Final Report

Solar Hot Water Market Development in Knoxville, Tennessee

Prepared for:

City of Knoxville

October 2010

Prepared by:

CH2MHILL

This report was made possible through funding from the U.S. Department of Energy's Solar America Cities program. To learn more, please visit www.solaramericacities.energy.gov.

SOLAR AMERICA CITIES

Preface

The purpose of this document is to assess the Solar Hot Water (SHW) market in Knoxville, Tennessee, identify market variables and barriers, and suggest strategies for overcoming market barriers and increasing SHW deployment in the area.

Much of the information that supports this document was obtained from existing research, information, and opinions from multiple sources within the Knoxville area including the City of Knoxville, local businesses, economic development groups, nonprofit organizations, and other local institutions. While the information is believed to be true and accurately represented, CH2M HILL has not performed an independent verification of all such data.

The recommendations included herein are based on the market understanding when the document was developed. If new information becomes available, this report should be reviewed to determine whether it should be revised.

Frequently in this report CH2M HILL refers to the *City of Knoxville*, give credit to *the City* for an accomplishment, or provide recommendations that *Knoxville* should take some action. These names refer primarily to the Office of Policy and Communications and the Office of Energy and Sustainability. Staff from these offices were the main City representatives contributing to and receiving this report.

"Solar Knoxville" refers to U.S. Department of Energy Solar America Cities Program activities funded within City limits.

Executive Summary

Background

In 2010, the Knoxville, Tennessee, Office of Policy and Communications and Office of Energy and Sustainability, through U.S. Department of Energy Solar America Cities funding, contracted CH2M HILL to study and report on the potential to build a local residential and commercial Solar Hot Water (SHW) market. Specifically, Knoxville requested that the major SHW market barriers be identified, and strategies suggested for overcoming these barriers. This report summarizes the study process and findings.

Findings

Solar Hot Water technologies are viable, reliable, and cost-effective means to offset electric or natural gas water heating or space heating costs. Although Knoxville has some experience with these systems, SHW technology is not a publicly well-recognized energy efficiency or conservation solution and even has some negative associations.

Four major categories of market variables were identified as the major influences on the growth of the SHW market:

- Cost and Value
- Public Policy and Process
- Products and Installation
- Local Conditions

From review of these variables, interviews with those involved with SHW locally, and evaluation of local conditions, five major barriers to growing the SHW market were identified:

- Insufficient knowledge and understanding of SHW systems
- Limited commitment and focus from public entities
- Insufficient incentives targeted toward SHW
- No recognized champion or leading entity for a SHW Initiative
- Inexperience in public approval processes

Conclusions

On the basis of the local SHW market variables and the specific barriers identified, five generally sequential strategic actions were suggested as part of an overall program to grow the Knoxville area SHW market. The suggestions were based on examples of relevant SHW programs throughout the U.S., interviews with Knoxville stakeholders, and CH2M HILL experience in market development and economic development. The suggestions are summarized as follows:

1. Identify or create a SHW program lead entity or staff person with overall responsibility for initiating, developing, and implementing a SHW initiative. This effort should include a strong group of community stakeholders that can support the effort.
2. Develop SHW system performance and cost data. The data can be developed through incentivizing the installation of new systems, requiring and sponsoring performance monitoring and data collection on all local area SHW installations, and utilizing data from knowledgeable resources such as Oak Ridge National Laboratory and the U.S. Department of Energy Solar Cities America program.
3. Utilizing system performance and cost data, build system cost and benefit models that refine SHW operational understanding and quantify individual and public benefits based on local conditions.
4. Based on the data and SHW system models, develop public policies, programs and organizations that support the SHW market. Supportive policies should be developed that potentially include installation grant and loan incentives, a prescriptive permitting process that is efficient and timely, flexible financing and ownership rules, a local renewable portfolio standard, or code requirements for SHW use. These efforts should include indentifying a supportive individual or group of individuals that can work with the program leader and stakeholders as a spokesperson and advocate for SHW installations. Utility providers have a critical role to play and every effort should be made to gain their support and assistance.
5. With a strategy and initiative in place, develop marketing and educational materials and conduct an outreach program targeted at multiple stakeholder groups including the public at large, targeted potential consumers, service providers, and public entities.

Based on the findings and analysis, CH2M HILL believes that Solar Knoxville can be successful in building the SHW market if it commits to a focused effort to overcome barriers through the implementation of strategies similar to those identified in this report. SHW market expansion can happen quickly and in the short term. An excellent local example is the highly focused and successful effort to expand the solar photovoltaic market in Tennessee.

Contents

Section **Page**

Preface ..... **iii**

Executive Summary ..... **v**

1 Project Background and Overview **1-1**
- 1.1 Goals and Scope 1-1
- 1.2 Approach and Activities 1-1

2 Solar Hot Water Overview **2-1**

3 Market Variables **3-1**
- 3.1 Cost and Value 3-1
- 3.2 Public Policy and Process 3-2
- 3.3 Products and Installation 3-2
- 3.4 Local Conditions 3-3

4 Barriers to Cost-Effective Deployment of Solar Hot Water **4-1**
- 4.1 Lack of Knowledge and Understanding of Solar Hot Water 4-1
  - 4.1.1 General Public and Potential Consumers 4-1
  - 4.1.2 Public Entities and Policymakers 4-2
  - 4.1.3 Service Providers 4-3
- 4.2 Commitment of Public Entities and Local Institutions 4-3
- 4.3 Lack of Financial Incentives 4-4
- 4.4 Lack of a Solar Hot Water Champion 4-5
- 4.5 Inexperience of Public Processes 4-5

5 Strategies for Reducing Barriers **5-1**
- 5.1 Identify Solar Hot Water Initiative Lead 5-1
  - 5.1.1 Funding Sources 5-2
  - 5.1.2 Examples of SHW Leadership 5-2
- 5.2 Gather Data and Information 5-2
  - 5.2.1 Examples of Data and Information Development 5-3
- 5.3 Develop Payback and Performance Models 5-3
  - 5.3.1 Examples of Payback and Performance Models 5-4
- 5.4 Coordinate Public Policy and Programs 5-4
  - 5.4.1 Examples of Public Policy and Stakeholder/Advisory Groups 5-5
  - 5.4.2 Examples of Pilot Programs 5-6
  - 5.4.3 Examples of Grant, Loan, and Rebate Programs 5-6
- 5.5 Establish Outreach and Education Program 5-6
  - 5.5.1 Examples of Outreach and Education Programs 5-7
- 5.6 Conclusions 5-7

