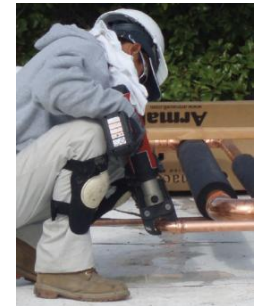


Solar Water Heating Supply Chain Market Analysis

Study for the City of Milwaukee



November, 2010



Content of Report

This presentation was prepared by Navigant Consulting, Inc.¹ exclusively for the benefit and internal use of We Energies and the National Renewable Energy Laboratory and/or its affiliates or subsidiaries. No part of it may be circulated, quoted, or reproduced for distribution outside these organization(s) without prior written approval from Navigant Consulting. The work presented in this report represents our best efforts and judgments based on the information available at the time this report was prepared. Navigant Consulting, Inc. is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report.

NAVIGANT CONSULTING, INC. MAKES NO REPRESENTATIONS OR WARRANTIES,
EXPRESSED OR IMPLIED.

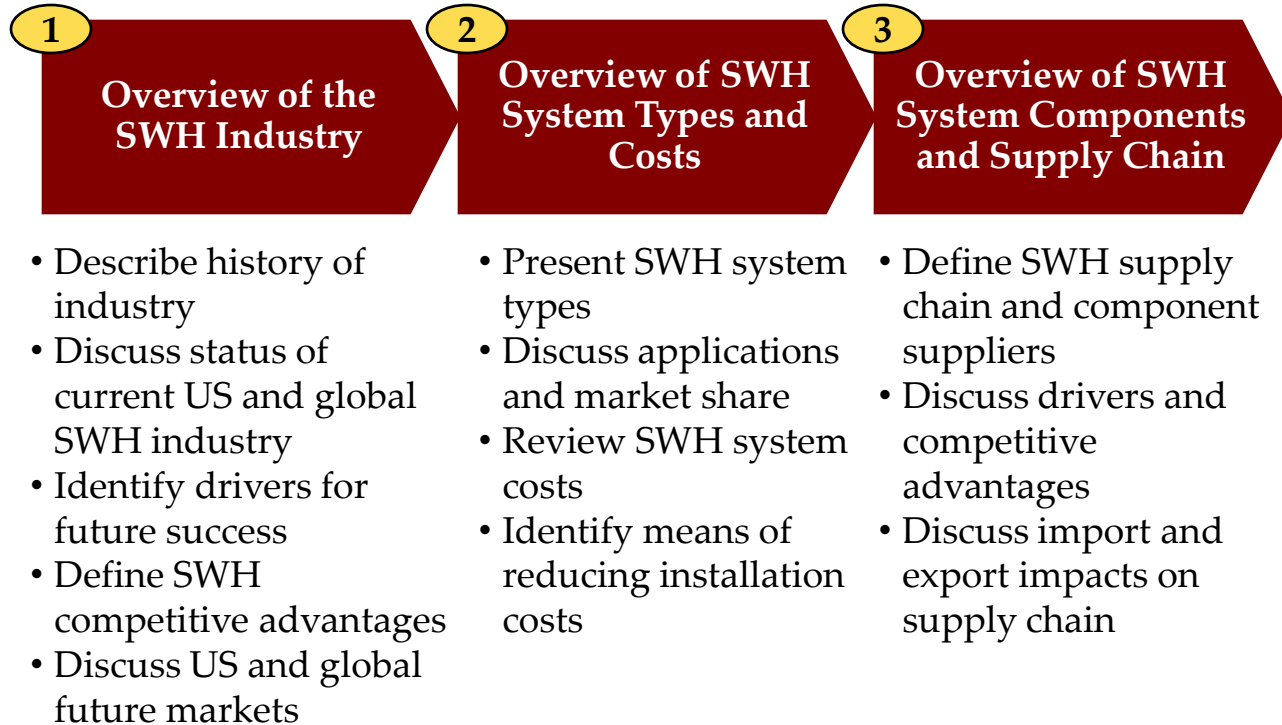
Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

October 20, 2010

1. "Navigant" is a service mark of Navigant International, Inc. Navigant Consulting, Inc. (NCI) is not affiliated, associated, or in any way connected with Navigant International, Inc. and NCI's use of "Navigant" is made under license from Navigant International, Inc.

