determination of pilot market size characteristics with a focus on supporting low- and moderate-income Delaware residents
- Identification of the supply and delivery chain
- Creation of the customer economic model
- Determination of program eligibility, partners, incentives, and other resources
- Development of an evaluation plan to verify pilot effectiveness

The criteria for assessing the potential for moving forward with a ZNE MH pilot in Delaware include:

- Sufficiency of potential market size, based on estimation of markets and submarkets of mobile and manufactured homes
- Determination that there are few insurmountable barriers in regulation and policy
- Favorable comparison of monthly loan and energy costs, and cumulative cashflow, between a typical HUD manufactured home and a ZNE MH
- Identification of non-energy benefits of a ZNE MH
- Identification of existing homeowner and developer affordable housing programs in Delaware and energy efficiency and renewable energy programs that could provide additional financial or technical assistance to a ZNE MH pilot
- Identification of potential regional manufacturer(s) for the ZNE MH



Market Analysis

Federal Codes and Standards

In 1976, HUD established minimum construction standards for manufactured housing. These standards addressed fire safety, structural requirements, plumbing systems, and thermal properties.² Regulated standards for construction quality in manufactured housing did not exist prior to 1976. The differences in manufactured housing before and after 1976 are notable.

Approximately 18% of existing manufactured homes in the United States predate the HUD standard.³ Many homes built prior to 1976 were manufactured in a style similar to recreational vehicle construction. These homes are now 38 or more years old, an age well beyond the expected useful life of such homes at the time they were built. They are generally in poor condition. They typically have poor insulation; air leaks are present because of poor manufacturing or installation, or because they have fallen into disrepair. These factors contribute significantly to high energy bills for heating and cooling. Further, these older units frequently offer compromised indoor air quality because of the presence of caustic interior materials, mold, and mildew.

Manufactured Home

A home designed and built in a factory to meet HUD standards, and labeled as such.

Minimum: 8' wide, 40' long, and 400 square feet. Built on permanent chassis and transportable.

Manufactured homes built in 1976 or later must comply with HUD's Manufactured Home Construction and Safety Standards ("HUD Code"),⁴ which supersede local building codes. Every manufactured home that is subject to sale or lease must display a red certification label on each transportable section. According to the HUD standard, manufactured homes are built as dwelling units with a permanent chassis to assure the initial and continued transportability of the home.

*The 1976 code provides the manufactured home industry with a clear set of standards for design and construction, strength and durability, fire resistance, energy efficiency, transportability, and quality control. It also sets performance standards for the heating and air conditioning, plumbing, thermal, and electrical systems.*⁵

² 24 CFR 3280. <http://www.gpo.gov/fdsys/granule/CFR-2010-title24-vol5/CFR-2010-title24-vol5-part3280>.

³ "2012 Market Facts Analysis," Foremost Insurance Group, <http://www.foremost.com/mobile-home-market-facts/2012-Market-Facts.pdf/>.

⁴ <http://www.hud.gov/offices/hsg/ramh/mhs/mfsheet.cfm>.

⁵ "Energy-Efficient Manufactured Homes," U.S. Department of Energy, <http://energy.gov/energysaver/articles/energy-efficient-manufactured-homes>.



In July 2014, the U.S. Department of Energy (DOE) initiated a working group to develop and propose multiple federal standards for the energy efficiency of manufactured homes. This working group will also evaluate life cycle costs of the proposed standards. The working group is expected to make a proposal by the end of 2014 or early in 2015. This work has not concluded as Phase 1 of this project completes. This work could have impact on future pilot programs but is not incorporated into the recommendations for the Phase 2 pilot contained at the close of this report.

Delaware Regulations and Policies

According to the Delaware State Housing Authority, more than half of the manufactured homes in Delaware in 2008 were sited on leased land.⁶ Leases can be as short as a year, making tenure insecure or unaffordable if a lease is terminated, ownership changes, or lot rents and / or lot service fees increase substantially. The Delaware Legislature has been addressing some of these affordability issues for more than a decade, beginning with the passage of the 2003 Manufactured Home Owners and Community Owners Act. Property rights for owners of manufactured homes in manufactured home communities are regulated by Delaware Code (Title 25 Chapter 70).⁷ The Code improves the security of tenure for owners of manufactured homes on leased land. It also created the Delaware Manufactured Home Relocation Authority to work with residents in cases of closure. Manufactured housing owners and park operators pay a monthly per-home fee into a Trust Fund⁸ that assists homeowners with relocation, or park owners with disposal of abandoned homes, in the event the mobile home park or community closes. The fee was established at \$3.00 per home per month, but has recently been increased to \$5.00 per home per month.

The Code also regulates disputes and general rights and responsibilities for land owners of communities and their renters (owners of the manufactured homes). Land lease rent increases are also regulated through the Delaware Manufactured Home Relocation Authority.⁹ Passed in 2013, the SB-33 Rent Justification Bill protects the homeowner by capping land lease rent increases, based on the Consumer Price Index for Urban Consumers (CPI-U) rate for the region.

Since 2008, homeowner associations within manufactured housing communities have had the option to collectively purchase the site in the event the owner wishes to sell the land, through the Right of First Offer Law.¹⁰ Ideally, the right of first offer can improve the stability of a community; it can also lead to better property financing rates and a more stable housing environment for occupants. In 2009, lenders and advocates provided technical support and loans to create the first resident-owned manufactured housing community in Delaware when the

⁶ "Manufactured Housing in Delaware," p. 5.

⁷ <http://delcode.delaware.gov/title25/c070/sc01/index.shtml>.

⁸ <http://regulations.delaware.gov/AdminCode/title1/200/201.shtml>.

⁹ Delaware Manufactured Home Relocation Authority, "Rent Increase Dispute Resolution procedures, 25 Del. C. Section 7011 thru 7015";

<http://demhra.delaware.gov/information/sb33/FinalRegulationsforRentJustificationProcedure.pdf>.

¹⁰ 25 Del. C. Section 7026; <http://delcode.delaware.gov/title25/c070/sc01/>.



Minquadale Village Homeowners Association purchased its manufactured home community. This purchase secured the homes for the 84 families living there.

Manufactured homes sited on leased land in Delaware are in nearly all cases considered personal property rather than real property. Properties so classified are registered with the State through the Division of Motor Vehicles. However the Delaware Code (Title 9, Chapter 83) provides that even though not considered real property, such properties are assessed and taxed at the same tax rate as real property in the county and in the school district in which the home is located.¹¹

Only manufactured homes located on land owned by the homeowner or with secure, very long-term leases are able to be titled as real property. However, the process of surrendering the title to have a home declared real estate varies in each of Delaware's three counties. For manufactured homes to be considered real property, the land ownership must be fee-simple or on a very long-term lease (for example, a 99-year lease with a land trust).

Characterizing Manufactured Housing

According to the U.S. Census Bureau (American Community Survey), there are approximately 403,000 housing units of all types in Delaware, of which 82.5% are occupied. Manufactured housing accounts for 9.6% of all housing units in the state; 67.8% of those units are occupied. Manufactured homes have a much lower occupancy rate, with many being used as seasonal dwellings. Among the occupied manufactured housing units, 80% are owner-occupied, and 20% are occupied by renters. **Table 1** provides information on housing units for the state as a whole, as well as by county.

