TETRA TECH

complex world | CLEAR SOLUTIONS™

Market Analysis for the Solar Home Builder Partnership Program

Final Report

Prepared by: Tetra Tech

Prepared for: We Energies and the We Energies Renewable Energy Collaborative

December 20, 2011

Market Analysis for the Solar Home Builder Partnership Program

Final Report

Prepared by: Tetra Tech

Prepared for: We Energies and the We Energies Renewable Energy Collaborative

December 20, 2011

Prepared by Tetra Tech

Tetra Tech
6410 Enterprise Lane, Suite 300 | Madison, WI 53719
Tel 608.316.3700 | Fax 608.661.5181
www.tetratech.com

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

We Energies partnered with Tim O'Brien Homes and Neumann Developments to design and implement the Solar Home Builder Partnership Program. Twenty-three 'spec' homes were built in 12 pairs[1]—one home in each pair featured a 3 kW solar photovoltaic (PV) energy generation system and the other home would be nearly identical in size and layout, but without the solar photovoltaic energy generation system. In some cases the homes were co-located within the same development; in other cases they were in separate near-by locations.

A variety of incentives and the federal solar investment tax credit were used to reduce the cost of the solar photovoltaic energy generation system. Prospective home buyers were offered the opportunity to roll the cost of the solar electric photovoltaic system into their mortgage, resulting in an incremental payment of $36 per month for a 30-year fixed rate mortgage at 5 percent interest.

This Project, conducted in two phases as part of We Energies Renewable Energy Development (RED) Program, was designed to help inform and educate the solar electric PV market in Wisconsin.

The Project identified four key research objectives for Phase 1:

- Identify the influence of a solar electric photovoltaic system on home buyers and home builders' decision-making processes.
- Understand Wisconsin home builders' views of solar electric photovoltaic systems and the likelihood that they will incorporate solar electric systems in future home construction.
- Document differences in perceptions between home builders in Wisconsin and home builders in other states where the residential solar market is more developed.
- Identify strategies to enhance Wisconsin home buyers' awareness and knowledge of solar electric technologies and benefits.

The data for the Phase 1 analysis were collected in the spring of 2011 through a series of qualitative in-depth interviews with program stakeholders, buyers of the solar and non-solar homes built for the program, Wisconsin home builders, solar industry experts in Wisconsin, real estate agents who showed and sold the 23 spec homes, and home builders in other states with a more developed solar home market.

Completed in the fall 2011, Phase 2 was an analysis of electricity consumption of the 12 matched pairs of solar and non-solar homes for an eight month duration. We examined the effectiveness of the installed photovoltaic systems, evaluated their performance over time, and compared the energy use behavior of solar and non-solar homeowners. Detailed results of the Phase 2 analysis are provided in Chapter 6.

[1] One non-solar home was paired with two solar homes.

1.2 PHASE 1 KEY FINDINGS AND CONCLUSIONS

1.2.1 Influence of solar electric on home buyers' purchase decisions

a. *For most home buyers, including those who purchased a solar or a non-solar spec house, the solar electric photovoltaic system was viewed as a positive feature, but was not one of the major factors that drove the purchase decision.*

b. *Solar home buyers report overwhelmingly positive comments and expressions of interest from family, friends, neighbors, and colleagues regarding their solar home.*

1.2.2 Home builders' views and likelihood of incorporating solar in new homes

a. *Wisconsin home builders who are active in the solar market see a lot of consumer interest and potential demand for solar homes, but they report the "economics" are not yet right, so many interested new home buyers eliminate solar when it gets down to budgetary decisions.*

b. *Wisconsin home builders do not see enough demand to build spec solar homes, but there is growing interest in information about solar homes from Builders' Associations.*

c. *Real estate appraisals of the spec solar homes did not currently reflect the investment required to install a solar electric photovoltaic system. There are still some homeowners' associations that prohibit rooftop solar panels in subdivisions.*

1.2.3 Home builders' perceptions in other states with more developed markets

a. *Home builders in the comparison states are more knowledgeable in the technology and have fewer misconceptions about the requirements for solar electric generation and the suitability of their climate for residential solar electric photovoltaic systems.*

b. *Home builders in comparison states are more likely to build entire solar subdivisions or offer solar electric generation as a feature on new homes they build. New homes that do not have a solar electric system are constructed to be 'solar ready.'*

c. *Home builders in comparison states are less likely than Wisconsin home builders to feel that significant incentives are required to make solar electric installations attractive to home buyers.*

1.2.4 Home buyers' awareness and knowledge of solar electric photovoltaic systems

a. *Real estate agents report that a solar home was not on most home buyers' list of features, even though they were interested when there was an opportunity to see a solar home.*

b. *Tim O'Brien Homes and their solar installer report that prospective home buyers had low levels knowledge and asked many unanticipated "practical" questions about the*

durability, operation, and maintenance requirements of the solar electric system and the solar panels.

c. *Prospective home buyers do not have an accurate perception of the cost of installing a solar electric photovoltaic system, the cost savings, required ongoing maintenance, or the payback.*

1.3 PHASE 1 RECOMMENDATIONS

1.3.1 Education

We Energies could consider working with other investor-owned utilities and renewable energy stakeholder groups to increase awareness, reduce the knowledge gap and promote accurate perceptions among key groups, such as buyers, home builders, developers, and other building trade groups. This could include activities such as the following:

a. *Sponsor model homes and demonstration projects to showcase new solar electric and renewable energy technology and build awareness for residential applications*

b. *Develop a resource for home builders and the home building trades with technical information about solar electric systems' specifications, requirements, and performance in Wisconsin*

c. *Develop a resource from the perspective of a home buyer, with information about technologies, costs and benefits, decision points, ongoing operation and maintenance and advice about talking to a builder regarding the addition of a solar electric system.*

d. *Publish results of the performance of the solar electric photovoltaic systems in the Project to provide actual Wisconsin data and experience*

1.3.2 Incentives

We Energies could consider working with Focus on Energy and other investor-owned utilities to identify appropriate incentives to reduce the payback on residential solar electric installations to encourage continued development of the residential solar market. Incentives, however, need to be applied with care to avoid market dependence.

a. *Solar home builders estimate that payback for a residential solar electric photovoltaic system in Wisconsin is 12-16 years*[2] *and the builders we spoke with believe that most home buyers want a payback of 10 years or less.*

b. *Continuing incentives for solar installations will help to increase the number of solar electric installations and help to encourage new manufacturers to build components, helping to reduce the upfront cost of a residential solar electric system*

[2] This payback calculation and other comments about the economics of solar photovoltaic systems was accurate at the time of the project. However solar prices have dropped, resulting in a shorter pay-back at the time of this report.

1.3.3 Policy Development

We Energies could consider working with regulators, the state legislature, and relevant state government agencies to encourage development of statewide policies, including state leadership initiatives and uniform net-metering rules across the State.

a. *A state leadership initiative and strategy, such as California's Million Solar Roofs Initiative, will signal a long-term commitment to encourage home builders and solar electric PV manufacturers.*

b. *Simplifying and streamlining the net-metering and interconnection rules and regulations that home builders and the industry have to work with will encourage more builders to enter the solar market and work across service area.*

1.4 PHASE 2 KEY FINDINGS

- **Solar households appear to have higher average energy use intensity than the non-solar home counterparts:** For solar households, the average energy use intensity is 1.34 kWh/sq-ft/person based on a sample of seven solar homes. The same measure for non-solar home households is 0.98 kWh/sq-ft/person based on a sample of five households. This finding should be viewed as tentative and interpreted with caution due to small sample sizes of households for both solar and non-solar homes, as well as the short duration (eight months) of the study.

- **3 kW solar systems supply on average, 37% of the household monthly electricity requirement:** Monthly output from twelve solar systems and the monthly electricity consumption from as many households were analyzed for a period of eight months (January 2011 through August 2011). The solar output ranged between 18% and 60% of the total household electricity consumption.

- **Solar systems are performing as expected:** Actual energy output from the solar systems is close to their pre-installation estimates, indicating robustness in the system design and installation. Out of the twelve systems, the average (over eight months) difference between the actual and the predicted outputs for eight systems is within ±5%. Only one system exhibited a difference of more than 10%.

2. INTRODUCTION

2.1 BACKGROUND ON THE SOLAR HOME BUILDER PARTNERSHIP PROGRAM

We Energies' goal for this study is to better understand customers' and builders' perceptions and attitudes toward solar electric power and to be prepared to meet customer demand for information about solar energy options.

As part of this effort to support the development of the solar market, We Energies partnered with Tim O'Brien Homes, Neumann Developments, and Renewable Energy Solutions (now Solar Innovations) to build 23 new "spec" homes in southeastern Wisconsin. The 23 "spec" homes were built in 12 pairs—one home in each pair featured a 3 kW solar photovoltaic (PV) energy generation system and the other home would be nearly identical in size, layout, and location, but without the solar photovoltaic energy generation system. All 23 homes were built to ENERGY STAR® specifications and exceeding the National Association of Home Builders (NAHB) Green Building criteria for new homes. In most cases, the builder installed the major appliances. Each pair of homes was designed to be comparable in terms of energy use, as much as possible, excluding the differences in characteristics of the homeowners.

As part of the Program, We Energies provided incentives to reduce the cost of the solar photovoltaic energy generation system. These incentives, along with the available Wisconsin Focus on Energy incentives, helped to more closely equalize the construction costs for the home builders between the solar and non-solar homes. The home builder also advised home buyers of the available federal solar investment tax credit for purchasing a home with solar electric generation capability.

All of the 23 homes were built in southeastern Wisconsin in the We Energies' service territory. When purchasing a home, buyers agreed to participate in the study, by allowing We Energies to monitor the household energy consumption, so that a comparative analysis could be conducted to identify differences in energy consumption between the solar and non-solar homes.

Table 2.1 shows the characteristics and location of the 12 pairs of new homes constructed for the Solar Home Builder Partnership Program.

Table 2.1: Characteristics and Location of Pairs of Homes for Solar Home Builder Partnership Program

Type of Home	City	Zip Code	County	kW	Home Design	Sq. Ft. finished
Solar	Kenosha	53142	Kenosha	3.024	2 - Story	2,244
Non-Solar	Kenosha	53142	Kenosha	NA	2 - Story	2,052
Solar	Milwaukee	53224	Milwaukee	2.940	2 - Story	2,195
Non-Solar	Milwaukee	53224	Milwaukee	NA	ranch	2,030
Solar	Waukesha	53186	Waukesha	2.940	2 - Story	2,387
Non-Solar	Waukesha	53186	Waukesha	NA	2 - Story	2,386
Solar	Jackson	53037	Washington	2.940	2 - Story	2,348
Non-Solar	Jackson	53037	Washington	NA	2 - Story	2,348
Solar	Jackson	53037	Washington	3.024	ranch	1,811
Non-Solar	Jackson	53037	Washington	NA	ranch	1,867
Solar	Kenosha	53142	Kenosha	3.024	2 - Story	3,067 (bsmnt)*
Non-Solar	Kenosha	53142	Kenosha	NA	2 - Story	2,125
Solar	Kenosha	53142	Kenosha	3.024	2 - Story	2,113
Non-Solar	Kenosha	53142	Kenosha	NA	2 - Story	2,196
Solar	Waukesha	TBD	Waukesha	3.080	ranch	2,290
Non-Solar	Waukesha	53186	Waukesha	NA	ranch	1,887
Solar	Jackson	53037	Washington	2.940	2 - Story	2,349
Non-Solar	Port Washington	53074	Ozaukee	NA	2 - Story	2,348
Solar	Jackson	53037	Washington	2.940	ranch	1,915
Non-Solar	Jackson	53037	Washington	NA	ranch	1,867
Solar	Jackson	53037	Washington	2.940	ranch	1,915
Non-Solar	Jackson	53037	Washington	NA	ranch	2,247
Solar	Pewaukee	53072	Waukesha	2.940	2 - Story	4286 (bsmnt)*
Non-Solar	Waukesha	53188	Waukesha	NA	2 - Story	2,426

* Additional square footage, relative to paired home, is due to a finished basement

2.2 CHARACTERISTICS AND COST FOR THE SOLAR ELECTRIC PHOTOVOLTAIC SYSTEMS IN PROGRAM HOMES

For the Solar Home Builder Partnership Program, 3 kW fixed solar electric photovoltaic systems were installed on each of the 12 'solar homes.' The 3 kW system was estimated to produce an average of 312 kWh of electricity per month or 3,740 kWh per year.

To reduce the difference in the cost of building the solar and non-solar homes, a variety of available incentives were used. Table 2.2 shows the typical cost of the 3 kW solar electric photovoltaic system installed in the Program homes[3].

