



0000100756

RECEIVED  
UniSource Energy  
SERVICES

2009 JUL 17 P 3:43

One South Church, Suite 2030, Tucson, Arizona 85701

Post Office Box 711, Tucson, Arizona 85702

ARIZONA CORPORATION COMMISSION  
DOCKET CONTROL

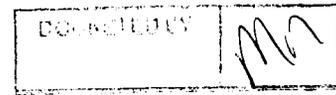
Philip J. Dion  
Vice President, Legal and  
Environmental Services

Office: (520) 884-3708  
Fax: (520) 545-1471

July 17, 2009

Arizona Corporation Commission  
DOCKETED

JUL 17 2009



Docket Control  
Arizona Corporation Commission  
1200 West Washington  
Phoenix, AZ 85007

RE: UNS Electric, Inc. Zero-Net Energy Homes Pilot Program  
Docket No. E-04204A-07-0365, Decision No. 70522

In Decision No. 70522 (September 30, 2008), the Arizona Corporation Commission ("Commission") ordered UNS Electric, Inc. ("UNS Electric") to evaluate the feasibility and cost-effectiveness of a pilot program to promote a "zero-net residential energy efficiency program." In compliance with the order, UNS Electric filed its Zero-Net Energy Homes ("ZEH") Pilot Program on March 30, 2009.

After the original report was filed on March 30, 2009, UNS Electric completed the 2009 update on avoided cost calculations and met with Commission Staff to develop a methodology to determine cost-effectiveness, based on the use of the societal cost test, that would be comparable to the methodology used by Commission Staff in its own analysis. Additionally, Commission Staff and UNS Electric discussed that the values used in cost-effectiveness calculations for Demand-Side Management/Energy Efficiency Programs should be the same as those values reported in UNS Electric's Integrated Resource Plan. As a result of these meetings, UNS Electric requested that Commission Staff allow UNS Electric to apply the new methodology and, if necessary, revise the original report for UNS Electric's ZEH Pilot Program.

Attached, please find the revised UNS Electric ZEH Pilot Program, as well as a redlined copy of the original filing, which documents the results of an analysis to explore the feasibility and cost-effectiveness of promoting a ZEH Pilot Program and the proposed program design and incentive levels.

The attached Pilot Program presents a program design that expands the existing New Home Construction Program through the addition of two high-performance tiers. By using this recommended program design, the existing Tier 1 energy efficient new home construction scenario, the new Tier 2 energy efficient home construction scenario and the new Tier 3 near zero-net energy homes scenario will be integrated into a single New Home Construction Program. Homes will qualify for one of the three tiers in the program based on a Home Energy Rating System ("HERS") Index score. Tier 1 will require a minimum HERS score that is  $\leq 85$ , Tier 2 will require a minimum HERS score  $\leq 70$ , and Tier 3 will require a minimum HERS score  $\leq 45$ . This program design will allow UNS Electric to

utilize existing delivery infrastructure and marketing to promote all three energy efficient home construction tiers. While the additional tiers significantly enhance the energy efficiency of the New Home Construction Program, they do not achieve 100% zero-net energy due to cost-effectiveness concerns.

An electronic copy of the Program and its appendices will be provided upon request.

Respectfully submitted,

 for  
Philip Dion

Enclosures

cc: Chairman Mayes  
Commissioner Newman  
Commissioner Pierce  
Commissioner Kennedy  
Commissioner Stump

**CLEAN**

**VERSION**

UNS Electric, Inc.

Zero-Net Energy Homes  
Pilot Program

July 17, 2009

**Zero-Net Energy Homes Pilot Program**

**Table of Contents**

Program Concept and Description ..... 2

Target Market..... 2

Relation to UNS Electric’s Current Residential New Construction Programs ..... 3

Program Objectives..... 4

Products and Services ..... 4

Program Budget ..... 4

Pilot Program Design Methodology ..... 5

Study Results ..... 7

Program Benefits and Costs..... 8

Recommendations for Pilot Program..... 10

Appendix 1 – Measure Analysis Sheet – 9 Cases ..... 11

Appendix 2 – Measure Analysis Sheet – Tier 2 and Tier 3 Only ..... 12

Appendix 3 – Measure Analysis Sheet- Total Resource Cost Test ..... 13

## Zero-Net Energy Homes Pilot Program

---

### Program Concept and Description

The Arizona Corporation Commission (“Commission”), in Decision No. 70522 (September 30, 2008), ordered UNS Electric, Inc. (“UNS Electric”) to evaluate the feasibility and cost-effectiveness for a pilot program to promote a “zero-net residential energy efficiency program.” The UNS Electric “Zero-Net Energy Homes Pilot Program” (“ZEH”) documents the results of an analysis regarding the feasibility and cost-effectiveness of promoting the proposed ZEH program design and incentive levels. This pilot program presents a program design that expands the existing New Home Construction Program through the addition of two high performance tiers. By using this recommended program design, the existing Tier 1 energy efficient new home construction scenario, the new Tier 2 energy efficient home construction scenario and the new Tier 3 near zero-net energy homes scenario will be integrated into a single New Home Construction Program. Homes will qualify for one of the three tiers in the program based on a Home Energy Rating System (“HERS”) Index score. Tier 1 will require a minimum HERS score that is  $\leq 85$ , Tier 2 will require a minimum HERS score  $\leq 70$ , and Tier 3 will require a minimum HERS score  $\leq 45$ . This program design will allow UNS Electric to utilize existing delivery infrastructure and marketing to promote all three energy efficient home construction tiers. While the additional tiers significantly enhance the energy efficiency of the New Home Construction Program, they do not achieve 100% zero-net energy due to cost-effectiveness concerns.

For the purposes of this report, the term “zero-net energy” is the ratio between annual energy generated by the house through on-site renewable devices to the total annual energy used by the house.

Thus, if 75% of the annual energy a building uses comes from on-site generation, it is considered to be a 75% ZEH. There will be times when the building is exporting to the grid (more electricity being generated than being used), times when it is importing energy from the grid (more energy being used than being generated), and periods when there is no import or export (all the energy the building needs is being generated on-site).

This report outlines the results of the planning study for a ZEH pilot program. As shown in “Recommendations for Pilot Program” (page 9 below), the results of the benefit-cost analysis shows that none of the ZEH scenarios studied actually pass the Total Resource Cost (“TRC”) test, however the recommended ZEH scenario came very close. Even though the cost-effectiveness is marginal, UNS Electric recommends proceeding with Tier 2 and Tier 3 standard, as an investment in market transformation for the residential new construction sector. Over time, UNS Electric will monitor estimated incremental costs and re-screen the program.

---

### Target Market

The target market of the ZEH Pilot Program is comprised of all individually-metered new homes that receive electric service from UNS Electric. This includes home developments, townhomes and condominium projects where individual units are sold to homeowners, and custom home projects. The program would be marketed to all builders within the UNS Electric service territory for homes that are either all electric or have a combination of electric and natural gas energy supplies.

For the purposes of the Tier 2 energy efficiency homes and Tier 3 near zero-net energy homes options, UNS Electric focused the enclosed savings and cost analysis on homes that are all-electric, because a home using gas for space heating or water heating cannot be 100% zero-net, as the renewable devices cannot replace all of the energy used by the house. However, by providing a tiered program approach, UNS Electric will have the opportunity to promote the second tier of efficiency for homes constructed with a combination of electric and natural gas energy supplies, even if these homes cannot achieve the Tier 3 near zero-net approach.

## Zero-Net Energy Homes Pilot Program

### **Relation to UNS Electric's Current Residential New Construction Programs**

The existing UNS Electric residential new construction program already offers two construction approaches, as described below. The Energy Smart Solar Home Program described below will most likely be replaced by the new Tier 3 near zero-net option, if approved by the Commission.

- **Energy Smart Homes** – This program mirrors the 2006 ENERGY STAR Homes<sup>®</sup> standards. The requirement for the program is a HERS index of 85 or lower, and the builder incentive offered for this program is \$400.
- **Energy Smart Solar Home Program** – This program is based on the Energy Smart Homes program, in addition to solar Photovoltaic ("PV") or solar thermal and proper HVAC sizing. All guidelines in the RECPP must be followed for the solar thermal or PV additions.

In order to keep program administrative costs down and to streamline the presentation of UNS Electric's residential new construction programs to the marketplace, the program design is to merge the zero-net energy homes program with the existing Energy Smart Homes Program. Two additional tiers of increasing efficiency will be added to the Energy Smart Homes program to give participating builders and home buyers options for increasing energy savings, installing renewable energy, and receiving higher incentives.

The levels of efficiency for the new tiers will be based on how the homes perform based on a HERS Index score, which awards a numerical value gauging the homes performance. Higher performing homes achieve a lower HERS score.

In order for homes to qualify for each tier, they must meet the minimum HERS Index Scores from on-site testing by certified HERS Raters as shown in Exhibit 1.

#### **Exhibit 1: HERS Index Scores for Residential New Home Construction Program**

Tier 1 (Existing Program)	HERS Index Score of $\leq 85$
Tier 2 (New Level Energy Efficiency Only)	HERS Index Score of $\leq 70$
New Level 50% Zero-Net energy)	HERS Index Score of $\leq 45$

A number of additional items will be added to the construction standards in order for builders to achieve the second tier (HERS 70) and the third tier (HERS 45). As a result of these necessary additions, the incremental cost to build homes to the higher tiers will increase, and therefore, the recommended incentive to the builder will also increase. Modifications to the construction standards to achieve the Tier 2 and 3 homes are likely to include:

- Greater envelope and HVAC energy efficiency standards;
- Ducts are located within conditioned space;
- Both PV and solar water heating on all homes on the ZEH;
- Passive solar design that incorporates passive solar heating in the winter and shading in the summer for the highest efficiency homes;
- Energy Star<sup>®</sup> fixed appliances, and;
- CFL lighting.

## Zero-Net Energy Homes Pilot Program

---

### Program Objectives

The Program's objectives are:

- Reduce peak demand and overall energy consumption (electric) in new homes;
- Implement programs that include more aggressive energy efficiency standards that produce savings of at least 20% above baseline (HERS 70) and a near zero-net percentage of at least 50% (HERS 45) where approximately 50% of annual energy used by the home will come from on-site renewable generation;
- Stimulate the installation of solar photovoltaic systems and solar water heaters in new homes;
- Stimulate energy efficiency standards that are higher than EPA/DOE Energy Star Homes<sup>®</sup> performance standards;
- Stimulate construction of new homes that are inspected and tested to assure energy performance;
- Stimulate the installation of high efficiency heating and cooling systems, envelope, lighting, and fixed appliances (Energy Star<sup>®</sup> products);
- Assist sales agents with promoting and selling of zero-net energy homes;
- Provide information to help explain the benefits of zero-net energy home features;
- Train builder construction staff and sub-contractors in advanced building-science concepts to reach zero-net energy goals through improved design and installation practices, and through the installation of renewable energy devices;
- Increase homebuyer awareness and understanding of the benefits they receive from living in a zero-net energy home and how they can improve the performance of their home; and
- Educate builders who: 1) are not familiar with energy savings and on-site generation potential; 2) may be uncertain about zero-net energy performance; and 3) may be concerned about high initial costs for construction measures.

---

### Products and Services

The ZEH Pilot Program design would provide several products and services, including;

- Promotion of builders and subdivisions that achieve zero-net energy levels of at least 50%;
- Builder and sub-contractor education and training;
- Educational and promotional materials for builders and new home buyers; and

Homeowner or builder incentives for achieving increasing energy efficiency and zero-net energy levels as measured by a HERS index score of either  $\leq 70$  or  $\leq 45$ .

---

### Program Budget

This section presents an estimate of only the additional incremental cost associated with promotion of a multi-tiered program that includes Tier 2 and Tier 3 options. Exhibits 2 and 3 present estimated pilot program budgets over a three-year period, from 2010-2012. This budget represents only the incremental increase in budget over the budget approved for the current Energy Smart Home Program. Overall, the Company anticipates that 25 homes per year will participate in the pilot program in 2010, of which 70% will be at Tier 2 and 30% at Tier 3, with overall participation increasing at 10% per year over time."

## Zero-Net Energy Homes Pilot Program

On average, over the life of the program, incentives are expected to account for 85% of the total budget.