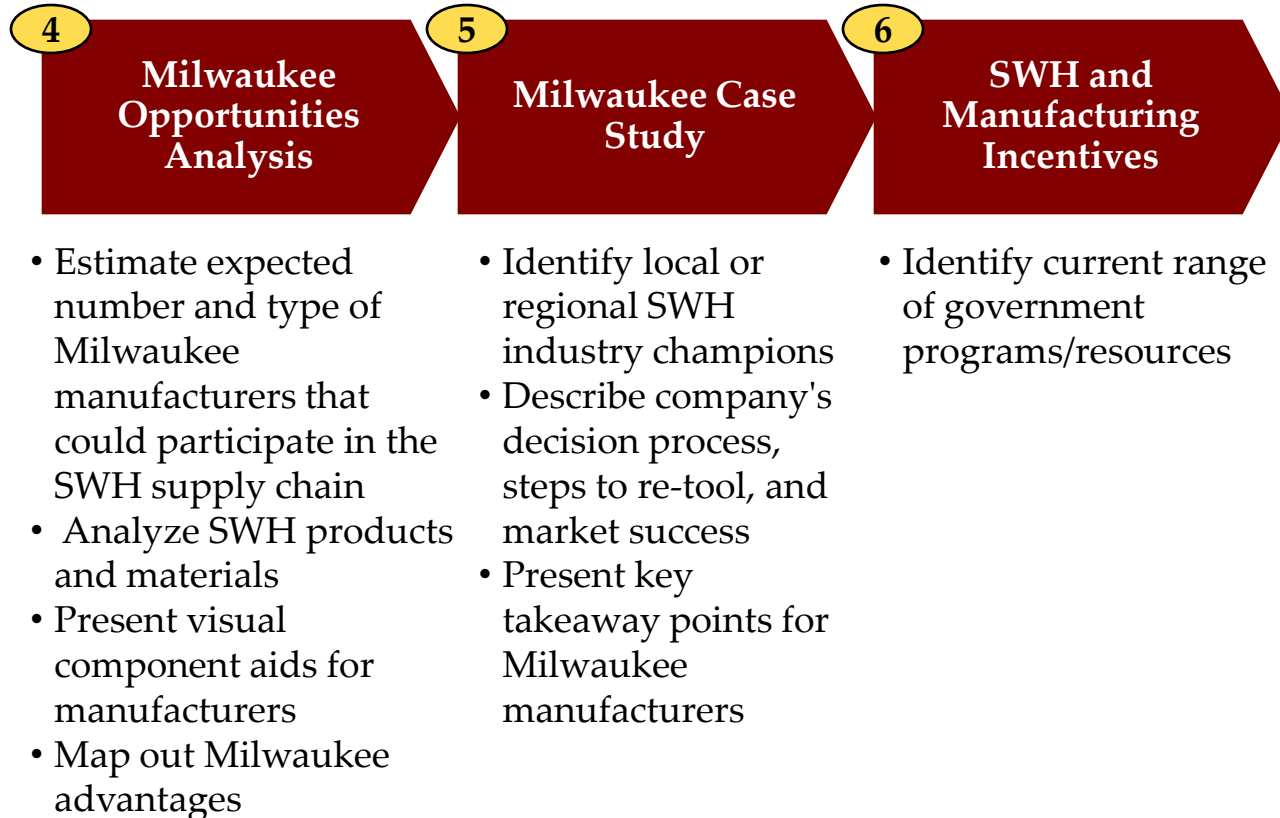
Navigant reviewed the Solar Water Heating (SWH) market for the City of Milwaukee as part of the Solar America Cities Program.

NCI Scope of Work – SWH Market



Navigant then analyzed the opportunity and viability of Milwaukee area manufacturers to enter the SWH component industry.

NCI Scope of Work – Milwaukee Manufacturing



The U.S. SWH market may support new manufacturers. However, the market remains small, fragmented and presents risks.

Should Milwaukee manufacturers retool their factories to enter the SWH industry?

Will the SWH market be large enough over the short and long term?

Yes No

- The current US market is estimated around \$800MM (millions) for total system installations with about \$200MM for non-collector components.
- Over the next five years that US market could double due to federal and state incentives.

Will the SWH market support Milwaukee retooling requirements?

Yes No

- Milwaukee manufacturers need to capture a market of \$1MM to justify retooling.
- To reach this target manufacturers would have to capture 5-10% of the SWH component market they manufacture.

Can local manufacturers capture a large enough market share?