¹¹ Title 9 Chapter 83 of the Delaware Code. <http://delcode.delaware.gov/title9/c083/sc01/index.shtml>.



Table 1. Delaware housing units, manufactured housing units, and occupancy status

	Delaware	Kent	New Castle	Sussex
All units	403,095	64,616	216,801	121,678
Manufactured housing units	38,808	8,653	5,233	24,922
All occupied units	332,837	57,629	199,922	75,286
Occupied manufactured housing units	26,308	7,746	4,986	13,576
Owner-occupied units	242,808	41,713	140,936	60,159
Owner-occupied manufactured housing units	21,011	5,977	4,162	10,872
Renter-occupied units	90,029	15,916	58,986	15,127
Renter-occupied manufactured housing units	5,297	1,769	824	2,704
Manufactured housing as a % of housing stock	9.6%	13.4%	2.4%	20.5%
Manufactured housing as a % of occupied stock	7.9%	13.4%	2.5%	18.0%
Manufactured housing as a % of owner-occupied units	8.7%	14.3%	3.0%	18.1%
Manufactured housing as a % of renter-occupied units	5.9%	11.1%	1.4%	17.9%

Source: "Delaware Housing Needs Assessment," Delaware State Housing Authority, 2014, Table 14, Manufactured Homes in Delaware. Data derived from American Community Survey 2007-11.

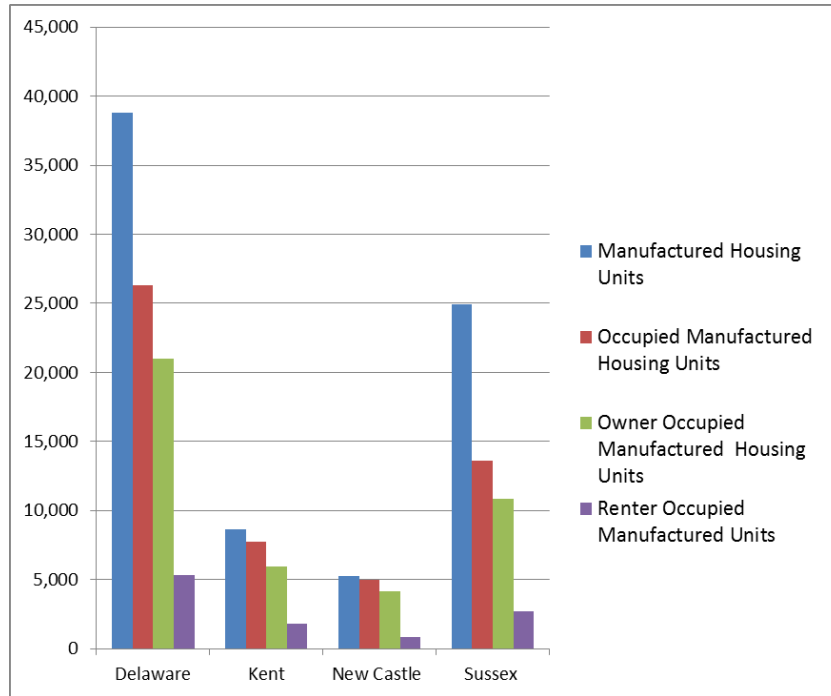
The rural parts of Delaware have larger proportions of manufactured homes than the state overall, with a high of 20.5% percent in Sussex County.¹²

It is estimated that 56% of manufactured homes in the state are on leased land, compared to only 30 to 35% for the United States as a whole, according to the Delaware State Housing Authority.¹³

¹² American Community Survey – 2007 -2011, through "Delaware Housing Needs Assessment," Delaware State Housing Authority, 2014.

¹³ See also "Manufactured Housing in Delaware," p. 12.





Source: “Delaware Housing Needs Assessment,” Delaware State Housing Authority, 2014.

Figure 1. Numbers of manufactured housing units in Delaware, by occupancy and ownership.

There are approximately 200 leased-land communities in Delaware.¹⁴ These communities host the majority of manufactured homes in Delaware. Statewide, the average number of units at a given site is 120 units. Although most communities are small, there are several with more than 500 homes. Pot-Nets, the largest development near the coast in East Sussex has nearly 3,500 homes; Murray Manor in New Castle has approximately 750 homes; and Rehoboth Bay has more than 500 homes. Communities provide the benefits of infrastructure, such as access to utilities (electricity, water, sewer) without the capital required by the individual homeowner to purchase and develop land. Monthly lot rents generally range from \$300 to \$500.¹⁵ This can exceed mortgage costs for landownership.

¹⁴<http://demhra.delaware.gov/information/DEMhRA%20Registered%20Communities%20for%202013%20for%20websiteR.pdf>.

¹⁵ Advertisement reveals lot rent of \$568 in West Bay Park: <http://www.mhvillage.com/Mobile-Homes/Mobile-Home-For-Sale.php?key=1120413> and telephone conversation on September 5, 2014, with Jen Allen, Association Director, First State Manufactured Housing Association.

There are four different manufactured housing neighborhood types in Delaware:

- *Larger, higher-income land-lease communities in Kent and Sussex Counties, often for retirees*
- *Very large land-lease communities near the waterfront in Eastern Sussex County*
- *Small, older communities, often with infrastructure problems and in some cases deteriorating homes, mainly in rural Sussex and Kent Counties*
- *Mobile homes on fee-simple individual lots, both newer homes and older homes, throughout Kent and Western Sussex Counties*¹⁶

In the past 15 years, the market for new manufactured housing has sharply declined. Whereas up to 2,000 new homes were being placed annually in Delaware in the late 1990s, the numbers fell to approximately 1,000 annually in the mid-2000s and to 200 – 300 new homes since 2008. Approximately two-thirds of these homes are double-wides.¹⁷

The average size of a manufactured home is 968 square feet.¹⁸ The median age of a manufactured home nationally is approximately 16 years. Most manufactured homes are not moved once they have been placed in a location.

Eighteen percent of existing manufactured homes in the United States pre-date the HUD standard (see **Figure 2**). If it is assumed that this proportion is similar in Delaware, then there are approximately 5,000 manufactured homes in Delaware built before 1976. As many as 36 percent of manufactured homes in Delaware were built and sited before 1979, according to U.S. Census data.

Although weatherization support has been available through the Delaware Weatherization Assistance Program (WAP) to assist low-income homeowners, approximately 50 percent of the existing low-income manufactured homes whose owners apply for weatherization assistance are deferred because of problems such as leaky roofs, poor plumbing, or drainage.¹⁹ Those same construction concerns have limited installations of photovoltaic (PV) energy systems on the homes—measures that would help homeowners to save significant energy costs.