Table 2.2: Incentives and Net Cost for Solar Electric Photovoltaic System in Program Homes

Costs and Incentives	Amount
Typical System Cost (3 kW)	$24,000.00
WI Focus on Energy rebate ($1.50/kWh)*	(5610.00)
We Energies buy-down ($0.75/kWh)*	(2805.00)
We Energies Cash Back Reward ($2,000/kW)	(6000.00)
30% Federal solar investment tax credit (taken after other incentives applied)	(-$2,875.50)**
Net System Cost (3 kW)	**$6,709.50**

* Based on the estimated annual kWh production of 3,740kWh per year

** Federal solar investment tax credit paid to homeowner, all other incentives paid to the builder

Prospective home buyers were offered the opportunity to roll the cost of the solar electric photovoltaic system into their mortgage. Tim O'Brien Homes provided analyses that showed that the Net System Cost of $6,700 for a 3 kW (from Table 2.2) would require an increase of $36 per month in the monthly payment for a 30-year fixed rate mortgage at 5 percent interest.

The analysis used by Tim O'Brien Homes showed that in Year 1, the system would generate an average of $33 per month in electricity savings to the homeowner. As the rate per kWh that is charged for electricity increases, the amount of homeowners' electricity bill savings will increase. The analysis also noted that in annual terms, the 3,740 kWh of electricity estimated to be generated would offset the typical annual consumption of many household appliances, including a refrigerator, freezer, washing machine, and clothes dryer combined.

[3] Source: Renewable Energy Solutions slide pack August 21, 2009.

2.3 SCOPE OF WORK FOR WISCONSIN SOLAR MARKET ANALYSIS

There are two phases to the Project. In Phase 1 the Tetra Tech research team used qualitative in-depth telephone interviews to collect information from home buyers, Wisconsin home builders, home builders in other states with more developed solar home markets, and the Program stakeholders.

The Phase 1 research was designed to help educate and build awareness of the solar electric PV opportunities in Wisconsin. The Project identified five key research objectives:

Phase 1

- Identify the influence of a solar electric photovoltaic system on home buyers and home builders' decision-making processes
- Understand Wisconsin home builders' views of solar electric photovoltaic systems and the likelihood that they will incorporate solar electric systems in future home construction
- Document differences in perceptions between home builders in Wisconsin and home builders in other states where the residential solar market is more developed.
- Identify strategies to enhance Wisconsin home buyers' awareness and knowledge of solar electric technologies and development benefits.

Phase 2

Completed in the fall 2011, Phase 2 was an analysis of electricity consumption of the 12 matched pairs of solar and non-solar homes for an eight month duration. We examined the effectiveness of the installed photovoltaic systems, evaluated their performance over time, and compared the energy use behavior of solar and non-solar homes. Detailed results of the Phase 2 analysis are provided in Chapter 6.

3. PHASE 1 DATA COLLECTION METHODOLOGY

3.1 IN-DEPTH INTERVIEWS

In Phase 1, a series of qualitative in-depth interviews were conducted with Solar Home Builder Partnership Program stakeholders, buyers of the solar and non-solar homes built for the program, Wisconsin home builders, and home builders in other states with a more developed solar home market. In total, the following Phase 1 in-depth interviews were conducted by telephone:

Interview Target	Number of Interviews
Solar home buyers	7
Non-solar home buyers	4
Program stakeholders	4
Tim O'Brien Company real estate agents	3
Wisconsin solar home builders	3
Wisconsin home builder association	1
Wisconsin Focus on Energy solar program expert	1
Solar home builders in other states	4
Total number of interviews	**27**

A description of the methodology employed to conduct the in-depth interviews with each group is presented below.

3.1.1 Solar and Non-solar home buyer in-depth interviews

A total of 11 in-depth interviews were conducted with buyers of the homes constructed as part of the Program—seven interviews with buyers of the solar homes and four interviews with buyers of non-solar homes. A list of home buyers, along with contact information and address was provided by Tim O'Brien Homes for twenty-three of the spec homes constructed for the Program. One of the homes with a solar electric photovoltaic system was still being used as a demonstration model and was unsold at the time of the Phase 1 data collection.

The twenty-three home buyers were contacted by telephone and, in some cases, by e-mail (if the home buyer could not be contacted by telephone) and asked to schedule an in-depth interview regarding their decision to purchase their Tim O'Brien-built home. An incentive of $50 was offered for their participation, in the form of a Visa or MasterCard gift card. All of the homeowners we were able to speak to agreed to participate in the interview.

The interviews were conducted by telephone and the interviews were taped, with the home buyers' permission. Interviews lasted from 20-40 minutes. The home buyers were first asked to describe the general factors involved in their purchase decisions, without specifically asking about the influence of the solar electric photovoltaic system. Solar home buyers were then asked if the solar electric system had an influence on their purchase decision, and generally about their experience operating the solar electric system to date. Non-solar home buyers were asked about their awareness of the availability the solar electric systems on some Tim O'Brien Homes. If they were aware, they were then asked whether this influenced their purchase decision. Finally, all respondents were asked a series of demographic questions. A complete copy of the Home Buyer In-depth Interview Guide is in Appendix A.

3.1.2 Program stakeholder in-depth interviews

The following Program stakeholders were interviewed;

- Carl Siegrist and Jessica Thibodo-Johnson from We Energies who were instrumental in the design and management of the Program; and

- Tim O'Brien from Tim O'Brien Homes and Matt Matrise from Solar Innovations (formerly Renewable Energy Solutions) who were responsible for the design, implementation, and management of the Program from the home builder side.

The Program stakeholder interviews asked about perceptions of the solar new home market in Wisconsin, relative to other states, factors that stimulate the market, barriers to market development in Wisconsin, and objectives and lessons learned to date from the Solar Home Builder Partnership Program. Interviews were scheduled with each of the four stakeholders and conducted by telephone and recorded with their permission. Each interview lasted 30-45 minutes.

A copy of the Program Stakeholder In-depth Interview Guide is provided in Appendix A.

3.1.3 Tim O'Brien Homes real estate agent in-depth interviews

Tim O'Brien Homes provided the names and contact information for three real estate agents who had been most involved in showing and selling the 23 spec homes. Interviews were scheduled with each of the three real estate agents and conducted and taped with their permission. Each interview lasted 30-35 minutes. These agents worked with Tim O'Brien Homes and both showed and sold a number of the 23 spec homes built for the Program.

The real estate agents were asked for their assessment of the solar home market in Wisconsin, the factors that influenced home buyers' purchase decisions for the 23 spec homes, the reaction of home buyers to the solar electric photovoltaic systems, and their level of comfort with selling the solar homes.

A copy of the Tim O'Brien Homes Real Estate Agent In-depth Interview Guide is provided in Appendix A.

3.1.4 Wisconsin solar home builder in-depth interviews

Interviews were conducted with four Wisconsin home builders who have been active in the construction of new homes with solar electric generation capability. The initial goal of this task was to interview builders who constructed spec solar homes. However, research indicated there were no Wisconsin home builders constructing spec solar homes at this time. The twelve spec solar homes constructed for this Program are among the very few that have been constructed in Wisconsin.

Therefore the interviews focused on builders of solar custom homes. To identify these builders we contacted the Wisconsin Green Building Alliance and received a list of four builders. We also interviewed a representative from the Metropolitan Builders Association in Milwaukee.

The Wisconsin solar home builders were asked about their experience in constructing new homes with solar generation capability, their view of the current state of the solar new home market in Wisconsin, the current barriers to market development, and factors that might stimulate the market. The four Wisconsin home builder interviews were conducted by telephone and taped with the respondents' permission. The interviews lasted 20-30 minutes. A copy of the Wisconsin Solar Home Builder In-depth Interview Guide is in Appendix A.

3.1.5 Other state solar home builder in-depth interviews

Interviews were conducted with well-known solar home builders in four different states—states that were assumed to have a more developed market for solar new home construction than Wisconsin. The goal of these interviews was to compare responses of these home builders with Wisconsin home builders to the same questions.

Based on discussions with We Energies staff, California, Arizona, Colorado, and Massachusetts were selected as the comparison states, using the assumption that the solar home market in each of these states is more developed than the Wisconsin market. Table 3.1 shows a comparison of solar initiatives and incentives available in the comparison states as of March 2011. Table 3.2 shows the average residential electric rate in each state, as of November 2010 from the Energy Information Administration website at the following link: (http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html)

Table 3.1: Characteristics of Comparison States

State	Current Solar Initiatives/Incentives	Residential Incentive Amount
California	California Solar Initiative	Based on expected performance
Massachusetts	Commonwealth Solar II Rebates	$8,500
Arizona	Sales tax waived, personal income tax credit, no property tax adjustment	Variable
Colorado	Residential Renewable Energy Rebate Program	$10,000
Wisconsin	Focus on Energy - Renewable Energy Incentives	Based on rated capacity - 30% max

Table 3.2: Average Residential Electric Rate in Comparison States

State	Ave. Residential Electric Rate (cents per KWh)
California	15.20
Massachusetts	14.71
Arizona	10.15
Colorado	10.39
Wisconsin	12.76

To identify solar home builders in each of the four comparison states, we conducted an Internet search of reports, news articles and stories about solar homes in the four states. A prominently mentioned solar home builder was identified and interviewed in each of the four comparison states.

The interviews with home builders from the comparison states used the same topics—their experience in constructing new homes with solar generation capability, their view of the current state of the solar new home market in their state, the factors that have stimulated the current market, and the current barriers to market development. Interviews were conducted by telephone with the four home builders from the comparison states and taped with their permission. The interviews lasted 20-30 minutes.

A copy of the Other State Solar Home Builder In-depth Interview Guide is in Appendix A.

3.1.6 Interview with Niels Wolter, Wisconsin Focus on Energy Renewable Energy Program

An interview was conducted with Niels Wolter, the Wisconsin Focus on Energy solar market expert to provide background information on the market in Wisconsin and the outlook in Wisconsin and in other comparison states.

A copy of the in-depth interview guide for the Wisconsin FOE interview is in Appendix A.

4. PHASE 1 KEY FINDINGS

4.1 INTERVIEWS WITH SOLAR AND NON-SOLAR HOME BUYERS

A total of 11 interviews were conducted with buyers of the Tim O'Brien 'spec' homes constructed as part of the Solar Home builder Partnership Program—seven interviews were conducted with buyers of the solar homes and four interviews were conducted with buyers of the non-solar homes. All of the home buyers sampled and contacted for this study were very cooperative and willing to participate in the 30-45 minute interview.

The detailed findings from the 11 in-depth interviews are discussed below.

4.1.1 General factors in purchase decision

Initially, respondents were asked a series of open-ended questions, with no mention of a solar electric photovoltaic (PV) system, to gauge the relative importance of the solar system among the many different factors that influenced their purchase decision.

a. *For most solar home buyers who purchased a spec house, the solar electric PV system was <u>not</u> one of the major factors in their decision to purchase the house.*

Two of the solar home purchasers expressed an interest in a solar home prior to the homes being constructed, indicating that the solar system was a primary factor in their purchase decision. The five other solar home buyers purchased a spec home that had already been completed and the solar electric PV system had been installed. For these five spec solar home buyers, the most important factors in their purchase decision were typically the layout, location (including school district), the lot, and the quality of the construction. Four of these buyers of spec solar homes did not mention the presence of the solar electric PV system as one of the most important factors in their purchase decision in an open-ended question.

