



Department of Commerce

# Ultra-Efficient Affordable Housing Demonstration

*Pursuant to Chapter 3, Laws of 2015 3<sup>rd</sup> Sp. Sess.*

December 2018  
Report to the Legislature  
Brian Bonlender, Director

## Acknowledgements

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# Executive Summary

## Overview

This report satisfies the reporting requirements of the Ultra-High Energy Efficient (UHEE) Affordable Housing Demonstration Program appropriated in the 2015-2017 capital budget (Chapter 3, Laws of 2015 [2EHB 1115], Section 1033[5]), including:

- Project costs compared to the costs of traditional design and construction.
- Life-cycle costs.
- Use of sustainable resources.
- Energy savings and reduction of carbon footprint.
- Lessons learned.
- A data collection plan to monitor actual performance to validate projected savings.

## Summary of Demonstration Project Status

Commerce selected three projects out of the five UHEE applications received through the 2016 HTF competitive funding round. The Riverton Park project received a direct appropriation in the 2016 supplemental budget (Chapter 35, Laws of 2016, Section 1006). Funded projects:

- Everett Safe Streets Supportive Housing: 65 units, under construction.
- HopeWorks Station II, Everett: 65 units, under construction.
- Transitions Permanent Supportive Housing, Spokane: 24 total units, 15 UHEE units, construction completed.
- Riverton Park, Tukwila: 11 units, seeking additional funding.

## Key Findings

Key findings are summarized below. For more detail, see the following sections: Modeled Project Costs Compared to Traditional Design and Construction Costs, and Energy Efficiency Strategies Used, and Lessons Learned.

- First costs are still high, which is to be expected for early adopter programs. As the techniques are adopted more widely, the costs are expected to come down.
- The replacement cost of equipment results in higher-than-expected life-cycle cost. This may lead to more emphasis on more permanent building envelope improvements.

## Projected Energy Savings

Data about actual energy efficiency performance are not yet available. This report details the projected energy savings based on the application materials of the competitive projects.

# Introduction

## Background

Gov. Jay Inslee's proposed 2015-17 capital budget included a \$5 million Housing Trust Fund (HTF) appropriation for a demonstration program with the purpose of financing the design and construction of ultra-high energy efficient affordable housing projects. The governor's proposal reflected the housing finance and energy policy expertise within the Dept. of Commerce (Commerce), including previous work at the intersections of housing and energy efficiency, such as the Evergreen Sustainability Development Standard (ESDS) for HTF projects.<sup>1</sup>

The 2015 Legislature appropriated \$2.5 million from the HTF repayment account (Fund 532) and passed an ultra-efficient affordable housing demonstration program in the 2015-2017 capital budget. In the 2016 supplemental capital budget (Chapter 35, Laws of 2016), the Legislature modified the proviso by including language that set aside \$600,000 of the \$2.5 million appropriation for a Riverton Park home-ownership project in Tukwila.

## Project Objectives

This demonstration loan and grant program supports a number of objectives beyond reducing energy costs to households in low-income housing projects. This is a market transformation effort that makes a strategic intervention in the low-income housing market. This program will accelerate the adoption of very efficient building practices and the use of renewable energy systems. Through this demonstration program, low-income housing developers learn how to design and construct net-zero<sup>2</sup> energy buildings. This will impact future project designs and systems for these developers, and the building industry overall.

This demonstration program will gather data on project development and performance and share it with a broad audience. The program requires the participants to provide documentation of the design, construction and occupancy of the buildings, including energy outcomes, first costs<sup>3</sup> and life-cycle costs<sup>4</sup> of the projects. These elements were developed as part of the program design process and will be revised based on actual project experience. Each project is required to report energy use each year for three years after occupancy. This data will be used to inform the market, assess future funding requests and eventually support energy

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<sup>1</sup> Learn more about the Evergreen Sustainable Development Standards: <http://www.commerce.wa.gov/building-infrastructure/housing/housing-trust-fund/housing-trust-fund-evergreen-sustainable-development/>

<sup>2</sup> Net-zero means that 100 percent of the building's energy needs must be supplied by on-site renewable energy on a net annual basis.

<sup>3</sup> First cost are the cost of land, design and construction of the project prior to occupancy.

<sup>4</sup> Life-cycle cost include first cost, cost for utilities, operations, maintenance, and system replacements over the life of the project. For these projects, a 50-year life cycle is used.

code development. The project also requires participants to provide summary presentations on their projects and share the information with the marketplace.

Reducing the life-cycle operating costs for low-income housing projects may free up resources to build and preserve more units of low-income housing to better respond to the homelessness and affordable housing crisis facing Washington. Reducing energy costs for low-income households increases their financial stability and frees up resources for other important household expenses.

### **About the Housing Trust Fund**

The Washington State Legislature created the HTF in 1986 to finance construction and preservation of housing for low-income and vulnerable households. Since 1986, the HTF has developed almost 50,000 units within projects in every county, with almost \$1 billion in state capital investments made to date. Each dollar invested by the HTF leverages five to six dollars, on average, from other public and private sources.

# Project Development and Funding Process

## Overview

The Dept. of Commerce (Commerce) made funding available to affordable housing projects through the 2016 Housing Trust Fund (HTF) funding round. Projects that received general funding through the HTF were eligible to apply for the ultra-high energy efficient (UHEE) enhancement. Commerce published a UHEE funding plan that outlined the schedule and general application requirements in December 2015. This funding plan also was included in the HTF solicitation for applications (included in Appendix A).

Applicants were required to develop a complete package of information that demonstrated they could achieve the UHEE objectives. Applications needed to demonstrate energy-saving and/or renewable energy systems designed to reach net-zero energy use after housing projects are fully occupied. The successful applicants are required to provide a life-cycle cost analysis report to Commerce annually for the three years following occupancy.