6 Resources and Contacts **6-1**

Table

1 Interviewed Knoxville Area SHW Stakeholders Identified by Solar Knoxville and CH2M HILL 1-1

Figures

1 Solar Hot Water System Types 2-1
2 Solar Hot Water Market Variables 3-4

SECTION 1

Project Background and Overview

1.1 Goals and Scope

The goals of this report are to present a qualitative analysis of solar hot water (SHW) markets in Knoxville/Knox County and advise Solar Knoxville on strategies to increase SHW installations by specifically reviewing the following:

- Market variables that most impact the rate of SHW system installation
- Market barriers to SHW installation
- Strategies that local government, community, and industry can implement to increase the rate of SHW deployment

1.2 Approach and Activities

The qualitative analysis presented in this report was completed through completion of the following steps:

1. Desktop study of Knoxville area details relevant to SHW, including local climate, demographics, local energy generation, and consumption profiles
2. Kick-off meeting with Solar Knoxville staff, including sharing of information relevant to local SHW markets
3. In-person interviews with Knoxville stakeholders and follow-up phone interviews. Interviews were attended and guided by both CH2M HILL and City staff as a part of the Solar Knoxville program (Table 1).

TABLE 1
Interviewed Knoxville Area SHW Stakeholders Identified by Solar Knoxville and CH2M HILL

City of Knoxville Community Development	Knoxville Utilities Board (KUB)
City of Knoxville Inspections and Permitting	Knoxville-Knox County CAC Construction Services
Cooper Hotels Airport Hilton	Lyon Plumbing Services
Efficient Energy of Tennessee (EETN)	Oak Ridge National Laboratory (ORNL)
FLS Energy	Pellissippi State Community College
Green Earth Solar	Southern Alliance for Clean Energy (SACE)
Home owner with SHW system	Sustainable Future
Knox Heritage	TRANE
Knox Housing Partnership	Knox County Sheriff's Office (County Prison)

4. Ongoing analysis of data gathered in Knoxville, ongoing interaction with Solar Knoxville staff, and writing of the report.

SECTION 2

Solar Hot Water Overview

Solar hot water systems have been commercially available in the U.S. and in the Knoxville area since the 1970s when rising energy prices from the Oil Embargo and increased attention on alternate energy systems created a small local market. Federal and state governments and the Tennessee Valley Authority (TVA) responded to concerns over energy dependence, peak load offsetting, and the politics of the day by creating incentives to encourage SHW use, generating a wave of SHW installation in the Knoxville area.

In the 1980s, energy prices stabilized and incentives for SHW disappeared, orphaning installed SHW systems, system design expertise, and qualified local installers. This also stunted further development of SHW product technology nationally.

SHW system technology has changed very little over the last 20 to 30 years, and very few of the design and installation companies active in the 1970s and 1980s remain in business today. The general reliability, performance, and standardization of SHW systems have improved significantly, as has the qualification of system service providers. These improvements combined with long-term commitment to solar technologies from the highest federal levels make SHW an ideal candidate for focus, funding, and promotion at the city level.

As shown in Figure 1, system types are typically chosen according to local climate. While there is not a rigid distinction, system types are either intended for mild climates, where there is no freeze risk (or very little), or for harsh climates where freezing temperatures are normal during the year. As can be expected, harsh climates require more complex and expensive SHW systems.

FIGURE 1
Solar Hot Water System Types

	Mild Climates				Harsh Climates
Characteristics	**Batch**	**Thermosyphon**	**Open Loop Direct**	**Glycol**	**Drainback**
Low Profile			X	X	X
Lightweight			X	X	X
Freeze Tolerant				X	X
Easy Install, Low Maintenance	X	X	X		
Design Simplicity	X	X			

(For a more detailed analysis of system types, see Marken & Puffer, 2008)

Knoxville is categorized as a harsh climate. System types most reasonably used in the Knoxville climate are glycol and drainback.

Freeze protection may be claimed on other system types, However, it is likely in the form of an added valve or recirculation controls setting, not in a system-wide attention to the rigors of freezing temperatures. For a SHW system to operate efficiently for 20 years or longer, these added features are typically not sufficient.

While the installer community in Knoxville has some familiarity with SHW for domestic potable water heating (typically used for functions such as howers, laundry, and dishwashing), the community has little familiarity with SHW for space heating. Solar Hot Water for space heating is a significantly underutilized technology application. Space heating systems using SHW can be designed using one of two primary methods:

- Radiant Floor Heating – Water or another working fluid heated by the sun is pumped through tubes in the floor, providing space heating without air exchange. This is most common in new construction, but can be included in remodels or retrofits.
- Forced Air Heat Coil – Water or another working fluid heated by the sun is pumped through a heat coil in a forced air HVAC system, providing space heating and reducing demand for electric or natural gas heat sources.

Solar Hot Water systems are simple, reliable and effective when the proper system is matched to the existing climate and purpose. Glycol and drainback systems are most appropriate for the Knoxville climate, and can significantly reduce or eliminate energy and expense from water heating and space heating.

SECTION 3

Market Variables

Market variables influential in determining SHW system demand and installation in the Knoxville area can be grouped into the following categories:

- Cost and Value
- Public Policy and Process
- Products and Installation
- Local Conditions

Understanding these variables will allow Solar Knoxville staff to better understand what influences potential SHW users, and how and to what degree *policy and process* changes might impact the market.

3.1 Cost and Value

Cost and Value variables are the key to increasing SHW demand for potential consumers driven predominantly by financial metrics. However, convincing metrics and calculations on the true value of SHW systems are difficult for most home or building owners to intuitively understand. This is driven by two factors:

- Solar hot water systems produce value over many years, and can be paid for over many years, making cost/benefit calculations more complex.
- Traditional costs of water or space heating are not usually separated on electricity or natural gas utility bills, making it challenging to know how much a SHW system will reduce your overall energy demands.
- Once installed, solar hot water system costs are fixed, while electric and natural gas costs are likely to rise over time.