### Exhibit 1: 2010-2012 Program Budget Details

Year	2010	2011	2012
Financial Incentives	\$48,000	\$52,500	\$55,500
Total Direct Implementation	\$7,068	\$7,106	\$7,143
Total Marketing Allocation	\$860	\$929	\$997
Total Administrative and O&M Cost Allocation	\$696	\$752	\$808
Total EM&V Cost Allocation	\$158	\$170	\$183
<b>Total Program Budget</b>	<b>\$56,782</b>	<b>\$61,457</b>	<b>\$64,631</b>

### Exhibit 2: Incentives as % of Program Budget

Year	2010	2011	2012
Total Budget	\$56,782	\$61,457	\$64,631
Incentives	\$48,000	\$52,500	\$55,500
Administrative Costs	\$8,782	\$8,782	\$8,782
<b>Incentives as % of Budget</b>	<b>85%</b>	<b>85%</b>	<b>86%</b>

---

### Pilot Program Design Methodology

The approach used in the feasibility assessment for a ZEH program was to develop a baseline simulation model of a new home; and then several versions of the baseline model with increasing levels of energy efficiency, and, finally, several versions of the energy efficiency models with increasing levels of zero-net energy goals.

The four stages of the study were:

- 1) Define and simulate a baseline home, reflecting current practice for new single family homes in Kingman, Arizona, as an approximate representative location for UNS Electric territory. The home was modeled as all-electric;
- 2) Define and simulate three homes with increasing levels of efficiency. The targets for the models were a 30%, 40% and 50% reduction in annual energy use;
- 3) Simulate three homes with increasing levels of zero-net energy by adding both solar water heating and solar PV. The targets for the models were 50%, 75%, and 100% zero-net energy levels. These models were based on either the 30% or the 50% energy efficiency home; and

## Zero-Net Energy Homes Pilot Program

- 4) Combine estimated demand and energy savings from all of the models, incremental costs over baseline costs, and other utility data to produce a benefit-cost test result for each model. This was done in the format of a Measure Analysis Sheet.

The models were developed with the eQuest™ simulation software to generate savings estimates, and, in addition, the homes were modeled with REM/Rate simulation software in order to determine what HERS index they would achieve.

The baseline home simulation model was an all-electric, 1,850 square-foot home in Kingman, Arizona. The level of efficiency in the baseline model was based on a combination of three sources: the 2007 Enovity Report<sup>1</sup>, the 2003 International Energy Conservation Code for residential new construction, and a 2009 study completed by Summit Blue Consulting to determine baseline construction standards in the UNS Electric service territory.

In total, nine cases were developed, three of which were energy efficiency, three zero-net models based on a 30% energy efficient house, and three zero-net models based on a 50% energy efficient house.

In developing the energy efficiency-only models, a goal of 30%, 40% and 50% reduction in annual energy use over the baseline was initially set. Various efficiency measures were added to the baseline to produce increasing levels of savings, including the following:

- **Orientation:** Orienting a house in a north-south direction. (This is normally not possible when working with production builders in subdivision design, and can typically only be applied to custom projects.);
- **Windows:** Reducing total window area; increasing window area on south-facing wall to increase passive solar heating; and reducing glass U and SHGC values;
- **HVAC Measures:** Reducing infiltration, reducing duct leakage, heat pump quality installation, increasing heat pump SEER and COP or HSPF values, moving ducts into conditioned space;
- **Envelope:** Increasing R values in walls and ceiling;
- **Lighting:** Reducing lighting power density; and
- **Appliances:** Replacing standard fixed appliances with Energy Star® fixed appliances.

The zero-net cases had goals of 50%, 75%, and 100% zero-net energy for the year. They were based on either the 30% energy efficient home, or the 50% energy efficient home.

In developing the zero-net models, estimated hourly output from a solar water heating system and a solar PV system were subtracted from the hourly total energy use of the 30% energy efficiency or 50% energy efficiency model results, giving the net hourly and net annual use of the home. The solar output was estimated using PVWatts simulation software for the solar PV system, and an in-house built spreadsheet model for the solar water heating system. The hourly model results were used to determine coincident and non-coincident peak demand for each case.

Finally, incremental costs were researched for each combination of measures in each model and are detailed in the Measure Analysis Sheets (“MAS”), as shown in Appendices 1, 2 and 3.

---

<sup>1</sup> *Residential Home Standards: Energy Analysis and DOE-2 Simulation*, Prepared by Enovity Inc for Tucson Electric Power Company, February 12th, 2007

## Zero-Net Energy Homes Pilot Program

### Study Results

As detailed in Exhibit 4, the baseline home model consumption is 14,880 kWh per year and the HERS Index for this model is 104. As noted in the description of the different model scenarios, energy consumption decreases and the HERS Index improves as the number and amount of efficiency measures and efficient designs increase and renewables are added.

After reviewing a variety of different modeling scenarios, with varying levels of efficiency and percentages of zero-net energy, and associated HERS index scores and cost-effectiveness, the pilot program design proposes two additional higher performing Tiers (additional detail on model results for different scenarios is included in the MAS sheets, as shown in Appendices 1, 2 and 3).

Tier 1 is the current Energy Smart Homes qualifying standard at a HERS index of  $\leq 85$ . Re-analysis of the existing Energy Smart Homes program was not included in this pilot program design.

Tier 2 is a proposed new Energy Smart Homes Plus and has a qualifying HERS index score of  $\leq 70$ . This home is modeled to be approximately 30% more efficient than the baseline home.

Tier 3 is a proposed new Energy Smart Homes Near Zero-Net and has a qualifying HERS index score of  $\leq 45$ . This home is modeled to be approximately 50% zero-net energy and is based on the home that is approximately 50% more efficient than the baseline home.

#### **Exhibit 3: Results of Simulation Modeling**

	Baseline Home	Tier 2: HERS Index $\leq 70$	Tier 3: HERS Index $\leq 45$
Modeled Annual Consumption (kWh)	14,880	11,186	4,451
Peak Demand – Coincident (kW)	6.45	3.85	2.44
Annual kWh Savings	n/a	3,694	9,247
Annual Peak kW Savings	n/a	2.71	3.39

## Zero-Net Energy Homes Pilot Program

Total annual participation goals and energy savings are presented in Exhibit 4.

The current status of home construction throughout the country leads UNS Electric to believe there would be a limited number of builders and/or customers willing to incur the additional costs of the program at this time. Therefore, for the purpose of this analysis, UNS Electric expects to start with a maximum of 25 participants in 2010, with an estimated 70% achieving Tier 2 and 30% achieving Tier 3. UNS Electric anticipates an annual increase in participation of 10% per year. Exhibit 5 provides further information about estimated incremental energy savings for the program. This forecast does not include participants in Tier 1 – the existing Energy Smart Home Program.

**Exhibit 4: Zero-Net Energy Homes Program Annual Demand and Energy Savings**

Year	2010	2011	2012	Total
Participants at Tier 2: Energy Smart Homes Plus (Index <= 70)	18	19	21	58
Participants at Tier 3: Energy Smart Homes Near Zero-Net (50% zero-net)	7	8	8	23
Projected Total Tier 1 and 2 participants/year	25	27	29	81
Annual Energy Savings (MWh)	139	154	161	454
Cumulative Energy Savings (MWh)	139	293	454	454

---

### Program Benefits and Costs

A Measure Analysis Sheet (MAS) was developed for the nine different cases that were assessed, to gauge the benefit/cost results of different ZEH scenarios and assist in the selection of the Tier 2 and Tier 3 standards, included as Attachment 1. A Separate MAS was developed for the two cases that represent the Tier 2 and Tier 3 standards, included as Attachment 2. In addition to estimating the savings from each measure, this analysis relies on a range of other assumptions and financial data provided in Exhibit 6.

## Zero-Net Energy Homes Pilot Program

### Exhibit 5: Other Financial Assumptions

	Value		
	Low	Medium	High
Carbon AC \$/kWh	\$0.0212	\$0.0371	\$0.0637
Summer On-pk Energy AC (\$/kWh):	\$0.0872		
Summer Off-pk Energy AC (\$/kWh):	\$0.0525		
Winter On-pk Energy AC (\$/kWh):	\$0.0672		
Winter Off-pk Energy AC (\$/kWh):	\$0.0586		
IRP Discount Rate	7.00%		
Conservation Life (yrs):	20		
NTG Ratio:	100%		
Program Admin Costs per Participant	\$350		

\* UNS Electric met on three occasions during 2009 with Commission Staff to 1) develop a methodology to determine cost-effectiveness, based on the use of the societal test, that would be comparable to the methodology used by the Commission Staff in their own analysis, 2) gain agreement that the values used in cost-effectiveness calculations for DSM/EE Programs should be the same as those values reported in the Company's Integrated Resource Plan, and 3) provide Staff with updated avoided cost tables for UNS Electric, Tucson Electric Power Company and UNS Gas, Inc.. As a result of these meetings UNS Electric modified cost-effectiveness calculations to represent a more realistic Societal Cost test. The three most significant changes in the UNS Electric evaluation of cost effectiveness now include:

- Use of load-curves in addition to on-peak and off-peak levelized energy costs to calculate avoided cost of energy to match Commission Staff calculations;
- Use of a point-in-time methodology that does not include carrying costs of capital, to calculate avoided cost of capacity to match Commission Staff calculation of the societal test. Note: while the California Standard Practice Manual, 2002 version, is explicit on this approach, UNS Electric would like to continue conversations with Commission Staff on whether this approach is actually consistent with how the societal cost tests are actually calculated by the California utilities; and
- A valuation of Carbon Dioxide (CO<sub>2</sub>) at a low, medium, and high projection starting at \$14, \$25, or \$43/ton, and inflating over time based on information that will be reported in the 2009 IRP. Inclusion of an estimated carbon value as an externality cost is consistent with the societal cost test methodology.

\*\*Represents estimated administration and implementation costs per home participating in the program.

Although Commission Staff advised UNS Electric to include a valuation of CO<sub>2</sub> in the benefit-cost calculations for the societal test, Commission Staff and UNS Electric also understand it is up to the Commissioners to accept or deny this value. Until the Commission provides a formal acceptance regarding inclusion of CO<sub>2</sub> in the calculation of the Societal Cost ("SC") test, UNS Electric will continue to provide results of the Total Resource Cost ("TRC") test for Commission review. Exhibit 7 provides a summary of program costs and benefits for the proposed Tier 2 and Tier 3 homes, including the TRC test and the SC test results<sup>2</sup>. Savings are net based on 100% net-to-gross ratio.

<sup>2</sup> State and Federal tax credits for solar PV and solar water heating were added to the TRC benefits according to the methodology outlined in the California Standard Practice Manual as a one-time benefit to the avoided costs. Tax credits were not included in the SC test, as they are considered to be a pass-through. Solar rebates were not included at all in the benefit-cost calculations.

## Zero-Net Energy Homes Pilot Program

### Exhibit 6: Benefit-Cost Analysis Results

	Tier 2: HERS Index <=70	Tier 3: HERS Index <=45 (50% Zero-Net)
Incremental Costs	\$4,110	\$20,147
State/Federal Tax Credits	\$0	\$2,785
UniSource Solar Rebates	\$0	\$3,679
Total Resource Cost ("TRC")	0.91	0.70
Societal Test ("SC") – Low Carbon Avoided Costs	0.92	0.56
Societal Test ("SC") – High Carbon Avoided Costs	1.36	0.83

### Recommendations for Pilot Program

Given the results of the benefit-cost tests, UNS Electric recommends proceeding with Tier 2 and Tier 3 standard, as an investment in market transformation for the residential new construction sector, even though the cost-effectiveness is marginal,. Over time, UNS Electric will monitor estimated incremental costs and re-screen the program. Exhibit 8 below presents the proposed tiers, qualifying standards, and incentive levels.

### Exhibit 8: UNS Electric Energy Efficient Homes Program Prescriptive Incentives

Participation Requirement	HERS Index	Incentive
Tier 1: Energy Smart Homes (Current Program)	<=85	\$400 per home
Tier 2: Energy Smart Homes Plus	<=70	\$1,500 per home
Tier 3: Energy Smart Homes Near Zero-Net (50% ZEH)	<=45	\$3,000 per home

Note: The HERS index takes into account all the energy efficiency and renewable energy measures in the house. The lower the HERS index, the more energy efficient and closer the home is to zero-net. Also note that this incentive is not designed to be added to the \$400 incentive for the Energy Smart Homes program, but a stand-alone incentive.