The UHEE applications included documentation of a base case that meets the requirements of the Evergreen Sustainable Development Standard (ESDS) and the proposed design that achieves the net-zero energy goal. This provides the information needed to determine the incremental cost and the life-cycle cost relative to other HTF projects. Developing a base case energy model also serves to demonstrate the applicant has addressed all the energy loads in the net-zero design.

Commerce supported applicants through the application process by providing technical guidance on energy analysis and life-cycle cost tests. These are presented in the HTF UHEE application forms.<sup>5</sup> Commerce provided direction on development of the models, recommendations on analysis software and typical energy use assumptions. For life-cycle cost analysis, Commerce required the applicants to use the Office of Financial Management (OFM) Life-Cycle Cost Tool, which can be found on the OFM website, along with instructions and training videos.<sup>6</sup>

Like all projects that the HTF funds, successful projects must put housing covenants in place that will keep the units affordable for low-income households for 40 years.

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<sup>5</sup> Housing Trust Fund (HTF) Ultra-Efficient Affordable Housing Demonstration (UHEE) Application <https://www.commerce.wa.gov/wp-content/uploads/2015/12/hfu-htf-uhee-application-v1x0-2016.docx>

<sup>6</sup> Washington State Office of Financial Management, "The Life-cycle Cost Tool," <https://www.ofm.wa.gov/budget/budget-instructions/budget-forms>

## **Project Plan Development**

Between June and December of 2015, the Commerce HTF team and Energy Office staff convened and worked closely to develop the demonstration project plan in conjunction with the following key stakeholders:

- Elizabeth Rinehart, Walsh Construction
- Stacia Miller, International Living Future
- Joanne Quinn, Seattle Office of Housing
- Myra Baldini, Office of Financial Management
- Steve Masse, Legislative Staff
- Julie Murray, Legislative Staff
- Chuck Murray, Dept. of Commerce, State Energy Office
- Sean Harrington, Dept. of Commerce, Housing Trust Fund
- Corina Grigoras, Dept. of Commerce, Housing Trust Fund
- Dena Harris, Dept. of Commerce, Housing Trust Fund

The group met several times and worked on the funding criteria for projects and a set of reporting requirements that successful applicants would have to incorporate in their contracts. A copy of the Funding Plan, which also includes the data collection plan to monitor actual performance to validate projected savings, is included in Appendix A.

## **Project Timeline**

Below is a timeline of key project milestones:

1. 2015-2017 biennial capital budget passed: June 2015
2. UHEE planning and stakeholder engagement: June through November 2015
3. UHEE Funding Plan released: December 2015
4. Stage 1 applications solicited: January 2016
5. Stage 1 applications due: February 2016
6. 2016 supplemental capital budget passed: April 2016
7. Stage 2 applications solicited: July 2016
8. Stage 2 applications due: September 2016
9. Awards announced: December 2016

## **Project Eligibility and Application Requirements**

Commerce used the typical HTF two-stage competitive application process to distribute the remaining \$1.9 million to three projects. An additional project – the Riverton Park home ownership project – received a direct legislative appropriation of \$600,000 through a proviso amendment in the 2016 supplemental capital budget (Chapter 35, Laws of 2016).



## **Project Eligibility**

The following eligibility criteria were used to select the three competitive projects:

- Applicants had to be eligible HTF recipients under RCW 43.185.060.
- Applicants were required to apply during the 2016 HTF Stage 1 application round in January 2016.
- Applicants were required to apply during the HTF Stage 2 application round, meet all of the project funding criteria identified in the Notice of Funding Availability, and *receive* a regular HTF award. The UHEE awards were offered *in addition* to the regular HTF awards.
- Applicants were required to demonstrate energy-saving and renewable energy systems designed to reach net-zero energy use after projects are fully occupied. Successful applicants were required to submit a series of life-cycle cost analysis reports to Commerce.

## **Application Requirements**

In addition to the application materials required for all HTF projects, UHEE applications were required to include the following elements:

- Energy model comparing the base case, which was provided by Commerce, to the project's model.
- Life-Cycle Cost Tool comparing the base case provided by Commerce to the project proposal.
- Applicable narrative sections describing the project.

## **Commerce Funding Priorities and Limits**

### **Funding Priorities**

Commerce used the following funding priorities to select projects for the UHEE competitive awards:

- Life-cycle project costs were compared among similar projects, with priority given to those projecting lower life-cycle costs.
- Whether the project demonstrated a design, use of materials, and construction process that can be replicated by the Washington building industry.
- The extent to which the project leveraged non-state funds.
- The extent to which the project was ready to proceed with construction.
- The extent to which the project promoted sustainable use of resources and environmental equality.
- How well the project demonstrated good management to fund maintenance and capital depreciation.

- The extent to which the project demonstrated a reduction of housing and utilities carbon footprint.
- The extent to which the project planned for anticipated and unexpected occupant behaviors in operations in order to encourage behaviors that optimize performance.
- Other criteria including: integrated design, local economic benefits, resiliency planning, and post-occupancy commissioning.

## **Funding Limits**

Commerce aimed to fund projects across Washington to demonstrate net-zero energy performance. Given the relatively small amount of funds available (\$1.9 million), applicants were encouraged to consider the following guidelines when building their budgets:

- Part of a project, rather than the entire project, can demonstrate net-zero energy performance, but it must be scaled down to a building or buildings.
- \$100,000 to \$250,000 per project may be awarded for homeownership projects.
- \$500,000 to \$1,000,000 per project may be awarded for multifamily projects.
- UHEE funding was awarded *in addition to and in conjunction with* an HTF award. Applications were also subject to the HTF funding limit policy identified in the Stage 2 solicitation for applications. For example, a project could receive a \$3 million award from the HTF and receive an additional \$500,000 UHEE award.

## **Application Review Process**

The UHEE application and award process was conducted in conjunction with the standard HTF application and award process that began in January 2016 with an invitation to submit Stage 1 applications, which were due to Commerce in March 2016. Stage 1 applications provide preliminary information about a proposed project, including:

- Overall project concept.
- Location.
- Target low-income population to benefit from project.
- Number of affordable housing units created.
- Proposed total development budget.
- Proposed sources of funds and leverage of other public and private funding sources.
- Project schedule.