Because of these factors, strong models are needed to better understand the real cost and value of SHW systems. Increasing the difficulty of this determination of value are the perceptions and assumptions that appear when carefully measured or modeled performance and costs are unavailable.

Major variables that contribute to real *cost and value* include the following:

- System costs, consisting of materials, design, and installation labor up front, and ongoing maintenance
- Incentives available from the federal, state, city, or local utility, including upfront and ongoing incentives in the form of cash or cash equivalents, or tax credits
- System Economic Benefits in terms of future avoided utility costs and incentives considering the time value of money

- Loan Terms and the availability of loans that recognize and address SHW system costs and benefits.

Without an understanding of these variables, assumptions and perceptions (usually poor ones) will drive consumer behavior.

3.2 Public Policy and Process

Public Policy and Process variables are critical to overcoming any technical hurdles, and making SHW worth consideration to the general public. These variables are also important factors in minimizing bureaucracy, regulatory delays or excessive costs, and quantifying benefits to society and the environment.

These variables are important considerations especially when the general level of SHW knowledge is low. Careful analysis and communication can create more accurate and favorable perceptions and help to guide the creation of unencumbered public processes.

Major variables that contribute to *policy and process* determinations include the following:

- Public policy support in the form of installation targets, promotion, and incentives from multiple levels of government provides legitimacy to SHW as an option worthy of consideration. Public policy support can also fund and endorse credible analysis of *cost and value* metrics, and help distribute the results.
- Informed permitting at its best ensures safe installations and guides users toward reliable, high performing options fit to users' needs without encumbering the process. At its worst, permitting processes have sufficient influence over project economics, schedule, or complexity to deter potential users.
- Public education is critical to give potential users accurate information for decision making. This includes details on cost and value in addition to a clear and accurate set of steps ending in a safe, high performing, and optimized system. Public education must also serve involved public agencies and service providers and be catered to their role.
- System benefits to the environment are beyond the calculation and decision making processes of most individual consumers and many service providers. They involve aggregate SHW system benefits, measured by avoided utility-generator carbon emissions and other pollutants, avoided utility-generator construction of additional peak generation capacity, and avoided additional distribution costs. Making these measurements and calculations, and distributing the results require access to expertise and detailed utility and city data available only at the *policy and process* level.

3.3 Products and Installation

Products and Installation variables are important to determine ideal system configurations and sizes matched to user demands, to minimize costs and risks, to maximize system value, to provide ongoing service, and to promote SHW as an option worthy of consideration.

These variables are established by the general level of technical and business expertise in SHW system products and system design available through local service providers. *Product*

and installation variables can only be improved through local committed and dedicated technical resources with sustainable business plans.

Major variables that contribute to p*roducts and installation* determinations include the following:

- Confidence in and availability of products are important to reduce perceived risk of SHW systems. Credible product performance details are addressed in the *cost and value* and *policy and processes* sections.
- Confidence in and availability of service providers is critical to:
  - Reduce the risk and perceived risk of installing SHW systems
  - Streamline processes
  - Best match design solutions to user needs
- Service providers with a high degree of technical expertise and a Knoxville presence can also help develop measurements of *costs and value*, and inform and improve the creation of p*olicy and processes*.

3.4 Local Conditions

Local Conditions variables are important in determining all of the above variables, and need to be well-understood. These variables are often fixed by the local environment and very often misunderstood. They are all critical to accurate models of *cost and value*, which should influence p*olicy and process*, and thus drive expertise in local *product and installation* service providers.

Major variables that contribute to *local conditions* determinations include the following:

- Local climate in terms of temperature, humidity, and solar resources
- Site-specific criteria like building surroundings that may create shade, and roof structure and materials
- Competing cost of energy, and the environmental public impacts of that energy generation and distribution

The matrix presented in Figure 2 highlights the major variables that influence the rate of SHW installations in Knoxville and contains a brief explanation of why each variable is important. At this preliminary level of analysis, residential and commercial markets are influenced by very similar variables, often in very similar ways. The difference between residential and commercial market variables presented here will become more apparent later in this report as the identified variables are refined into the most significant barriers based on local conditions.

FIGURE 2
Solar Hot Water Market Variables

	SHW Market Variables	Residential	Commercial
Cost & Value	Perception of Cost	Capital cost of systems often seems high. Real cost of system and payback are not well understood when systems are uncommon and not well matched to residential hot water demand.	May be viewed as unnecessary expense in a down economy. Benefits are poorly understood in cost terms, and a credible source of SHW system value over time is often unavailable
	Incentives	Improves payback and reduces sticker shock. Incentive terms, availability, and application process are not often clear.	Important to impact ROI, or payback metrics, and lower operating costs. Incentive terms, availability, and application process are not often clear.
	System Benefits in Cost Terms	Need accurate and understandable payback analysis from a credible source. Need to bridge the gap between relatively low water heating bill and cost of system.	Important to have credible and accurate calculations that justify decision making metrics like ROI, payback and influence on operating costs. Can impact use behaviors to maximize benefits
	Lender and Finance Experience	Somewhat important, but often rolled into other remodel activity loans that are well understood.	Important for loan agents to understand benefits of system to match loan features to needs and reduce perception of risk.
Policy & Process	Public Policy Support (City, County, and State)	Often influences confidence in products and installers, understanding of system benefits, perception of aesthetic value, and is the source of incentives.	Often influences confidence in products and installers, understanding of system benefits, and is the source of incentives.
	Permitting Process	For residential customers the designers/installers should handle all permitting, however it can impact schedule and cost especially if engineering stamps are required.	Commercial designers/installers typically permit as part of the normal design process, however permitting is relatively unfamiliar with SHW systems.
	Public Education	Residential customers often rely on marketing and other publicized information in understanding and evaluating SHW value. Outreach programs to educate the public on cost, installation, permitting, rebates, and environmental impact are important.	Commercial customers are sometimes more aware of their hot water need. A credible analysis of system cost benefits is the core driver of SHW system installations.
	System Benefits to the Environment	Important in motivation to purchase system, and in appreciation of aesthetic value. Reduces carbon and other pollutant emissions and energy demand.	Important, but second to payback and ROI for most commercial operations. educes carbon and other pollutant emissions and energy demand.
Products and Installers	Confidence in Products	Legacy systems, especially those that failed can have a lasting impact on consumer confidence. Aesthetically pleasing, well known, low cost, and low risk products with good warrantees are the goal.	Low risk, understanding the system and products, and confidence in the benefit of the system are important when choosing a system.
	Confidence in Design/Installation Companies	Important to perception of risk, and confidence in benefits. Important in motivation to purchase system, and in appreciation of aesthetic value.	Important to perception of risk, confidence in benefits, and warrantee and maintenance terms. Important in motivation to purchase system, and understanding of benefits.
	Availability of Products	If conventional distributors of residential construction materials included SHW products it would likely improve confidence in products, installation best practices, and installation rate.	If conventional distributors of commercial construction materials included SHW products it would likely improve confidence in products, installation best practices, and installation rate.
	Availability and Capability of Design/Installation Companies	The same system is not always appropriate for every customer. Residential customers often rely their designer/installer to understand and design a system to best match their needs.	A well designed system matched to specific hot water needs, and a credible analysis of system benefits is the core driver of system benefits and SHW system installations.
Local Conditions	Local Climate	Impacts system benefits and downstream metrics. Often no credible performance analysis is available based on local climates.	Impacts system benefits and downstream metrics. Often no credible performance analysis is available based on local climates.
	Local Structures/Buildings/Architectures Visibility Requirements	Aesthetic compatibility requirements impacts system features, design, costs, and benefits.	Aesthetic compatibility requirements impacts system features, design, costs, and benefits.
	Building Surroundings	Shading ad other influence from local structures impacts system efficiency, design, costs, and benefits.	Shading ad other influence from local structures impacts system efficiency, design, costs, and benefits.
	Competing Cost of Electricity/Gas from Local Utilities	Low conventional energy costs create longer system paybacks, and reduce motivation to investigate SHW options.	Competing conventional energy costs and price schedules impact important decision making metrics. Can influence use behaviors to maximize benefits.