One of the five spec solar home buyers, however, indicated that the solar electric system was a major factor in their purchase decision:

> *"We looked at this house, and then immediately we were drawn back to it. It all had to do with the solar panel system. If we were going to buy a home, we would rather take our chances in buying something like this than something that isn't solar-panel related. Somebody who's not educated in the solar panel system was interested enough to know that I'd rather have something like this than any other house around me."*

4.1.2 Influence of solar electric PV system on purchase decision.

a. *Even though it was not one of the major purchase drivers for four of the spec solar home buyers, the solar electric PV system was viewed as a "plus."*

All of the solar home buyers described the solar electric system as a positive feature of the home they purchased. Even though four spec solar home buyers did not mention the solar electric PV system as one of the most influential factors in their purchase decision (in response to an open-ended question), all viewed the presence of the solar electric PV system as a "plus." One respondent said:

> *"I think the solar is a positive. I think it's an asset. It makes the house more valuable."*

b. *For most of the non-solar home buyers who had also viewed a solar home, the solar electric PV system was seen as a positive feature. For these non-solar home buyers, other factors, such as the layout, location, and lot prompted them to purchase one of the non-solar homes.*

The non-solar home buyers interviewed all expressed an interest in Tim O'Brien Homes because of the builder's reputation for constructing energy efficient homes. The non-solar homeowners seemed as interested and receptive to solar technology as the solar home buyers. These non-solar home buyers seemed open to the idea of a solar home (when they saw one), but purchased a non-solar home for other reasons. Two of the non-solar home buyers reported their initial interest in looking at one of the Tim O'Brien model homes was due to the solar electric PV system. In both cases, it seemed that these home buyers might have purchased a solar home if the model they looked at had met their other requirements. According to one respondent, timing was the reason they purchased their non-solar home:

> *"We actually see [solar electric technology] as a positive; if this home would have been ready and had [a solar electric system] on it, we may have considered it. We needed to [move] now; we didn't want to wait for another house. This one was going to be better than what we had, so we decided if we needed to retrofit later, we could decide then whether we wanted to do wind or solar."*

Other comments from non-solar home buyers included the following:

> *"I think it would be a positive for sure. You're talking about harvesting your own energy. I wouldn't look down on one. I would have considered one had there been one in [respondent's city]."*

> *"I did not know there were solar electric PV homes in the area. I did not know if there was one available for me to look at. I would have been interested in looking at one, especially if it would have been the same design as the home I have now.*

With respect to the above comment, it should be noted that since pairs of houses (one solar and one non-solar) were constructed in the same specific local area, it may have been the case that the solar home in that area had already been sold or was under construction at the time of the purchase decision.

c. *Most of the solar and non-solar home buyers had only minimal level of knowledge of solar technology and how the solar electric PV system. Many of the solar home buyers expressed confidence in the builder as an offset to specific knowledge of the solar electric PV technology.*

While most of the solar and non-solar home buyers indicated that they were aware of solar electric technology being used in residential homes, most reported only a very general level of knowledge about solar technology or how the solar electric PV system would function. Two respondents reported conducting research on their own to learn more about the technology before looking at any Tim O'Brien models, but in the other cases, buyers purchased their

homes without knowing much about solar electric technology or the solar electric PV system. One respondent said:

> *"Nobody really knew a lot about the solar system, except that it offsets your utility bill; for that, it was positive."*

d. *Most solar home buyers who purchased spec homes were not aware of the cost of the solar electric PV system or how much the solar electric PV system added to the price of the home they purchased.*

One solar home buyer reported that a third party electrical company indicated that the solar electric PV system probably cost about $40,000. Other solar home buyers reported they had not heard anything about the cost of the solar electric PV system. When asked what they thought the solar electric PV system might have cost, most solar home buyers estimated a cost of $10,000-$15,000.

The two solar home buyers who had requested a solar home prior to construction had differing perceptions of the additional cost that the solar electric PV system added to their home. One believed the solar electric PV system added about $20,000 to the cost of the home, while the other believed it added $6,000-$8,000 to the cost of the home.

The solar home buyers who were not aware of the cost of the solar electric PV system were asked what amount, if any, they would have been willing to pay to have the solar electric PV system installed on their new home. Most responded that they would be willing to pay about $10,000 for the solar electric PV system. However, one respondent indicated he would not have been willing to pay an additional amount for the solar electric PV system, without a better explanation of the amount he could expect the solar electric PV system to save him on his electricity bill.

e. *Solar and non-solar home buyers generally did not express concerns about the appearance of the solar panels on the roof.*

None of the solar home buyers or the non-solar home buyers who had seen one of the Tim O'Brien Homes with an solar electric PV system felt the solar panels on the roof detracted from the appearance of the house, although some felt that it was preferable to have the panels on the back, so they were not visible from the street. Other respondents felt that the design of the solar panels was much more attractive (lower profile and fitting the contour of the roof) than they had expected.

Several respondents noted that the solar panels are more attractive than a satellite dish, which many people don't mind putting on their roofs. One respondent even indicated that the solar panels looked "cool."

> *"I get people telling us that it looks like a rich home; it adds to it. And you can clearly see them from the road."*

> *"From the back of the house and looking at it, it looks really great with the solar panels. It looks really nice. I know people probably wonder how it works, and can I get something like that on my house?"*

4.1.3 Operation of the solar electric PV System

Most solar home buyers had lived in their new home for less than one year. None of the solar home buyers had lived in a residence with a solar energy system, such as a solar water heater or a solar electric PV system, prior to their current residence. None of the solar home buyers expressed any concerns or complaints about the operation of the solar electric PV system in their home.

a. *Solar home buyers did not report any concerns or problems with the operation of the solar electric PV system.*

The solar home buyers did not have major reservations about the reliability, maintenance or safety of the equipment. One respondent mentioned a concern about snow hampering the operation of the solar electric PV system. Another indicated uncertainty about what to do in the event of a power outage. However, all solar home buyers expressed a high level of satisfaction with their new home and the solar electric PV system.

b. *All solar home buyers report significant savings on their We Energies electricity bills.*

Solar home buyers report monthly savings ranging from $40 to more than $100. Those respondents who have lived in their homes in both summer and winter reported higher savings in summer, as expected. Following are some comments from solar home buyers regarding their electricity bill savings:

> *"It absolutely has had an effect; not so much in the winter months, maybe 10% savings, but in summer, it basically cut my bill in half."*
>
> *"I would say in this house a normal bill would be about $300 bill in the winter. Ours is $100 to $200."*

c. *Solar home buyers report positive comments from family, friends and neighbors regarding the solar electric PV system.*

One respondent noted that their family is known as the "solar people" around their community, and indicated that their solar house is better known than they are at many of the local area shops. Other comments from solar home buyers are as follows:

> *"When I tell people in my family that we saved at least $40 or more every month on energy bill and the house is nice and warm and feels great, they think that's excellent and wish they had that ability. It's given good conversation, where people are actually starting to think that maybe this is something that they should look into. It's making people think when they see you can do this, maybe I can do this. It's not something that's out there that people are talking about and can't relate to. Now they know people who have an ENERGY STAR home and solar panels. They can see it and ask questions about it; I think they're excited for us."*
>
> *"At work, I'm an electrical engineer, and I can't tell you how many conversations I've had with people about solar, where they find out about it, and people I don't know very well. Word gets around, and people are asking me all kinds of questions about solar."*

d. *Solar home buyers generally perceive that the solar electric PV system will have a positive effect on the resale value of their home, but are not able to quantify the amount.*

While most solar home buyers feel that the solar electric PV system will increase the resale value of their home, some expressed concerns about the cost of maintenance and upkeep for the solar electric PV system, which could work against an increase in resale value. For these solar home buyers, the costs of maintenance and upkeep are an unknown at this time.

Comments about the effect of the solar electric PV system on the resale value of their home included the following:

> *"It kind of forces [people] to look at the green way of doing things; and I think that they think that it was a smart decision for us to go for a green home over just a regular home that's just being built in an area. It attracts attention. Every single quality about this house is going to be better for resale than one that's next to me."*

> *"I think it would be an extremely good selling point, because in this day and age, when people are trying to save any way they can, when they know that a home, a new home, has all these great amenities and solar panels on top of that to cut energy bills, people are going to think it's great."*

The solar home buyer who expressed some reservations about the potential enhancement to the resale value of the home noted that any added expenditures for maintenance or upkeep might offset a modest decrease in electric bills.

> *"When we first moved in, we felt like it [the solar electric PV system] was a plus; but with the way the economy is, we don't know if it would be a plus. Seeing we get a third [off of our] utility bill, that's kind of a plus, but with the way that the economy is, I don't know if that would be enough of a plus for somebody to say, "I'd take your house over somebody else's if there were additional expenses."*

4.1.4 Characteristics of Home buyers Interviewed

Table 4.1: Solar Home buyer Characteristics

	Year born	Highest education level	Number in household	Annual household income	Contributors to household income
Respondent 1	1975	Bachelor's degree	5	$125,000 - $150,000	2
Respondent 2	1969	High school	7	$75,000 - $100,000	1
Respondent 3	1978	Bachelor's degree	5	$100,000 - $125,000	2
Respondent 4	1972	Bachelor's degree	4	$100,000 - $125,000	1
Respondent 5	1983	Advanced degree	2	$175,000 - $200,000	2
Respondent 6	1959	Bachelor's degree	1	$50,000 - $75,000	1
Respondent 7	1980	Advanced degree	2	$125,000 -$150,000	2

Table 4.2: Non-solar Home buyer Characteristics

	Year born	Highest education level	Number in household	Annual household income	Contributors to household income
Respondent 1	1972	Master's degree	3	$175,000 - $200,000	2
Respondent 2	1981	Bachelor's degree	3	$100,000 - $125,000	2
Respondent 3	1962	Bachelor's degree	4	$125,000 - $150,000	1
Respondent 4	1981	Bachelor's degree	2	$50,000 - $75,000	2

4.2 INTERVIEWS WITH WISCONSIN SOLAR HOME BUILDERS

In-depth interviews were conducted with Tim O'Brien from Tim O'Brien Homes and Matt Matrise from Solar Innovations, both stakeholders and partners with We Energies in the Solar Home Builder Partnership Program. In addition, in-depth interviews were conducted with three other Wisconsin home builders currently offering solar homes to customers and the Metropolitan Home Builders' Association in Milwaukee.

4.2.1 The current market and barriers for solar electric in new homes in Wisconsin –

a. *Currently the market in Wisconsin is stronger than it is generally perceived to be, especially in the nonprofit sector.*

The Wisconsin solar home builders believe that the market for solar electric PV systems in Wisconsin is stronger than most industry observers would expect. They report that at national conferences and in discussions with others in the industry, Wisconsin is generally considered an unfavorable market. However, they think the market for solar in Wisconsin is actually flourishing, especially in the nonprofit sector, where they have seen exponential growth in the past few years.

> *"Interest is strongest in the nonprofit world; that's where most of our jobs come from currently. We do solar electric PV for churches and schools. We also do some residential solar jobs, but the nonprofit sector is where the demand for solar is strongest. That is because of available incentives, and intangible benefits, such as environmental and educational. Schools and large congregations are more interested in these types of benefits; when you have a large group of people pushing it, it's easier."*

b. *While there appears to be a lot of consumer interest and potential demand for solar homes, the "economics" are not yet right, so most interested new home buyers often eliminate solar when it gets down to budgetary decisions.*

There is a lot of interest and apparent consumer demand for solar electric systems, but in the final analysis, when it comes down to cost, most customers decide to go with other amenities, such as granite countertops or wood floors, rather than installing a solar electric system. Wisconsin home buyers are reported to be conservative and frugal. Solar is not something people feel they need to have and it is has yet reached a status as a 'fashionable' feature in

new homes. Even for those home buyers who are interested in solar, solar is the first thing that gets removed when they look at budgets.

c. *The perception in the home builder industry is that the payback for solar is too long for most home buyers, even with available rebates and tax credits.*

The general consensus in the industry is that a payback of 7-9 years is the longest period that is acceptable to many home buyers. Once the payback exceeds 10 years, home buyers don't see an economic benefit to installing solar electric generation in their home.

Tim O'Brien Homes believes the current payback for solar is 12 to 16 years, even when accounting for Focus on Energy rebates and the federal solar investment tax credit. The federal solar investment tax credit played a big role in moving people into renewable energy, but other forms of renewable energy are currently viewed as more cost-effective (with a shorter payback) than solar. The builder feels that for the Solar Home Builder Partnership Program, if the We Energies subsidy was removed, geothermal becomes more cost-effective than solar. Tim O'Brien Homes feels that home builders can demonstrate a payback on natural gas to geothermal of 7-9 years. In Wisconsin, many home builders feel that geothermal is going to pay back quicker than solar and it's something consumers know more about. Once you explain the geothermal system, it is similar to a traditional furnace, which makes home buyers more comfortable than using something like solar which still seems like a new technology.

> *"The biggest hurdle is the upfront cost; people generally want to do solar, because they know it's the right thing to do environmentally. This makes building 'green' the easiest hurdle. The upfront financial cost is pretty tough; that and education; a lot of people have heard of it, but don't know what it does or are a little bit scared of new technology."*

> *"[For financing in the Solar Home Builder Partnership Program] We looked at it as 3 kW system, we job-costed it around $9,000. Depending upon the type of panels we were buying; later on, the cost was about $8,000; and that's taking the We Energies rebate into consideration. With a couple of clients, the only way we could get them to do it was to take the rebate right off the top; we took rebate to help lower the cost basis. Also, in two cases, we actually financed in-house the tax credit portion of the system. When clients got their federal solar investment tax credit back, they paid off the loan at 0% financing. People (or builders) are doing this around the country. We are looking into this, but in a lot of cases, the project is not big enough to offset overhead with leasing systems."*

d. *Misperceptions and a lack of knowledge among new home buyers is a barrier to developing the solar market in new homes in Wisconsin.*

Wisconsin home builders report there are misunderstandings about how a solar electric photovoltaic system works. One common misperception is that solar is not appropriate for Wisconsin's climate. One builder uses Germany as a model, showing that Germany is one of the highest users of solar electric photovoltaic systems in the world, even though they have a similar climate and latitude as Wisconsin. Other misunderstandings include a lack of knowledge about required maintenance and the durability and life expectancy of the solar electric system components, such as the solar panels.