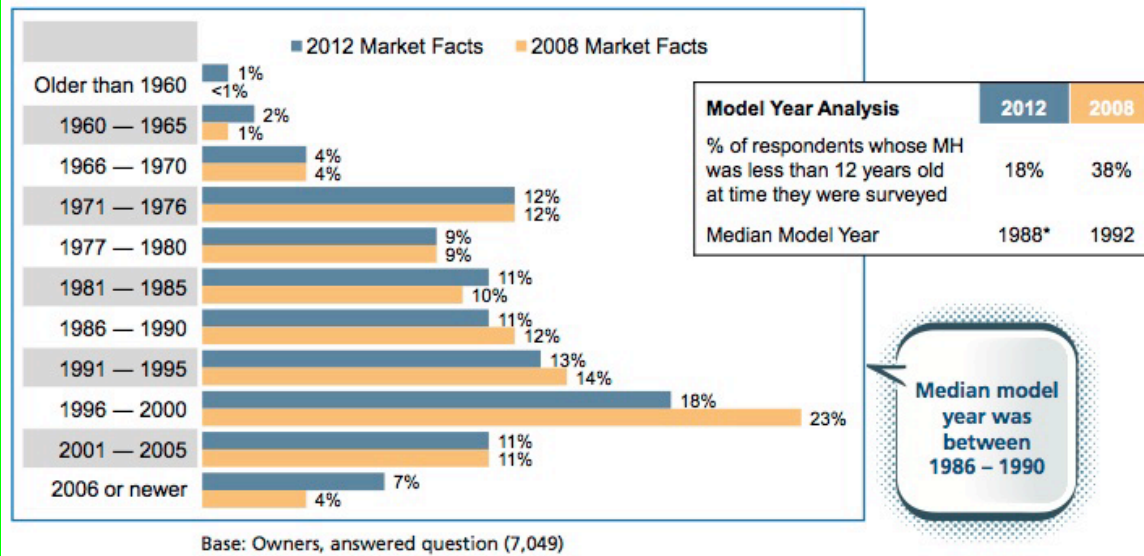
¹⁶ “Manufactured Housing in Delaware,” p. 10.

¹⁷ American Community Survey – 2007 -2011, “Delaware Housing Needs Assessment,” Delaware State Housing Authority, 2014.

¹⁸ Telephone conversation, September 4, 2014, Phil Cherry, Director, Delaware Weatherization Assistance Program.

¹⁹ Telephone conversation, September 4, 2014, Phil Cherry, Director, Delaware Weatherization Assistance Program.





Source: <http://www.foremost.com/mobile-home-market-facts/2012-Market-Facts.pdf>.

Figure 2. Reported model year of manufactured homes

Housing Needs

The Delaware State Housing Authority projects demand for 25,872 additional housing units by 2020. The estimate is split between rental units (7,525) and owner-occupied homes (18,347).²⁰

Delaware has more than 18,000 substandard housing units, defined as: (1) vacant and abandoned; (2) occupied, but in unlivable condition; or (3) occupied and in disrepair. Many of these homes are older manufactured / mobile homes and / or in distressed urban areas. It is challenging to rehabilitate these homes since the cost of repair often exceeds replacement value and market value, once repairs are made.²¹

Occupant Income Demographics

Manufactured homes provide housing to nearly 70,000 of Delaware’s 917,000 residents.²² Not surprisingly, low-income residents are over-represented in manufactured housing, compared to other types of housing. According to 2011 U.S. Census data, median household income for households living in manufactured homes was approximately \$30,000 compared to approximately \$47,000 for all households nationally. More than one in five households in manufactured homes nationwide have incomes at or below the Federal Poverty Level. Retirees

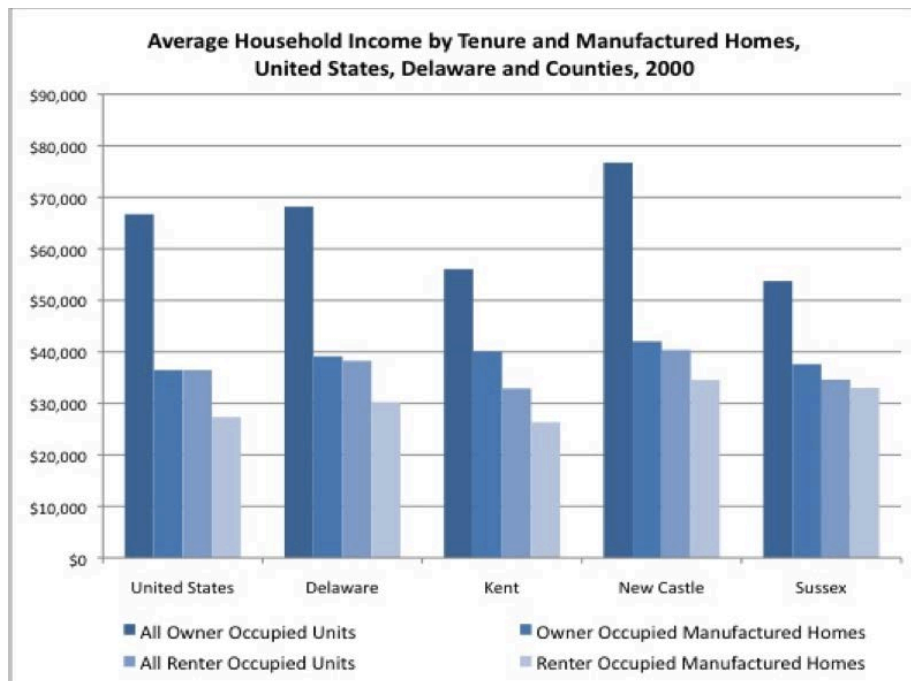
²⁰ “Delaware Housing Needs Assessment,” 52.

²¹ “Delaware Housing Needs Assessment.”

²² 2008 data on occupancy. “Manufactured Housing in Delaware,” 4.

who live on fixed incomes represent 23 percent of the total population of manufactured housing occupants.²³ All who are on fixed incomes are not necessarily at low income levels. Any ZNE MH programming by the Delaware SEU would be targeted to year-round households of low or moderate income.

The data in **Figure 3** show Delaware as a whole trending quite closely to U.S. average income when comparing all owned and rented housing units with owned and rented manufactured housing units. There are in Delaware, however, wide variations by county, with New Castle showing a much larger income disparity among the groups, and Sussex showing much smaller disparity. It is worth noting that one reason for less disparity in Sussex is that its incomes are lower overall.



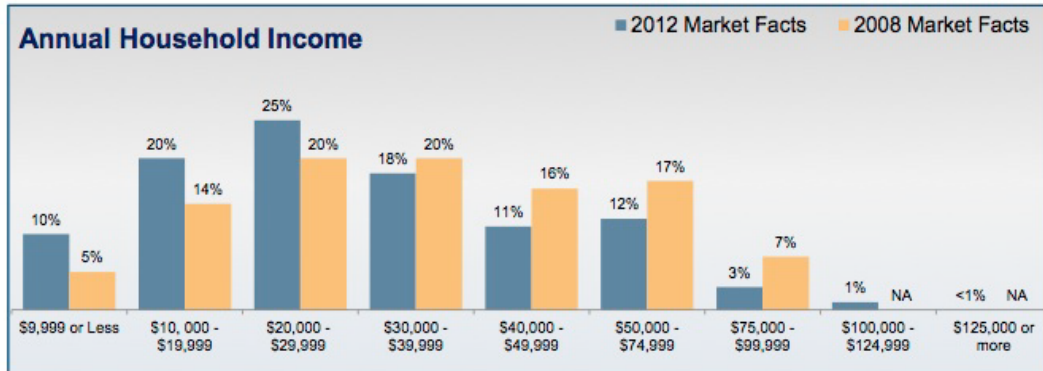
Source: “Manufactured Housing in Delaware”

Figure 3. Average household incomes by tenure, for all units and for manufactured housing units in the United States, Delaware, and by each Delaware county.