A total of 97 Stage 1 applications were received for a total request of over \$165 million in HTF and \$9.4 million in UHEE funds. HTF staff reviewed these applications to determine whether the projects were sound in concept and reasonably ready to proceed, demonstrated financial viability, and were likely to be competitive for full funding in Stage 2. The applications were then separated into two categories: encouraged to apply in Stage 2, and not encouraged to apply. However, all applicants were allowed to apply in Stage 2 if they chose to.

In July 2016, Commerce published the Stage 2 Notice of Funding Availability (NOFA), with applications due to Commerce on Sept. 15, 2016. Commerce received five Stage 2 applications, requesting \$2.9 million in UHEE funds.

### **Application Evaluation Criteria**

A team of five HTF staff reviewed the five Stage 2 UHEE applications and sought input from Energy Office staff and other Commerce staff regarding:

- The acceptability of proposed services for homeless households with input from the Commerce Housing Assistance Unit.
- Meeting the UHEE requirements with input from the Commerce Energy Division.
- Compliance with the ESDS from the Commerce ESDS program manager.
- For those applicants with existing HTF portfolios, current and previous project performance, compliance, and organizational strength were evaluated with input from Commerce HTF asset management staff.

Each application was evaluated and rated in the following areas, based on the HTF statute and capital budget proviso:

- Population served: priority given for projects serving the legislatively required target populations<sup>7</sup> in the 2015-2017 capital budget.
- Soundness of concept: overall design, location, demonstrated need, and availability of appropriate services if applicable.
- Financial feasibility: reasonableness of cost, and the leveraging of other public and private funds.
- Readiness to proceed: commitment of funds, site control, land use and permitting issues, local funding and support.
- Long-term viability: ability to support ongoing operations and maintenance costs, and services where applicable.
- Organizational strength: experience with type of project and target population, performance of existing projects in portfolio and financial capacity.
- Location: geographical location of a project in an area designated as rural.
- Energy efficiency: for projects applying for UHEE funds, the extent to which UHEE requirements were met.

### **Coordination with Public Funders**

Typical to an HTF application evaluation process, local public funders (cities and counties) and the Housing Finance Commission were consulted where they participated in funding a project.

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<sup>7</sup> The Legislature identified the following target populations in the 2015-17 capital budget: people with chronic mental illness, homeless families with children, people with disabilities, people with developmental disabilities, veterans, homeless youth, farmworkers, seniors, homeownership.

HTF staff organized and participated in several teleconferences with all the public funders to coordinate funding and project priorities.

### **Application Scoring**

All applications received an overall score of “low,” “medium,” or “high.” Funding preference was given to all of the “high” rated applications, as well as to some “medium” rated applications if all or most of the following conditions were met:

- The applicant proposed units in a legislative population target or a high-need population, including homeless households.
- The project had local funding and community support.
- The project was located in a rural area.
- The per unit cost was reasonable compared to similar projects.

The “low” rated applications and the remaining “medium” rated applications were not proposed for funding. These projects were typically not ready to proceed, did not have sufficient committed funding or local funders’ support, did not propose enough units in a legislatively required category, and/or had a high per unit cost.

## Funded Projects

Commerce received five applications through the competitive process for UHEE funding and selected three multifamily rental projects to participate in the UHEE demonstration. As previously described, one project received a direct appropriation in the 2016 supplemental budget. The four projects receiving UHEE funds:

- Everett Safe Streets Supportive Housing
- HopeWorks Station II, Everett
- Transitions Permanent Supportive Housing, Spokane
- Riverton Park, Tukwila (direct appropriation)

Two project applications were not selected for funding:

- Community Action Center, Whitman County Housing Program
- Community Resource Service Center, Yakima Neighborhood Health Services

Details about the four UHEE projects are included in narratives and in Figure 1 below.

**Figure 1: UHEE Project Details**

	<b>Everett Safe Streets Supportive Housing</b>	<b>HopeWorks Station II</b>	<b>Transitions Permanent Supportive Housing</b>	<b>Riverton Park</b>
<b>UHEE Funds Recipient</b>	Catholic Housing Services of Western Washington	Housing Hope Properties	Transitions	Homestead Community Land Trust
<b>Location</b>	Everett, Snohomish County	Everett, Snohomish County	Spokane, Spokane County	Tukwila, King County
<b>Project Status</b>	Contract executed Feb. 2018; in construction	Contract executed April 2018; in construction	Contract executed Sep. 2017; construction complete, partially placed in service	Not ready to contract; raising funds
<b>Unit Type</b>	Apartments	Apartments	Cottages	Single-family residences
<b>Total Housing Units in Project</b>	65	65	24	11
<b>UHEE Housing Units</b>	65	65	15	11
<b>Total Development Cost</b>	\$17,532,070	\$17,724,361	\$6,702,069	\$5,661,186
<b>Non-UHEE State Funds</b>	\$3,000,000	\$1,000,000	\$550,000	n/a
<b>UHEE State Funds</b>	\$950,000*	\$750,000*	\$200,000*	\$600,000**

\*Competitive award.

\*\*2016 direct appropriation.

## Everett Safe Streets Supportive Housing

This project, by Catholic Housing Services of Western Washington, is currently in construction and will create 65 affordable housing units in Everett. Part of a collaborative effort among City of Everett, Snohomish County, and HTF to provide low-barrier, supportive service housing, the project will provide affordable housing units to people with chronic mental illnesses, people with disabilities, and homeless youth.

Everett Safe Streets was one of five projects to receive a “health home” direct appropriation in the 2016 supplemental capital budget (Chapter 35, Laws of 2016, Sec. 1005) to construct or renovate units of permanent supportive housing for people with chronic mental illness. The health homes appropriation for this project was \$1,500,000.