> *"Some people shy away from solar because of their concern about what their future expenses might be, such as a 5-8 year timeframe to replace the inverter. People are also concerned about the toughness and warranty of the panels. It appears that people are adding up lifecycle costs in their head. We didn't expect this in the beginning and we found people weren't willing to pay us for the solar because of future concerns for replacement. These were not people who were driven to solar because of environmental concerns. Among these home buyers there is still a concern about the total cost of solar. It gets back to the discussion about the economic benefits."*

e. *Many Wisconsin home builders are reluctant to change the way they have been building houses.*

Wisconsin home builders are resistant to venture into solar electric systems. Because it seems to be a relatively unknown area, they are unwilling to change the way they have always built houses. The specialized group of solar home builders currently operating in Wisconsin has sufficient demand for solar homes to keep busy, with custom residential and nonresidential building. However, there has not yet been a sufficient level of home buyer demand to convince builders to move into solar spec home construction.

f. *Some Wisconsin builders are not familiar with the improved appearance of the newer solar panels.*

Some Wisconsin builders are concerned that prospective home buyers will view solar panels as detracting from the overall appearance of a new home. There are also restrictions in some subdivisions against rooftop solar panels. However, some builders, such as Tim O'Brien Homes, report that new improvements in panel design have created a wider array of choices for new homes and home buyers who do not like the look of the older style of panels often end up liking the new cylindrical models.

g. *Appraisals of homes with solar electric PV systems often do not reflect the cost of installation.*

Tim O'Brien Homes reported that appraisals were a continual challenge during the Solar Home Builder Partnership Program. It was rare when an appraisal of one of the solar electric PV homes reflected the cost of installing the solar electric PV system. For appraisers, one of the problems is the lack of "comparables" sold in the same area. Tim O'Brien Homes reports this was also an issue with geothermal systems. It is a "catch-22" situation where home builders with a commitment to renewable have to discount the systems in order to get more of them built and do a better job of educating clients and other parties, such as appraisers.

h. *There is a shortage of solar electric photovoltaic system installers with North American Board of Certified Energy Practitioners (NABCEP) certification in Wisconsin.*

The person who installs a solar electric photovoltaic system has to have NABCEP certification in order to get the Focus on Energy rebate and the federal solar investment tax credit. To date, there is a shortage of installers with NABCEP certification. There has also been a greater demand for space in the NABCEP certification courses—currently there are more than four times as many applicants as there are spaces in the local programs.

4.2.2 Opinions on factors stimulating growth in the solar market for new homes in Wisconsin

a. Prices for labor and components for solar electric PV systems are expected to decrease.

Over time, the supply of NABCEP-certified installers will catch up with demand. That will begin to drive down the labor component of solar electric PV systems. In addition, the cost of components, such as panels and inverters will also come down as manufacturing takes place on a larger scale.

b. New larger designs for solar panels enable them to generate more electricity.

Tim O'Brien Homes are now installing panels that produce 235 watts per panel. On the first trend homes, they installed panels that produced 185 watts per panel.

c. The concept of making new homes "solar ready" is starting to catch on among Wisconsin home builders.

To make a new home solar-ready, it only costs about $250 for conduit and installation. Some builders are also taking into account the positioning of the house on the lot to make future conversion to solar easier. If the house is positioned correctly, and the conduit is installed, the house is essentially solar ready.

d. Federal solar investment tax credits may motivate more manufacturers to build panels and components.

The longer-term availability of tax credits will likely motivate more manufacturers to build panels and components, and more home builders to begin discussing solar with clients.

e. Future energy prices are likely to increase, which will stimulate interest in solar electric technology.

Some home builders and others in the industry believe that future increases in energy prices are going to stimulate an increased interest in solar electric technology among home buyers. Some builders point to an increased interest in solar in new home construction a few years ago when gasoline prices rose significantly.

f. It is not clear whether the driving force for new home construction with solar electric PV systems will come from home builders or consumers and home buyers.

According to one builder, a lot of new home markets are conservative markets. He feels that in these markets the mainstream builders still tend to look at solar as something that's going to come and go. They view an uptick in interest or demand as a potentially brief blip.

Especially in today's new home market, some builders don't expect interest and demand for solar and renewable energy to come back for 10-15 years. There are stories of builders trying to talk customers out of installing solar or geothermal, using incorrect numbers and data to show that the cost-benefit ratio is not favorable.

One builder noted:

> *"In terms of getting to mainstream market, I think the demand for solar is going to have to be consumer-driven. I just don't see builders doing this. Consumers are going to have to bring it up to builders, because builders have a hard enough time selling what they have now."*

On the other hand, one of the Program stakeholders involved in building the solar spec homes reported:

> *"I did receive some calls from consumers, but more calls from builders (about the spec solar homes). Metropolitan Builders Association drove some builders to call. I had some calls from builders and a developer saying, "I see what Tim's done out there, I want to talk about that and see what we could do as well."*
>
> *"I've personally talked to ten or more builders that have had interest and I know that some have moved on it. Tim O'Brien Homes has done the most, but I know there are talks going on at the Metropolitan Builders Association and in their Green Building Council on taking solar electric photovoltaic systems a step further and making it a standard feature that is offered in new home construction.*

4.2.3 What else is still needed to stimulate the market for solar electric PV in new home construction?

a. *Incentives are needed to overcome the upfront cost barrier to solar electric PV systems.*

The combination of federal investment tax credits, rebates from Focus on Energy, and other rebate or incentive programs from electric utilities provides a combined package that could have a significant impact on home buyer decisions.

b. *Standardization of interconnection rules between utilities in the State of Wisconsin would help to make solar electric PV systems easier to install.*

Standardizing how interconnection rules are applied to govern how solar electric generating systems actually connect to the grid would make it easier for home builders and developers to offer solar electric systems and develop building programs that cut across utility service territories.

c. *Education for home builders and home buyers is needed to increase the likelihood that solar electric technology is considered in new home construction.*

There are a relatively small number of home builders in Wisconsin who offer custom solar homes. Only one other builder in Milwaukee offers spec solar homes, outside of the Solar Home Builder Partnership Program. Both Tim O'Brien and Matt Matrise regularly field questions from other builders and developers about solar electric technology. Their perception is that most home builders are not prepared to provide a sufficient amount of information to prospective home buyers if they were asked about a solar electric PV system. Similarly, most home buyers have only a very general level of awareness of solar electric technology.

d. *Developers need to have someone on staff that is familiar with solar electric technology and can explain the benefits and costs to potential home buyers.*

If developers had someone on staff that was familiar with solar electric technology, they could develop a standardized set of options to be offered to home buyers. The options could range from the relatively inexpensive ones, such as making their new home "solar ready" for future installation to more comprehensive options for installing solar electric PV systems. Offering solar options to the features to be selected for a new home would expose more home buyers to the idea and probably result in more installations.

4.2.4 Lessons learned from the solar home builder partnership program

As part of the interviews with Tim O'Brien (from Tim O'Brien Homes) and Matt Matrise (from Solar Innovations), we asked them to discuss the lessons they had learned from the Solar Home Builder Partnership Program. In summary, Tim O'Brien indicated

a. *Reactions of prospective home buyers to the solar electric PV systems were almost all positive, but selling solar electric PV homes in the current housing market is difficult.*

A lot people who visited the model solar electric PV homes thought it was "cool" and innovative. This seemed to be especially true for people with higher education levels. Most of the time, people were interested, but ultimately were not willing to commit money to it. Tim O'Brien indicated he would not be confident of being able to sell homes for a higher price because of the solar electric photovoltaic system in the current housing market. When home prices drop, it is harder for people to justify adding the cost of a solar electric photovoltaic system. He feels it could be two to five years before people start actively looking at solar electric PV systems in new construction again.

b. *It is important to be able to accurately address home buyers' concerns about the maintenance, durability, and cost of maintaining the solar electric PV system.*

Tim O'Brien indicated that the Program underscored the need to better anticipate and address the fears and concerns, and lack of understanding about the technology of home buyers. He and Matt Matrise indicated they had not anticipated the number and range of questions, such as "what happens if a basketball lands on the solar panel?" or "what happens when the panels get covered by snow?" or "who do I call if the solar electric PV system breaks down or doesn't function properly?" Both felt they got three to five years' worth of feedback from home buyers in a condensed 18-month timeframe as a result of participating in this Program.

c. *It is important to keep promoting renewable and solar electric technology, even if they aren't building many houses in the next few years.*

Given the need for increasing home builders' and home buyers' awareness and knowledge about solar electric technology, it is important that builders such as Tim O'Brien Homes, who have a long-term commitment to renewable energy, maintain the momentum developed by this program. This will include working the MBA and Green Building Council, networking with

other interested home builders and developers, and helping to provide information and educational materials for home buyers.

> *"We tried to put [the model solar electric homes] in communities that would be receptive—where you would expect to find $235,000-$300,000 homes. We wanted to give exposure to the product, so we strategically placed them on busy streets and corners. People see them when they are driving around, so we kept a model home or two, so we could demonstrate and talk to people and groups about them."*
>
> *"We will continue promoting solar electric PV systems for residential new construction; that's one of our market differentiation points. Even if we're not going to be building as many [solar electric homes], people still call us wanting feedback and background. We continue to get calls from builders as well—they say they have a client that wants solar electric and they want to know who to contact."*

d. *We need to improve the education of the real estate sales agents with respect to the solar electric PV systems.*

Matt Matrise indicated that, in retrospect, he may have focused too much on a general overview of solar technology and not enough on the specific features and characteristics of the solar electric photovoltaic system that was installed on the spec homes for the program. There was a lot of information to digest in a single briefing. Matt indicated that he ended up meeting with two of the solar electric PV home buyers to answer questions and give them more information.

There are also a lot of 'unknowns' about how the solar electric photovoltaic system will perform on specific homes and the maintenance and upkeep that is required. It will be important to capture these types of data, as well as feedback from solar electric homeowners for future sales efforts.

e. *There is a need to educate building inspectors, community homeowner associations, and appraisers about the benefits and advantages of solar electric PV systems on residential homes.*

There were several cases where community homeowner associations had regulations against rooftop panels. Further, in one metropolitan community, the local building inspector was adamantly against solar. He told the builders "there is no way I'm going to allow that." It was eventually approved, but there are likely to be other building inspectors with similar views in Wisconsin.

4.3 INTERVIEWS WITH TIM O'BRIEN HOMES' REAL ESTATE AGENTS

A total of three interviews were conducted with real estate agents selling the Tim O'Brien "spec" homes constructed as part of the Solar Home builder Partnership Program. As originally planned, Tetra Tech was to conduct a series of in-depth interviews with potential home buyers who visited the solar and non-solar homes. We learned later that contact information for this "interested" home buyer group was not available. As an alternative, we agreed with We Energies to interview the real estate agents who were showing and selling the spec solar and non-solar homes to prospective home buyers. We obtained the real estate agent's contact information from Tim O'Brien Homes.

The detailed findings from the three in-depth interviews with Tim O'Brien real estate agents are discussed below.