On a national level, the percent of lower-income households living in manufactured homes has risen compared to rates in all occupied units since the collapse of real estate markets in 2008. From a telling article in *New York Times Magazine* in March 2014, *The Cold Hard Lessons of Mobile Home U*: “The trailer park is people’s last resort.”²⁴

²³ “Mobilizing Energy Efficiency in the Manufactured Housing Sector,” American Council for an Energy-Efficient Economy, 2012.

²⁴ Rivlin, Gary. “The Cold, Hard Lessons of Mobile Home U.,” *New York Times Magazine*, March 13 (online); March 16 (print), 2014. http://www.nytimes.com/2014/03/16/magazine/the-cold-hard-lessons-of-mobile-home-u.html?_r=0.



Source: www.foremost.com/mobile-home-market-facts/2012-Market-Facts.pdf

Figure 4. Annual household income for owner-occupied manufactured homes in the United States.

Home Energy Costs and Energy Burdens for Low-Income Delawareans

For the more than 38,000 households in Delaware that have annual incomes below the 2014 Federal Poverty Level (\$11,670 for a one-person household; \$19,790 for a three-person household in 2014), paying the costs of energy for the home is often a debilitating financial burden, added to so many other burdens of poverty. According to the most recent American Community Survey by the U.S. Census, the nearly 18,000 Delaware households with incomes at or below 50 percent of the Federal Poverty Level (\$5,835 for a one-person household; \$9,895 for a three-person household) pay an average of 45 percent of annual income on home energy bills.

Table 2. Energy burden for the financially vulnerable in Delaware

Poverty Level	Home Energy Burden	No of Households
Below 50%	45%	17,828
50 – 100%	24%	20,558
100 – 125%	16%	11,618
125 – 150%	13%	13,556
150 – 185%	11%	21,675
185% - 200%	9%	7,274

Source: Delaware Home Energy Affordability Gap Report 2013

Table 2 provides more detail on the energy burdens of Delaware households, and how many households are at risk. Households with incomes between 150 and 185 percent of Federal Poverty face an energy burden of 11 percent of their incomes.²⁵ The number of households facing unaffordable home energy burdens is large. All told, more than 85,000 Delaware households face energy burdens of greater than 10 percent of income. For low-income households, a hot summer or cold winter can mean monthly peak energy bills well in excess of 50 percent of their monthly income.

Available Financing for Factory-Built Homes

A key part of understanding the market is understanding the differences in available financing for the various types of factory-built housing. Financing varies and dramatically affects the affordability of the home.

Manufactured Homes

Nationally, 74 percent of manufactured homes—homes built to federal manufactured home standards—are considered personal property, and are therefore financed via personal property loans, often called “chattel” loans. Only 22 percent are titled as real estate and therefore potentially able to secure conventional mortgage financing.²⁶ Financing for manufactured homes is usually restricted just to the building itself, and does not include the land on which it is situated. Costs for that must be financed separately.

The chattel mortgage system has implications for both the owner’s ability to finance and the costs of financing. Compared to loans secured with real property, loans secured with personal property carry higher interest rates and shorter amortization schedules. In 2014, conventional mortgage interest rates have been in the range of 4 to 5 percent for 30-year terms. For a \$100,000 loan, a monthly payment with 4.5% interest over 30 years is \$507. A typical chattel mortgage

²⁵ Delaware Home Energy Affordability Gap Report 2013, (Findings #1 and #2).

²⁶ Census 2011.



rate can be up to 15 percent for a 15-year term.²⁷ So the same \$100,000 loan at those terms would require a monthly payment of \$1,400, assuming straight-line amortization.

Modular Homes

Modular homes are built offsite, generally in a climate-controlled factory, and must be built and sited in compliance with state or local building codes. Often, significant amounts of finish work are done at the site. These homes are considered real property and can generally be financed with conventional mortgages that comply with terms required in the secondary mortgage market. Further, homeowners might have access to federally supported programs that provide lower-cost financing like those from the USDA Rural Development Program, the Federal Housing Administration, and the Veterans Administration.

Existing Programs for Owners and Developers of Affordable Housing

Delaware and the federal government offer many statewide incentive and loan programs that provide financial assistance to affordable housing developers and low-income homebuyers. In general, these programs apply only when the home is considered real property, not personal property. This distinction will be critical in determining the targeted markets for both the initial pilot (Phase 1) and long-term programming (Phase 2) for Zero Net Energy Manufactured Homes. Other financial assistance for energy efficiency and renewable energy projects might also be available.

Programs offered to homeowners include:

- **Homeownership Program:** Provides first-mortgage financing at below-market interest rates to qualified homebuyers
- **Delaware First-Time Homebuyer Tax Credit:** Allows first-time buyers to claim a portion of the annual interest paid on their mortgage as a special tax credit
- **Delaware Talent Cooperative:** Allows members of the cooperative to receive a reduced interest rate on their first mortgages
- **Neighborhood Stabilization Program:** Helps homeowners purchase redeveloped homes that are under foreclosure or have been abandoned
- **Second Mortgage Assistance Program:** Provides down payment and closing cost assistance in the form of second mortgages
- **Advantage 3:** Provides down payment and closing cost assistance in the form of a grant equal to 3 percent of the first-mortgage loan amount²⁸

²⁷Talbot, Jacob. "Mobilizing Energy Efficiency in the Manufactured Housing Sector," Research Report A124. Washington, DC: American Council for an Energy-Efficient Economy, July 31, 2012. <http://www.aceee.org/research-report/a124>.



Programs for affordable housing developers are:

- **Housing Development Fund:** Provides developers with assistance in acquiring and / or rehabilitating existing housing, the adaptive reuse of nonresidential buildings, and new construction
- **HOME Investment Partnerships:** Offers federal financial assistance for acquiring single-family or multifamily housing and transitional / group housing, demolition, new construction, reconstruction, conversion, or rehabilitation
- **Low-Income Housing Tax Credits:** Provides a direct federal income tax credit to qualified owners and investors to build, acquire, or rehabilitate rental housing units to rent to low-income Delawareans.²⁹

Sources of Factory-Built Homes

Although Delaware has many retailers of manufactured homes, there are no manufactured home builders in the state. The ZNE MH is designed to replace traditional manufactured and mobile homes by placement on frost-stable slabs or foundations in mobile home parks; the construction of the ZNE MH is similar in process and materials to modular homes. VEIC is working with the DOE and others in an ongoing effort to have this type of construction incorporated into federal manufactured home codes; that effort is not complete. Therefore, for the purposes of a pilot program, a ZNE MH would be classified as a modular home but with the size characteristics of a traditional manufactured home.