# Appendix 1 – Measure Analysis Sheet – 9 Cases

Measure Type	BASELINE AND MEASURE PERFORMANCE				DEMAND/ENERGY SAVINGS				INCENTIVE AND PV CALCULATIONS										CUSTOMER COSTS/SAVINGS		WGT	% Incent	Societal Cost Test			
	Current Practices : Practices	Current Demand kW	Non-Coin Demand kW	Total Annual kWh	ZEH Annual kWh	ZEH Coin. Demand kW	ZEH Non-Coin. Demand kW	Non-Coincidence Demand (kW)	On-pk Energy Savings (kWh)	Off-pk Energy Savings (kWh)	PV Energy Benefit (\$)	PV Capacity Benefit (\$)	PV Carbon Benefit - Benefit - High (\$)	Recommended Incentive (\$)	% PV Incentive	PV Customer Cost (\$)	PV Admin Cost (\$)	NPV/low case (\$)	Inc. Cost (\$)	Inc. Savings w/Inc. w/Inc. (\$)			Payback	Incremental w/Inc. Cost (\$)	Weighting Factor	Low Carbon Cost (\$/kWh)
40% EE Case based on 20% EE	14,880	6.45	6.45	11,186	3.74	3.74	3.85	2.60	956	2,738	53,129	37	3,914	33,927	33,927	54,110	550	-5361	\$4,110	\$303	116	8.6	11%	37%	0.92	1.08
50% EE Case based on 30% EE	14,880	6.45	6.45	8,917	3.12	3.12	3.01	1,329	3,634	5,981	51,581	37	3,914	33,927	54,110	550	-51,107	\$6,496	\$425	153	11.8	11%	25%	0.84	0.99	
50% EE Case based on 30% EE	14,880	6.45	6.45	8,917	3.12	3.12	3.01	1,329	3,634	5,981	51,581	37	3,914	33,927	54,110	550	-51,107	\$9,623	\$490	156	16.6	11%	18%	0.66	0.78	
75% ZEH Case based on 30% EE	14,880	6.45	6.45	2,849	3.06	3.27	3.18	2,394	4,893	57,931	37	3,914	33,927	54,110	550	-59,319	\$39,428	\$739	253	21.4	11%	16%	0.32	0.62		
100% ZEH Case based on 30% EE	14,880	6.45	6.45	65	3.06	3.24	3.21	3,836	10,980	\$12,547	37	3,914	33,927	54,110	550	-51,860	\$21,647	\$316	31.1	30.0	11%	10%	0.54	0.51		
75% ZEH Case based on 50% EE	14,880	6.45	6.45	4,651	2.44	2.44	4.01	3,277	7,729	58,832	37	3,914	33,927	54,110	550	-52,937	\$20,147	\$856	33.5	30.0	11%	15%	0.56	0.48		
100% ZEH Case based on 50% EE	14,880	6.45	6.45	2,224	2.44	2.44	4.01	3,848	11,015	\$12,587	37	3,914	33,927	54,110	550	-52,075	\$29,468	\$1,039	38.4	35.5	11%	10%	0.47	0.55		
Weighted Average				17	2.44	2.44	3.05	3.40	2557	7319	58,365	37	3,914	33,927	54,110	550	-51,646	\$22,252	\$810	24.8	21.5	100%	16%	0.58	0.68	

--this format has values imported from ACC calc

--this format is calculated or linked

OTHER FACTORS

Line Loss Factor:	9.50%
Capacity Reserve Factor:	0.00%
Application:	New
Cost Basis:	Incremental Equip

OPERATING DATA

Summer Ratio:	50%
Winter Ratio:	50%
Summer On-Peak Ratio:	34.5%
Summer Off-Peak Ratio:	65.5%
Winter On-Peak Ratio:	17.1%
Winter Off-Peak Ratio:	82.9%
Coincidence Factor:	100%

DATE DATA

Rate:	0.00
S/WWh:	0.05092
S/WWh, On-Peak:	0.07897
S/WWh, Off-Peak:	0.07897

PROGRAM DATA

Conservation Life (yrs):	20
Carbon S/WWh:	\$0.2317
Summer On-pk Energy AC (S/WWh):	\$0.2872
Summer Off-pk Energy AC (S/WWh):	\$0.2326
Winter On-pk Energy AC (S/WWh):	\$0.2872
Winter Off-pk Energy AC (S/WWh):	\$0.2366
Weighted Avoided Cost:	\$0.2682
Ratio Measure Administrative Costs to Incentive Costs:	MA
IRP Discount Rate:	7.00%
NTG Ratio:	100%
Program Admin Costs per Participant:	\$350

# Zero-Net Energy Homes Pilot Program

## Appendix 2 – Measure Analysis Sheet – Tier 2 and Tier 3 Only

### Incentive Calculations UNSE Zero-Net Energy Homes

- this format has values imported from ACC calc  
- this format is calculated or linked

PROGRAM DATA	Low		Medium	High	CONVERSION LIFE (YRS)	OPERATING DATA		OTHER FACTORS				
	Carbon S/KWh	Energy/AC (\$/MWh)	Carbon S/KWh	Energy/AC (\$/MWh)		Summer Ratio	Winter Ratio	Line Loss Factor	Capacity Reserve Factor	Application	9.50%	0.00%
Carbon S/KWh	\$0.0537	\$0.0537	\$0.0537	\$0.0537	30	50%	50%	0.00	Incremental Equip			
Summer On-Pk Energy/AC (\$/MWh)	\$0.0537	\$0.0537	\$0.0537	\$0.0537		35.2%	35.2%					
Summer On-Pk Energy/AC (\$/MWh)	\$0.0537	\$0.0537	\$0.0537	\$0.0537		65.3%	65.3%					
Winter On-Pk Energy/AC (\$/MWh)	\$0.0537	\$0.0537	\$0.0537	\$0.0537		17.1%	17.1%					
Winter On-Pk Energy/AC (\$/MWh)	\$0.0537	\$0.0537	\$0.0537	\$0.0537		82.9%	82.9%					
Weighted Average Cost	\$0.0537	\$0.0537	\$0.0537	\$0.0537		100%	100%					
Rate Measure Administrative Costs to Incentive Costs	NA	NA	NA	NA								
IRP Discount Rate	7.00%	7.00%	7.00%	7.00%								
NTG Ratio	100%	100%	100%	100%								
Program Admin Costs per Participant	\$550	\$550	\$550	\$550								

MEASURE TYPE	BASELINE AND MEASURE PERFORMANCE				DEMAND/ENERGY SAVINGS				INCENTIVE AND PV CALCULATIONS				CUSTOMER COSTS/SAVINGS				WGTT	% Incent	B/C			
	Current Practices	Current Practices	Current Practices	Current Practices	Non-Concordant Demand	On-Pk Energy Savings	On-Pk Energy Savings	On-Pk Energy Savings	PV Carbon	PV Carbon	PV Carbon	PV Carbon	Recommended	Customer Admin	Customer Admin	Customer Admin				Customer Admin	Customer Admin	
Tier 2 - 30% EE Case (no solar)	14,880	6.45	6.45	6.45	2.60	956	2,738	2,738	51,500	37%	54,110	5350	5350	54,110	5303	13.6	8.6	70%	37%	0.92	1.08	1.36
Tier 3 - 50% ZEH Case based on 30%	14,880	6.45	6.45	6.45	4.01	2,700	7,729	7,729	53,000	26%	53,000	5350	5350	53,000	5856	23.5	20.0	30%	15%	0.56	0.66	0.83
Weighted Average					3.03	1480	4235	4235	\$1,950	33%	\$8,921	\$350	\$350	\$8,921	\$469	16.6	12.0	100%	30%	0.81	0.96	1.20

# Zero-Net Energy Homes Pilot Program

## Appendix 3 – Measure Analysis Sheet- Total Resource Cost Test

PROGRAM DATA		RATE DATA		DEMAND/ENERGY SAVINGS		INCENTIVE CALCULATIONS		CUSTOMER COST/SAVINGS		OTHER FACTORS			
Measure Type	Conservation Life (Yrs)	Rate	Rate	Concide nt Demand	Total Annual Energy Savings (kWh)	IRP PV Recommended Program	ZEH Program Incremental Cost (\$)	Gross Incremental Cost (\$)	Net Cost (with rebates)	Savings w/nc. (yrs)	Payback (yrs)	WGT. % Incent	TRC
30% EE Case (no solar)	20	0.00	0.09346	2.60	3,694	6,271	0%	4,110	4,110	349	11.8	0.0%	0.91
40% EE Case (no solar)	5	0.0872	0.09346	3.01	5,173	7,740	0%	6,496	6,496	489	13.3	0.0%	0.83
50% EE Case (no solar)	0.0572	0.0872	0.09346	3.33	5,969	8,749	0%	9,623	9,623	564	17.1	0.0%	0.70
75% Net Zero Energy Case - based on 30%	0.0572	0.0572	0.09346	3.18	9,247	15,352	600	19,228	13,562	874	17.2	16.7%	0.70
100% Net Zero Energy Case - based on 30%	0.0572	0.0572	0.09346	3.20	12,031	20,817	800	30,735	10,979	1,137	20.3	16.7%	0.62
50% Net Zero Energy Case - based on 50%	53,800	0.0586	0.09346	3.21	3,999	26,183	1,000	41,947	10,979	1,400	22.1	16.7%	0.59
75% Net Zero Energy Case - based on 50%	53,800	0.0586	0.09346	4.01	10,439	15,563	600	20,147	3,785	1,400	17.6	16.7%	0.68
100% Net Zero Energy Case - based on 50%	53,800	0.0586	0.09346	4.01	12,657	20,070	800	29,468	5,581	1,400	19.3	16.7%	0.62
Weighted Average				3.61	3,70	20,412	800	30,007	6,570	1,166	19.8	100.0%	0.62

**REDLINED**

**VERSION**

Style Definition: Heading 1: Centered

Formatted

UNS Electric, Inc.

Zero-Net Energy Homes  
Pilot Program

July 17, 2009

**Zero-Net Energy Homes Pilot Program**

**Table of Contents**

<u>Program Concept and Description</u> .....	2
<u>Target Market</u> .....	3
<u>Relation to UNS Electric’s Current Residential New Construction Programs</u> .....	3
<u>Program Objectives</u> .....	5
<u>Products and Services</u> .....	5
<u>Program Budget</u> .....	6
<u>Pilot Program Design Methodology</u> .....	7
<u>Study Results</u> .....	9
<u>Program Benefits and Costs</u> .....	12
<u>Recommendations for Pilot Program</u> .....	15
<u>Appendix 1 – Measure Analysis Sheet – 9 Cases</u> .....	18
<u>Appendix 2 – Measure Analysis Sheet – Tier 2 and Tier 3 Only</u> .....	22
<u>Appendix 3 – Measure Analysis Sheet- Total Resource Cost Test</u> .....	26
<u>I. Program Concept, Description and Recommendation</u> .....	2
<u>II. Target Market</u> .....	3
<u>III. Relation to UNS Electric’s Current Residential New Construction Programs</u> .....	3
<u>IV. Program Objectives</u> .....	3
<u>V. Products and Services</u> .....	4
<u>VI. Program Budget</u> .....	5
<u>VII. Pilot Program Design Methodology</u> .....	5
<u>VIII. Study Results</u> .....	7
<u>IX. Program Benefits and Costs</u> .....	9
<u>X. Recommendations for Pilot Program</u> .....	10
<u>Appendix 1 – Treatment of Tax Credits in Benefit Cost Tests</u> .....	11
<u>Appendix 2 – Details of Simulation Models</u> .....	13
<u>Appendix 3 – Details of Incremental Costs</u> .....	15
<u>Appendix 4 – Details of Solar Costs</u> .....	18
<u>Appendix 5 – Measure Analysis Sheet</u> .....	19

## Zero-Net Energy Homes Pilot Program

### ~~I. Program Concept, and Description and Recommendation~~

Formatted: Border: Top: (Single solid line, Auto, 2.25 pt Line width)

~~The Arizona Corporation Commission (“Commission”), in Decision No. 70522 (September 30, 2008), requested ordered UNS Electric, Inc. (“UNS Electric”) to evaluate the feasibility and cost-effectiveness for a pilot program to promote a “zero-net residential energy efficiency program.” The UNS Electric “Zero-Net Energy Homes Pilot Program” (“ZEH”) documents the results of an analysis regarding the feasibility and cost-effectiveness of promoting the proposed ZEH program design and incentive levels. This pilot program presents a program design that expands the existing New Home Construction Program through the addition of two high performance tiers. By using this recommended program design, the existing Tier 1 energy efficient new home construction scenario, the new Tier 2 energy efficient home construction scenario and the new Tier 3 near zero-net energy homes scenario will be integrated into a single New Home Construction Program. Homes will qualify for one of the three tiers in the program based on a Home Energy Rating System (“HERS”) Index score. Tier 1 will require a minimum of a HERS score that is <= 85, Tier 2 will require a minimum of HERS score <= 70, and Tier 3 will require a minimum of HERS score <= 45. This program design will allow UNS Electric to utilize existing delivery infrastructure and marketing to promote all three energy efficient home construction tiers. While the additional tiers significantly enhance the energy efficiency of the New Home Construction Program, they do not achieve 100% zero-net energy due to cost-effectiveness concerns. After considering several options for a program to promote zero-net energy buildings, UNS Electric decided to evaluate several different pilot program designs in the residential new construction sector, promoting Zero-Net Energy Homes (“ZEH”).~~

For the purposes of this report, the term “zero-net energy” is defined as:

~~the ratio between annual energy generated by the house through on-site renewable devices to the total annual energy used by the house.~~

Formatted: Font: Not Italic

Formatted: Indent: Left: 0", Right: 0"

Thus, if 75% of the annual energy a building uses comes from on-site generation, it is considered to be a 75% ZEH. There ~~would~~ be times when the building is exporting to the grid (more electricity being generated than being used), times when it is ~~using~~ importing energy from the grid (more energy being used than being generated), and periods when there is no import or export (all the energy the building needs is being generated on-site).