SECTION 4

Barriers to Cost-Effective Deployment of Solar Hot Water

Through interviews with Knoxville stakeholders, analysis of local conditions, consideration of market variables, and the experience and knowledge of CH2M HILL staff, several barriers to cost-effective deployment of SHW have been identified. These barriers have resulted in a very small number of SHW installations over the past several years. Identified barriers are as follows:

- Lack of knowledge and understanding by some stakeholders and the community at large of the personal and community costs, benefits, and other impacts of SHW installation
- Limited visible commitment by public entities and local institutions to increase the deployment of SHW systems
- Lack of financial incentives from state or local sources
- No visible SHW champion or spokesperson that is promoting the use of SHW
- Limited experience of the public approval processes for SHW installations

4.1 Lack of Knowledge and Understanding of Solar Hot Water

Through numerous interviews with area stakeholders, CH2M HILL found that there is a general lack of knowledge and understanding of the personal and community costs, benefits, and impacts of installing SHW systems. The following three primary stakeholder groups require a broader understanding of Knoxville SHW systems:

- General public and potential consumers
- Public entities and policymakers
- Service providers

4.1.1 General Public and Potential Consumers

The general public and potential consumers need to have a good understanding of the real costs and impacts of installing SHW to make an informed decision. One issue repeatedly encountered was the negative perception of SHW in the community stemming from SHW programs in the early 1980s. Specifically, the program was short lived, and without ongoing support most service providers left the market and orphaned systems to fail without maintenance and repairs. In many cases these systems are the only example of SHW systems available. Their failures and states of disrepair have created a false perception that SHW is not viable or positive in Knoxville.

Following are major components of the *Lack of Knowledge and Understanding* barrier:

- Before consumers can make an informed decision about installing SHW they need to have relevant, accurate, and credible information and data to replace vague rumors and anecdotes. Interviews with local stakeholders showed that there is limited real information available and that no local group was known to be developing this information. Payback periods ranging from 3 to 16 years recounted from Knoxville residents or service providers are likely not based on strong models.
- There is not a good financial cost and benefit model based on local conditions. Most of the information available is not specific to the Knoxville climate, electrical and gas costs, solar resource, ongoing operation and maintenance costs, and hot water demand models.
- Information on the performance and cost of different SHW systems is not readily available. Most service providers in the Knoxville area provide only one or two packaged SHW systems that are not optimized for individual users. One installer is providing the option to assemble a system from various companies on a project basis. It is difficult for a consumer to start their consideration of SHW installation without an easily accessible and understandable system comparison based on metrics they can relate to.
- Currently consumers, installers and public entities are focused primarily on solar photovoltaics (PV) with little emphasis on SHW. Most data, promotion and financial incentives are directed towards PV. This has created confusion on the part of the public and potential consumers as to the differences between PV and SHW and the cost and benefits of each. Additionally, the financial benefits of PV are more visible than SHW with cost benefits indicated on the monthly electric bill.

4.1.2 Public Entities and Policymakers

Public entities and policymakers have an important role to play in increasing SHW installations. Similar to potential users, these groups need to have a clear understanding of the impacts and benefits of SHW as they consider assisting the development of more installations. Beyond the level of understanding potential users need, these groups need to understand macro impacts of community SHW installations, including impacts to local utility and home values, among others. Public entities and policymakers need to consider and understand the following factors:

- How different levels of community adoption impact aggregated energy demand. This is important to TVA and the Knoxville Utility Board (KUB) in considering SHW support as they are looking to reduce peak load. More data and modeling is required to determine these community level impacts.
- The true cost and benefits of different types of systems needed to determine incentives that may be required to reduce costs, and the benefits created by increased demand. Currently there is limited local system performance data, making it difficult to assess real costs and system pay back measurements.
- The economic development opportunities created by increased SHW deployment. As Tennessee has already experienced with PV, many jobs can be created by promoting manufacturing and installation of solar systems. Models of the economic impact of

similar promotion of SHW would be helpful to understand potential returns on investments.

- The differences between SHW and PV in terms of costs, benefits, paybacks, technologies, and installation needs. While both are solar technologies, PV is really a renewable energy generator, while SHW is an energy efficiency and conservation technology. The significant differences between technologies need to be considered in developing a program to increase SHW usage.
- The needs and impacts of public processes and the policies that create an environment that is supportive of SHW deployment. These can include permitting, codes (such as fire safety), licensing requirements, inspections, and even Home Owners Association rule impacts. These processes and policies need to be timely, easy to understand, and supportive.