Based on this approach, VEIC initiated discussions with Beracah Homes – the only modular home builder located in Delaware – about its ability to produce a ZNE MH. These discussions have been very positive, and it appears to be technically feasible. The Beracah Homes production facility is ENERGY STAR[®] certified, according to its website, and all homes built there are built to earn the ENERGY STAR label. Beracah’s Preferred Builders are Green Advantage certified. The company focuses on energy efficiency, conservation of natural resources, and indoor air quality as the three interrelated goals of green building. The Delaware stakeholders engaged in this study knew of Beracah and were impressed with its current product offering and high quality. If the second phase, pilot design and development, is initiated, then discussions with regional modular home manufacturer(s) will be used to obtain pricing for a ZNE MH for the Delaware climate. These discussions will include Beracah Homes and at least one other modular home manufacturer in the region.

Outside Delaware, several companies are piloting the design and construction of net zero manufactured homes. Among them is Southern Energy Homes, Inc. (a division of Clayton Homes), which has built a manufactured home to the DOE Zero Energy Ready Homes[™] (DOE ZERH) standard. This home meets all of the site-built high-efficiency criteria of that rigorous

²⁸ “Delaware State Housing Authority - How can we assist you?”

<http://www.destatehousing.com/HomeOwnership/HomeOwnership.php>.

²⁹ “From Delaware State Housing Authority - How can we assist you?”

http://www.destatehousing.com/Developers/Developers.php_br.



DOE standard and is designed in such a way as to accept a rooftop PV system. The energy performance, indoor comfort, and indoor air quality of this pilot home will be monitored for 15 months. Preliminary results show that the unit is using about half the space-conditioning energy of a unit meeting baseline HUD code.³⁰

Next Step is a Louisville, Kentucky, nonprofit organization working to replace pre-HUD code homes with energy-efficient homes. Next Step has developed a national strategy to promote modular and manufactured units as viable affordable housing options that help to build wealth in low-wealth populations. Its program promotes high-quality and energy-efficient homes placed on permanent foundations, which helps to qualify a building for a long-term, lower-rate, fixed-payment mortgage-secured loan.³¹

Other Market Conditions

In addition to review of secondary sources of data and information for this analysis, VEIC convened stakeholders with a shared interest in affordable housing for Delawareans. This group offered local knowledge of the market and insights on the opportunities and barriers for a ZNE MH pilot program. The research involved phone conversations and an in-person meeting with stakeholders from state government and nonprofit organizations. The contributions of all of these participants have yielded valuable insights that have informed the recommendations at the conclusion of this analysis. Stakeholders represented the following organizations:

- Delaware Manufactured Home Relocation Authority
- Delaware Sustainable Energy Utility
- Delaware State Housing Authority
- Delaware Weatherization Assistance Program
- Diamond State Community Land Trust
- Division of Energy and Climate, Delaware Department of Natural Resources and Environmental Control
- First State Manufactured Housing Association
- NCALL Research, Inc.

If this project proceeds to Phase 2, future stakeholder engagement will involve the above and other organizations such as:

- Delaware Economic Development Office

³⁰ Southern Energy Homes: First DOE Zero Energy Ready Manufactured Home, Russellville, AL. DOE case study. http://energy.gov/sites/prod/files/2014/09/f18/DOE_ZEH_SouthernHomesDivision_09-20-14.pdf.

³¹ The organization's website contains more information about its mission and work. See: <http://www.nextstepus.org/index.htm>.



- Financial institutions that originate mortgages
- Affordable housing developers
- Regional manufacturer(s) of modular homes
- Manufactured and modular homes distributors

Manufactured Home Market Sectors

Creating and launching a program like the ZNE MH will require an understanding of the circumstances that determine where such homes could be deployed. Three parameters define the possible conditions:

1. Whether the home is owned or rented
2. Whether the land on which the home is placed is owned or rented
3. Whether the new home purchase is an early replacement of an existing home

In energy efficiency terminology, the third condition typically defines whether an efficiency “purchase” is a retrofit or a market opportunity. In efficiency programming, it is critically important to address market opportunities first, especially for purchases that have lives as long as that of a building. If the purchaser does not make a choice of energy-efficient building material or construction practice (or, in the case of equipment, of an energy-efficient model), the energy savings from efficiency are “lost.” In the case of a building, the value of those “lost opportunities” can extend for decades.

Table 3 shows characteristics of each of the five market sectors.

Table 3. Manufactured home target market sector characteristics

Owned unit Owned land Replacement unit	<ul style="list-style-type: none"> • Low and moderate income owners • Full-time occupancy • Secure tenure • Referrals from WAP, LIHEAP, distributors
Owned unit Rented land Replacement unit	<ul style="list-style-type: none"> • Low and moderate income owners • Full-time occupancy • Insecure land tenure • Referrals from WAP, LIHEAP, distributors
Rented unit Rented land Replacement unit	<ul style="list-style-type: none"> • Low and moderate income owners • Full-time occupancy • Insecure land tenure • Referrals from WAP, LIHEAP
Rented unit Land trust land New unit	<ul style="list-style-type: none"> • Low and moderate income owners • Full-time occupancy • Long-term leasing for land • Referrals from distributors and land trusts
Owned unit Owned or land trust land New unit	<ul style="list-style-type: none"> • Low and moderate income owners • Full-time occupancy • Secure land tenure or long-term lease • Referrals from distributors and land trusts



Estimated Target Market Sizes, Opportunities, and Barriers

Using the above target market sectors and the data sources in this report, estimates of potential market sizes can be made, along with identification of each sector's most relevant opportunities and barriers. As in the categorization above, some terminology from potential studies in energy efficiency and renewable energy are useful in the consideration of market sizes:

1. **Technical potential** is the total potential for a new technology, with no regard for customer economics or for customer preferences. In the context of ZNE MHs, the technical potential considers the full number and type of homes that the ZNE MH has been designed to replace.
2. **Economic potential** is the potential for a new technology that is economically feasible and so takes into account the cost-effectiveness of the home purchase.
3. **Achievable potential** takes into account customer preferences and habits, which might encourage or dissuade them from making a purchase.

Owned Unit, Owned Land, Replacement Unit

Estimated technical potential is up to 9,000 units, derived by multiplying the estimated number of occupied units by the estimated percent of units that are on land owned by the occupants. These units create the best opportunity for a pilot because of the security of land tenure, the ability to qualify for mortgage-secured financing, and the somewhat lower first cost because infrastructure is already in place. Principal barriers to participation in a pilot will be the ability to locate and recruit “early adopters.”

Owned Unit, Rented Land, Replacement Unit

The estimated technical potential is approximately 11,500 units, the number of owner-occupied manufactured homes multiplied by the estimated percent of such homes that are on leased land. Although the size of the market would make this seem an appealing opportunity for a pilot, the inability to qualify for traditional mortgage financing makes the economics a challenge. This is not a good market for pilot work, but eventually, with significant changes in policy at the federal or state level, the economic market could approach the technical potential. Those policies remain the principal barrier for this larger market segment.

Rented Unit, Rented Land, Replacement Unit

The estimated technical potential is approximately 5,000 units, derived based on the reasonable assumption that there are very few rental units on owned land. As a pilot opportunity, this market holds little early potential. The economics of this scenario are generally even more challenging than that of owned units on rented land, because the split incentive issue (the owner making the investment may not be the beneficiary of the energy savings) would pertain.