Yes No

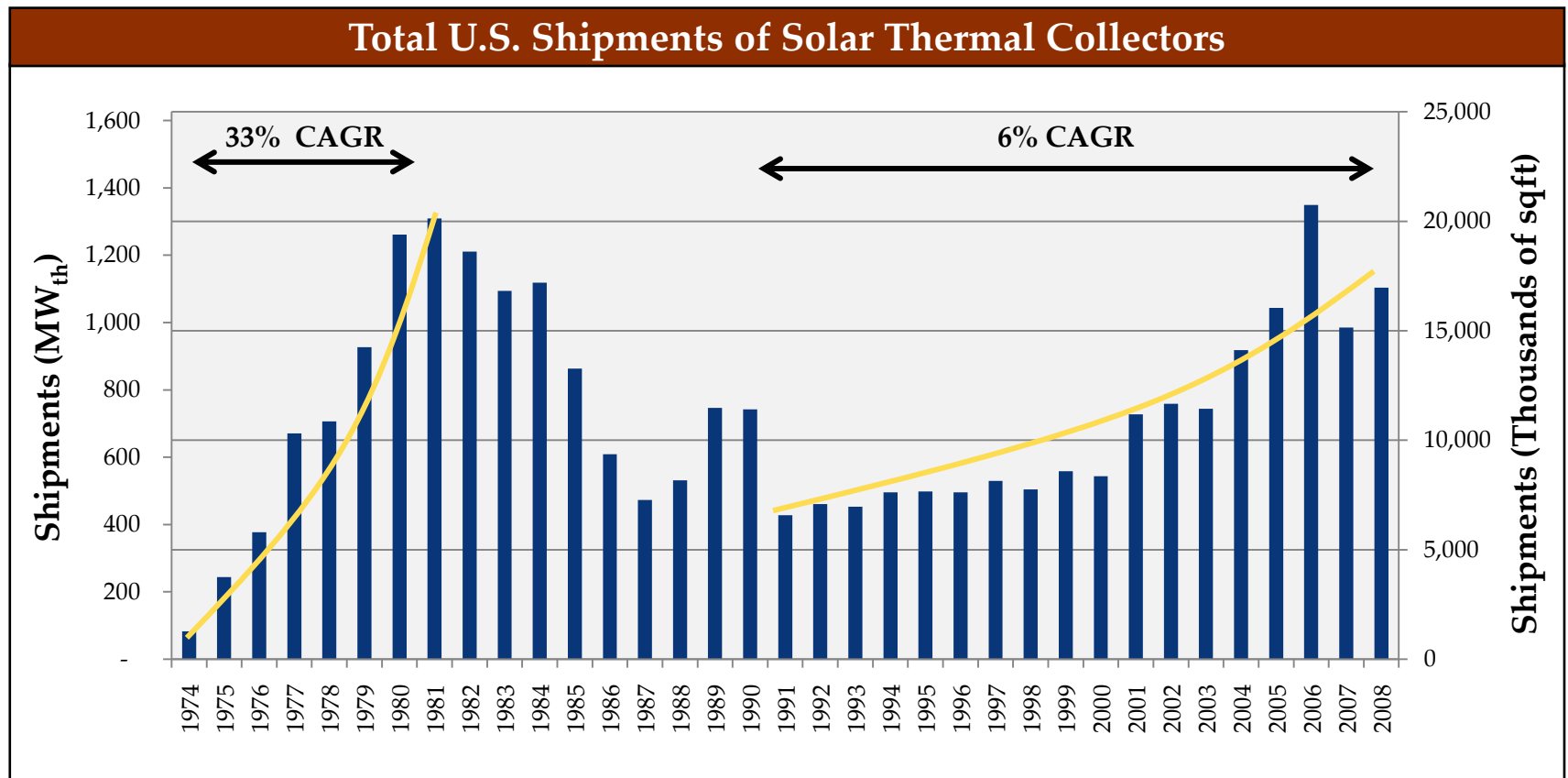
- Capturing a 5-10% market share may be possible with some components.
- Established players within the market may provide stiff competition.
- However, the SWH market is highly fragmented presenting an opportunity for new suppliers and manufacturers.

Do Milwaukee manufacturers have the capabilities and resources to enter SWH market?

Yes No

- Milwaukee manufacturers have the capabilities to enter the market and make high quality components.
- However, to capture their target market share they may require multiple customers and resources to find them.

After 33% average annual growth prior to 1981, the U.S. market declined. Since 1991, there has been a 6% compounded annual growth rate (CAGR).