**Figure 2: Everett Safe Streets Supportive Housing Concept Drawing**



## HopeWorks Station II

This project by Housing Hope Properties also is under construction and will create 65 affordable housing units in Everett. Units will be available for homeless families with children, homeless youth, people with disabilities, veterans and farmworkers. In addition to a community hub offering convenient access to meals and meeting space, the project will include culinary training programs and career counseling to help residents access lasting and gainful employment.

**Figure 2: HopeWorks Aerial Concept Photo**



## Transitions Permanent Supportive Housing

This project by Transitions recently completed construction of 24 cottage-style affordable housing units in the City of Spokane. Originally, only 15 out of the 24 units were intended to achieve net-zero energy efficiency. All 24 units will be available for people with chronic mental illnesses, homeless families with children, and homeless single mothers.

**Figure 3: Transitions Supportive Housing**



## Riverton Park

The Riverton Park project received a \$600,000 direct appropriation in the 2016 capital budget. This project is being developed by Homestead Community Land Trust in partnership with the Riverton Park United Methodist Church. The project aims to build 11 net-zero demonstration single-family homes in Tukwila. The project is still in the process of securing all construction and permanent funding and has not yet begun construction. No concept drawings are available for this project.



## Modeled Project Costs Compared to Traditional Design and Construction Costs

Each applicant was required to complete a life-cycle cost assessment using the Office of Financial Management (OFM) Life-Cycle Cost Tool. This provides a preliminary assessment of the project outcomes. In accordance with their HTF UHEE contracts, the successful applicants will be providing updates to this documentation at construction completion and at the end of the three-year energy performance period that follows project occupancy.

### First Costs

“First costs” are the initial capital investment costs for land acquisition, construction and for the equipment needed to operate a facility prior to occupancy.

For this report we have compiled the data from all of the projects and presented it as a percent of the total project cost. The UHEE costs, as percent of total project cost, is the engineer’s estimate of the total incremental cost to the project. State UHEE funding as a percent of total project cost provides the cost covered by the state funds. The total cost is then split into two sub-categories, solar incremental cost and efficiency incremental cost, to provide additional details from the cost estimates. First costs are summarized in Figure 2.

**Figure 2: First Costs**

	Everett Safe Streets Supportive Housing	HopeWorks Station II	Transitions Permanent Supportive Housing	Riverton Park
Number of units	65	65	15 of 24	11
Total project cost	\$17,532,070	\$17,724,361	\$6,702,069	\$5,661,186
UHEE cost as % of total project cost	7.3%	4.3%	7.2%	n/a*
State UHEE funding as % of total project cost	5.4%	4.2%	3.0%	11%
Solar incremental cost %	3.6%	2.4%	5.8%	n/a*
Efficiency incremental cost %	3.7%	1.9%	1.5%	n/a*

*\*Project is not fully funded; therefore these percentages are not available.*

## Life-Cycle Costs

Life-cycle costs include all costs and benefits of the project over a 50-year life. This includes not only the first cost, but the cost of replacement equipment, maintenance and utilities.

The base case energy provided by each applicant changes the life-cycle cost outcomes. A higher energy use base case results in greater savings and benefits. Base case assumptions can result in an incremental change in savings of 25 percent.

Each applicant analyzes the equipment replacement and maintenance cost differently, resulting in some of the variations in life-cycle cost. The life-cycle cost of capital for Everett Safe Streets is 170 percent of first cost. For HopeWorks, the life-cycle cost of capital is 311 percent of first cost. This reflects the cost of replacing equipment as it fails over the 50-year analysis. Everett Safe Streets used a more detailed build-up of space and water heating systems, allowing segregation of long-life and short-life components of the systems and a more discrete analysis.

In addition to the figures provided by each applicant, this report includes an alternate analysis assuming the projects will be able to use the federal solar energy tax credits. One equity issue for low-income housing providers is that it is more difficult to take advantage of the federal solar energy tax credits. At least one of the projects has been able to find a tax-burdened sponsor to assume the tax credits, resulting in a 30 percent reduction in cost for the solar energy systems. The cost reduction is represented assuming all of the projects can achieve this result. Negative numbers in the life-cycle costs presented in Figures 3 and 4 represent an increase in life-cycle cost.

**Figure 3: Life-Cycle Costs**

	Everett Safe Streets Supportive Housing	HopeWorks Station II	Transitions Permanent Supportive Housing	Riverton Park*
Net Present Savings	-3.4%	-6.7%	-7.1%	n/a
Net Present Savings with Federal Solar Tax Credit	-0.6%	-5.3%	-3.9%	n/a

*\* Figures are based on preliminary designs. Actual figures to be reported after project completion. Reduction of Carbon Footprint*

A feature of the OFM Life-Cycle Cost Tool is a life-cycle cost assessment that includes the social cost of carbon. This dollar figure represents the value of damages avoided by small emission reductions. For each project, the value is added to the benefits of the project. Figure 3 provides results from the life-cycle cost analysis for each project and an assessment that includes the 30 percent federal tax credit. Life-cycle costs including the social cost of carbon are presented in Figure 4.

**Figure 4: Life-Cycle Costs Including the Social Cost of Carbon<sup>8</sup>**

	Everett Safe Streets Supportive Housing	HopeWorks Station II	Transitions Permanent Supportive Housing	Riverton Park*
Net Present Savings	-0.57%	-5.34%	-3.86%	n/a
Net Present Savings with Federal Solar Tax Credit	0.08%	-0.67%	-0.37%	n/a

*\*Figures are based on preliminary designs. Actual figures to be reported after project completion.*

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<sup>8</sup> The value of the social cost of carbon are from the U.S. Government Interagency Working Group on SCC, “Social Cost of Carbon – Table A1,” as adopted in the Office of Financial Management Life-Cycle Cost Tool, <https://obamawhitehouse.archives.gov/sites/default/files/omb/assets/infocreg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf>

# Energy Efficiency Strategies Used

## Overview

While all three competitively funded projects are either still under construction or just completed, we can provide only preliminary results based on the application data. This information is based on early designs and may change as the projects move through final design and construction.