Rented Unit, Land Trust-Owned Land, New Unit

The technical potential of this market is relatively small at first, but highly promising. The size of the market is dependent on the actions of local land trusts and existing owners of parks. The market opportunities for addressing some of the challenges caused by park closures are enormous, and make it worth exploring as a pilot opportunity. The opportunities to improve cost-effectiveness through resources from the Relocation Trust could increase the economic potential



at the owner level, and could provide a lower-cost alternative to the normal costs of displacement. This would require the identification of both a community facing relocation as well as a land trust interested in stepping into the role.

Owned Unit, Owned or Land-Trust-Owned Land, New Unit

Although there are only a few hundred units of new manufactured housing placements each year in Delaware, the potential for driving market demand for ZNE MHs can make this particular sector one of the most interesting for a pilot. The existing technical potential is relatively small, but the economic potential is approximately equal to the technical potential because of the cost-effectiveness at the time of purchase (see cost benefit analysis in next section). The technical and economic potentials could grow significantly as affordable home providers adopt the ZNE MH at a cost lower than current affordable home options. In addition to siting ZNE MHs on privately owned single lots or as additional housing for farm families, these homes could also be grouped in land trust communities. The owned unit on owned land is as interesting a possibility as the rental unit on land owned by a land trust, describe in the section above.



Cost-Benefit Analysis

Comparing the costs and benefits of a ZNE MH with those of a traditional manufactured home provides insight into their long-term affordability. Although first costs for a ZNE MH are higher, the lower energy costs provide long-term benefit and security. Affordable housing providers that have opted to participate in developing the ZNE MH focused on a variety of benefits, some of which can be easily monetized, and others that cannot.

Non-Energy Benefits

At the outset, it is worth outlining some of the non-energy benefits that the ZNE MH provides. Some of these benefits pertain solely to replacement of existing manufactured homes; some pertain solely to new units; nearly all pertain regardless of what the starting condition is.

- Stability of housing costs
- Predictability of housing costs
- Reduced risk of unexpected energy cost increases (from energy price volatility, extreme weather events, etc.)
- Increased durability of the housing
- Increased resilience of housing and communities
- Increased energy independence, personally for the homeowner and nationally
- Reduced greenhouse gas emissions from lower energy use
- Improved indoor air quality, which can result in better occupant health

Each of these benefits is critically important, but indoor air quality is of significant interest to homeowners and of increasing concern to rental property owners. Studies continue to show strong interest in the health benefits that a high-quality home offers. Most Americans spend nearly 90 percent of their time indoors, making indoor air quality an important consideration for overall health. Although the quantification and monetization of health benefits has begun, there is still a long way to go for the research to provide figures that can be calculated and put into working cost-benefit models.

If ZNE MHs were manufactured by a factory in Delaware, the following additional non-energy benefits would pertain:

- Creation of good jobs in local manufacturing
- Additional tax revenues from manufacturers and building contractors working at the sites
- Economic multiplier effects of income produced and kept in state



Assumptions

The market analysis indicates that some of the best potential for a pilot program comes from individuals or organizations already “in the market.” This can tremendously reduce outreach and marketing costs. In sales and marketing terms, one can consider the ZNE MH an “up-sell,” a product with greater benefits, higher upfront costs, and substantial long-term benefits. This also focuses the work to prioritize programming that minimizes “lost opportunities” first, which is in line with best practices of energy efficiency programming. With this most basic assumption, the analysis provides the economics of four new-home purchase choices: (1) a standard HUD-approved manufactured home, (2) ZNE MH, which is a high-performance MH with PV installed with incentive from DE SEU, (3) ZNE MH with PV installed with no incentive from DE SEU, and (4) the same high-performance home with no PV (specified as HP MH because it is no longer ZNE).

Table 4 shows the assumptions for the most important modeling parameters.

Table 4. Financial modeling assumptions

	Built to HUD Standards	Built to ZNE MH Standards (w/o Incentive)	Built to ZNE MH Standards (w/ Incentive)	Built to HP MH Standards
Factory home purchase price	\$65,100	\$83,160	\$83,160	\$83,160
Site preparation	\$5,000	\$12,000	\$12,000	\$12,000
Delivery and set-up	\$2,000	\$7,000	\$7,000	\$7,000
Solar installation (5 kW PV)	NA	\$26,667	\$26,667	
PV Inverter costs, every 10 years	NA	\$2,000	\$2,000	
Delaware solar incentive	NA		\$4,250	
Delaware efficiency incentive	NA		\$5,000	
Net purchase price	\$72,100	\$128,827	\$119,577	\$102,160
Annual energy cost	\$1,847	\$180	\$180	\$746
Down payment (10%)	\$7,210	\$12,883	\$11,958	\$10,216
Interest rate	9%	4.5%	4.5%	4.5%
Loan term (years)	15	30	30	30



The analysis used a national average cost for the new HUD home, as reported by the U.S. Census. Lending terms were as referenced by the Delaware State Housing Authority 2008 report, “Manufactured Housing in Delaware” and values contained in rate sheets provided by manufactured home dealers. Energy costs were as estimated by the Pacific Northwest National Laboratory (PNNL), a member of the DOE Manufactured Home Working Group, based on climate data for Baltimore. (See **Appendix** for energy specifications.).

For the new home built to ZNE MH standards, the analysis assumed that the unit was all-electric, meets IECC 2015 standards, and contains an installed 5 kW PV array. Delivery and site costs are derived from experience in the Vermont Manufactured Home Replacement Pilot Program. Delaware PV costs are from the DE Green Energy Fund, which collects data on PV installed costs when providing a rebate. Data provided ranged from approximately \$16,000 to \$26,000 for retrofit installations and the highest range was used to provide conservative results. The inverter costs and expected equipment life were provided by DE SEU after communication with a solar electric provider located in Newark, Delaware. Incentives to offset the solar installation cost were based on those currently available in Delaware. Loan terms based on real property (mortgage) security gives a term of 30 years and a rate of approximately 4.5%. Energy costs for the ZNE MH are based on a small monthly grid interconnect fee. These vary by electricity territory and provider, but the assumption is that the home is truly net zero, and energy costs only include grid tie service costs.

It is likely that incentives would be made available by the Delaware SEU should it decide to offer a program to develop ZNE MHs for the energy savings they provide. Incentives would most likely be necessary during early stages to encourage early adopters of ZNE MHs. For this exercise, \$5,000 was used as an incentive amount. (This is not a recommendation of an incentive level.) Design of incentives, whether through rebates, down payment assistance or reduced-rate financing, would be done as part of Phase 2 of this project, which focuses on pilot program design.

Cashflow Analysis

The energy costs of a new home of either model (high performance or ZNE) are significantly lower than what one would see in a mobile home or older manufactured homes. Energy costs for those living in older manufactured homes are an enormous drain on the budgets of low-income people, with monthly costs just for energy in the range of \$200 to \$500 per month, even higher in some of the worst housing.

Figure 5 shows the housing costs, which include loan payments and energy costs, on a monthly basis once the new home is installed. With lower energy and loan costs, the ZNE MH with and without rebates as well as the HP MH provide significant monthly positive cashflow ranging from \$200 to 300 when compared to a new home built to HUD standards. Costs shown are nominal, and so represent first-year monthly costs, post installation. The analysis makes no attempt to adjust for tax implications of the home mortgage deduction, nor any tax credits for renewable energy installations or energy efficiency measures. In each case, such adjustment would generally continue to reduce the monthly costs of the ZNE MH, making the cashflow difference somewhat larger.