4.3.1 The current market for solar electric in new homes in Wisconsin

a. *The market for solar electric PV systems in residential new construction is not strong enough to support spec homes.*

All three agents acknowledge that the current market for solar electric PV market in Wisconsin is not strong, but it occupies a small segment of the market led by green conscious homeowners. Regarding home builders offering solar electric PV on their spec homes, one agent stated, *"There's probably not a builder in this marketplace who would include solar panels on a spec home."*

b. *The solar market is likely to grow, but the amount of growth will be based on consumers' awareness and perception that solar electric generation capability adds significant value.*

The real estate agents do share an optimism that the market will grow in the future. Two felt that the market will increase over the next five to ten years as prices for solar electric PV technology reduce and awareness continues to rise. The third agent was less enthusiastic, emphasizing that the market will be driven by customer demand; and that solar electric PV systems are not currently viewed as a critical aspect of their decision making process. Further to this point, another agent mentioned,

> *"[I] don't see solar panels as being in the same category as the granite countertops and wood floors; it's not a sexy thing; I think if you gave people the choice of granite countertops, hardwood floors and a fireplace, or I can strip all that stuff out and go with basic vinyl laminate and no fireplace but I'll give you solar panels, they would pick the other creature comforts before they would opt for the solar."*

4.3.2 Factors that will stimulate growth in the residential market

Real estate agents offered three factors needed to stimulate the growth of the solar electric PV market: (1) consumer education; (2) reduced costs; and (3) continued improvements in solar panel aesthetics.

a. *Increased consumer education will help consumers develop a positive view of the benefits and costs of solar electric PV systems.*

One agent argued that the Internet will increase home buyer's access to information about solar electric PV systems. Further, with this information they can understand better the potential long-term return on investment. Another agent reinforced the need for specific real-world examples of cost savings to educate home buyers,

> *"I think consumers will want to know how well a $20,000 investment on the roof actually performs. It's one thing to say that it's going to produce X amount of electricity and save this amount of money, but we need to have real-world data that shows clearly how much is actually saved."*

b. *The cost of solar electric PV systems is expected to decrease, making the benefit-cost analysis more favorable.*

One real estate agent explicitly stated, *"The [upfront cost of solar electric photovoltaic systems] is paramount."* The real estate agents underscored the importance of increasing the benefit-cost ratio in light of home buyer's current tight budgets. If the homeowner's upfront costs are reduced, that combined with an electricity bill reduction will make the investment in a solar electric PV system very attractive.

c. *Improvements in solar panel aesthetics will increase the installation of solar electric PV systems.*

The last factor mentioned to stimulate growth was the need to continue to improve solar panel aesthetics, stating, *"One of the other big things is the new panel design—moving towards ones that blend in with the house and are not so obtrusive will help."*

4.3.3 Barriers to growth in the residential solar electric PV market

Real estate agents cite four specific impediments to solar electric PV market growth: (1) upfront costs and payback in a Wisconsin climate; (2) an 'intimidation' factor; (3) panel aesthetics; and (4) broader market influences.

a. *Upfront costs and the perceptions of the payback period are a key barrier in the current market.*

Two agents mentioned upfront cost as an impediment to home buyer investment in solar electric. Another discussed that in addition to upfront costs, homeowners may negatively view the investment costs vs. payback in a Wisconsin climate. This agent stated,

> *"I would say the biggest thing is people understanding the investment versus the payback. I think some of the perception is that solar won't work in WI; really, it has more to do with days of sunlight than temperature and all that kind of stuff. WI really has a lot of good days of sun, compared to other parts of country. It's a matter of people understanding the fact that they're able to save enough to offset the cost."*

b. *For many home buyers, the lack of knowledge about solar electric PV systems is intimidating.*

Also mentioned by a real estate agent was an "intimidation factor"—home buyers trying to decide on purchasing a solar electric PV home and asking themselves, "how do I take care of it?" Underlying this sentiment is the need to educate home buyers about solar electric systems to reduce feelings of intimidation. Just as increased education is a factor to stimulate growth; one agent believes that the lack of education and general misunderstandings about solar electric photovoltaic systems impede growth.

c. *Real estate agents continue to express a concern that having to place panels on the front of the house is a barrier.*

Panel aesthetics and location, especially solar panels located on the front of the house, was viewed as a deterrent. One agent offered a couple of thoughts,

> *"Have sold four solar homes—three had panels on the rear of the house, so you couldn't actually see them from the road; no concern. One of them had them on the side of the house, and that was a concern for a lot of potential buyers."*
>
> *"House with panels on the side [is] not necessarily an eyesore, but detracts from the overall appeal of the house. Obviously, no one would ever want them on the front, and the side is also a little bit of a concern to a lot of potential buyers."*

d. *The price of electricity and gasoline will have an impact on the solar market.*

The real estate agents felt that broader market influences, such as changes in energy and gasoline prices, can also affect home buyers' interest in solar electric systems.

4.3.4 Influence of interest in energy efficiency and solar in purchase decisions

Real estate agents described home buyers interested in Tim O'Brien Homes as having a good mix of demographic backgrounds, but generally sharing an interest in green building and energy efficiency. In addition, one agent mentioned that most are not first time home buyers.

a. *The solar home buyers did not start out specifically looking for a solar home, but the presence of a solar electric PV system was viewed as a "bonus."*

Agents were in agreement that prospective home buyers did not approach them with a specific leaning towards solar or non-solar homes. One agent said, *"It's not something that people come out looking for."* When home buyers learn about the options of either solar or non-solar homes, one agent mentioned that there was an initial heightened interest in the solar homes. They stated,

> *"I think that more people are interested in the solar houses upfront; they like the idea of it; it's an interesting thing; just the fact that it was new technology for the area."*

Another agent mentioned they did not get a higher interest from the solar homes, and described home buyer interest in solar as more of an afterthought. This agent did describe situations where home buyers had similar choices within a subdivision, one solar and the other non-solar.

> *"In a subdivision, if I've got a home that has solar on it and one that does not, the solar is kind of an added thing; people would ask questions about it, and we would tell them they would save some money on electric."*

Two real estate agents described solar electric PV system as a 'plus' factor in the decision to purchase a solar home, but it was not high up on their priority lists. The agents said,

> *"[The] PV system was a notch in the plus column; as people are looking at different homes, they're keeping track; they're looking at positives and negatives."*

> *"For a lot of those buyers, solar was "nice"—get a check for $30 or $40 per month; it doesn't deter, doesn't scare them away, but wasn't a big factor in buying the house."*

b. *There was not much difference in the rate at which the solar and non-solar homes sold.*

In terms of closing sales on both solar and non-solar homes, two agents stated that they sold at about the same rate. The third thought that although there was upfront interest in the solar homes, they took longer to sell because of the increased cost of the homes[4].

Later, one of these two agents continued, discussing the price-point similarities between paired solar and non-solar homes,

> *"…because we had solar homes that were priced aggressively and competed with non-solar homes, solar was seen as a positive thing."*

The third agent stressed electricity cost savings as an important factor. Further, the agent described sitting down with the prospective home buyer and detailing monthly cost savings,

> *"The most important factor was energy/cost savings; being able to sit down with somebody and show them the numbers—you're going to save this much per month."*

c. *There was no evidence that the solar electric systems were a factor in prospective home buyer's decisions not to purchase a house.*

For the prospective home buyers who looked at the solar homes, but decided not to purchase one, the real estate agents agreed that the solar electric PV system was not a deciding factor in the decision not to purchase.

d. *The real estate agents were only moderately enthusiastic about the idea of purchasing a solar home for themselves sometime in the near future.*

Finally, we assessed the real estate agents' interest in purchasing a home with a solar electric PV system in the near future. Agents reported they were open to considering a solar home, but expressed concern about the long perceived payback period (15-20 years). They

[4] Agents' views of the cost differences between solar and non-solar homes varied. One agent indicated the cost for the paired solar home was higher, while two others indicated the solar homes were not substantially different from non-solar homes.

noted that most homeowners do not live in a home for that length of time. In addition, one mentioned geothermal as an energy efficiency option with a shorter perceived payback period.

4.3.5 Prospective home buyers' reactions to the solar electric photovoltaic systems

We asked real estate agents to share thoughts from the home buyers' perspective about solar panel placement and appearance, their initial thoughts and questions about the solar electric PV system, and any feedback regarding solar home pricing.

a. *The appearance of the solar panels was not an issue for most prospective buyers, since the panels were typically placed in the back of the house.*

Regarding solar panel placement and appearance, real estate agents mentioned that a majority of their homes had solar panels on the back side of the roof. One was quick to note that had the solar panels been visible from the front of the home, it would have detracted from the home's appearance. Another agent provided particularly telling sentiments regarding perceptions of solar panel appearance, stating,

> *"It really comes down to the home, the location, the placement on the lot. One of the homes was a two-story, and when you drive from one direction, you can really see them; the other was a ranch, and because of placement and location, it was perfect, because you absolutely cannot see them at all. Appearance is better if you cannot see them readily—that's my opinion and others' as well. For the two-story, it did not prevent them from buying the home; pluses outweighed any aesthetics concerns."*

b. *Prospective home buyers wanted to know the cost savings attributable to the solar electric PV system, as well as its impact on the house purchase price.*

Real estate agents shared prospective home buyer comments and questions about the solar home. The two main questions were (1) the cost savings from solar electric generation; and (2) the effect of solar electric system on the home's purchase price.

Agents said questions about the cost savings of solar electric PV were common. One agent explained that if asked, they provided information; but usually the prospective home buyer was interested in the overall energy savings, not just the savings attributable to the solar electric system.

> *"…we have it on a cheat sheet—on our sell sheet—this home has a potential savings of this amount; but that's building in the construction of the home as well; so really, people don't necessarily care specifically about the solar, it's the whole package—it's part of the overall energy efficiency package."*

The three real estate agents discussed their understanding of the solar electric PV system specific cost and its effect on the home's purchase price. One agent stated that their understanding of the cost was unclear*, "[The] 30% tax rebate was consistent, but other rebates from Focus on Energy, etc. fluctuated. It was kind of a moving target to say how much the unit was going to cost."* A second agent was more confident in their understanding, but said no one asked about the cost. The third agent discussed the costs in general, citing their competitiveness with non-solar homes; but also provided cost figures when asked.

> *"[Questions about price] happened occasionally, and I would say, this system's valued at about $22,000, of that, currently you'd be eligible for a 30% tax credit; once you take advantage of that, you're probably looking at about $16,000."*

When asked whether or not the home buyer thought the costs were reasonable, the same agent stated,

> *"Yes, but if the house wasn't what they were looking for, or if it didn't have the other things they were looking for, I don't think they would have been swayed that it had the solar system.*

c. *There were also questions about maintenance, upkeep, durability, and warranties.*

Other home buyer comments included questions about maintenance, durability, warranties, and how the solar electric PV system will react, and hold up to inclement weather, such as snow, hail, and wind. Also, one potential home buyer asked whether or not the system could act as a power backup. Regarding questions about maintenance, one agent provided a creative response, saying,

> *"They're a little more at ease when we explain that there's very little, basically nothing in comparison to some of your other [household] mechanicals."*

4.3.6 Real estate agents' views about resale with a solar electric PV system

a. *Real estate agents were not optimistic that homeowners could recoup the cost of the solar electric PV system when they sold the house.*

Real estate agents found it difficult to discuss the likely effect of a solar electric PV system on a home's resale value. They thought having solar electric PV when selling the home was a positive, and all else being equal, may tip the scales on someone's decision. One agent also mentioned that the solar electric system might increase the value of the house if electricity costs increase in the future.

One agent was less optimistic that homeowners would be able to recoup the cost of a solar electric PV system at resale, saying,

> *"If you were to build a house and you actually added in the value you wanted to recoup at resale, I think that would hurt them. I don't think that Joe public is going to pay the extra $20,000 that that system cost."*

The same agent added a more general thought,

> *"That's the biggest challenge with some of these renewables; if people are not going to stay in the home long enough pay the thing off and get the return, the public is not going to pay a premium for them."*

4.3.7 Real estate agents' preparedness to sell solar homes and additional sales tools needed.

We asked real estate agents about their marketing and preparedness to sell solar homes. The real estate agents mentioned several differences between marketing a solar vs. non-solar home. One said that they are adding solar electric PV documentation on the MLS system, and will list "solar powered home" on their marketing sheets. Another pointed out that currently customer demand is not high, and people are not choosing homes because they are solar. Rather the agent stressed the importance of selling the cost saving benefits. A third agent discussed the challenge of selling solar home benefits to home buyers that may be skeptical about the savings, or may not even care about solar as an option, stating, *"The challenge is getting people to care about something they don't even know about."*

a. *Real estate agents felt they could have been better prepared to sell the solar homes if they had more detailed and practical knowledge of solar electric PV system, from the perspective of a potential home buyer.*

In hindsight regarding their experiences selling Tim O'Brien Homes, two real estate agents conceded that they were not as well prepared as they are now to sell solar homes. Both discussed the benefits of additional information and training. They stated,

> *"I would say that there is always an open invitation for more information on it; for the first one I sold, I was more unprepared, because I had just jumped onboard with TOB; new product and pricing, and then that on top of it; the second one, much better confidence level in talking about it and having the excitement to talk about it; can speak for the whole team that we would always want more information."*
>
> *"I would tell people you're going to save anywhere from 25% to 40% on your electric bill; but it would still be nice to have accurate data to say you pay X per kWh; as an agent, you don't want to quote hard numbers."*

The third agent felt prepared and referenced their Tim O'Brien/Neumann Developments training.

When asked about additional sales tools or information that would have helped, real estate agents mentioned two items: (1) detailed cost savings information; and (2) practical information about the solar electric PV system itself. To the latter, real estate agents wanted to be prepared to answer questions about safety concerns, or questions like *"What if a rock hits it?"*

4.3.8 Final thoughts from the real estate agents

a. *The real estate agents believe that consumer information and model homes are the key to increasing demand for solar homes.*

In concluding the interview, we asked real estate agents for any final thoughts or "lessons learned." One agent in particular offered several opinions on the Wisconsin solar home market in general, and stressed the need for supply-side movement,

"The biggest thing to getting this out there is marketing. Unfortunately, WI is notorious for being five to ten years behind the rest of the country; just not getting this out to the mainstream as much as we'd want, so we have to think of new and creative ways to market this and get people interested in it in order to be able to sell it more."