This report outlines the results of the planning study for a ZEH pilot program. As shown in “Recommendations for Pilot Program” (page 9 below), the results of the benefit-cost analysis shows that none of the ZEH scenarios studied actually pass the Total Resource Cost (“TRC”) test, however the recommended ZEH scenario came very close. Even though the cost-effectiveness is marginal, UNS Electric recommends proceeding with Tier 2 and Tier 3 standard, as an investment in market transformation for the residential new construction sector. Over time, UNS Electric will monitor estimated incremental costs and re-screen the program. To remain consistent in implementing only programs that meet cost effectiveness, UNS Electric does not recommend the implementation of a ZEH pilot program at this time. UNS Electric’s analysis demonstrates that achieving such high levels of energy efficiency (“EE”) and levels of zero-net energy is not cost effective as a ratepayer funded utility program, given the current estimates of avoided costs and incremental costs for high performing homes.

## Zero-Net Energy Homes Pilot Program

However, if the Commission instructs UNS Electric to proceed with implementation of a pilot program, we recommend that the requirements and incentives for the program be as follows:

- **Energy Efficiency**—Homes must be at least 50% more efficient than baseline as measured by a Home Energy Rating System (“HERS”)<sup>†</sup> index of approximately 60;
- **Renewable Energy**—Capacity of solar water heating and solar photovoltaic must be sufficient enough to reach a minimum of 50% zero-net energy over the course of a year;
- **Incentives**—Increasing homeowner incentives must be based on the projected percentage of zero-net that will be achieved in the home, as verified by a HERS index rating, as follows:

Participation Requirement	HERS Index	Incentive
Achieves Near 50% zero-net energy	≤45	\$600 per home
Achieves Near 75% zero-net energy	≤35	\$800 per home
Achieves Near 100% zero-net energy	≤25	\$1,000 per home

**II.**

### —Target Market

The target market of the ZEH Pilot Program is comprised of all individually-metered new homes that receive electric service from UNS Electric. This includes home developments, custom homes, home developments, townhomes and condominium projects where individual units are sold to homeowners, and custom home projects. The program would be marketed to all builders within the UNS Electric service territory for homes that are either all electric or have a combination of electric and natural gas energy supplies.

For the purposes of the Tier 2 energy efficiency homes and Tier 3 near zero-net energy homes optionsef this study, UNS Electric focused the enclosed savings and cost analysis on participating homes that were assumed to be all-electric, because a home using gas for space heating or water heating cannot be 100% zero-net, as the renewable devices cannot replace all of the energy used by the house. If a home uses gas for space heating or water heating, then it cannot be 100% zero-net energy, as the renewable devices cannot replace all of the energy used by the house. However, by providing a tiered program approach, UNS Electric will have the opportunity to promote the second tier of efficiency for homes constructed with a combination of electric and natural gas energy supplies, even if these homes cannot achieve the Tier 3 near zero-net approach.

### **III. —Relation to UNS Electric’s Current Residential New Construction Programs**

The existing UNS Electric residential currently runs two residential new construction programs already offers two construction approaches, as described below. The Energy Smart Solar Home Program described below will most likely be replaced by the new Tier 3 near zero-net option, if approved by the Commission.

<sup>†</sup>The HERS index takes into account all the EE and renewable energy measures in the house. The lower the HERS index, the more EE and closer the home is to zero-net.

Formatted: Heading 1, Left

Formatted: Heading 1, Left, No bullets or numbering, Don't adjust space between Latin and Asian text

Formatted: Bullets and Numbering

Formatted: Heading 1, Left, No bullets or numbering

Formatted: Heading 1, Left, No bullets or numbering

Formatted: Bullets and Numbering

Formatted: Heading 1, Indent: First line: 0"

Formatted: Heading 1

Formatted: Heading 1, Left, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Left, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Border: Bottom: (No border)

Formatted: Heading 1, Left, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Border: Top: (Single solid line, Auto, 2.25 pt Line width)

Formatted: Heading 1, Left, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Border: Top: (Single solid line, Auto, 2.25 pt Line width)

**Zero-Net Energy Homes Pilot Program**

- **Energy Smart Homes** – This program mirrors the 2006 ENERGY STAR Homes<sup>®</sup> standards. The requirement for the program is a HERS index of 85 or lower, and the builder incentive offered for this program is \$400.
- **Energy Smart Solar Home Program** – This program, ~~initiated in December 2008,~~ is based on the Energy Smart Homes program, ~~in addition to solar Photovoltaic -plus the following- solar (“PV”)~~ or solar thermal and proper HVAC sizing. All guidelines in the RECPP must be followed for the solar thermal or PV additions.

Formatted: Superscript

~~In order to keep program administrative costs down and to streamline the presentation of UNS Electric’s residential new construction programs to the marketplace, the program design is to make the zero-net energy homes program will merge the zero-net energy homes program with the existing Energy Smart Homes Program. Two additional tiers of increasing efficiency will be added to the Energy Smart Homes program to give participating builders and home buyers options for increasing energy savings, installing renewable energy, and receiving higher incentives.~~

~~The levels of efficiency for the new tiers will be based on how the homes perform based on a HERS Index score, which awards a numerical value gauging the homes performance. Higher performing homes achieve a lower HERS score.~~

~~In order for homes to qualify for each tier, they must meet the minimum HERS Index Scores from on-site testing by certified HERS Raters as shown in Exhibit 1.~~

**Exhibit 1: HERS Index Scores for Residential New Home Construction Program**

<u>Tier 1 (Existing Program)</u>	<u>HERS Index Score of &lt;= 85</u>
<u>Tier 2 (New Level Energy Efficiency Only)</u>	<u>HERS Index Score of &lt;= 70</u>
<u>New Level 50% Zero-Net energy)</u>	<u>HERS Index Score of &lt;= 45</u>

- Formatted: Left
- Formatted: Centered, Indent: Left: 0.25"
- Formatted Table
- Formatted: Left
- Formatted: Centered, Indent: Left: 0.25"
- Formatted: Left
- Formatted: Centered, Indent: Left: 0.25"
- Formatted: No bullets or numbering
- Formatted: Bullets and Numbering

~~A number of additional items will be added to the construction standards in order for builders to achieve the second tier (HERS 70) and the third tier (HERS 45). As a result of these necessary additions, the incremental cost to build homes to the higher tiers will increase, and therefore, the recommended incentive to the builder will also increase. Modifications to the construction standards to achieve the Tier 2 and 3 homes are likely to include:~~

- ~~Greater envelope and HVAC energy efficiency standards; than for the existing programs, with an additional category of measures, to include lighting;~~
- ~~Ducts are located within conditioned space;~~

Formatted: Bullets and Numbering

~~Both To make a ZEH program worthwhile, it would need to be clearly distinguishable from the existing programs, as they already incorporate many of the features of a zero-net energy home. The concept behind a pilot program would be to improve efficiencies of UNS Electric’s current programs.~~

Formatted: Indent: Left: 0", First line: 0", Bulleted + Level: 1 + Aligned at: 0.25" + Indent at: 0.5"

~~In order to meet this goal, other factors that are not incorporated in the existing programs will need to be added. These include:~~

~~Greater envelope and HVAC EE standards than existing programs, with an additional category of measures to include lighting;~~

Formatted: No bullets or numbering

- ~~Both~~ PV and solar water heating on all homes ~~at the highest tier on the ZEH;~~
- ~~Passive solar design that incorporates passive solar heating in the winter and shading in the summer for the highest efficiency homes; and~~

**Zero-Net Energy Homes Pilot Program**

- [Energy sStar<sup>®</sup> fixed appliances, and;](#)
- [CFL lighting.](#)
- 

Formatted: Bullets and Numbering

Formatted: Indent Left: 0.5", No bullets or numbering

Formatted: Bullets and Numbering

Formatted: Border: Top: (Single solid line, Auto, 2.25 pt Line width)

---

**IV. — Program Objectives**

The Program's objectives are:

- Reduce peak demand and overall energy consumption (electric) in new homes;
- Implement programs that include more aggressive energy efficiency standards that produce savings of at least 20% above baseline (HERS 70) and a near zero-net percentage of at least 50% (HERS 45) where approximately 50% of annual energy used by the home will come from on-site renewable generation;
- ~~Stimulate construction of ZEH that have a zero-net percentage of at least 50% (i.e., 50% to 100% of annual energy used by the home is generated by on-site renewable facilities);~~
- Stimulate the installation of solar photovoltaic systems and solar water heaters in new homes;
- Stimulate ~~E~~Energy efficiency standards that are higher than EPA/DOE Energy Star Homes<sup>®</sup> performance standards;
- Stimulate construction of new homes that are inspected and tested to assure energy performance;
- Stimulate the installation of high efficiency heating and cooling systems, envelope, lighting, and fixed appliances (Energy Star<sup>®</sup> products);
- Assist sales agents with promoting and selling of zero-net energy homes;
- Provide information to help explain the benefits of zero-net energy home features;
- Train builder construction staff and sub-contractors in advanced building-science concepts to reach zero-net energy goals through improved design and installation practices, and through the installation of renewable energy devices;
- Increase homebuyer awareness and understanding of the benefits they receive from living in a zero-net energy home and how they can improve the performance of their home; and
- Educate builders who: 1) are not familiar with energy savings and on-site generation potential; 2) may be uncertain about zero-net energy performance; and 3) may be concerned about high initial costs for construction measures.

---

**V. — Products and Services**

The ZEH Pilot Program design would provide several products and services, including;

- Promotion of builders and subdivisions that achieve zero-net energy levels of at least 50%;
- Builder and sub-contractor education and training;
- Educational and promotional materials for builders and new home buyers; and
- 

Formatted: Border: Top: (Single solid line, Auto, 2.25 pt Line width)

Formatted: Justified, Bulleted + Level: 1 + Aligned at: 0.25" + Indent at: 0.5", Border: Bottom: (No border)

**Zero-Net Energy Homes Pilot Program**

- Homeowner or builder incentives for achieving increasing energy efficiency and zero-net energy levels as measured by a HERS index score of either  $\leq 70$  or  $\leq 45$ , as shown in Exhibit 1. These incentives would be paid based on the HERS index of the home as measured after construction.

**Formatted:** Bulleted + Level: 1 + Aligned at: 0.25" + Indent at: 0.5"  
**Formatted:** Bullets and Numbering

Exhibit 1: Zero-Net Energy Homes Program Prescriptive Incentives

Participation Requirement	HERS	Incentive
	Index	
Achieves Near 50% Zero-Net Energy	$\leq 45$	\$600 per home
Achieves Near 75% Zero-Net Energy	$\leq 35$	\$800 per home
Achieves Near 100% Zero-Net Energy	$\leq 25$	\$1,000 per home

**Formatted:** Normal, Justified, Indent: Left: -0.25", Bulleted + Level: 1 + Aligned at: 0.25" + Tab after: 0.5" + Indent at: 0.5"

**Formatted:** Justified, Indent: Left: -0.25", Space Before: 6 pt, After: 0 pt, Bulleted + Level: 1 + Aligned at: 0.25" + Tab after: 0.5" + Indent at: 0.5"

**Formatted:** Indent: Left: -0.25", Space Before: 6 pt, After: 0 pt, Bulleted + Level: 1 + Aligned at: 0.25" + Tab after: 0.5" + Indent at: 0.5"

**Formatted:** Indent: Left: -0.25", Space Before: 6 pt, After: 0 pt, Bulleted + Level: 1 + Aligned at: 0.25" + Tab after: 0.5" + Indent at: 0.5"

**Formatted:** Indent: Left: -0.25", Space Before: 6 pt, After: 0 pt, Bulleted + Level: 1 + Aligned at: 0.25" + Tab after: 0.5" + Indent at: 0.5"

**Formatted:** Justified, Border: Bottom: (No border)

Note: The HERS index takes into account all the EE and renewable energy measures in the house. The lower the HERS index, the more EE and closer the home is to zero net. The HERS index requirement for the Energy Smart Homes program is 85 or less, so this program would produce an improvement of between 50% and 76% from the existing program. This is reflected in the increased incentives. Also note that this incentive is not designed to be an additive to the \$400 incentive for the Energy Smart Homes program, but a stand-alone incentive.