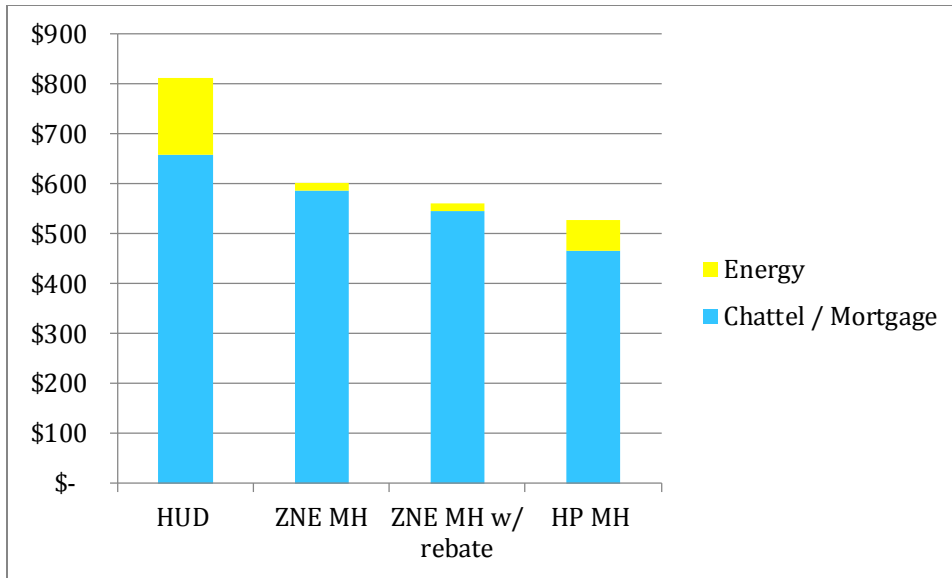


Figure 5. Monthly housing and energy costs, by housing type, nominal dollars.

This positive cash effect extends through the life of the new homes, allaying concern that the only reason that the monthly cashflow is better is because of differences in upfront costs or the longer loan term. **Figure 6** shows the cumulative total of housing and energy payments, and includes down payments for each case. The end of the repayment term on the chattel loan is easy to observe in year 15. Once again, costs in this graph are shown in nominal terms. At year 25 the ZNE MH without incentives is higher than the HUD-standard home. If incentives are provided, there is no point through the 30-year period that the costs for the ZNE MH or the HP MH are higher than costs for the HUD-standard home. Not shown on this graph is after year 30, when the ZNE MH will no longer have a loan payment, only minimal energy costs.

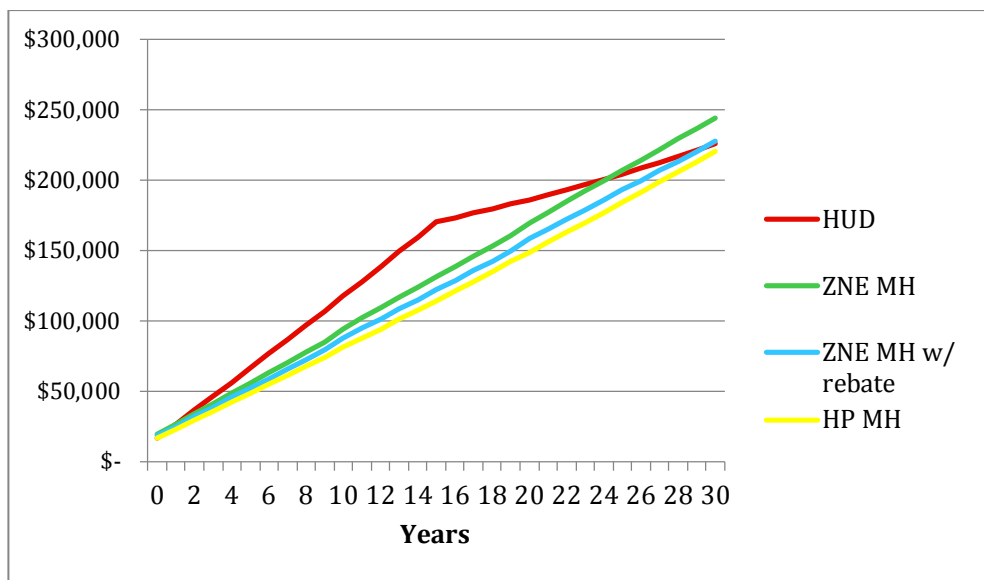


Figure 6. Cumulative monthly housing and energy costs, by housing type, in nominal dollars.

Net Present Value of Housing and Energy Costs

This cost analysis accounts for upfront costs in 2014 dollars and a stream of future costs expressed in nominal dollars. The future value of a dollar is generally worth less than the present value of a dollar. How much less depends on one’s circumstances and future plans, and there is a wealth of research on appropriate discount rates to estimate the present value of tomorrow’s costs. This analysis uses a 5% discount rate. This is higher than most current investment options. Research has shown that personal valuations of the future value of money differ markedly from those used in the investment setting.³² People tend to place a lower value on the future money flows, so this analysis uses a higher discount rate, to acknowledge the realities of low-income households, which struggle to make ends meet today.

Figure 7 provides the net present value of the present and future housing and costs for each of the four cases over a 30-year period. The discount on future costs means that the totals in **Figure 7** are much lower than the totals in **Figure 6**, illustrating the difference between discounted future dollars and nominal future dollars, in aggregate.

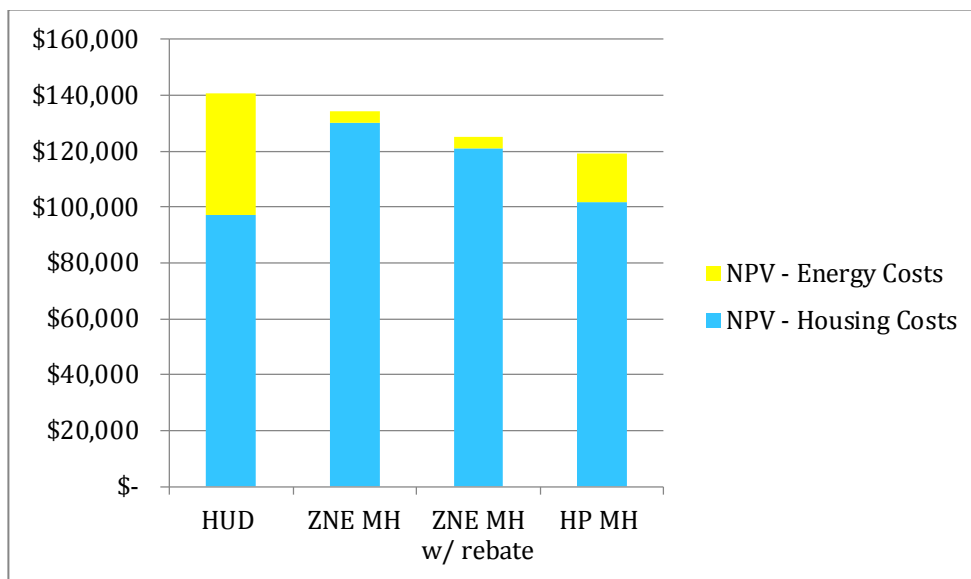


Figure 7. Net present value of monthly housing and energy costs over 30 years, by housing type.