"We have to be able to get it to the consumer; we have to do more models and spec homes and find more creative ways of getting it out to the community, because it's not something people are asking for."

4.4 INTERVIEWS WITH SOLAR HOME BUILDERS IN COMPARISON STATES

To compare the Wisconsin solar home market with other states, we conducted interviews with a well-known solar home builder in 4 states where the solar market is arguably more developed. The states selected as comparison states were California, Arizona, Colorado, and Massachusetts. Agreement on these comparison states was reached in consultation with We Energies staff. For each state, we selected a single solar home builder who was featured in one or more reports or news articles about solar homes.

The detailed findings from the interviews with the solar home builders in the comparison states are discussed below.

4.4.1 The solar home markets in the comparison states appear to be more robust and perceived as growing, in contrast to the market in Wisconsin

The solar electric markets in the comparison states are more robust (and seen as growing) than in Wisconsin. Comparison state solar home builders cited a number of factors, such as increasing energy prices, favorable changes in solar buy-back and net-metering rules, and a state vision and plan for developing the solar market, typically with initiatives and goals, as the factors that help to encourage solar electric technology in homes.

4.4.2 Home buyers in the comparison states are more likely to seek out and demand solar generation as one of the features of a new home.

Home buyers in other states seem to have a more accepting view of solar electric homes in general. One builder reported they recently built sixteen spec homes, and potential buyers could choose additional upgrades or features to incorporate into the home; for fifteen of the homes, the buyers opted to add solar electric technology.

a. *Difficulty of obtaining financing was cited as a larger barrier than the upfront cost of a solar generation system for new home buyers.*

Some of the concerns brought up by home builders and real estate agents in Wisconsin regarding impediments to solar electric growth were not as readily voiced by home builders in other states. For example, although the upfront costs were mentioned by home builders in the comparison states, more emphasis was placed on the reluctance of banks to lend money to prospective homeowners because of the current economic conditions.

b. *The appearance of the solar panels is more likely to be seen as adding to the aesthetic appearance of a new house than detracting from it.*

The appearance of the panels was cited by respondents in Wisconsin as a potential negative; this is a much smaller issue in other states. Improvements in panel design were mentioned as having a positive effect on their appearance, but one builder did say that if they need to place the panels on the front of the house, then they will.

4.4.3 Federal and state incentives are seen as welcome, but not necessary by builders.

In Wisconsin, the various incentives for solar are seen by home builders as necessary to sustain the market. However, in the other states, builders said that the demand is high enough that they would continue to build solar homes, or at least seriously consider it. This may be put to the test soon, as the builder in Colorado we spoke with said that the utility company very recently announced that the incentive for solar electric systems in that state will be ending.

4.4.4 Environmental considerations are reported to be a strong driver of the purchase of new homes with solar generation capability

Builders in other states more readily mentioned environmental considerations of home buyers. One respondent said some people view the panels as a “badge of honor,” that they’re doing something good for the environment. One builder mentioned that buyers of solar electric homes tend to be better educated, with occupations such as doctors, professors, and engineers.

4.4.5 Solar electric generation capability is widely perceived to add value to a home.

In the Wisconsin solar electric market, we did not consistently hear that solar technology increases the value of a home. However, two builders in the other states noted, without being asked the question, that the value of a home is enhanced when solar electric generation technology is added to the home.

5. PHASE 1 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

5.1.1 Solar PV was a positive feature, but not a primary factor in purchase decisions for most of the spec solar homes.

a. *A solar electric PV system was viewed as a "plus," but was not a primary reason for the purchase decision for five of seven spec homes for which an interview was conducted.*

b. *There were no reported cases where prospective homeowners decided not to make an offer on a house because it had a solar electric photovoltaic system.*

5.1.2 Solar PV homes attract positive comments and interest from family, neighbors, friends, and colleagues of homeowners, as well as other builders.

a. *Solar attracts attention in Wisconsin, typically in the form of positive comments and interest in the amount of savings they experience on electric bills.*

b. *Tim O'Brien Homes reported a large number of requests for tours of solar model homes from community groups, in addition to prospective home buyers.*

c. *The spec solar homes produced a significant number of inquiries from other builders.*

5.1.3 There is currently not enough demand for builders to construct solar spec homes in Wisconsin.

a. *We were unable to find a Wisconsin solar home builder who was currently building spec solar homes and very few are constructing new homes to be "solar ready."*

b. *Wisconsin Focus on Energy staff report that the solar market in Wisconsin has grown an average of 62% per year since 2006, but builders report that most of the activity is in the nonresidential market.*

5.1.4 There are several key barriers to growth of the residential new construction solar market in Wisconsin

a. *Builders and real estate agents cite the upfront cost of installing solar electric PV systems, along with the length of the payback, as the primary barrier in the residential market.*

b. *For Wisconsin home buyers and builders, there is large learning curve that lengthens the decision to install a solar electric PV system (how much do I need to learn and where do I get the information; how do I find qualified installers; how do I solicit and compare bids for supply and installation; what kind of structural improvements do I need for the roof?), and so on. Wisconsin Focus on Energy staff estimates that it can take one year from the time of the decision to install solar to a completed installation.*

c. *There are misperceptions and a general lack of knowledge about the benefits and costs, as well as durability and maintenance of solar electric systems among home buyers that limit the growth of the residential market.*

d. *The solar buy-back and net metering rules in Wisconsin differ by electric utility service area. This makes it difficult for builders to get "up to speed" on the rules and economic benefits of solar electric PV systems for new homes.*

5.1.5 Some factors are expected to stimulate the solar new-home market

a. *Incentives in the form of tax credits and rebates are viewed by builders and industry experts as critical in developing markets.*

b. *Builders, real estate agents, and home buyers all recognize that increasing energy costs will make solar electric PV systems more economical and decrease the payback period.*

c. *Solar home builders and industry experts believe improvements in solar panel technology—both in lower costs and higher efficiency—will make solar electric PV systems more attractive to home buyers.*

d. *Increasing consumer awareness and education is expected to increase the demand for solar electric PV systems and increase the number of solar home builders.*

5.1.6 Education is needed for residential home builders, appraisers, real estate agents, and others in the new home industry.

a. *Builders who inquired about the spec model solar homes indicated they would need a resource to help them get up-to-speed on selecting and installing solar electric PV systems if they were to "test the waters."*

b. *Appraisals for spec solar homes generally did not reflect the additional cost of installing the solar electric PV system. Appraisers need information on the benefits of solar, as well as "comparables" to base appraisals on.*

c. *Real estate agents showing and selling the spec solar homes report they need additional sales tools that are developed from the perspective of potential buyers, such as data on electricity bill savings and case studies of solar home owner experiences*

5.2 RECOMMENDATIONS

5.2.1 Education

Increase awareness and knowledge about solar home systems and promote accurate perceptions among key groups, such as buyers, home builders, real estate agents, developers, and other building trade groups. This could include activities such as the following:

a. *Sponsor model homes and demonstration projects to showcase new solar electric and renewable energy technology and build awareness for residential applications.*

b. *Develop a resource for home builders and the home building trades with technical information about solar electric systems' specifications, requirements, relevant laws, and performance in Wisconsin.*

c. *Develop a resource from the perspective of a home buyer, with information about technologies, costs and benefits, decision points, and advice about talking to a builder.*

5.2.2 Case Studies

Publish results of the Solar Home Builder Partnership Program to provide actual "Wisconsin" data and experience with solar electric photovoltaic systems.

a. *Results of energy generated and sold back to We Energies for Year 1 and over the longer term.*

b. *Results of maintenance and replacement of system components from solar homes.*

c. *Follow-up data from homeowners after 2-3 years of experience with solar electric systems.*

d. *Resale data on paired solar and non-solar homes as data become available.*

5.2.3 Incentives

Identify appropriate incentives to reduce the payback on residential solar electric installations to encourage continued development of the residential solar market.

a. *Solar PV home builders estimate that payback for a residential solar electric photovoltaic system in Wisconsin is 12-16 years and the builders we interviewed believe most home buyers want a payback of 10 years or less.*

b. *Continuing to offer incentives for solar installations will help to increase the number of solar electric installations and help to encourage new manufacturers to build components, helping to reduce the upfront cost of a residential solar electric system.*

5.2.4 Policy Development

Develop statewide policies, including state leadership initiatives and uniform net-metering rules across the state.

a. *State leadership initiative and strategy will signal a long-term commitment to encourage home builders and solar electric PV manufacturers.*

b. *Simplifying and streamlining the net-metering rules and regulations that home builders and the industry have to work with will encourage more builders to enter the solar market and work across service area boundaries.*

6. PHASE 2 COMPARISON OF THE ENERGY USE BEHAVIOR OF SOLAR AND NON-SOLAR HOUSEHOLDS

The objective of the Phase 2 component of the Wisconsin Solar Home Builder Partnership Program study is to assess and compare the energy use behavior of solar and non-solar households. Two other equally important goals are to establish the effectiveness of the installed rooftop solar systems in terms of their ability to offset household electricity consumption (and hence cost), and evaluate how these solar systems perform over time. Based on an analysis of the solar output and household electricity consumption of 12 matched pairs of solar and non-solar homes for eight month duration, our main findings are:

- **Solar households appear to have higher average energy use intensity than the non-solar home counterparts:** For solar households, the average energy use intensity is 1.34 kWh/sq-ft/person based on a sample of seven solar homes. The same measure for non-solar home households is 0.98 kWh/sq-ft/person based on a sample of five households. This finding should be viewed as tentative and interpreted with caution due to small sample sizes of households for both solar and non-solar homes, as well as the short duration (eight months) of the study.

- **3 kW solar systems supply on average, 37% of the household monthly electricity requirement:** Monthly output from twelve solar systems and the monthly electricity consumption from as many households were analyzed for a period of eight months (January 2011 through August 2011). The solar output ranged between 18% and 60% of the total household electricity consumption.

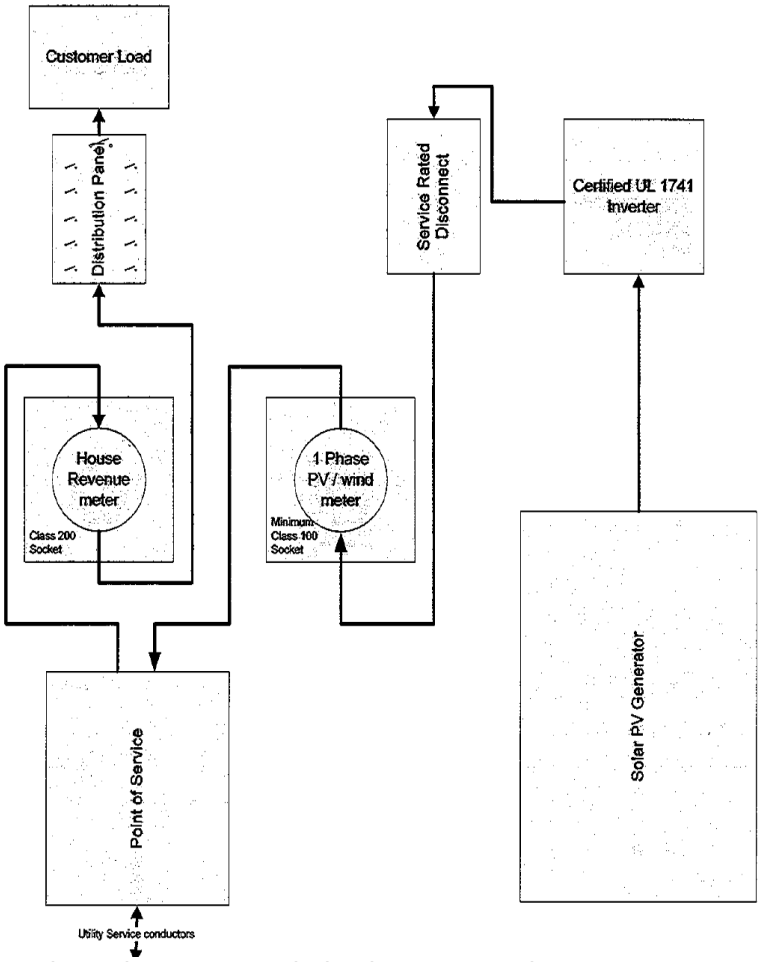
- **Solar systems are performing as expected:** Actual energy output from the solar systems is close to their pre-installation estimates, indicating robustness in the system design and installation. Out of the twelve systems, the average (over eight months) difference between the actual and the predicted outputs for eight systems is within ±5%. Only one system exhibited a difference of more than 10%.