**VI. Program Budget**

**Formatted:** Border: Top: (Single solid line, Auto, 2.25 pt Line width)

This section presents an estimate of only the additional incremental cost associated with promotion of a multi-tiered program that includes Tier 2 and Tier 3 options. Using the Energy Smart Homes program budget as a basis, Exhibits 2 and 3 present estimated pilot program budgets over a five-year period, from 2009-2013. This budget represents only the incremental increase in budget over the budget approved for the current Energy Smart Home Program. Overall, the Company anticipates that 25 homes per year will participate in the pilot program in 2010, of which 70% will be at Tier 2 and 30% at Tier 3, with overall participation increasing at 10% per year over time. Estimating the additional cost associated with promotion of a ZEH pilot program. Given this program would require significant training and coordination with builders and homeowners, UNS Electric anticipates the majority of program expenses would be in program promotion and implementation costs, as opposed to direct incentives.

On average, over the life of the program, incentives are expected to account for 28.5% of the total budget.

## Zero-Net Energy Homes Pilot Program

**Exhibit 1: 2009-2012 Program Budget Details**

Year	2010	2011	2012
Financial Incentives	<del>\$20,200</del> 48,000	<del>\$2,500</del> 21,800	<del>\$23,200</del> 55,500
Total Direct Implementation	<del>\$43,065</del> 7,068	<del>\$43,292</del> 7,106	<del>\$43,519</del> 7,143
Total Marketing Allocation	<del>\$5,6288</del> 60	<del>\$6,0459</del> 29	<del>\$6,4629</del> 97
Total Administrative and O&M Cost Allocation	<del>\$5,0656</del> 96	<del>\$5,4407</del> 52	<del>\$5,8158</del> 08
Total EM&V Cost Allocation	<del>\$1,1261</del> 58	<del>\$1,2091</del> 70	<del>\$1,2921</del> 83
<b>Total Program Budget</b>	<del>\$75,083</del> <b>56,782</b>	<del>\$77,786</del> <b>61,457</b>	<del>\$80,288</del> <b>64,631</b>

Formatted: Font: 12 pt

Formatted Table

Formatted: Centered

Formatted: Font: 12 pt

Formatted Table

**Exhibit 2: 2009-2013 Program Budget Incentives as % of Program Budget**

Year	2010	2011	2012
Total Budget	<del>\$75,083</del> 56,782	<del>\$77,786</del> 61,457	<del>\$80,288</del> 64,631
Incentives	<del>\$20,200</del> 48,000	<del>\$21,800</del> 52,500	<del>\$23,200</del> 55,500
Administrative Costs	<del>\$53,781</del> 8,782	<del>\$53,781</del> 8,782	<del>\$53,781</del> 8,782
<b>Incentives as % of Budget</b>	<b>2785%</b>	<b>2885%</b>	<b>2986%</b>

Formatted: Font: Bold

### VII.—Pilot Program Design Methodology

Formatted: Border: Top: (Single solid line, Auto, 2.25 pt Line width)

The approach used in the feasibility assessment for a ZEH pilot program was to develop a baseline simulation model of a new home; ~~next, develop and then~~ several versions of the baseline model with increasing levels of ~~EE~~energy efficiency; and, finally, ~~develop~~ several versions of the ~~EE~~energy efficiency models with increasing levels of zero-net energy goals.

The four stages of the study were:

- 1) Define and simulate a baseline home, reflecting current practices for new single family homes in Kingman, Arizona, as an approximate representative location for UNS Electric territory. The home was modeled as all-electric;
- 2) Define and simulate three homes with increasing levels of efficiency. The targets for the models were a 30%, 40% and 50% reduction in annual energy use;
- 3) Simulate three homes with increasing levels of zero-net energy by adding both solar water heating and solar PV. The targets for the models were 50%, 75%, and 100% zero-net energy levels. These models were based on either the 30% or the 50% ~~EE~~energy efficiency home; and

## Zero-Net Energy Homes Pilot Program

- 4) Combine estimated demand and energy savings from all of the models, incremental costs over baseline costs, and other utility data to produce a benefit-cost test result for each model. This was done in the format of a Measure Analysis Sheet.

The models were developed with the eQuest™ simulation software to generate savings estimates, and in addition, the homes were ~~also~~-modeled with REM/Rate simulation software in order to determine what HERS index they would achieve.

Formatted: Border: Bottom: (No border)

The baseline home simulation model was an all-electric, 1,850 square-foot home in Kingman, Arizona. The level of efficiency in the baseline model was based on a combination of three sources: the 2007 Enovity Report<sup>2</sup>, the 2003 International Energy Conservation Code for residential new construction, and a 2009 study completed by Summit Blue Consulting to determine baseline construction standards in the UNS Electric service territory.

Formatted: Don't adjust space between Latin and Asian text, Border: Bottom: (No border)

In total, ~~n~~Nine cases were developed ~~altogether~~, three of which were with only EE energy efficiency, ~~three zero-net models based on a 30% EE energy efficient house~~, and three zero-net models based on a 50% ~~EE energy efficient~~ house.

Formatted: Border: Bottom: (No border)

In developing the ~~EE energy efficiency~~-only models, a goal of 30%, 40% and 50% reduction in annual energy use over the baseline was initially set. Various efficiency measures were added to the baseline to produce increasing levels of savings, including the following:

- **Orientation:** Orienting a house in a north-south direction. (This is normally not possible when working with production builders in subdivision design, and can typically only be applied to custom projects.);
- **Windows:** Reducing total window area; increasing window area on south-facing wall to increase passive solar heating; and reducing glass U and SHGC values;
- **HVAC Measures:** Reducing infiltration; reducing duct leakage; heat pump quality installation; increasing heat pump SEER and COP or HSPF values; moving ducts into conditioned space;
- **Envelope:** Increasing R values in walls and ceiling;
- **Lighting:** Reducing lighting power density; and
- **Appliances:** Replacing standard fixed appliances with Energy Star® fixed appliances.

The zero-net cases had goals of 50%, 75%, and 100% zero-net energy for the year. They were based on either the 30% ~~energy efficient EE~~ home, or the 50% ~~energy efficient EE~~ home (i.e., ~~solar water heating and solar PV were added to the measures already included in those models~~).

In developing the zero-net models, estimated hourly output from a solar water heating system and a solar PV system were subtracted from the hourly total energy use of the 30% ~~energy efficiency EE~~ or 50% ~~EE energy efficiency~~ model results, giving the net hourly and net annual use of the home. The solar output was estimated using PVWatts simulation software for the solar PV system, and an in-house built spreadsheet model for the solar water heating system. The hourly model results were used to determine coincident and non-coincident peak demand for each case.

Finally, incremental costs were researched for each combination of measures in each model and are detailed in the Measure Analysis Sheets ("MAS"), as shown in Appendices 1, 2 and 3.

---

<sup>2</sup> Residential Home Standards: Energy Analysis and DOE-2 Simulation, Prepared by Enovity Inc for Tucson Electric Power Company, February 12th, 2007

## Zero-Net Energy Homes Pilot Program

### VIII.—Study Results

Formatted: Border: Top: (Single solid line, Auto, 2.25 pt Line width)

The results of the study are presented in Exhibit 4. Each model is represented in one column—the baseline home (standard practice), the homes with only EE measures, and the homes with both EE and renewables (Zero-Net).

The total annual consumption of the house is given on line 1 of Exhibit 4. This is the net consumption for the year, and it includes the power generated by the solar water heater and solar PV. Hence, for the 100% zero-net models, this is close to zero.

Peak coincident demand is the maximum demand of the home during peak hours, as defined by the residential rate (summer: 2 to 6 p.m., weekdays; winter: 6 a.m. to 10 a.m. and 5 p.m. to 9 p.m., weekdays). Non-coincident peak demand is the maximum demand of the home in any hour of the year. This peak occurs in the early morning in January, due to electric heating load.

The HERS Index<sup>3</sup> for each case, as generated by the REM/Rate model, is shown in the last row of Exhibit 4. All but the 30% EE case of the non-baseline models have a HERS index of less than 70, indicating that builders would likely benefit from the \$2,000 Federal tax credit for 50% energy savings for heating and cooling over the 2004 International Energy Conservation Code (“IECC”).

As detailed in Exhibit 4, the baseline home model consumption is 14,880 kWh per year and the HERS Index for this model is 104. As noted in the description of the different model scenarios, energy consumption decreases and the HERS Index improves as the number and amount of efficiency measures and efficient designs increase and renewables are added.

After reviewing a variety of different modeling scenarios, with varying levels of efficiency and percentages of zero-net energy, and associated HERS index scores and cost-effectiveness, the pilot program design proposes two additional higher performing Tiers (additional detail on model results for different scenarios is included in the MAS sheets, as shown in Appendices 1, 2 and 3).

Tier 1 is the current Energy Smart Homes qualifying standard at a HERS index of  $\leq 85$ . Re-analysis of the existing Energy Smart Homes program was not included in this pilot program design.

Tier 2 is a proposed new Energy Smart Homes Plus and has a qualifying HERS index score of  $\leq 70$ . (Phil took this out of TEP’s: “Annual energy savings are estimated to be 3,694 kWh/yr and estimated peak demand savings of 2.71 kW.”) (TEP had this sentence: “This home is modeled to be approximately 30% more efficient than the baseline home.”)

Formatted: Not Highlight

Formatted: Not Highlight

Tier 3 is a proposed new Energy Smart Homes Near Zero-Net and has a qualifying HERS index score of  $\leq 45$ . This home is modeled to be approximately 50% zero-net energy and is based on the home that is approximately 50% more efficient than the baseline home. (Phil took this out of TEP’s: “Annual energy savings from efficiency improvements and incorporation of renewables are estimated to be 9,247 kWh/yr and estimated peak demand savings are estimated to be 3.39 kW.”) The percentage decrease in annual consumption, when compared to the base case for the three EE-only models, did not in fact reach the

<sup>3</sup> The HERS Index is a scoring system established by the Residential Energy Services Network (RESNET) in which a home built to the specifications of the HERS Reference Home (based on the 2006 International Energy Conservation Code) scores a HERS Index of 100, while a 100% net-zero energy home scores a HERS Index of 0. The lower a home’s HERS Index, the more energy efficient it is. Each 1-point decrease in the HERS Index corresponds to a 1% reduction in energy consumption compared to the HERS Reference Home.

**Zero-Net Energy Homes Pilot Program**

goals that were set. The 30% EE home saved 25%, the 40% EE home saved 35%, and the 50% EE case saved 40% of annual consumption, when compared to the baseline model.

Focusing just on those modeled homes that approach varying percentages of zero-net energy, the HERS Index ranges from 50 for a home that is 30% more efficient than the baseline home and self-generates 50% of its energy consumption through the use of PV and solar hot water, to a HERS Index of 20 for the 100% zero-net home with 50% improvements in EE as compared to baseline.

**Exhibit 3: Results of Simulation Modeling**

	Baseline Home	30% EE home Tier 2: HERS Index <=70	40% EE home Tier 3: HERS Index <=45
Modeled -Annual Consumption (kWh)	14,880	11,186	9,707 4,451
Peak Demand – Coincident (kW)	6.45	3.7485	3.244
Peak Demand – Non-Coincident (kW)	n/a	3.8536	3.44924
Annual kWh Savings	n/a	94	7
Annual Peak kW Savings	n/a	2.7173	3.3967
HERS Index	104	27	39

Formatted: Font: 12 pt

Formatted: Font: 11 pt

Formatted Table

Formatted: Font: 11 pt

Formatted: Centered

**Zero-Net Energy Homes Pilot Program**

Total annual participation goals and energy savings are presented in Exhibit 4~~Exhibit 5~~Exhibit 5.