³² “Delivering Energy Efficiency to Middle-Income Single Family Households,” Lawrence Berkeley National Laboratory, 2011, <http://middleincome.lbl.gov/reports/report-lbnl-5244e.pdf>.

The NPV of the housing costs are similar over the 30-year time horizon for the HUD and ZNE MH. In total, the net present value of the monthly housing and energy costs for the HUD manufactured home is \$141,000, and for the ZNE MH is \$135,000, a reduction of \$6,000 in total NPV for the ZNE unit. When rebates are included, the ZNE MH NPV is \$125,000 which is \$16,000 less to operate over 30 years than HUD. The HP MH also provides benefits with a NPV of \$119,000 or \$21,000 less than HUD.

Vermont High Performance Manufactured Home Replacement Pilot

Since 2012, Efficiency Vermont³³ and the Vermont Housing and Conservation Board (VHCB) have been working with partners including the High Meadows Fund, University of Vermont and the Champlain Valley Office of Economic Opportunity to develop a way to design and install mobile / manufactured homes that are durable, energy efficient, and affordable to Vermonters.

In 2011, Tropical Storm Irene destroyed approximately 150 mobile homes in Vermont. This unfortunate event highlighted the importance of mobile and manufactured homes as source of affordable housing for many low- and moderate-income Vermonters.

The Vermont High Performance Manufactured Home Replacement Pilot (VT HP MH Pilot) , initiated by VHCB and Efficiency Vermont soon after Irene, has helped design a new kind of home to fit into the footprint of a manufactured home: one that is both durable and extremely energy efficient. The current units consume less than one-third of the energy of new code-compliant manufactured homes that are typically purchased today. The design is based on cutting-edge, passive house principles, which enable the homes to maintain temperature using air-tight construction, triple-pane windows, and high-efficiency heating and ventilation systems.

As of October 2014 VERMOD, the factory project partner, has installed 15 units which are currently occupied. Most of the units were placed in mobile homes parks with a long term lease structure and four units were placed on owner land. The VERMOD factory is able to produce two units a month and the current pipeline has 6 units with confirmed buyers for 2015. Typical homeowner incentives include tax credits, Efficiency Vermont rebates and financing with extended terms and low rates (e.g. 20 years at 6%). Preliminary energy monitoring data indicates the units are performing as expected saving home owners about 30% in energy costs over a new HUD compliant manufactured home.

The VT HP MH Pilot provides a resilient, comfortable and affordable housing option for Vermonters; a model that could be replicated in other jurisdictions. Progress is being made on appraisal education with more Vermont appraisers becoming aware of the increased value of the VT HP MH Pilot homes and local lenders agreeing to typical mortgage terms. These efforts help overcome the barrier of higher upfront costs and will help bring this type of affordable housing to markets across the county.

³³ Efficiency Vermont is operated by VEIC



Conclusions and Recommendations

From the data points and analysis contained in this report, VEIC concludes that:

- There is sufficient need for more energy-efficient, resilient, and affordable housing in Delaware.
- The barriers to effecting change in manufactured home financing in the short term create a positive impetus to look at modular housing, sited on owned land or land leased with secure long-term tenure.
- Such modular housing, built and sited to ZNE MH standards, can reduce the net present value of housing and energy costs over a 30-year period compared to manufactured homes built to the HUD standard.
- When compared to a new manufactured home built to HUD standards, the ZNE MH provides positive cashflow of \$200 - \$300 per month, starting in the first year, and continuing throughout a 30-year period.
- The PV costs used in the analysis are the high estimate from the DE Green Energy Fund, which focuses on retrofit installations. Actual PV installation costs will be lower for new homes designed with PV infrastructure, which will increase the benefits of the ZNE MH.
- An HP MH, built to the same standards as the ZNE MH but without PV, is a cost effective option for locations that are not optimized for solar arrays.
- There is sufficient market to create a ZNE MH pilot program, and sufficient market in the long-term to justify the costs of a pilot program.
- The market of a pilot program would involve new purchases of homes on owned land or on land that is deeded by land trusts for very long-term tenures.
- The role that land trusts can play in transforming manufactured home parks to zero net energy communities can be catalytic, the type of change that could draw new sources of funds to the table.

Thus, VEIC recommends that pilot program development work (Phase 2) begin by addressing one of the following market segments:

1. Owned Unit / Owned Land / Replacement Unit
2. Rented Unit / Land Trust Land / New Unit
3. Owned Unit / Owned Land or Land Trust / New Unit



In Option 1, the first step in Phase 2 is to conduct primary research to determine more precisely the size of market, with additional exploration and segmentation of owners of existing units who are willing to invest in a new unit either to lower overall energy costs or need to replace a unit that is at the end of its useful life.

In Options 2 and 3, the first step will be to further explore a working relationship with Delaware's land trusts to determine how the ZNE MH could be valued as an alternative to the modular homes currently considered in this type of market.

Those first steps of Phase 2 will provide a fully characterized submarket for the pilot program, which then allows design of a pilot program that meets the needs of the submarket. Pilot program design steps would include:

- Engage stakeholders, expanding the current group to include
 - economic development officials
 - local distributors of manufactured / modular housing
 - potential utility partners
 - financing partners
 - funding partners
- Work with regional modular home manufacturer(s) to revise open-source ZNE MH plans for Delaware's climate
- Estimate ZNE MH costs, based on Delaware's climate, production costs, and siting costs.
- Define potential ownership models
- Investigate funding and financing sources for pilot project, with the objective of sustainability of funding and financing for long-term market development
- Compare costs and benefits of ZNE MH to those of site-built homes
- Document pilot program design, including details on
 - Number of homes
 - Locations of homes
 - Land trust partners and / or owner characteristics
 - Available financing
 - Available incentives, subsidies, and other reductions of initial cost
 - Estimated budget required for pilot program implementation
 - Definition of performance metrics for pilot program
 - A plan for energy evaluation, measurement, and verification to assess cost-effectiveness of the pilot, both on the basis of individual homes and at the program level

Appendix

Energy Efficiency Characteristics

Building Components	HUD Manufactured Home	ZNE Modular Home
Wall insulation R-value	13	20
Ceiling insulation R-value	30	38
Floor insulation R-value	22	19
Window U-factor	0.52	0.35
Window solar heat gain coefficient (SHGC)	0.5	0.4
Envelope leakage limit (ACH50)	Not rated	3
Duct leakage limit (CFM25 / 100 ft ² CFA)	Not rated	4
Domestic hot water pipe insulation	Not rated	R-3
High-efficacy lighting percentage	Baseline	75%
Hot water heater	Electric resistance	Heat pumps
Heat recovery	NA	Included
Heating system	Electric resistance	Heat pumps
Refrigerator	Baseline	ENERGY STAR Tier 3
Clothes washer	Baseline	ENERGY STAR Tier 3
Dryer	Baseline	ENERGY STAR Tier 3

Source: Building components from DOE MH Working Group. Appliance standards from Vermont Manufactured Home Pilot.