This chapter is organized in five sections, as follows. Section 6.1 provides a brief description of the solar systems. Section 6.2 discusses the data collection methods for household monthly electricity consumption and monthly solar output. In sections 6.3, 6.4 and 6.5 the estimation methodologies and corresponding results are presented for the energy use intensity (i.e., kWh/sq-ft/person) of solar and non-solar households, solar systems output as a percentage of monthly household electricity consumption and the solar system performance, respectively.

6.1 SOLAR HOME SYSTEMS

The nameplate capacity (or wattage) of the rooftop solar systems is approximately 3 kW. Specifically, each system was designed for either 2.904 kW or 3.042 kW. Seven solar homes have a 2.904 kW system installed, while for the remaining five homes the system size is 3.024 kW. Note that the solar systems are connected to the line side of the main utility meter for each home. This implies that the solar output directly feeds into the grid (not the homes) and the electricity requirement for a solar home is supplied fully from the grid. The solar output does not affect the electricity consumption of a household. In other words, the solar output from each rooftop system is sold to the grid, which in turn adjusts the monthly cost of electricity for each home.

Figure 1: One-line Diagram for the Solar Home System



Schematic Source: Carl Siegrist, We Energies

6.2 UTILITY AND SOLAR OUTPUT DATA AND DATA COLLECTION

The electricity consumption for each household (12 solar and 12 non-solar homes) was collected monthly from January 2011 through August 2011. The meter read dates and the start and end dates in a monthly billing cycle differed from home to home. Similarly, the number of days in a monthly billing cycle varied from one home to the other. In order to maintain a consistent analytical approach for data analysis, the following data adjustments were made:

1. If a meter read period began within the 1st half of a month, then usage for the period was considered as the monthly electricity consumption for the same month. For example, if the meter read dates were within January 7th through February 6th 2011, the usage for that period was assumed to be the electricity consumption for January, 2011. However, if the meter read start date was recorded in the 2nd half of a month, the usage for that period was considered to be the next month's electricity usage.

2. The monthly electricity consumption has been normalized according to the number of days in a month if it differed from the reported monthly billing period. To illustrate, if the electricity consumption for March was recorded for 29 days for a solar or non-solar home, then it was adjusted to reflect 31 days of consumption.

3. Each solar system is equipped with a data-logger which enables the hourly recording of power output. The data is processed and shared through an online platform operated by Fat Spaniel[5]. Similar to the utility data, the solar output data were normalized to correspond to output for a complete month.

6.3 ENERGY USE BEHAVIOR OF SOLAR AND NON-SOLAR HOUSEHOLDS

The energy use intensity for each household is estimated in kWh per square foot per person. For each house, the built area was provided by Tim O'Brien Homes (the Home Builder) and We Energies. For Phase I, Tetra Tech conducted in-depth interviews with solar and non-solar home owners and obtained the household size (number of occupants) information during those interviews. For the 12 matched pairs, the household size for seven solar homes and five non-solar homes were available. The household size varied from one to seven, with three to five more common.

Figure 2 and Table 1 show the energy use intensity of both solar and non-solar households. Solar households appear to have higher average energy use intensity than the non-solar households. The average energy use intensity for a solar household is 1.34 kWh/sq-ft/person, and the non-solar household average is 0.98 kWh/sq-ft/person. A possible explanation for this finding is that the output from the solar systems was sold to the grid and offset the homeowners' electricity bills. The lower monthly electric bills might have encouraged the solar home owners to consume more electricity on the presumption that the unit cost of electricity is less than what they paid before relocating to the solar homes. In addition, the cost of the solar photovoltaic system was subsidized and, in many cases, the subsidized cost was rolled into the mortgage, so that the initial cost of the system was not readily apparent to the solar homeowners.

Figure 2: Energy Use Intensity for Solar and Non-solar Households

[5] http://www.fatspaniel.com/

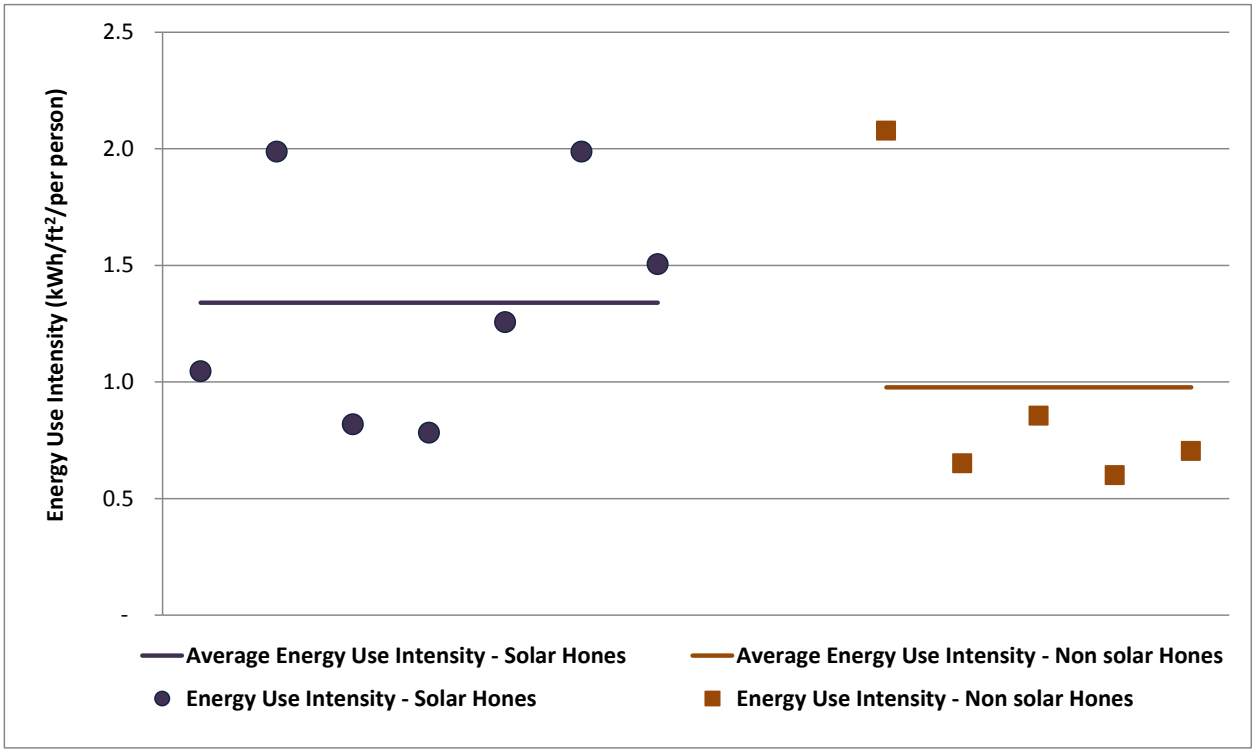


Table 1: Energy Use Intensity of Solar and Non-solar Homes*

Home Pair	Solar Home			Non-Solar Home		
	(kWh)	# in Household	Energy Use Intensity (kWh/sq-ft/person)	(kWh)	# in Household	Energy Use Intensity (kWh/sq-ft/person)
P1	16,417	7	1.05	8,526	2	2.08
P2	4,361	1	1.99	4,370	NA	
P3	9,761	5	0.82	6,205	4	0.65
P4	9,173	5	0.78	7,478	NA	
P6	5,737	NA		5,449	3	0.85
P7	10,615	4	1.26	5,269	4	0.60
P9	9,338	2	1.99	4,954	3	0.70
P10	5,761	2	1.50	10,741		
		Average	**1.34**		**Average**	**0.98**

*For home pairs 8, 11 and 12 household size for solar nor non-solar homes were not available

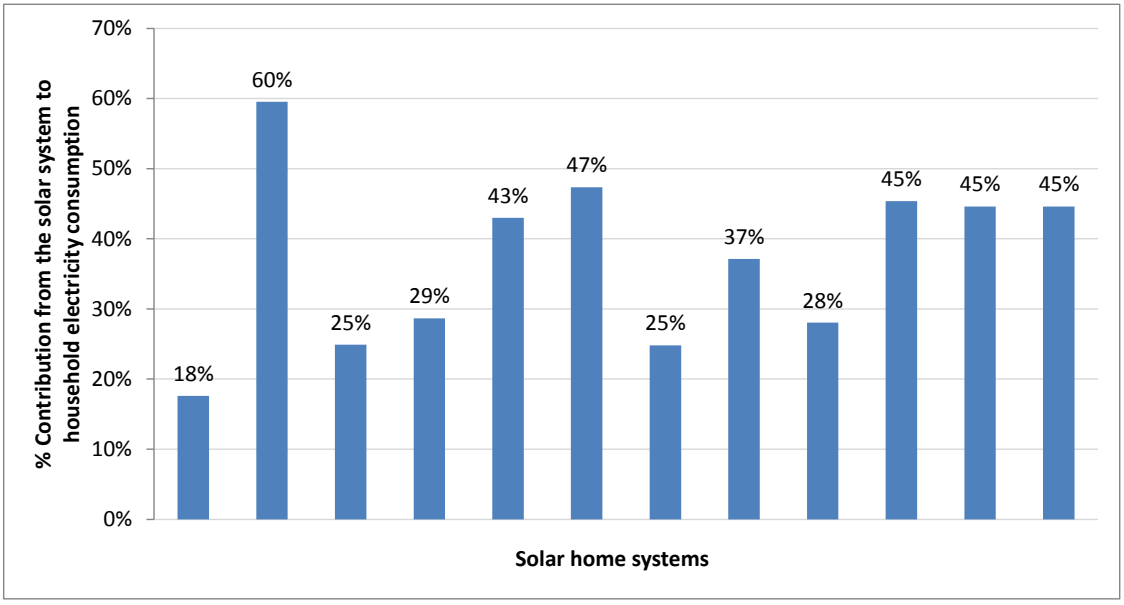
Note that the output from the solar photovoltaic system is directly supplied to the grid and the electricity usage of a solar household is not linked to onsite generation. However, the electricity bills are adjusted according to the amount of electricity supplied to the grid.

6.4 ELECTRICITY SUPPLY FROM THE SOLAR SYSTEM

In Phase I, solar home sellers and prospective buyers both expressed the need for data on the extent to which electricity supplied from the solar systems offsets their monthly household electricity cost, as well as information on how the solar system performs in different seasons.

The sales agents felt this information was needed to help prospective solar homebuyers make informed decisions on their solar home purchase. Figure 3 shows the solar system contribution to the total consumption across all twelve solar households.

Figure 3: Percent Contribution from Solar Systems to Solar Household Electricity Consumption



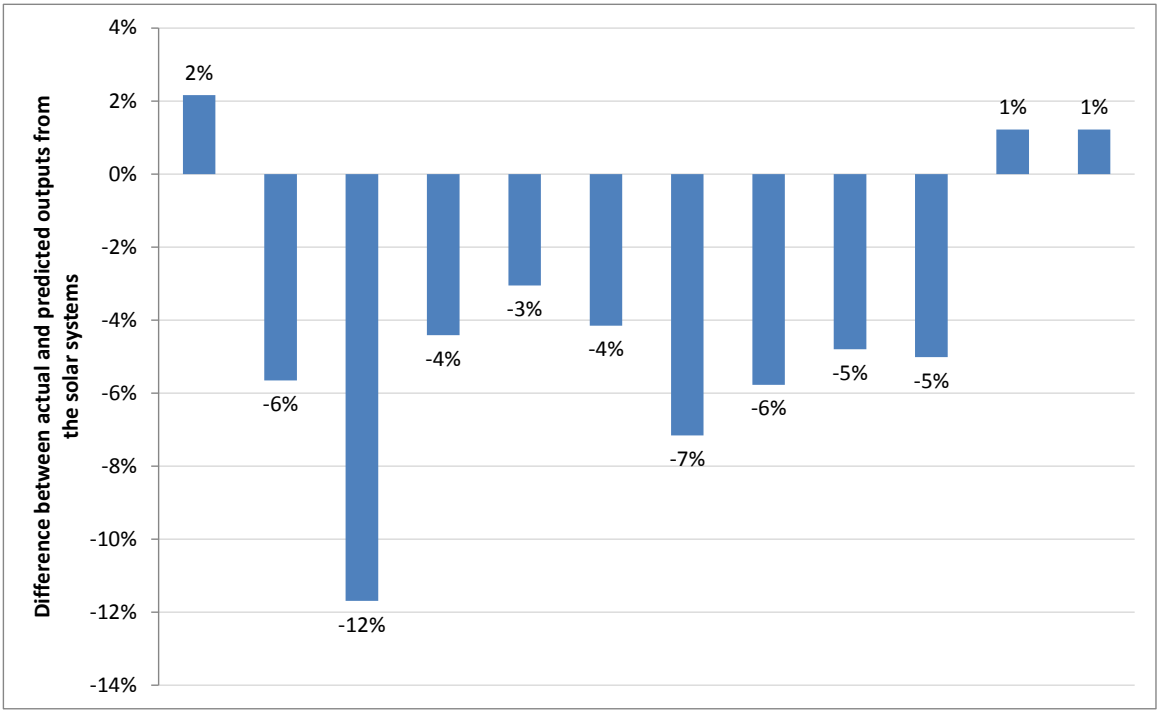
The solar systems generated within 18% and 60% of the total monthly electricity requirement of a household. On average, the systems contributed about 37% of the household electricity consumption.