Formatted: Font: 12 pt

The current status of home construction throughout the country leads UNS Electric to believe there would be a limited number of builders and/or customers willing to incur the additional costs of the program at this time. ~~Therefore, for~~ the purpose of this analysis, UNS Electric ~~thus~~ expects to start with a maximum of 25 participants in 2010, with an estimated 70% achieving Tier 2 and 30% achieving Tier 3. UNS Electric anticipates an annual increase in participation of 10% per year. Exhibit 5 provides further information about estimated incremental energy savings for the program. This forecast does not include participants in Tier 1 – the existing Energy Smart Home Program, about half of whom will achieve the minimum 50% ZEH target, with an annual increase in participation of 10% per year. Exhibit 5 provides further information about estimated energy savings.

**Exhibit 4: Zero-Net Energy Homes Program Annual Demand and Energy Savings**

Formatted: Font: 12 pt

Year	2010	2011	2012	Total
Participants at Tier 2: Energy Smart Homes Plus (Index <= 70) Projected ZEH Participants/Year	1827	2919	3421	5846
Participants at Tier 3: Energy Smart Homes Near Zero-Net (50% zero-net) Participants at 50% Zero-Net Energy	713	148	158	713
Projected Total Tier 1 and 2 participants/year Participants at 75% Zero-Net Energy	258	278	299	8142
Annual Energy Savings (MWh) Participants at 100% Zero-Net Energy	1396	7154	7161	33845
Cumulative Energy Savings (MWh) Coincident Peak Savings (kW)	91.5139	98.2293	105.0454	494.5887
Annual Energy Savings (MWh)	305.4	329.4	350.7	1,651
Cumulative Energy Savings (MWh)	589	919	1,270	4,713

Formatted: Font: 11 pt

Formatted Table

Formatted: Font: 11 pt

Formatted: Highlight

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: Highlight

Formatted: Font: 11 pt

## Zero-Net Energy Homes Pilot Program

---

### **IX. Program Benefits and Costs**

A Measure Analysis Sheet (MAS) was developed for the nine different cases that were assessed, to gauge the benefit/cost results of different ZEH scenarios and assist in the selection of the Tier 2 and Tier 3 standards, included as Attachment 1. A Separate MAS was developed for the two cases that represent the Tier 2 and Tier 3 standards, included as Attachment 2. In addition to estimating the savings from each measure, this analysis relies on a range of other assumptions and financial data provided in Exhibit 6.

Formatted: Border: Top: (Single solid line, Auto, 2.25 pt Line width)

**Zero-Net Energy Homes Pilot Program**

**Exhibit 5: Other Financial Assumptions**

	Value		
	Low	Medium	High
Carbon AC \$/kWh	\$0.0212	\$0.0371	\$0.0637
Summer On-pk Energy AC (\$/kWh):	\$0.0872		
Summer Off-pk Energy AC (\$/kWh):	\$0.0525		
Winter On-pk Energy AC (\$/kWh):	\$0.0672		
Winter Off-pk Energy AC (\$/kWh):	\$0.0586		
IRP Discount Rate	7.00%		
Conservation Life (yrs):	20		
NTG Ratio:	100%		
Program Admin Costs per Participant	\$350		

- Formatted: Font: 12 pt, Bold
- Formatted: Font: Bold
- Formatted: Font: 11 pt
- Formatted Table
- Formatted: Font: 11 pt

\* UNS Electric met on three occasions during 2009 with Commission Staff to 1) develop a methodology to determine cost-effectiveness, based on the use of the societal test, that would be comparable to the methodology used by the Commission Staff in their own analysis, 2) gain agreement that the values used in cost-effectiveness calculations for DSM/EE Programs should be the same as those values reported in the Company's Integrated Resource Plan, and 3) provide Staff with updated avoided cost tables for UNS Electric, Tucson Electric Power Company and UNS Gas, Inc.. As a result of these meetings UNS Electric modified cost-effectiveness calculations to represent a more realistic Societal Cost test. The three most significant changes in the UNS Electric evaluation of cost effectiveness now include:

- Use of load-curves in addition to on-peak and off-peak levelized energy costs to calculate avoided cost of energy to match Commission Staff calculations;
- Use of a point-in-time methodology that does not include carrying costs of capital, to calculate avoided cost of capacity to match Commission Staff calculation of the societal test. Note: while the California Standard Practice Manual, 2002 version, is explicit on this approach, UNS Electric would like to continue conversations with Commission Staff on whether this approach is actually consistent with how the societal cost tests are actually calculated by the California utilities; and
- A valuation of Carbon Dioxide (CO2) at a low, medium, and high projection starting at \$14, \$25, or \$43/ton, and inflating over time based on information that will be reported in the 2009 IRP. Inclusion of an estimated carbon value as an externality cost is consistent with the societal cost test methodology.

Conservation Life (yrs):	20
Program Life (yrs):	5
Demand Avoided Cost ("AC") (\$/kW):	\$64.94
Energy AC (\$/kWh):	\$0.07314
Administrative and Implementation Costs*	\$2,800
IRP Discount Rate	7.00%
Social Discount Rate	5.00%

- Formatted: Normal
- Formatted: Font: 11 pt
- Formatted: Font: 9 pt

\*Represents estimated administration and implementation costs per home participating in the program.

## Zero-Net Energy Homes Pilot Program

Although Commission Staff advised UNS Electric to include a valuation of CO2 in the benefit-cost calculations for the societal test, Commission Staff and UNS Electric also understand it is up to the Commissioners to accept or deny this value. Until the Commission provides a formal acceptance regarding inclusion of CO2 in the calculation of the Societal Cost ("SC") test, UNS Electric will continue to provide results of the Total Resource Cost ("TRC") test for Commission review. Exhibit 7 provides a summary of program costs and benefits for the proposed Tier 2 and Tier 3 homes, including the TRC test and the SC test results<sup>4</sup>. Savings are net based on 100% net-to-gross ratio.

Exhibit 7 provides the program costs and benefits, the TRC test and the Societal Cost (SC) test results<sup>5</sup>. Savings are net based on 100% net to gross ratio. Details of the incremental costs are presented in Appendix 3 and Appendix 4, and the full MAS is presented in Appendix 5.

As demonstrated in Exhibit 7, all of the TRC values are less than 1, indicating that the ZEH Pilot Program is not cost effective at this time. This shows that achieving such high levels of EE and levels of zero-net energy is not cost effective as a ratepayer funded utility program, given the current estimates of avoided costs and incremental costs for high performing homes.

The TRC values for the EE homes decrease as the level of efficiency increases, indicating that the efficiency measures introduced do not save enough energy to make them cost effective, when considered from the point of view of UNS Electric. The TRC is even less for the cases with renewable energy. The incremental costs and TRC values for modeled homes range from \$4,110 for the 30% efficient home with a TRC value of 0.76 to \$41,947 in additional incremental costs for the 100% zero-net home based on the 30% EE case with a TRC value of 0.59.

### Exhibit 6: Benefit-Cost Analysis Results

	30% efficient home Tier 2: HERS Index ≤70	40% efficient home Tier 3: HERS Index ≤45 (50% Zero-Net)
Incremental Costs	\$4,110	\$20,147,496
State/Federal Tax Credits	\$0-	-\$2,785

Formatted: Font: 12 pt

Formatted: Font: 11 pt

Formatted Table

Formatted: Font: 11 pt

Formatted: Font: 11 pt

<sup>4</sup> State and Federal tax credits for solar PV and solar water heating were added to the TRC benefits according to the methodology outlined in the California Standard Practice Manual as a one-time benefit to the avoided costs. Tax credits were not included in the SC test, as they are considered to be a pass-through. Solar rebates were not included at all in the benefit-cost calculations.

<sup>5</sup> State and Federal tax credits for solar PV and solar water heating were added to the benefits according to the methodology outlined in the California Standard Practice Manual. For the TRC test, they were added as a one-time benefit to the avoided costs. Tax credits were not included in the SC test, as they are considered to be a pass-through. Solar rebates were not included at all in the benefit-cost calculations. A detailed discussion of the TRC and SC is given in Appendix 1.

**Zero-Net Energy Homes Pilot Program**

UniSource Solar Rebates	-\$0	-\$3,679
Total Resource Cost ("TRC")	0.7691	0.720
Societal Test ("SC") – Low Carbon Avoided Costs	0.92	0.56
Societal Test ("SC") – High Carbon Avoided Costs	01.8936	0.835

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted Table

Formatted: Border: Bottom: (No border)

Formatted: Border: Top: (Single solid line, Auto, 2.25 pt Line width)

**X. — Recommendations for Pilot Program**

Given the results of the benefit-cost tests, UNS Electric recommends proceeding with Tier 2 and Tier 3 standard, as an investment in market transformation for the residential new construction sector, even though the cost-effectiveness is marginal, as an investment in market transformation for the residential new construction sector. Over time, UNS Electric will monitor estimated incremental costs and re-screen the program. ~~This sentence is not in the TEP filing: "Due to the significant increase in incremental costs, UNS Electric is also recommending a significant increase in the incentive offered to builders who choose to participate at the Tier 2 or Tier 3 level."~~ Exhibit 8 below presents the proposed tiers, qualifying standards, and incentive levels.

**Exhibit 8: UNS Electric Energy Efficient Homes Program Prescriptive Incentives**

<b>Participation Requirement</b>	<b>HERS Index</b>	<b>Incentive</b>
Tier 1: Energy Smart Homes (Current Program)	<=85	\$400 per home
Tier 2: Energy Smart Homes Plus	<=70	\$1,500 per home
Tier 3: Energy Smart Homes Near Zero-Net (50% ZEH)	<=45	\$3,000 per home

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: Font: 11 pt

## Zero-Net Energy Homes Pilot Program

The results of the benefit cost analysis show that none of the ZEH scenarios studied pass the TRC test. To remain consistent with implementing only programs that meet cost effectiveness, UNS Electric does not recommend the implementation of a ZEH pilot program. UNS Electric's existing Energy Smart and Energy Smart Solar Homes programs are providing builders significant opportunities to advance building design and integration of renewables. The Federal \$2,000 tax credit for homes that achieve at least 50% greater efficiency in heating and cooling compared to a baseline home also provides motivation to advance building science for efficiency and integration of renewables in the residential sector.

UNS Electric will continue to co-promote efficiency and renewables to meet program DSM and REST goals; and for this reason it is UNS Electric's position that the added cost for a ZEH program is not in the best interest of the majority of UNS Electric ratepayers. However, if the Commission instructs UNS Electric to proceed with implementation of a pilot program, we recommend that the requirements and incentives for the program be as follows:

- Energy Efficiency—Homes must be at least 50% more efficient than baseline as measured a Home Energy Rating System (“HERS”) index of approximately 60;
- Renewable Energy—Capacity of solar water heating and solar photovoltaic must be enough to reach a minimum of 50% zero-net energy over the course of a year;

Note:  
HERS  
takes  
account  
energy

Participation Requirement	HERS Index	Incentive
Achieves Near 50% zero-net energy	≤45	\$600 per home
Achieves Near 75% zero-net energy	≤35	\$800 per home
Achieves Near 100% zero-net energy	≤25	\$1,000 per home

The  
index  
into  
all the

efficiency and renewable energy measures in the house. The lower the HERS index, the more energy efficient and closer the home is to zero-net. (This is not in TEP's filing: “The HERS index requirement for the Energy Smart Homes program is 85 or less, so this program would produce an improvement of between 50% and 76% from the existing program. This is reflected in the increased incentives.”) Also note that this incentive is not designed to be added to the \$400 incentive for the Energy Smart Homes program, but a stand-alone incentive.

Formatted: Heading 1

Formatted: Heading 1, No bullets or numbering

Formatted: Bullets and Numbering

Formatted: Heading 1, Justified, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Justified, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Justified, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

Formatted: Heading 1, Justified, Space Before: 0 pt, After: 0 pt, Don't keep with next, Don't keep lines together

**Formatted:** Font: Bold

**Formatted:** Left: 1", Right: 1", Top: 1",  
Bottom: 1", Width: 11", Height: 8.5"



**Zero-Net Energy Homes Pilot Program**

**Appendix 1— Treatment of Tax Credits in Benefit-Cost Tests  
Notes on Tax Credits and the TRC**

**For both renewable energy and EE measures included in utility programs there are three types of costs that need to be considered:**

- 1) Incremental measure cost (incremental cost to buy and install the measure, compared to a baseline);
- 2) Direct up-front rebates (utility or other rebates *not connected* with the program being analyzed); and
- 3) Tax credits (State and Federal) that the participant can take advantage of.