4.1.3 Service Providers

Service providers are companies that design, install, and maintain SHW systems. In discussions with existing providers there was a clear interest in increasing SHW installations, but no clear market driving them to do so. Their businesses were almost entirely driven by increasing demand for PV systems enabled by PV targeted incentives, and better consumer understanding of PV's costs and benefits. This sector has a large role to play in distributing SHW knowledge. However, service providers currently lack the following background:

- A deep knowledge of the various physical components available, their integration into optimized designs based on local conditions, and their costs and benefits through SHW system lives. With a limited focus on SHW to date, existing service providers have not invested the time and dollars in developing performance and financial models that are informative and useful to potential consumers.
- Models based on real performance data. These models should help service providers understand and present information on the following:
  - Costs and paybacks for different system types and configurations.
  - Solar hot water system interactions with local structures, and other electrical, and mechanical systems.
  - Solar hot water system settings and their effect on costs and performance.
  - Ongoing costs such as SHW system maintenance.
- Marketing programs that promote SHW with local performance data, costs, benefits, and payback information. With little public focus on SHW they have not invested in marketing to potential consumers.

4.2 Commitment of Public Entities and Local Institutions

Potential consumers of SHW systems often make decisions based on factors beyond economic costs and payback. Commitment and endorsement of public entities and

institutions can be very influential. State and local public leaders, the Tennessee State Energy Office, the Tennessee Valley Authority, Knoxville Utilities Board, Oak Ridge National Laboratory, and Tennessee Solar Institute all have the opportunity to take a specific public SHW position. To date, however, there appears to be no clear owner or leader of SHW promotion; collecting, assembling, and interpreting of SHW data; or SHW communications and marketing, all of which require public entity and local institutional support.

Impacts at the community and city level need to be well understood for public entities and local institutions to support these efforts. These impacts include the following:

- Impacts on the utility
- Economic development impacts and jobs created
- Tax impacts

Further studies may be required to develop this information.

4.3 Lack of Financial Incentives

Discussions with stakeholders revealed that financial incentives for SHW are needed to stimulate the market. In the case of PV, incentives are one of the key factors driving demand, which should be no different for SHW. However, it is important that these financial incentive options are based on credible analysis using local cost and performance data. The few existing commercial scale SHW installations (the Airport Hilton, and the County Detention Center) were enabled by financial incentives, and to date there appears to be no incentives for general residential SHW installation.

Incentives are important to accomplish the following:

- Assist demonstration and showcase projects that are not otherwise justifiable, so that these projects can prove concepts and provide a basis of performance models, cost and payback calculations. To date, incentives have provided needed funding to the large installation at the County Jail, a commercial installation at the Airport Hilton Hotel, a renovation of a low/moderate income home, and for the inclusion of SHW in the renovation of an historic residence by Knox Heritage. These projects are important to increase visibility of SHW projects and to provide a cost basis for different types of systems and can be monitored to provide real case data.

- Help reduce costs for residential and commercial systems by giving service providers additional experience, and allowing the aggregate product demand in the Knoxville area grow enough to gain some small economies of scale. It is also important to develop some momentum for SHW that will show public commitment, and provide experience for public processes.

Many options for incentives can be provided and matched with local granting agencies' needs, including loans, grants, rebates, or public policies such as renewable energy tax credits.

4.4 Lack of a Solar Hot Water Champion

Although multiple stakeholders were interested in increasing SHW installations locally, there is a clear lack of a visible, credible champion to coordinate all of the parties toward their common goal.

Solar hot water promotion has also remained relatively uncoordinated because PV activities occupy the attention of the same parties interested in promoting SHW. In coordination with state efforts to recruit PV manufacturing companies, Solar Knoxville and other stakeholders have been focusing on PV activities, including creating demand for locally produced products. This emphasis has been successful in increasing PV demand, but has been detrimental to the ability to implement activities directed to SHW.

A clear champion and leader is needed to provide focus on and act as a visible messenger for the benefits of SHW. This champion should also be tied closely and coordinate with the owner of the overall SHW program.

4.5 Inexperience of Public Processes

In the past few years there have been a very limited number of SHW systems installed. While it appears to date that public processes such as permitting have not been roadblocks to SHW installations, it is important that this does not change as SHW programs scale up. Current processes, while simple in extremely low volume, approved the existing base of installations using existing processes and codes, and building officials indicated that residential approvals should require an approximately 3-day turnaround. Although approvals have been relatively easy to obtain at a low level of demand, the following potential issues were identified as risks if SHW system installations increase dramatically in response to City programs such as those suggested in Section 5:

- Limited recent SHW experience and limited depth of knowledge or experience in different system types will make nonstandard installations, or unique equipment or applications challenging. There is experience with PV installations that is somewhat applicable but building officials will want more data on SHW system specifications as they involve more building systems.
- A rapid increase in demand for SHW could strain the existing permit system and increase approval times, or allow poor systems to be approved. As the program grows it will not only grow in volume but may also become more administratively and technically complex.
- There is limited experience measuring and prescribing structural requirements for SHW systems on existing buildings. There currently are limited prescriptive rules for approving SHW systems that avoid full engineering drawings and analysis, which at residential scales, can add significant cost as a percentage of the complete system.
- Any new regulatory processes and incentive programs need to be easy to understand, apply for, receive, and fit into prescriptive and preapproved design configurations. None of these processes should slow or encumber the process or add cost.

SECTION 5

Strategies for Reducing Barriers

Section 3 identifies the market variables influential in determining SHW system demand and installation in the Knoxville area. Section 4 identifies and describes barriers to the cost-effective deployment of SHW. This section identifies and describes strategies for reducing the barriers.

Developing a comprehensive SHW program is complex in that each barrier is influenced to some degree by the market variables. In this section CH2M HILL suggests strategies and actions that can reduce or overcome the identified barriers. These strategies were developed based on interviews with stakeholders, review of existing programs and policies, and CH2M HILL SHW knowledge and research into experiences and strategies utilized by other cities and states to increase SHW deployment. As the different barriers are somewhat intertwined, this section takes a comprehensive approach, and groups suggested actions into five categories. Strategy categories are as follows:

- Identify SHW Initiative Lead
- Gather Data and Information
- Develop Payback and Performance Models
- Coordinate Public Policy and Programs
- Establish Outreach and Education Program

Implementation timelines for many of the activities in each category can overlap but are generally envisioned to be sequential.