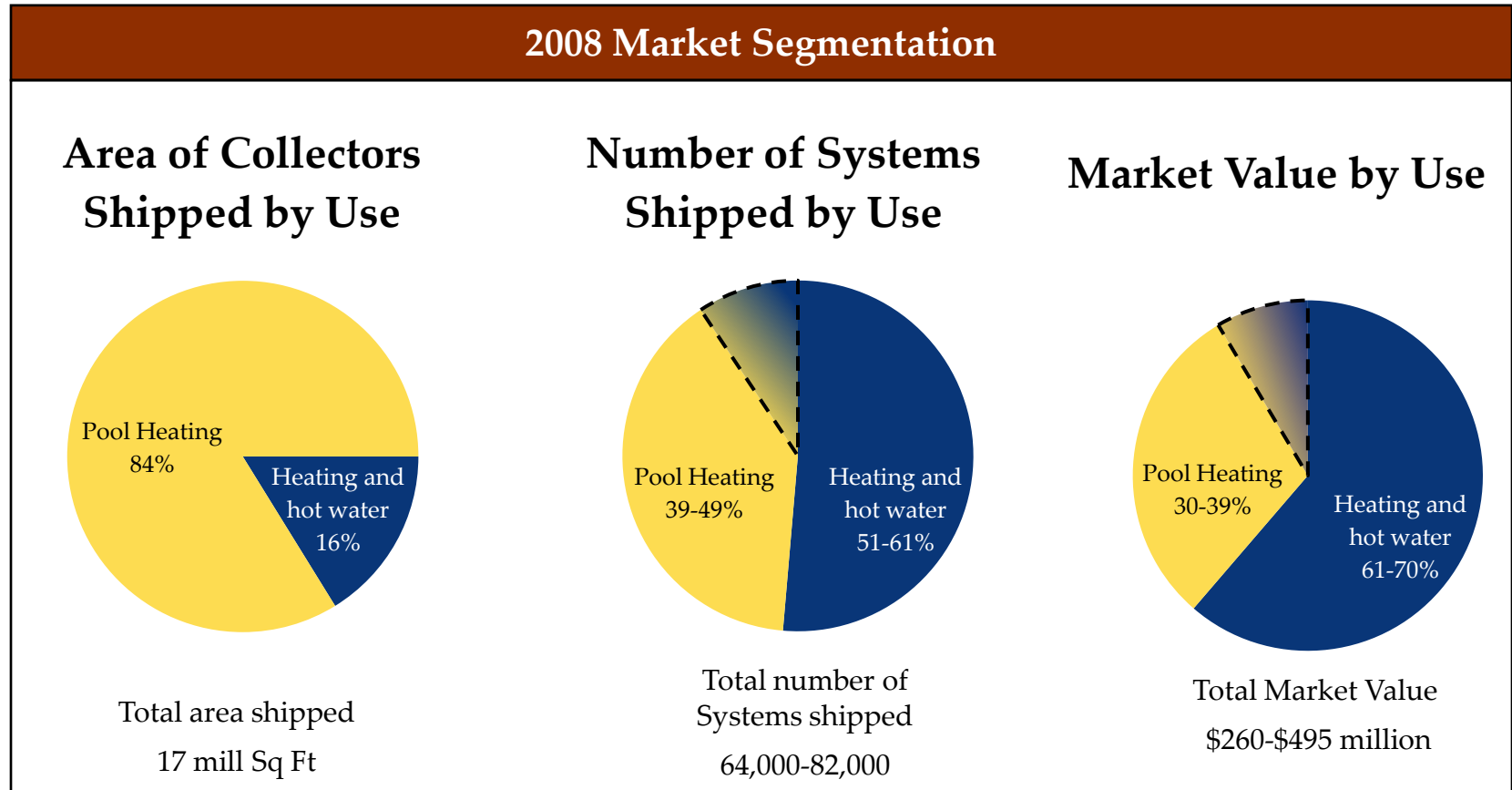


*Data reported in 1000's of sq.ft. MW_{th} is calculated based upon an internationally agreed upon conversion factor of 0.7 kW_{th}/m².

Source: International Energy Agency's Solar Cooling and Heating Program, Solar Heating Worldwide 2008 Edition, Industry Interviews, Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal Collector Manufacturing Activities 2008 & Renewable Energy Annual. Annual installations domestic production and imports of low, medium and high temperature collectors.

CAGR – Compound Annual Growth Rate

The hot water and heating market represents nearly 70% of the market value, but only 16% of the area of collectors shipped.