Shown below is the definition of the TRC calculation:

**Exhibit 9: Definition of the TRC calculation from the California Standard Practice Manual**

$$\begin{aligned} NPVTRC &= BTRC - CTRC \\ BCRTRC &= BTRC / CTRC \\ LCTR &= LCRC / IMP \end{aligned}$$

Where:

- NPVTRC = Net Present Value of Total Costs of the Resource
- BCRTRC = Benefit-Cost Ratio of Total Costs of the Resource
- LCTR = Levelized Cost per Unit of the Total Cost of the Resource (Cents per kWh for Conservation Programs; Dollars per kW for Load Management Programs)
- BTRC = Benefits of the Program
- CTRC = Costs of the Program
- LCRC = Total Resource Costs Used for Levelizing
- IMP = Total Discounted Load Impacts of the Program
- PCN = Net Participant Costs

The BTRC, CTRC, LCRC, and IMP terms are further defined as follows:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Formatted: Bullets and Numbering

## Zero-Net Energy Homes Pilot Program

In calculating the TRC benefit-cost ratio (BC/TRC), the tax-credit term (TC) is included in the PV Benefits term (BTRC); it is added to the utility-avoided costs (but not included in the NPV calculation as it is a one-time benefit). The tax-credit term is not used to calculate the CTRC term (program costs). Direct rebates are not included at all in the TRC, although it could be argued that they should be subtracted from the TRC will be:

$$\text{BC/TRC} = \frac{\text{BTRC} + \text{CTR}}{\text{NPV}(\text{UAC}) + \text{TC} + \text{NPV}(\text{PRC} + \text{PCN})}$$

Where:

$$\begin{aligned} \text{BTRC} &= \text{Benefits of the Program} \\ \text{CTR} &= \text{Costs of the Program} \\ \text{UAC} &= \text{Utility-Avoided Supply Costs} \\ &\quad + \text{Tax Credits} \\ \text{TC} &= \text{Program Administrator Costs} \\ \text{PRC} &= \text{Net Participant Costs (Incremental Measure Costs)} \\ \text{PCN} &= \text{Net Present Value} \end{aligned}$$

In the Measure Analysis Sheet, the Benefits of the program are calculated as:

$$(\text{PV}(\text{TRP\_Discount\_Rate} + \text{Energy\_Savings} \times \text{Energy\_Avoided\_Cost} \times (1 + \text{Line\_Loss\_Factor})) + \text{Tax\_Credits}) \times \text{NTG\_Ratio}$$

The Costs of the program are calculated as:

$$(\text{Administrative\_Costs} + \text{Incremental\_Costs}) \times \text{NTG\_Ratio}$$

Societal Cost Test and thus left out of the SC test:

Societal Cost Test  
 Tax credits are treated as transfer payments in the Societal Cost Test and thus left out of the SC test:  
 In the MAS the societal cost test is calculated as:  

$$-\text{PV}(\text{Social\_Discount\_Rate} + \text{Conservation\_Life}, (\text{Coincident\_demand\_savings} \times \text{Demand\_Avoided\_Cost} \times (1 + \text{Line\_Loss\_Factor})) + \text{Energy\_Savings} \times \text{Energy\_Avoided\_Cost} \times (1 + \text{Line\_Loss\_Ratio})) + \text{Administrative\_Costs} + \text{Incremental\_Costs}) \times \text{NTG\_Ratio}$$

**Zero-Net Energy Homes Pilot Program**

## Zero-Net Energy Homes Pilot Program

### Appendix 2 – Measure Analysis Sheet – Tier 2 and Tier 3 Only

Formatted: Normal

PROGRAM DATA	BASELINE AND MEASURE PERFORMANCE			DEMAND/ENERGY SAVINGS				INCENTIVE AND PV CALCULATIONS				CUSTOMER COSTS/SAVINGS				WGT		% Incent	B/C	
	Low	Medium	High	Current Practices Annual kWh	Current Practices Annual kWh	Current Practices Annual kWh	Non-Con. Demand Annual kWh	24h Demand Annual kWh	24h Non-Con. Demand Annual kWh	24h Demand Annual kWh	24h Non-Con. Demand Annual kWh	24h Demand Annual kWh	24h Non-Con. Demand Annual kWh	24h Demand Annual kWh	24h Non-Con. Demand Annual kWh	24h Demand Annual kWh	24h Non-Con. Demand Annual kWh		24h Demand Annual kWh	24h Non-Con. Demand Annual kWh
<b>PROGRAM DATA</b> Conservation Life (Yrs): 30 Carbon D (kWh Energy AC (S/NWh): 52,513 Summer On-Peak Energy AC (S/NWh): 52,513 Summer Off-Peak Energy AC (S/NWh): 52,513 Winter On-Peak Energy AC (S/NWh): 52,513 Winter Off-Peak Energy AC (S/NWh): 52,513 Weighted Avoided Cost: \$51.984 Administrative Costs to Incentive Costs: 7.00% IPR Discount Rate: 100% PV Ratio: 100% Program Admin. Costs per Participant: \$325	<b>BASE DATA</b> Rate: 0.00 S/Wk: 0.0987 S/Wk: 0.0987 S/Wk: 0.0987	<b>OPERATING DATA</b> Summer Ratio: 50% Winter Ratio: 50% Summer Off-Peak Ratio: 65.5% Winter Off-Peak Ratio: 37.1% Coincidence Factor: 32%	<b>OTHER FACTORS</b> Line Loss Factor: 9.50% Capacity Reserve Factor: 0.00% Summer Peak Demand Incremental Ratio: 0.00%	<b>DEMAND/ENERGY SAVINGS</b> On-Peak Energy Savings (kWh): 3,420 Off-Peak Energy Savings (kWh): 4,032 Total Energy Savings (kWh): 7,452	<b>INCENTIVE AND PV CALCULATIONS</b> PV Capacity: 3.42 kW Recommended PV Capacity: 3.42 kW PV Energy: 51,100 kWh PV Savings: 51,100 kWh PV Benefit: \$5,110 PV Cost: \$5,110 PV NPV: \$0	<b>CUSTOMER COSTS/SAVINGS</b> Net Cost: \$0 Savings: \$7,452 Cost: \$0 Net Savings: \$7,452	<b>WGT</b> Weighted Savings: 100% Weighted Cost: 0%	<b>% Incent</b> Incentive as % of Net Savings: 0%	<b>B/C</b> Net Savings / Net Cost: 0.81											

**Zero-Net Energy Homes Pilot Program**

~~Appendix 2—Details of Simulation Models~~

~~**Exhibit 9**~~

~~Exhibit 9 below shows the differences between the baseline home and the other nine models. Each model is represented by one column.~~

~~**Exhibit 9: Simulation Model Details**~~

## Zero-Net Energy Homes Pilot Program

Property	Baseline Home	30% efficient home	40% efficient home	50% efficient home	50% Net Zero, 30% EE Base	75% Net Zero, 30% EE Base	100% Net Zero, 30% EE Base	50% Net Zero, 50% EE Base	75% Net Zero, 50% EE Base	100% Net Zero, 50% EE Base
Total conditioned floor area (sq.ft.)	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850
No. of stories	1	1	1	1	1	1	1	1	1	1
Window Area (% floor area)	18%	18%	18%	15%	18%	18%	18%	15%	15%	15%
Total window area (sq.ft.)	333	333	333	277.5	333	333	333	277.5	277.5	277.5
Perimeter dimensions (ft.)	43	43	43	43	43	43	43	43	43	43
Perimeter length (ft.)	172	172	172	172	172	172	172	172	172	172
Floor To Floor Height (ft)	9	9	9	9	9	9	9	9	9	9
Wall Frame	Wood	Wood	Wood	Wood	Wood	Wood	Wood	Wood	Wood	Wood
Wall Solar Absorptance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Wall Emittance	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Roof Frame	Wood/With Shingle	Wood/With Shingle	Wood/With Shingle	Wood/With Shingle	Wood/With Shingle	Wood/With Shingle	Wood/With Shingle	Wood/With Shingle	Wood/With Shingle	Wood/With Shingle
Roof Solar Absorptance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Roof Emittance	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Ceiling height (ft.)	8	8	8	8	8	8	8	8	8	8
Gross wall area (sq.ft.)	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1
	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1
	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1
	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1
Window area (sq.ft.)	83.3	83.3	83.3	111.0	83.3	83.3	83.3	111.0	111.0	111.0
	83.3	83.3	83.3	55.5	83.3	83.3	83.3	55.5	55.5	55.5
	83.3	83.3	83.3	55.5	83.3	83.3	83.3	55.5	55.5	55.5
	83.3	83.3	83.3	55.5	83.3	83.3	83.3	55.5	55.5	55.5
Net wall area (sq.ft.)	303.9	303.9	303.9	276.1	303.9	303.9	303.9	276.1	276.1	276.1
	303.9	303.9	303.9	331.6	303.9	303.9	303.9	331.6	331.6	331.6
	303.9	303.9	303.9	331.6	303.9	303.9	303.9	331.6	331.6	331.6
	303.9	303.9	303.9	331.6	303.9	303.9	303.9	331.6	331.6	331.6
Total Wall Area	1215	1215	1215	1271	1215	1215	1215	1271	1271	1271
Ceiling area (sq.ft.)	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850

## Zero-Net Energy Homes Pilot Program

	Baseline Home	30% efficient home	40% efficient home	50% efficient home	50% Net Zero, 30% EE Base	75% Net Zero, 30% EE Base	100% Net Zero, 30% EE Base	50% Net Zero, 50% EE Base	75% Net Zero, 50% EE Base	100% Net Zero, 50% EE Base
Infiltration	0.3 ACH	0.1 ACH	0.1 ACH	0.1 ACH	0.1 ACH	0.1 ACH	0.1 ACH	0.1 ACH	0.1 ACH	0.1 ACH
Fresh Air Ventilation	None	System								
Ceiling Insulation	R27	R33	R38	R42	R33	R33	R42	R42	R42	R42
Wall Insulation	R15	R21								
Perimeter Insulation	None	None	None	None	None	None	None	None	None	None
DHW Fuel	Electricity	Electricity	Electricity	Electricity	Electricity	Electricity	Electricity	Electricity	Electricity	Electricity
DHW tank Size	40 Gallons	41 Gallons	42 Gallons	43 Gallons	44 Gallons	45 Gallons	46 Gallons	47 Gallons	48 Gallons	49 Gallons
HVAC Quality Installation	No	Yes								
Heating System Type	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Heating System Efficiency	3 COP	3.5 COP	3.5 COP	3.5 COP	3.5 COP	3.5 COP	3.5 COP	4 COP	4 COP	4 COP
Cooling System Type	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Cooling System Efficiency	13 SEER	15 SEER	15 SEER	18 SEER	15 SEER	15 SEER	15 SEER	18 SEER	18 SEER	18 SEER
Design HP Size (kbtu)	35.2	28.37	28.13	25.96	28.37	28.37	28.37	25.96	25.96	25.96
Design HP Size (tons)	2.93	2.36	2.3	2.2	2.36	2.36	2.36	2.16	2.16	2.16
Final HP Size (tons)	4	3	3	3	3	3	3	3	3	3
Fixed Appliances	Non Energy Star	Non Energy Star	Energy Star	Energy Star	Non Energy Star	Non Energy Star	Non Energy Star	Energy Star	Energy Star	Energy Star
Lighting	Incandescent	CFL								
Daylighting	None	None	1 Daylighting Unit	1 Daylighting Unit	None	None	None	1 Daylighting Unit	1 Daylighting Unit	1 Daylighting Unit
Lighting Power Density	0.5	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Ducts in Conditioned Space	Ducts in unconditioned space	Ducts in conditioned space								
PV Size (kW DC)	0	0	0	0	1.36	3.05	4.74	0.70	2.05	3.39
SWH Size (kWh-year)	0	0	0	0	3300	3300	3300	3300	3300	3300