5.1 Identify Solar Hot Water Initiative Lead

Any focused effort to increase deployment of SHW in Knoxville will require an entity to lead and manage the activities. The lead would likely be a public entity but could also be a public or private group formed for the effort. This entity would assume the following responsibilities:

- Develop a SHW initiative with strategic plans and goals.
- Provide general oversight and management of the program.
- Coordinate and compile data and information required to get the effort started.
- Develop or coordinate the development of payback and performance models.
- Provide leadership for the development of public policies programs that support SHW deployment.
- Develop an outreach and public education effort.
- Become the primary interface between the public and the program including consumers, general public, public officials, utilities, and service providers.

The City of Knoxville Office of Sustainability appears to be a logical choice to lead this effort. Their involvement with the Solar America Cities Program, this report, installer training, and other activities make them a good choice. Other potential program managers could include Southern Alliance for Clean Energy or the Tennessee Solar Institute. This effort requires a long-term commitment of financial and staff resources which may be beyond the city or any other entity's current funding capability.

5.1.1 Funding Sources

A consortium of stakeholders may be the best option to contribute to the effort financially. The contributors could become a managing policy board for the program, and could include local public offices and departments (Knoxville and Knox County), service providers, utilities (TVA and KUB), state and federal agencies (Tennessee Energy Office, Tennessee Solar Institute, legislature, Oak Ridge National Laboratory, U.S. Department of Energy), nonprofits (Southern Alliance for Clean Energy) and other interested parties. Getting this lead entity started and funded is the critical first step for successful implementation of the following steps, and ultimately in increasing the number of local SHW installations.

5.1.2 Examples of SHW Leadership

The Florida Solar Energy Center (FSEC) was created by the Florida Legislature in 1975. FSEC's advisory board is made up of representatives from the following entities: hospitals, a grocery chain, solar companies, home developers, power companies, universities, and the governor's office. FSEC offers consumer information about commercial and residential installation costs and benefits, training to installers, and more. Further details on the FSEC SHW programs are available in resources listed in Section 6.

Milwaukee, Wisconsin, has recently developed the "Milwaukee Shines! Solar Hot Water Business Council." The council is a partnership between the City of Milwaukee and local businesses. The council purpose is to build the solar hot water industry in the Milwaukee region through education and support of businesses and manufacturers. Further details on the Milwaukee, Wisconsin, SHW programs are available in resources listed in Section 6.

5.2 Gather Data and Information

To effectively develop an overall approach it is necessary to have relevant data and information that is based on local conditions and leverages experience from other areas and the SHW industry in general. To develop this knowledge base, the following actions are suggested:

- Require the installation of monitors on all new SHW projects, and carefully collect system performance and cost data for various system types and sizes using local climate, solar resource, and competing energy costs. The additional costs of monitoring equipment should not encumber projects. These costs are an ideal target for SHW incentives.
- Assist in getting demonstration and showcase projects developed that would include monitors.

- Use data from existing projects such as the Detention Center, Airport Hilton, and Knoxville Heritage's recent remodel.
- Engage with Oak Ridge National Laboratory to assist in developing, analyzing, and interpreting local data and providing access to system data from other areas.
- Engage Tennessee Solar Institute and as much as possible, the University of Tennessee, or other nearby academic institutions.
- Work with other Solar America Cities to use information they have developed for SHW.

The SHW Initiative lead entity should be the organizer and coordinator for the information and data-gathering effort, but will likely utilize technical resources like Oak Ridge National Laboratory to collect and interpret it.

The Oak Ridge National Laboratory is a valuable resource for the Knoxville area as a source of technical expertise for solar energy and SHW data and could take the lead in the development of additional local information. A strong relationship with Oak Ridge National Laboratory is invaluable in this effort, as well as a potential route to additional funding for research and development of SHW in the region through U.S. Department of Energy solar programs or other federal opportunities.

The University of Tennessee could be another resource, possibly through collaboration with faculty or student projects, or in the joint application to funding opportunities. Other major players in data and information development should be the Southern Alliance for Clean Energy and the U.S. Department of Energy Solar America Cities Program.

The only way to generate real local data is through the direct monitoring of real system performance. Any project that receives public funding should be required to include a system monitor. Service providers could also be incentivized to install monitors and provide data on installed systems as available.

5.2.1 Examples of Data and Information Development

In 1999, Lakeland Electric (Lakeland, Florida) began a program that installed 29 solar thermal systems on homes. These 40-square-foot (80-gallon) systems were installed at no upfront cost to the homeowners, who were then billed for the hot water used. The resulting study describes the costs and benefits to the utility, consumer, and solar contractors. It also gives statistics on hot water generated and used, and lessons-learned during the study. Further details on the Lakeland's SHW programs are available in resources listed in Section 6.

5.3 Develop Payback and Performance Models

Having models that show the real costs/benefits and system performance is critical to the effort to inform consumers, utilities, and public entities of the value and benefits of installing SHW systems. These models are also valuable to service providers in their marketing efforts. With the data and information gathered through the efforts in Section 5.2, the following models can be developed:

- A payback model that is accurate, easy to understand, and ready for marketing. The model should include local utility costs, climate conditions, different operating systems, different hot water demand profiles, and real performance data based on actual systems.
- Models should include a discussion of nonfinancial benefits of SHW systems including energy conservation, carbon reduction, and other environmental benefits.
- Models of community benefit of aggregated SHW deployment are also critical to define and shape city level support for SHW in the form of incentives or outreach funding.

A specific action that can be pursued is to work with Oak Ridge National Laboratory to secure funding to design the monitoring program and develop the models. Oak Ridge National Laboratory has excellent credibility in the Knoxville area and nationally in the solar industry. The data presented in their models and endorsement of SHW would be beneficial in getting the initiative started.

5.3.1 Examples of Payback and Performance Models

There are several state Web sites that provide good information on SHW, including the Florida Solar Energy Center Web site, which provides types of systems, installation information, ratings for certified collectors and systems, and a system calculator. Hawaii and North Carolina also have payback calculators and explanations of incentives for system installations.