The application process included detailed energy modeling to estimate energy use. To assure that the applications fully account for the energy loads, each first developed a model that illustrates the energy use of the project simply meeting the HTF Evergreen Sustainable Development Standard. This standard already requires some improvement above the energy code. The applicants then provided documentation on the approaches used to reduce energy use. This is developed in a stepwise process designed to check each approach. Applicants were also allowed to take credit for behavior modification. This is supported with a combination of tenant education and more sophisticated control systems. Finally, solar energy systems sufficient to meet the remaining annual loads are specified by the energy analyst.

## Energy Efficiency Strategies Used

Most of the modeled energy savings are attributed to energy efficiency improvements in space and water heating. Smaller savings can be attributed to reductions in lighting and large appliances.

Space heating savings primarily can be attributed to the use of heat pumps. The base case assumption for multifamily housing is electric resistance heating. Moving to a heat pump can cut space heating energy use by more than half. It will also provide space cooling, a benefit not typically found in low-income housing. Additional insulation and better windows are also an important element in reducing space-heating loads in two of the three projects.

Air leakage control and heat recovery ventilation is included in every project. This combination provides good energy savings and provides better ventilation outcomes than the base code requirements. Everett Safe Streets included controls that enable natural ventilation while curtailing energy use of heating and ventilation systems when the windows are open.

Water heating systems also took advantage of heat pump technology. This cuts water heating energy use in half. This is becoming more common in all electric residential housing projects, but is not frequently found in low-income homes. For the two apartment buildings, large central heat pumps supply a central distribution loop. Hope Works selected an advanced CO<sub>2</sub>-based heat pump system that provides unusually robust performance. Everett Safe Streets also included a heat-recovery drain system to further reduce hot water loads.

Lighting power is reduced in all of the projects through the use of LED lighting. In addition, controls have been added to further reduce energy use. For example, one project included master switches that allow occupants to turn off half of the sockets when they leave the apartment. Another project used two-step lighting in the common areas and stairways.

All of the projects achieved some savings by specifying more efficient appliances. HopeWorks included heat pump dryers, a technology that is fairly new to the U.S.

Figure 5 below lists the primary approaches used by each project. Each project includes additional unique details, though the general approaches are similar.

**Figure 5: Energy Efficiency Strategies Used\***

Strategy	Everett Safe Streets	Hope Works	Transitions
Insulation exceeds code	X		X
Windows exceeds code	X		
Air leakage control exceeds code	X	X	X
Heat recovery ventilation	X	X	X
Heat pumps for space heating	X	X	X
Heat pumps for water heating	X	X	X
Other Water Heating Measures	X	X	X
Lighting power reduction	X	X	X
Appliance Strategies	X	X	X

*\*The Riverton Park project is not fully developed; therefore energy efficiency strategies are to be determined.*

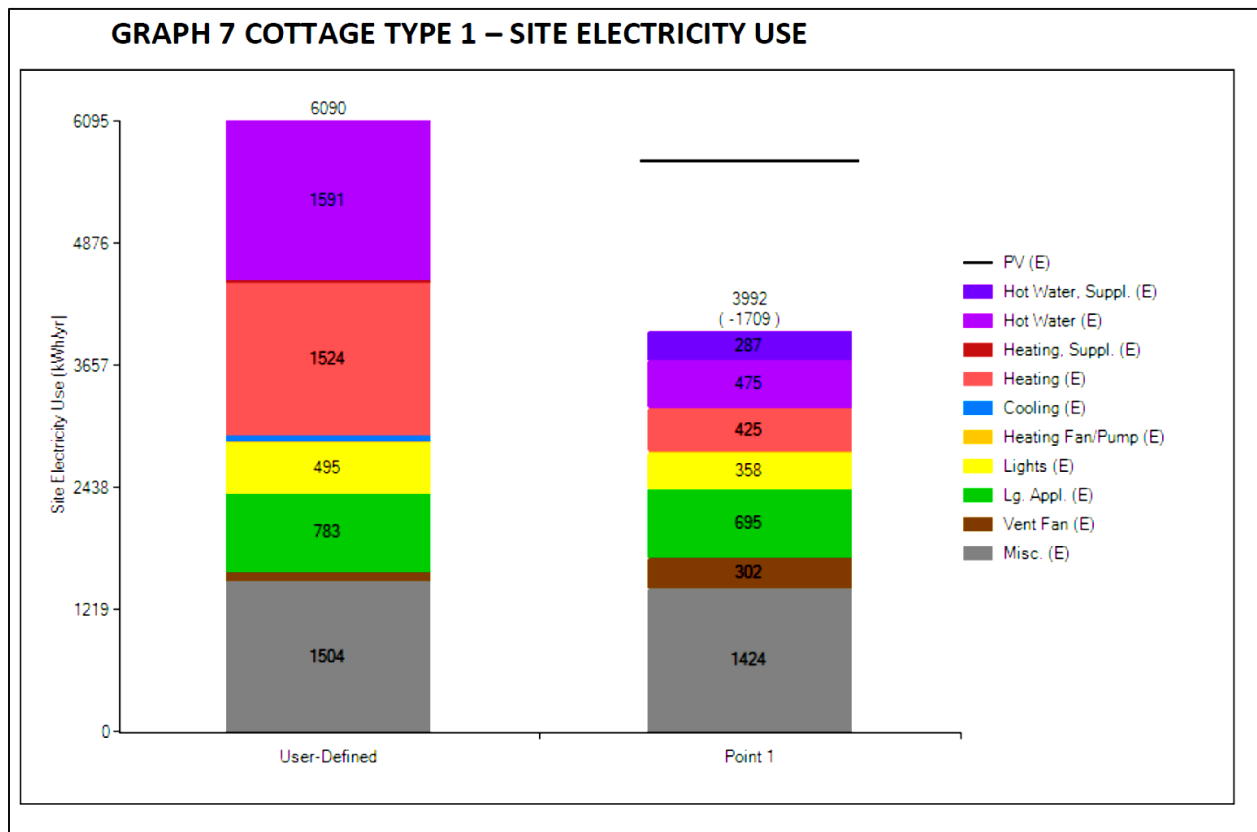
## Energy Savings

Graphic representations of the energy use reductions achieved by each project are presented below in Figures 6 through 8.