**Zero-Net Energy Homes Pilot Program**

**Appendix 3 – Measure Analysis Sheet- Total Resource Cost Test**



## Zero-Net Energy Homes Pilot Program

Property	Base Case	30% EE Case	Incr. Cost Basis	Total Incr. Cost	40% EE Case	Incr. Cost Basis	Total Incr. Cost	50% EE Case	Incr. Cost Basis	Total Incr. Cost	Units	Source
Duct Leakage	14%	3%	\$108.00	\$199.80	0	\$108.00	\$239.76	0	\$108.00	\$239.76	\$/house to reach 3%	DEER 2008
Fresh air ventilation	No	Yes	\$500.00	\$500.00	Yes	\$500.00	\$500.00	Yes	\$500.00	\$500.00	\$/house	Contractor quote
Glass U-value	0.5	0.3	\$5.03	\$1,674.99	0.3	\$5.03	\$1,674.99	0.3	\$5.03	\$1,395.83		DEER 2008 - Base = Code Standard - U-0.57 / SHGC-0.75 (clear) Window, Measure = U-0.25/SHGC-0.35 (clear) Window
SHGC	0.4	0.28			0.28			0.28				
Window Overhang	No	No	\$2,000.00	\$0.00	No	\$2,000.00	\$0.00	Yes	\$2,000.00	\$2,000.00	\$/overhang	Builder Quote
Infiltration	0.3 ACH	0.1 ACH	\$400	\$400	0 ACH	\$400	\$400.00	0 ACH	\$400	\$400.00	\$/house	www.homenet.org/archive/hem.dfs.and.gov/sehem/94/940708.html
Ceiling insulation	R27	R33	\$0.14	\$259.97	R38	\$0.26	\$476.61	R42	\$0.35	\$649.92	\$/SF	RE Means Costworks
Wall insulation	R15	R21	\$0.14	\$170.79	R21	\$0.14	\$170.79	R21	\$0.14	\$170.79	\$/sf	
Ducts in Conditioned Space	No	Yes	\$278.00	\$278.00	Yes	\$278.00	\$278.00	Yes	\$278.00	\$278.00	\$/system	Toolbase Tech Specs (www.pathtnet.org - from NAHB)
Quality installation	No	Yes	\$330.00	\$330.00	Yes	\$330.00	\$330.00	Yes	\$330.00	\$330.00	\$/system	APS MER Project
Heating System Efficiency	8 HSPF / 80 % AFUE	3.5 COP	\$26.00	\$26.00	3.5 COP	\$26.00	\$26.00	4 COP	\$1,259.00	\$1,259.00	\$/kbtu	DEER 2008 (assume heat pump efficiency rating goes by SEER only - i.e. no extra cost for COP increase)
Cooling System Efficiency	13 SEER	15 SEER			15 SEER			18 SEER			\$/ton	
Appliances	Non Energy Star	Non Energy Star	\$0.00	\$0.00	Energy Star	\$990.00	\$990.00	Energy Star	\$990.00	\$990.00	1 unit of each appliance	DEER 2008 (Clothes washer, Dishwasher, Refrigerator)
Lighting - general	Incandescent	CFL	\$18.00	\$270.00	CFL	\$1,158.00	\$270.00	CFL	\$1,158.00	\$270.00	Total lamp cost	DEER 2008
Lighting - daylighting	No	No	\$0.00	\$0.00	1 unit	\$1,140.00	\$1,140.00	1 unit	\$1,140.00	\$1,140.00	Daylighting unit cost	DEER 2008
<b>Total Incremental Cost</b>				\$4,109.55			\$6,496.15			\$9,623.30		

**Exhibit H - Incremental Costs Zero-Net Energy Cases - 30% EE Base**

**Zero-Net Energy Homes Pilot Program**

Property	Base Case	50% Net Zero, 30% EE Base	Incr. Cost Basis	Total Incr. Cost	75% Net Zero, 30% EE Base	Incr. Cost Basis	Total Incr. Cost	100% Net Zero, 30% EE Base	Incr. Cost Basis	Total Incr. Cost	Units	Source
Duct leakage	1.4%	3%	\$108.00	\$199.80	3%	\$108.00	\$199.80	3%	\$108.00	\$199.80	\$/house to reach 3%	DEER 2008
Fresh air ventilation	No	Yes	\$500.00	\$500.00	Yes	\$500.00	\$500.00	Yes	\$500.00	\$500.00	\$/house	Contractor quote
Glass U-value	0.5	0.3	\$5.03	\$1,674.99	30%	\$5.03	\$1,674.99	30%	\$5.03	\$1,674.99	\$/sq.ft. window	DEER 2008 - Base = Code Standard - U-0.57 / SHGC-
SHGC	0.4	0.28			28%			28%				Builder Quote
Window Overhang	No	No	\$2,000.00	\$0.00	No	\$2,000.00	\$0.00	No	\$2,000.00	\$0.00	\$/overhang	Builder Quote
Infiltration	0.3 ACH	0.1 ACH	\$400	\$400	0.1 ACH	\$400	\$400.00	0.1 ACH	\$400.00	\$400.00	\$/house	www.hometech
Ceiling insulation	R27	R33	\$0.00	\$259.97	R33	\$0.00	\$259.97	R33	\$0.00	\$259.97	\$/SF	RE Means Costworks
Wall insulation	R15	R21	\$0.00	\$170.79	R21	\$0.00	\$170.79	R21	\$0.00	\$170.79	\$/SF	
Ducts in Conditioned Space	No	Yes	\$278.00	\$278.00	Yes	\$278.00	\$278.00	Yes	\$278.00	\$278.00	\$/system	1-colbase-tech
Quality Installation	No	Yes	\$330.00	\$330.00	Yes	\$330.00	\$330.00	Yes	\$330.00	\$330.00	\$/system	AFS MER Project
Heating System Efficiency	8 HSPF / 80 % AFUE	3.5 COP	\$0.00	\$26.00	3.5 COP	\$0.00	\$26.00	3.5 COP	\$0.00	\$26.00	\$/kbtu	DEER 2008 (assume heat pump efficiency)
Cooling System Efficiency	13 SEER	15 SEER			15 SEER			15 SEER			\$/ton	DEER 2008 (assume heat pump efficiency)
Appliances	Non Energy Star	Non Energy Star	\$0.00	\$0.00	Non Energy Star	\$0.00	\$0.00	Non Energy Star	\$0.00	\$0.00	1 unit of each appliance	DEER 2008 (Clothes)
Lighting - general	Incandescent	CFL	\$18.00	\$270.00	CFL	\$18.00	\$270.00	CFL	\$18.00	\$270.00	Total Lamp cost	DEER 2008
Lighting - daylighting	No	No	\$0.00	\$0.00	No	\$0.00	\$0.00	No	\$0.00	\$0.00	Daylighting unit cost	DEER 2008
Solar PV	None	1.36	Regression Formula	\$9,509	3.05	Regression Formula	\$21,015	4.74	Regression Formula	\$32,227	\$/kW DC	TEP Program Data
Solar Water Heating	None	3300	\$5,610	\$5,610	3300	\$5,610	\$5,610	3300	\$5,610	\$5,610	\$/system	TEP Program Data
<b>Total Incremental Cost</b>				<b>\$19,228.10</b>			<b>\$30,734.61</b>			<b>\$41,946.85</b>		

**Exhibit 12: Incremental Costs Zero-Net Energy Cases - 50% EE Base**

### Zero-Net Energy Homes Pilot Program

Property	Base Case	50% Net Zero, 50% EE Base	Incr. Cost Basis	Total Incr. Cost	75% Net Zero, 50% EE Base	Incr. Cost Basis	Total Incr. Cost	100% Net Zero, 50% EE Base	Incr. Cost Basis	Total Incr. Cost	Units	Source
Duct Leakage	14%	0%	\$108.00	\$239.76	0%	\$108.00	\$239.76	0%	\$108.00	\$239.76	\$/house to reach 3%	DEER 2008
Fresh air ventilation	No	Yes	\$500.00	\$500.00	Yes	\$500.00	\$500.00	Yes	\$500.00	\$500.00	\$/house	Contractor quote DEER 2008 - Base = Code
Glass U-value	0.5	0.3	\$5.03	\$1,395.83	30%	\$5.03	\$1,395.83	30%	\$5.03	\$1,395.83	\$/sq.ft. window	Standard - U-0.57 / SHGC-0.79 (clear) Window, Measure = U-0.25/SHGC-0.35 (clear)
SHGC	0.4	0.28			28%			28%				
Window Overhang	No	Yes	\$2,000.00	\$2,000.00	Yes	\$2,000.00	\$2,000.00	Yes	\$2,000.00	\$2,000.00	\$/overhang	Builder Quote
Infiltration	0.3 ACH	0 ACH	\$400.00	\$400.00	0 ACH	\$400.00	\$400.00	0 ACH	\$400.00	\$400.00	\$/house	www.homeenergy.org/archiv
Ceiling insulation	R27	R42	\$0.35	\$649.92	R42	\$0.35	\$649.92	R42	\$0.35	\$649.92	\$/SF	RE Means Costworks
Wall insulation	R15	R21	\$0.14	\$170.79	R21	\$0.14	\$170.79	R21	\$0.14	\$170.79	\$/SF	
Ducts in Conditioned Space	No	Yes	\$78.00	\$278.00	Yes	\$78.00	\$278.00	Yes	\$78.00	\$278.00	\$/system	Toolbase Tech Specs (www.patinet.org - from
Quality Installation	No	Yes	\$330.00	\$330.00	Yes	\$330.00	\$330.00	Yes	\$330.00	\$330.00	\$/system	APS NER Project
Heating System Efficiency	8 HSPF / 80% AFUE	4 COP 18 SEER (3 ton)	\$1,259.00	\$1,259.00	4 COP 18 SEER (3 ton)	\$1,259.00	\$1,259.00	4 COP 18 SEER (3 ton)	\$1,259.00	\$1,259.00	\$/kbtu	DEER 2008 (assume heat pump efficiency rating goes by SEER only - i.e. no extra cost for COP increase)
Cooling System Efficiency	13 SEER Non Energy Star	Energy Star	\$990.00	\$990.00	Energy Star	\$990.00	\$990.00	Energy Star	\$990.00	\$990.00	\$/ton	DEER 2008 (Clothes washer, Dishwasher, Refrigerator)
Appliances	Incandescent	CFL	\$1,158.00	\$270.00	CFL	\$1,158.00	\$270.00	CFL	\$1,158.00	\$270.00	Total lamp cost	DEER 2008
Lighting - general	No	1 unit	\$1,140.00	\$1,140.00	1 unit	\$1,140.00	\$1,140.00	1 unit	\$1,140.00	\$1,140.00	Daylighting unit cost	DEER 2008
Lighting - daylighting	None	0.70	Regression Formula	\$4,914	2.05	Regression Formula	\$14,235	3.39	Regression Formula	\$23,281	\$/kW DC	TEP Program Data
Solar PV	None	3300	\$5,610	\$5,610	3300	\$5,610	\$5,610	3300	\$5,610	\$5,610	\$/system	TEP Program Data
Solar Water Heating	None											
<b>Total Incremental Cost</b>				<b>\$20,147.38</b>			<b>\$29,468.49</b>			<b>\$38,514.34</b>		

**Zero-Net Energy Homes Pilot Program**

**Appendix 4—Details of Solar Costs**  
**Exhibit 13 below shows details of the PV and solar water heater costs and sizes for each of the zero-net models, and Exhibit 14 shows the details and sources of the solar costs.**

**Exhibit 13: Solar Costs, Tax Credits, and Rebates for Zero-Net Energy Models**

	50% Net Zero, 30% EE Base	75% Net Zero, 30% EE Base	100% Net Zero, 30% EE Base	50% Net Zero, 50% EE Base	75% Net Zero, 50% EE Base	100% Net Zero, 50% EE Base
PV Size (kW DC)	1.36	3.05	4.74	0.70	2.05	3.39
SWH Size (kWh/year)	3,300	3,300	3,300	3,300	3,300	3,300
PV (DC) Equipment	9,509	21,015	32,227	4,914	14,235	23,281
PV Rebates	(4,091)	(9,156)	(14,221)	(2,104)	(6,156)	(10,169)
SWH Equipment	5,610	5,610	5,610	5,610	5,610	5,610
SWH Rebates	(1,575)	(1,575)	(1,575)	(1,575)	(1,575)	(1,575)
Total	13,062	19,504	25,651	15,968	21,238	26,271
Total Solar Rebates	5,666	10,731	15,796	3,679	7,731	11,744
Total Solar Tax Credits	4,163	7,615	10,979	2,785	5,581	8,295

**Exhibit 14: Details of Solar Costs**

Cost of Solar Photovoltaics	
System Cost	\$6,843 \$/installed kW DC (from TEP program data)
UNSE Rebate	\$3,000 \$/kW DC
Federal tax credit	\$1,153 30% of cost after rebates
Remaining cost	\$2,690 \$/kW DC
Cost of Solar Water Heating	
System Cost	\$/kWh-year (from TEP program data - average cost of systems >3000 kWh)
System Size	3,300 kWh-year
Total System Cost	\$5,610 \$/system
SWH Tax Credits	AZ State Tax Credit \$1,000 Federal Tax Credit \$1,211 UNSE Rebate \$1,575 Remaining Cost \$1,825
SWH Rebates	Single AZ tax rebate for SWH or PV - assign all to SWH. 25% of system cost after rebate, up to \$1000 30% of cost after rebate \$0.25/kWh plus \$750