6.5 SOLAR SYSTEM PERFORMANCE

Another important piece of information that sales agents and homebuyers requested in Phase I is how reliably the solar systems will perform during the winter season, given the likelihood that snow cover might affect the output. Figure 4 compares the predicted output of a 3kW system and the actual outputs from each of the systems installed on the solar homes. To determine the estimated output from a 3 kW system, we assumed the systems were tilted at latitude minus 15 degrees (which is about 28^{o} inclination) for the Milwaukee solar radiation data obtained from the National Solar Radiation Database[6] . This solar tilt angle assumption appeared reasonable as the roof pitches for the in-scope solar homes ranged from 26.6^{O} to 33.7^{O}.

[6] http://rredc.nrel.gov/solar/old_data/nsrdb/1961-1990/dsf/data/14839.txt

Figure 4: Comparison of actual versus predicted outputs from solar systems



The actual output for eight of the twelve solar systems is within ±5% of the estimated energy generation for a 3kW system. The difference between the predicted and actual output exceeds 10% for only one system. This indicates that the performance of the solar systems is well aligned to expectations.

APPENDIX A: DATA COLLECTION INSTRUMENTS

A.1 WE ENERGIES SOLAR IN-DEPTH INTERVIEW PROTOCOL— SOLAR ELECTRIC EXPERT AT FOCUS ON ENERGY

Context

C1. What is your title?

C2. What is your role at the Wisconsin Energy Conservation Corporation?

C3. What role does WECC play in the solar electric home market?

Solar Electric Home Market Characterization

M1. How would you characterize the solar electric home market for new construction in Wisconsin? [Has it changed in recent years?]

M2. Do you think the solar electric home market for new construction will increase, decrease or stay the same in the next five to ten years? [Why?]

M3. What factors, if any, are currently aiding the market?

M4. What do you see as barriers to the growth of this market in Wisconsin?

M5. In your experience, what kind of outreach has been successful in promoting the growth and awareness of the solar electric market? [PROBE FOR OUTREACH TO BUILDERS AND DEVELOPERS, AS WELL AS TO POTENTIAL HOME BUYERS]

M6. What other outreach is needed? [PROBE FOR OUTREACH TO BUILDERS AND DEVELOPERS, AS WELL AS TO POTENTIAL HOME BUYERS]

M7. Are there any policies adopted by the State of Wisconsin that are currently affecting the solar market in WI?

M8. What role could the State of Wisconsin play in developing the solar market in WI?

M9. What role, if any, should utilities, such as We Energies, play in developing the solar market in WI?

M10. What customer segments do you see as growing most quickly in the solar market in WI?

M11. How important are incentives—from the government or from utilities—for developing the solar market for new construction in the short term?

M12. What needs to happen in the market for builders to begin offering solar electric systems on spec homes without incentives from utility companies or the government?

M13. Are there any other comments you would like to make about the solar market for new construction in WI?

A.2 HOME BUYER INTERVIEW PROTOCOL

Introduction

General Factors in Purchase Decision

[Open-ended and unaided questions to see if solar electric photovoltaic system is mentioned. Interviewer will avoid asking specifically about solar PV or solar electric system in this initial section]

P1. Are you a first-time home buyer? How many home-buying experiences you had prior to purchasing this home?

P2. Thinking back to [TIME FRAME], how did you first hear about the house that you purchased at [LOCATION]?

P3. Did you look at any other newly constructed homes before purchasing this home?

[IF YES] What was different about this house than the other newly constructed homes you looked at?

P4. What were the most important factors in your decision to purchase the house?

P5. Do you remember any drawbacks or potential concerns you had about the house when you were making your decision whether or not to purchase it?

P6. Now that you have been in the house for [LENGTH OF TIME], how satisfied are you overall with the house?

P7. Have you ever lived in a home that had a solar energy system, such as a solar water heater or a solar electric photovoltaic system?

[FOR SPV HOME BUYERS -- Influence of SPV System on Purchase Decision]

I1. When did you first become aware that this home had a solar electric photovoltaic system?

I2. Before purchasing your house, did you look at any Tim O'Brien Homes in this area that did not have a solar electric PV system? [IF YES]—Did the presence of a solar electric PV system in this house have any influence on your decision to purchase the house?

I3. Were you already aware of SPV systems in residential homes when you heard about the system in this house?

I4. When you first heard about the SPV system, what did you think about it—was it a positive, negative, or neutral feature of the house? Why?

I5. What questions or concerns, if any, did you have about the solar electric PV system? [NOTE: If not mentioned, ask if they had any questions or concerns about the durability, safety, or maintenance of the solar panels and SPV system.]

I6. After you heard about the SPV system in this house, did you try to find out more about it from any sources other than Tim O'Brien Homes? What sources? What did you find out?

I7. What kind of an effect do you think the solar electric PV system has on the home's appearance? (Positive, negative, no effect?)

I8. Do you think the solar electric PV system has any effect on the resale value of the house? What effect?

I9. What comments, if any, have your friends/family/neighbors made to you about the house you purchased?

[FOR NON-SPV HOME BUYERS—Awareness and Influence of SPV System]

N1. Before purchasing your house, were you aware that some of the Tim O'Brien Homes in this area had a solar electric photovoltaic system?

[IF YES] Did you look at a Tim O'Brien Home in this area that had a solar electric PV system?

[IF YES] Did the fact that this house did not have a solar electric PV system influence your decision to purchase this house?

[IF NO TO INITIAL QUESTION N1, SKIP TO N5]

N2. When you first heard about the solar electric PV systems in some of the Tim O'Brien Homes, what did you think about it—was it a positive, negative, or neutral feature of the house? Why?

N3. Were you already aware of solar electric PV systems in residential homes when you heard that some of the Tim O'Brien Homes had this type of system?

N4. After you heard about the solar electric PV systems, did you try to find out more about it from any sources other than Tim O'Brien Homes? What sources? What did you find out?

N5. Have you seen any of the Tim O'Brien Homes in this area that have a solar electric PV system?

[If YES, What kind of an effect do you think the solar electric PV system has on the home's appearance? (Positive, negative, no effect?)

N6. Do you think a solar electric PV system has any effect on the resale value of a house in this area? What effect?

[Operation of SPV System—For SPV Home Buyers]

O1. How has the solar electric PV system performed so far, in terms of the reliability of the system?

O2. Do you think the solar electric PV system has had an effect on your electric bills? What effect?

O3. Would you recommend a solar electric PV system to a friend or family member who is looking to purchase a house? [PROBE FOR WHYOR WHY NOT?]

O4. Do you recall how much the purchase price of this house was increased to include the installation of the SPV system?

O5. There were a number of incentives that allowed the builder to reduce the cost of the solar electric PV system for this house. Would you have been willing to pay a higher price for the solar electric PV system for this house if the incentives were not available?

O6. If a solar electric PV system had not been available on this home, would you have installed a solar electric PV system on the rooftop after you purchased the home?

Demographics—All Home Buyers

D1. In what year were you born?

D2. What is the highest level of education you have completed?

D3. How many people are currently living in your household?

How many adults? Please specify their gender and age.

How many children over the age of 18?

How many children between the ages of 6 and 18 years of age?

How many children under 5 years of age or younger?

D4. How many people are usually at home during the daytime on weekdays during the school year?

D5. What temperature (or approximate temperature range) you set the home thermostat when:

A. Occupied

a. Summer

b. Winter

B. Unoccupied

a. Summer

b. Winter

D6. Have you added any major electrical appliances or equipment that were not furnished as part of the home you purchased?

D7. Do you or any member of your family work from home?

[If yes, how many days in a week?]

D8. How many persons in your household contribute to your total household income?

D9. Can you tell me which of the following categories best describes your total annual household, including wages, salaries, pensions, and social security for all members of the household? [I WILL READ THE CATEGORIES AND YOU CAN STOP ME WHEN I GET TO THE RIGHT CATEGORY]

> $50,000
$50,000 - > $75,000
$75,000 - > $100,000
$100,000 - > $125,000
$125,000 - > $150,000
$150,000 - > $175,000
$175,000 - > $200,000
$200,000 or more

A.3 REAL ESTATE AGENT INTERVIEW PROTOCOL

Introduction

Overview of the Market for Solar Homes in Wisconsin

O1. How would you characterize the market for solar homes in Wisconsin?

O2. Do you think the number of new solar electric homes constructed by builders and developers in WI will increase, decrease, or stay about the same in the next 5-10 years?

O3. What factors, if any, do you think will tend to stimulate growth in the solar market in WI?

O4. What do you perceive are the primary impediments to growth of the solar market in WI?

General Factors in Home buyers' Purchase Decisions for Tim O'Brien Homes

G1. What types of home buyers tend to be interested in Tim O'Brien Homes? [PROBE IF NEEDED: What differences, if any, do you see between buyers of Tim O'Brien Homes and other homes in your market area?]

G2. When the matched pairs of Tim O'Brien solar and non-solar homes were on the market, did either type of house have a higher level of interest among prospective home buyers?

G3. Did either type of house sell more quickly than the other?

G4. Did most of the prospective home buyers want to look at both a non-solar and a solar house, or did they tend to prefer to look at only one type or the other?

G5. Did you work with any prospective home buyers who told you upfront they were interested in a house with a solar electric PV system? [IF YES, what were the reasons?]

G6. When you sell a Tim O'Brien home, without a solar electric PV system, what are the primary factors in the home buyers' decisions to buy the house?

G7. Did you sell any of the homes with a solar electric photovoltaic system? [IF YES, What were the most important factors in home buyers' decisions to purchase these houses?]

G8. Did any of the home buyers you worked with tell you they were not interested in a home that had the solar electric photovoltaic system? [IF YES, what were the reasons?]

G9. Do you think you would want a solar electric PV system on a home that you lived in someday? [Why? / Why Not?]

Reactions to the Solar Electric PV System

R1. When you first saw one of the Tim O'Brien homes personally, what effect did you think the solar panels had on the appearance of the house?

R2. When you showed the houses with a solar electric PV system, what were prospective home buyers initial reactions to the appearance of the solar panels? What was their initial reaction to the idea of a solar electric PV system?

R3. What specific comments—either positive or negative—did you hear about the solar electric PV system from prospective home buyers?

R4. What kinds of questions did prospective buyers ask about the solar electric PV system? What concerns, if any, did they express? [IF NOT MENTIONED, ask about any expressed concerns about the appearance of the solar panels, maintenance or durability, or safety]

R4. Did anyone ask specifically about the cost of the solar electric PV system or how much it added to the price of the house? [IF YES, what did you tell prospective home buyers?]

R5. Does adding a solar electric PV system to a house increase the commission that real estate agents receive from selling the house?

R6. Did anyone ask you about the amount of reductions or savings on their electricity bill? [IF YES, what did you tell prospective home buyers who asked this question?]

R7. Overall, do you think that a solar electric PV system, like the ones on these Tim O'Brien Homes, has any effect on the ease or difficulty of selling the house? What effect?

R8. Do you think the solar electric PV system has any effect on the resale value of the house? What effect?

R9. Based on your experience, if one of your clients asked you about whether they should look into buying a house with a solar electric PV system, what advice would you give them?

Agents' Preparedness and Additional Sales Tools Needed

A1. From your perspective as a Real Estate Agent, what are the differences in marketing and selling a solar home as compared to other homes without solar electric systems? [PROBE IF NEEDED for additional knowledge and training in specific areas.]

A2. Looking back at the process of showing and selling the Tim O'Brien solar homes, do you feel like you were well prepared or would you have liked to have some additional preparation?

A3. Were there any types of additional sales tools or additional information that you would have liked to have when you were showing and selling the Tim O'Brien solar homes?

A4. Is there anything else you recall or that you learned from showing and selling the Tim O'Brien solar homes that you would like to tell us?