### Energy Modeling Results, Transitions Permanent Supportive Housing

Figure 6 provides modeling results for one of the cottages developed for the Transitions Permanent Supportive Housing project. The left column provides results for the base case, and the right column provides results for the proposed net-zero project. The proposed project reduced space and water heating loads by two-thirds of the base case. This also demonstrates smaller reductions in proposed loads for most other end uses including lighting, appliances and some miscellaneous loads. Fan energy is higher in the proposed case because the heat-recovery ventilation system requires more fan energy than a code-compliant base case system. The line at the top of the proposed case is the estimated electrical generation provided by the solar energy system. The solar energy system is oversized to assure it meets the net-zero definition.

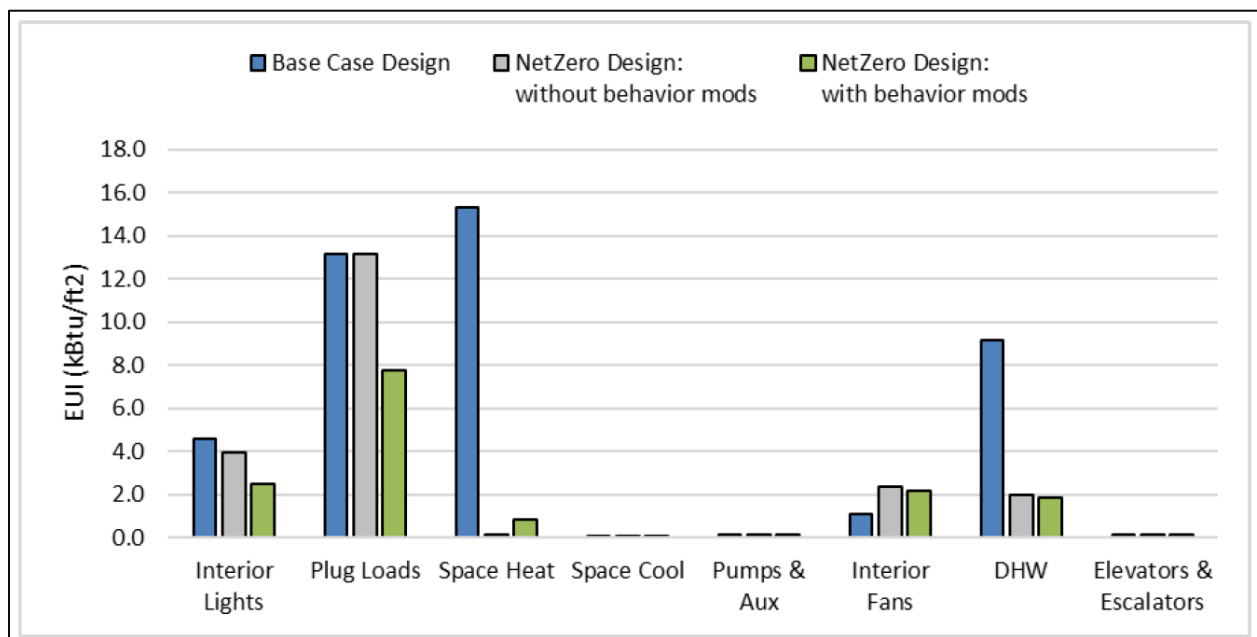
**Figure 6: Energy Modeling Results, Transitions Permanent Supportive Housing**



## Energy Modeling Results, Everett Safe Streets Supportive Housing

Figure 7 provides modeling results for the Everett Safe Streets Supporting Housing project. This graph presents three cases: the base case, a low-energy case without behavior modification and a net-zero case with behavior modification. Once again, most of the savings are achieved through reductions in space and domestic hot water energy. Behavior modifications enabled through enhanced control systems further reduce plug and lighting loads in the third case. The plug and lighting load reductions increase heating a bit compared to the low-energy case. Once again, heat recovery ventilation increases the fan energy requirements.