North Carolina Solar Center's Solar Thermal Calculator helps potential system owners, both commercial and residential, determine the financial payback of solar thermal systems, depending on a variety of system and incentive options. The calculator is Web-based (no download required), nontechnical enough for use by most educated laypeople, and includes a glossary. Further details on the North Carolina Solar Center's SHW programs are available in resources listed in Section 6.

RETScreen is a free downloadable Excel-based tool used to estimate sizing for solar thermal systems. It is not designed for the casual user, but rather for people who already have a solid understanding of alternative-energy terminology and metrics. Further details on the RETScreen are available in resources listed in Section 6.

5.4 Coordinate Public Policy and Programs

In conjunction with and continuing after the development of local data and models, a SHW initiative should be established with public policies and programs that promote the increased deployment of SHW. A focused program initiative is essential to expanding the number of installations. As discussed in Section 5.2, a lead entity must be identified to manage and coordinate the following activities:

- Identify a champion for the initiative that can work closely with the lead entity and be a public advocate for SHW. This could be a public official, business executive, solar industry leader or other individual that is visible and respected in the community and committed to SHW. The champion could also be a group of individuals if a single individual is not available.

- Develop a grant incentive program to assist in financing demonstration projects and an initial group of residential and small commercial projects. This effort can provide visibility and develop momentum good for general acceptance.
- Establish a stakeholder advisory group consisting of service providers, city/county departments, consumers, Tennessee Solar Initiative, Southern Alliance for Clean Energy, utilities, contractors, and others with a direct interest. This group can provide overall policy development and oversight, consumer input, industry insight, and assist in outreach programs.
- Enact public policies that encourage SHW such as a state or local Renewable Portfolio Standard (RPS), easy permit and approval processes, solar renewable energy credits, and specific support for third-party financing/ownership and lease models.
- In addition to the creation of a grant or loan program, other financial assistance efforts can be pursued such as tax credits, sales tax exemptions, or utility rebates.
- Reposition SHW as an energy conservation effort rather than renewable energy generation initiative that competes with solar PV for attention. This could be useful in providing SHW with an identity separate from PV and may also open access to additional funding sources.
- Work with TVA and KUB to implement programs that can use SHW to reduce peak load and encourage design of SHW systems that offset the most energy during peak hours.

A valuable action would be the creation of a pilot grant program that is focused on residential and small scale commercial projects. With the relatively low gas and electric costs in the area it is necessary to provide incentives to reduce initial costs and reduce payback periods until sufficient momentum is developed. The City of Knoxville could use the $135,000 fund currently available to provide grant funding for 50 to 100 projects, offering system grant amounts of around $1,500 to $2,000 to reduce the upfront costs to a level that provides a reasonable payback. The program should also provide funding for system monitors. This grant structure combined with the federal tax credit could reduce a low cost system to approximately $2,500.

A second specific action would be for the city permit agency to conduct an engineering study to evaluate and establish structural requirements for SHW systems on local structure types. Based on this study, a prescriptive method that permits SHW systems without engineering should be created. Prescriptive Standards could include number of roof coverings, type of roof construction, roof penetrations, slope, roofing material etc.

5.4.1 Examples of Public Policy and Stakeholder/Advisory Groups

The Florida Solar Energy Center was created by the Florida Legislature in 1975. Its advisory board is made up of representatives from hospitals, grocery chains, solar companies, home developers, power companies/utilities, universities, and the governor's office. Further details on the FSEC SHW programs are available in resources listed in Section 6.

Hawaii law requires that all new homes include solar water heaters beginning in 2010.

The North Carolina Solar Center is run by North Carolina State University, but is heavily supported by local and national funding. Funding is provided by the North Carolina General Assembly, North Carolina State Energy Office, North Carolina Engineering Foundation, and Federal grants (DOE EERE & NREL, IREC). Further details on North Carolina's Solar Center SHW programs are available in resources listed in Section 6.

5.4.2 Examples of Pilot Programs

The Na Makani Low-Cost Solar Water Heating Program in Hawaii ran from 2000 to 2002. The program target was to install 100 low-cost solar hot water systems, using $37,000 from the U.S. Department of Energy and Hawaii's Department of Business, Economic Development and Tourism. The program focused heavily on homeowner satisfaction with the installer and the system installed, cost of the system, and energy and cost savings. Further details on the Hawaii's SHW programs are available in resources listed in Section 6.

The California Center for Sustainable Energy (CCSE), in conjunction with the California Solar Initiative designed and implemented a Solar Hot Water Pilot Program, resulting in a 2009 report. The program included incentives and training for installers, homeowners, and inspectors. Solar hot water systems were installed and use was monitored to determine the market for SHW in San Diego and the impact of incentives. Further details on the CCSE's SHW programs are available in resources listed in Section 6.

5.4.3 Examples of Grant, Loan, and Rebate Programs

Hawaii offers a 35 percent state tax credit, in addition to the federal 30 percent tax credit. Oahu, Maui, Molokai, Lanai, and the Big Island offer a $750 instant rebate for SHW systems, while Kaua'I offers an $800 rebate. Further details on Hawaii's SHW programs are available in resources listed in Section 6.

In Florida, Lakeland Electric offers a solar water heating program in which the utility installs SHW system on house at no cost to the home owner. The homeowner then purchases hot water for $34.95 per month (approximately equal to the current cost of water heating in most households). Further details on the Lakeland's SHW are available in resources listed in Section 6.

The City of Tallahassee Utilities in Florida offers a $450 rebate program for SHW systems and a low interest loan program of 5 percent interest for 5 years on $500 to $10,000. Further details on the Tallahassee's SHW programs are available in resources listed in Section 6.

Tucson Electric in Arizona offers a rebate program which includes SHW for hot water and space heating. They offer a rebate of $750 plus $0.25 per kilowatt-hour (kWh) based on the rated energy savings of the system, to a maximum of $1,750. Further details on the Tucson's SHW programs are available in resources listed in Section 6.