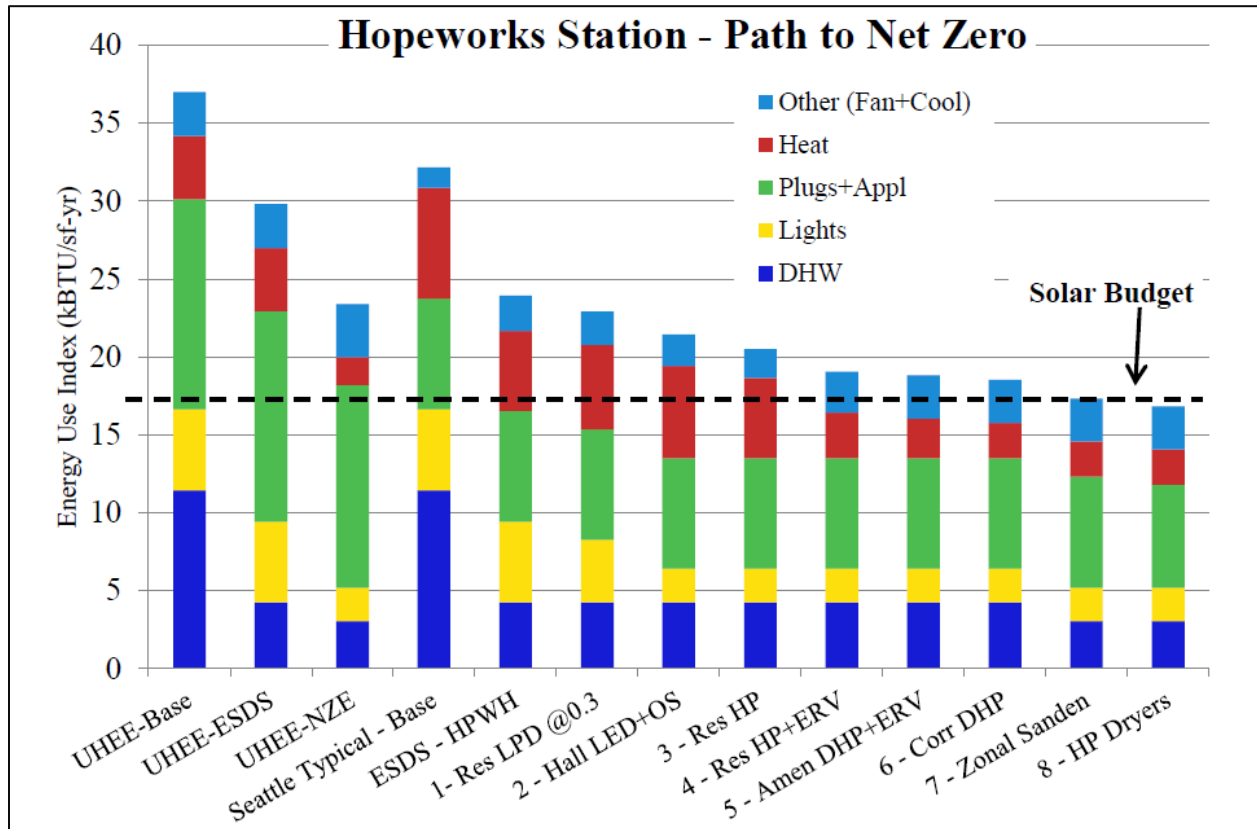
Figure 7: Energy Modeling Results, Everett Safe Streets Supportive Housing



## Energy Modeling Results, HopeWorks Station II

Figure 8 provides modeling results for HopeWorks Station II. Each bar represents a different energy modeling result. In the first four bars on the left, the analyst considers several different base cases. This is relevant work in determining the loads to be addressed by the design. Moving from the “Seattle Typical – Base” to the right, each bar represents an additional efficiency measure and the incremental change in efficiency from the previous bar. The first and most significant step represents the heat pump water heating measure. This is followed by two lighting measures and several space heating heat pump measures. This experimentation with different efficiency measures illustrates the progressive development of the least-cost approach to achieving the net-zero energy goals of the project.

Figure 8: Energy Modeling Results, HopeWorks Station II





# Lessons Learned

## Overview

Because the projects have not been completed yet, the lessons learned listed below are inclusive only of the application and design process. Reporting from the participants after the projects are fully in service may revise the comments provided below and may include insights based on construction and occupancy. As part of the post-construction reporting requirements, participants will submit annual narratives containing lessons learned through occupancy and operations to Commerce.

## Program Design

- The HTF competitive solicitation process provided a good selection of qualified participants for the funding.
- The program design has been successful to date. As a market transformation and demonstration project, data collection has been useful and informative. We are collecting valuable information on the approach, cost and benefits of the projects.
- Future programs can benefit from the technical work provided by the applicants. For example, the base case energy use needs to be further standardized based on data generated by these participants and other regional resources. This will result in a lower energy use baseline and likely lower first cost for projects. Additional standardization of equipment life assumptions will provide more comparable and realistic results.
- The program design requires each participant to provide continued reporting and provide presentation on their projects. This will transmit the results to the low-income housing community and encourage replication in future affordable housing projects.

## Efficiency and Solar Energy Features

- In general, the approaches to achieving low energy outcomes are consistent across projects. Additional detail gathered from the participants after the projects are completed will provide more specific data.
- First costs are still high. This is to be expected for early adopter programs. As the techniques are adopted more widely, the costs are expected to come down. Also additional market development has occurred since the UHEE applications were received in 2016. Air leakage control with heat recovery ventilation, LED lighting and efficient glazing continues to evolve. The cost of solar energy systems continues to decline.
- The replacement cost of equipment results in higher-than-expected life-cycle cost. This may lead to more emphasis on more permanent building envelope improvements. Program design could be developed that tests this hypothesis.

## Recommendations

### **Provide Funding to Build Additional Ultra-Efficient Low-income Housing**

Commerce recommends continued funding of ultra-efficient low-income housing to support adoption of net-zero technologies in housing construction, to reduce the life-cycle costs of low-income housing projects, and to reduce utility costs for low-income households.

### **Continue to Drive Market Transformation in Energy Efficient Housing**

The existing demonstration program resulted in the application of innovative approaches to achieving the targeted outcomes. This included the introduction of new equipment including CO<sub>2</sub> heat pumps, heat pump clothes dryers, plug load controls and controls that save energy when natural ventilation is appropriate. Continued funding would likely result in additional innovation and market introductions.

### **Provide the Benefits of Ultra-Efficient Housing to More Low-Income Households**

While the primary focus of these investments is on long-term transformation of Washington's economy, the program also delivers immediate benefits to low-income households by decreasing utility costs. To achieve an equitable clean energy transition, public policies must provide greater access to affordable clean energy and energy efficient technology for vulnerable communities and households. Ultra-low energy housing reduces and stabilizes energy costs for the occupants. Treatments like balanced heat recovery ventilation provide better indoor air quality and associated health benefits for the occupants. Space cooling also is made accessible, benefiting the health of the occupants.

### **Reduce Life-Cycle Costs of Low-Income Housing Projects**

Many low-income housing projects struggle to finance capital improvements because of the reduced cash flow from subsidized units. Reducing life-cycle costs supports preservation of low-income housing units and reduces demand for limited HTF preservation funds.

### **Provide Separate Funding for Net-Zero and Passive House Designs**

Commerce recommends creating separate pools of competitive funds for "net-zero energy" and "passive house" standards. A net-zero energy standard tends to favor designs that integrate advanced mechanical and electrical systems. Passive house favors aggressive building envelope and heat recovery ventilation strategies. While there is a good deal of crossover in design strategies, application of each standard will provide unique results and sets of data. The life-cycle cost of a net-zero approach can then be compared to the efficiency approach provided by passive house design. Unique benefits to the utility grid can also be examined.

## Appendix A: UHEE Funding Plan



## Department of Commerce

### Washington State Housing Trust Fund Ultra-High Energy Efficient Affordable Housing Demonstration Program FUNDING PLAN

#### Funding Availability

As part of the Capital budget for the 2015-17 Biennium, the Washington State Legislature has appropriated to Department of Commerce (Commerce) \$2.5 million for the purpose of designing and constructing ultra-high energy efficient affordable housing projects including single and multifamily units. The funds can be used solely for loans or grants to low-income housing developers.

#### Applicant Eligibility

- Applicant must be an eligible Housing Trust Fund (HTF) recipient, per [RCW 43.185.060](#).
- Applicant must apply during the 2016 HTF Stage 1 application round. Commerce expects to announce the Stage 1 Notice of Funding Availability (NOFA) in January 2016.
- Applicant must apply during the 2016 HTF Stage 2 application round and meet all of the Project Funding Criteria identified in the NOFA. Commerce expects to announce the Stage 2 NOFA in July 2016. Only applicants receiving a regular HTF funding award will be eligible to compete for an Ultra-High Energy Efficient award. The Ultra-High Energy Efficient awards will be offered in addition to the regular HTF awards.
- Applicant must demonstrate energy-saving and renewable energy systems designed to reach Net-Zero Energy use after housing is fully occupied. The successful applicants will be required to provide a series of life-cycle cost analysis reports to Commerce (see more details below).

#### Funding Priorities

- a) Whether the project is being awarded HTF funds in the 2016 application round.
- b) Whether the proposed design has demonstrated that the project will achieve Net-Zero Energy use when fully occupied;
- c) The life-cycle cost of the project; life-cycle costs will be compared among similar projects and priority given to projects projecting lower life-cycle costs;
- d) Whether the project demonstrates a design, use of materials, and construction process that can be replicated by the Washington building industry;
- e) The extent to which the project leverages non-state funds;
- f) The extent to which the project is ready to proceed to construction;
- g) Whether the project promotes sustainable use of resources and environmental quality;
- h) Whether the project is being well-managed to fund maintenance and capital depreciation;
- i) Whether the project demonstrates reduction of housing and utilities carbon footprint;
- j) The extent to which the project is planning for anticipated and unexpected occupant behaviors in operations in order to encourage behaviors that optimize performance;
- k) Other criteria that Commerce considers necessary to achieve the purpose of this program, such as, narrative discussion of key concepts including but not limited to: integrated design, local

economy benefits, resiliency planning, post-occupancy commissioning, and additional feedback loops to the affordable housing community.

### **Funding Limits**

Commerce aims to fund a few projects across Washington State to demonstrate Net-Zero Energy performance. Given the total amount of funds available, applicants are encouraged to consider the following guidelines when building their budgets:

- \$100,000-\$250,000 per project may be awarded for homeownership projects. Part of a project (rather than the entire project) can demonstrate Net-Zero Energy, but it must be scaled down to a building or buildings.
- \$500,000-\$1,000,000 per project may be awarded for multifamily projects. Part of a project (rather than the entire project) can demonstrate Net-Zero Energy, but it must be scaled down to a building or buildings.
- The Ultra-High Energy Efficient funding will be awarded in addition to the HTF award. Each application will also be subject to the HTF funding limit policy identified in the Stage 2 NOFA. For example: a project can receive a \$3 million award from the HTF and receive an additional \$500,000 Ultra-High Energy Efficient award.

### **Application Requirements**

- Applications must be submitted to Commerce by the date designated on the HTF Stage 1 and Stage 2 NOFAs. All necessary application materials will be available for download on the [HTF website](#). The Ultra-High Energy Efficient Application, as well as the following attachments, will be required in order to be considered for funding:
  - Energy model comparing the base case (which will be provided by Commerce) to the project's model;
  - Life-Cycle Cost Tool comparing the base case provided by Commerce to the project proposal;
  - Applicable narrative sections.

### **Estimated Timeline**

Stage 1 Applications Solicited: January 2016

Stage 1 Applications Due: February 2016

Stage 2 Applications Solicited: July 2016

Stage 2 Applications Due: September 2016

Awards Announced: December 2016

**Housing Trust Fund Reporting Requirements (post-construction)**

Requirements due:	Requirements:
<p><b>At Construction Completion</b></p>	<ol style="list-style-type: none"> <li><b>1. Narrative to Commerce:</b> Lessons learned during the design and construction phases. Examples of what would be expected are: (a) how the design, use of materials, and construction process could be replicated by the Washington building industry, including the affordable housing industry; (b) how project costs compare to the costs of traditional design and construction.</li> <li><b>2. Public Webinar:</b> Lessons learned during the design and construction phases. Examples of what would be expected are: (a) how the design, use of materials, and construction process could be replicated by the Washington building industry, including the affordable housing industry; (b) how project costs compare to the costs of traditional design and construction.</li> <li><b>3. Life-cycle Cost Analysis (as built):</b> Provide to Commerce an update to the initial Life Cycle Cost Tool with as-built costs and any design changes.</li> </ol>
<p><b>Annually, for the first three years after housing is fully occupied</b></p>	<ol style="list-style-type: none"> <li><b>1. Life-cycle Cost Analysis (update):</b> Verify Net-Zero Energy performance by providing to Commerce an update to the as-built Life Cycle Cost Tool with actual project utility data.</li> <li><b>2. Narrative to Commerce:</b> Lessons learned through occupancy and operations.</li> </ol>

**Process Changes:**

Commerce reserves the right to revise this process as needed.

**Questions?**

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