5.5 Establish Outreach and Education Program

With local data, performance and payback models, lead organization, and programs and policies in place, an outreach and education program should be established targeting potential consumers, the general public, and service providers. The program should include the following activities:

- Develop marketing materials that clearly discuss paybacks, incentives, and benefits of SHW. These materials can be used by the lead entity and service providers to market to potential consumers.
- Conduct an outreach and education program for potential buyers and the general public similar to the Solar 101 programs conducted earlier by the Southern Alliance for Clean Energy.
- Utilize a champion or champions to discuss and promote SHW at local events and in local media.
- Continue installer training program and work with Pellissippi State to develop education programs that train workers for positions in the SHW industry.

A specific activity would be to start a program similar to the Solar 101 program, focused instead on SHW that would be open to the general public, potential consumers, installation companies, public officials, and others interested in SHW.

A second effort would be the continuation of the installer training provided by the City to educate installers on codes, permits and processes. It could also provide information on different systems and their requirements.

5.5.1 Examples of Outreach and Education Programs

The Florida Solar Energy Center has information for residential and commercial customers about types of solar hot water systems, installation, ratings, costs, and incentives. The site has great diagrams to help users understand various system types. It also includes a very simplified calculator to help users estimate the cost savings and environmental impact of installing a system.

For commercial customers, the site explains the various types of commercial facilities that might benefit from solar hot water and space heating.

Florida Solar Energy Center also offers a Training Program for Residential Solar Water and Pool Heating Design, Installation and Troubleshooting for solar hot water installers. Further details on FSEC's SHW programs are available in resources listed in Section 6.

Hawaii Energy's Web site explains the impact hot water makes on the average home's energy usage. It breaks down the cost of a typical solar hot water system with rebates and tax credits. The site also includes links to more information about rebates, and to a list of participating contractors. Further details on the Hawaii's SHW programs can be linked to from Section 6.

5.6 Conclusions

As identified in this section, a variety of activities must be carefully managed and assembled into an overall strategy to increase deployment of SHW in the Knoxville area. Although the recommendations in this report are presented in the order they should generally be implemented, Knoxville SHW program coordinators will need to make final decisions on the program details, sequence, overlap, and general timing based on their position in the

community and knowledge of local processes. Although CH2M HILL believes that the suggested strategic activities in this section can successfully overcome the market barriers identified, the City of Knoxville, Solar Knoxville, and SHW program managers may decide that not all of the activities discussed need be implemented, or that they should be changed or modified according to changing conditions. At the core of whatever program Solar Knoxville develops, the most important criteria for program success are as follows:

- Focus on SHW installation and differentiation from PV solar
- Funding and staffing for a long-term effort
- Financial incentives at least in the short term
- Emphasis on environmental and community benefits
- Supported by most if not all stakeholders, especially TVA and KUB
- Emphasis in the near term to overcome perceptions of SHW from old or orphaned installations
- Marketing and consumer education focused on cost-effectiveness and SHW as a method to reduce energy usage, save on utilities, and improve the environment

These factors are based on CH2M HILL's experience and on findings derived from analyses of the Knoxville area and interviews with stakeholders; however, they are also supported by a powerful local and recent example.

Knoxville and Knox County have successfully participated in programs to grow the local PV market significantly between 2007 and 2010 (from an installed base of approximately 15 kilowatts [kW] to approximately 1,400 kW). This successful market building campaign and incentive programs and experience in PV had many of the same components of the market building steps suggested in this report. Although PV and SHW markets and technologies are different, the experience, examples, and lessons learned from Knoxville's recent PV growth period are invaluable in shaping SHW market growth programs.

By combining the market building experience and lessons learned from PV with the findings of this report, a strong, sustainable, SHW market in Knoxville is possible.

SECTION 6

Resources and Contacts

City of Palo Alto Utilities SWH Program (www.cityofpaloalto.org/swh)

California Center for Sustainable Energy
Phone: 866-611-CPAU
Fax: 858-244-1178
E-Mail: swhp@cityofpaloalto.org

City of Tallahassee Utilities
http://www.talgov.com/you/energy/energy_programs.cfm

Florida Energy Center
http://www.fsec.ucf.edu/en/consumer/solar_hot_water
James Fenton, Director
Phone: -321-638-1002
E-mail: http://www.fsec.ucf.edu/contact.php?id=1406

Hawaii Energy
http://www.hawaiienergyefficiency.com/16/water-heating
Phone: 808-537-5577
Email: hawaiienergy@saic.com

Lakeland Electric
http://www.lakelandelectric.com/Residential/EnergyEfficiencyProductsServices/SolarWaterHeatingProgram/tabid/360/Default.aspx
Jeff Curry, Alternative Energy Coordinator
Phone: 863-834-6853
Email: Jeff.Curry@lakelandelectric.com

Marken, Chuck and Doug Puffer. "Solar Water Heating Systems Buyer's Guide." Home Power Magazine, 125. June and July 2008. Retrieved September 24, 2010, from http://homepower.com/article/?file=HP125_pg92_Marken

Milwaukee Shines Solar Hot Water Business Council
http://www.ci.mil.wi.us/milwaukeeshines/AboutUs/SolarHotWaterBusinessCouncil.htm
Andrea Luecke, Milwaukee Shines Project Manager
Phone: 414-286-5593
LinkedIn Group: http://www.linkedin.com/groups?gid=3116274

Na Makani Low-Cost Solar Water Heating Program
http://hawaii.gov/dbedt/info/energy/publications/solar-gill.pdf
Andrea T. Gill, Energy Conservation Analyst
Hawaii Energy Extension Service
Phone: 808-933-0312
Email: agill@interpac.net

North Carolina Solar Center
http://www.ncsc.ncsu.edu/
Solar Calculator
http://www.ncsc.ncsu.edu/include/_upload/calculators/solarthermal.html
Carole Coble, Solar House Manager
Phone: 919-515-708
Email: carole_coble@ncsu.edu

Patterson, John. "Solar Hot Water Simplified." Home Power Magazine, 107. June & July 2005. Retrieved September 24, 2010 from
http://homepower.com/article/?file=HP107_pg18_Patterson

RETScreen
http://www.retscreen.net/ang/home.php

San Diego Solar Water Heating
http://www.swh.energycenter.org
Annie Henderson –SWH Program Manager
Phone: 858-244-7290
Email: annie.henderson@energycenter.org

Tucson Electric
http://www.tucsonelectric.com/Green/Home/Solar/spaceheating.asp