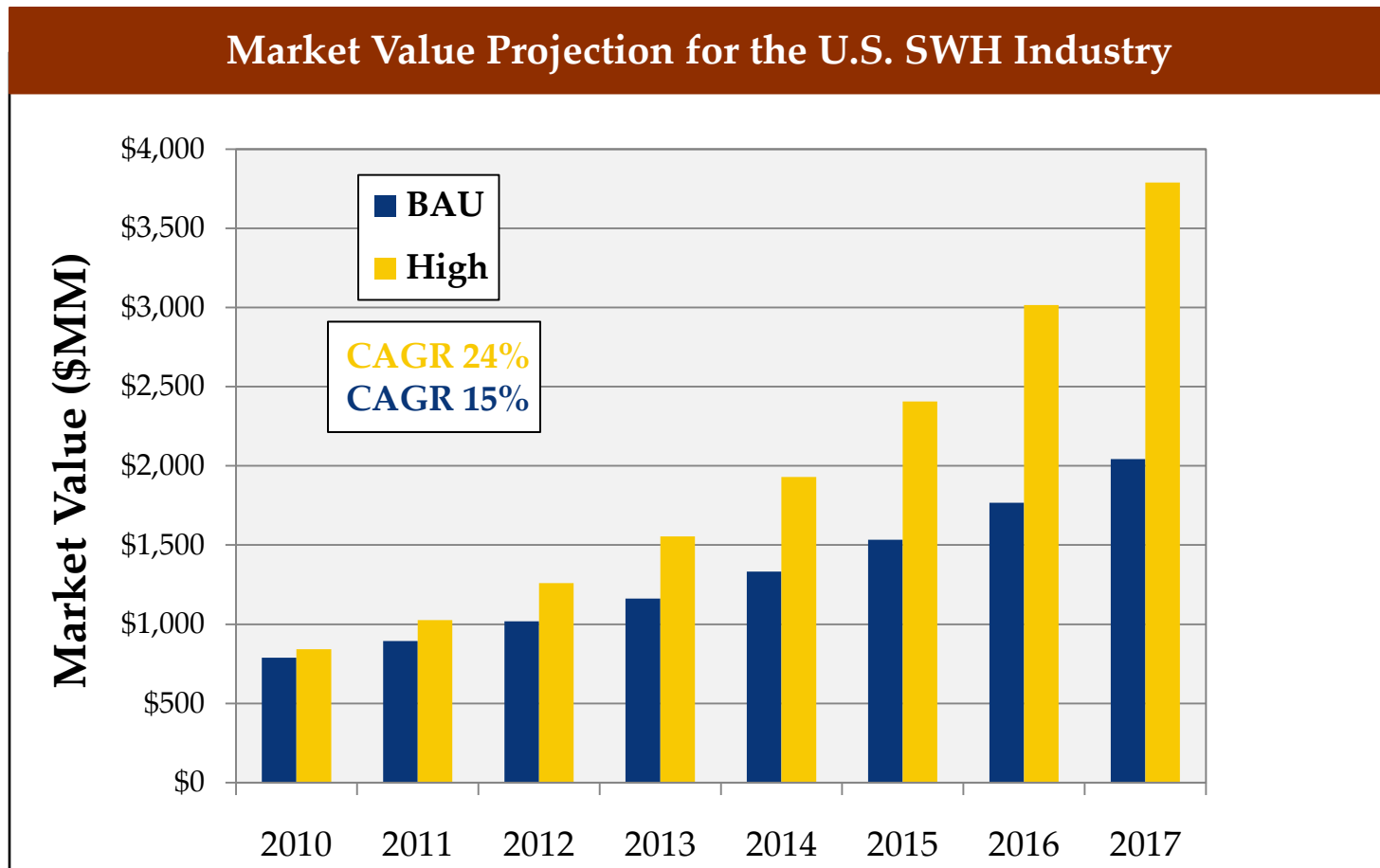


Source: Navigant Consulting, Inc. analysis based on data from: Industry Interviews, Energy Information Administration's Solar Thermal and Photovoltaic Collector Manufacturing Activities 2008 and Renewable Energy Annual, and internal analysis.

Note: Pool Heating System size was assumed to be 350-400sqft; Non-pool heating systems were assumed to be 50-64 sqft.

The dashed line represents the level of uncertainty in the calculations and should be considered as a range.

Even with optimistic U.S. market growth, the total value of the market remains modest between 2010-2017 (less than \$4 billion).



Source: Navigant analysis.

System Size: domestic SWH system 40sqft; Pool system 400 sqft;

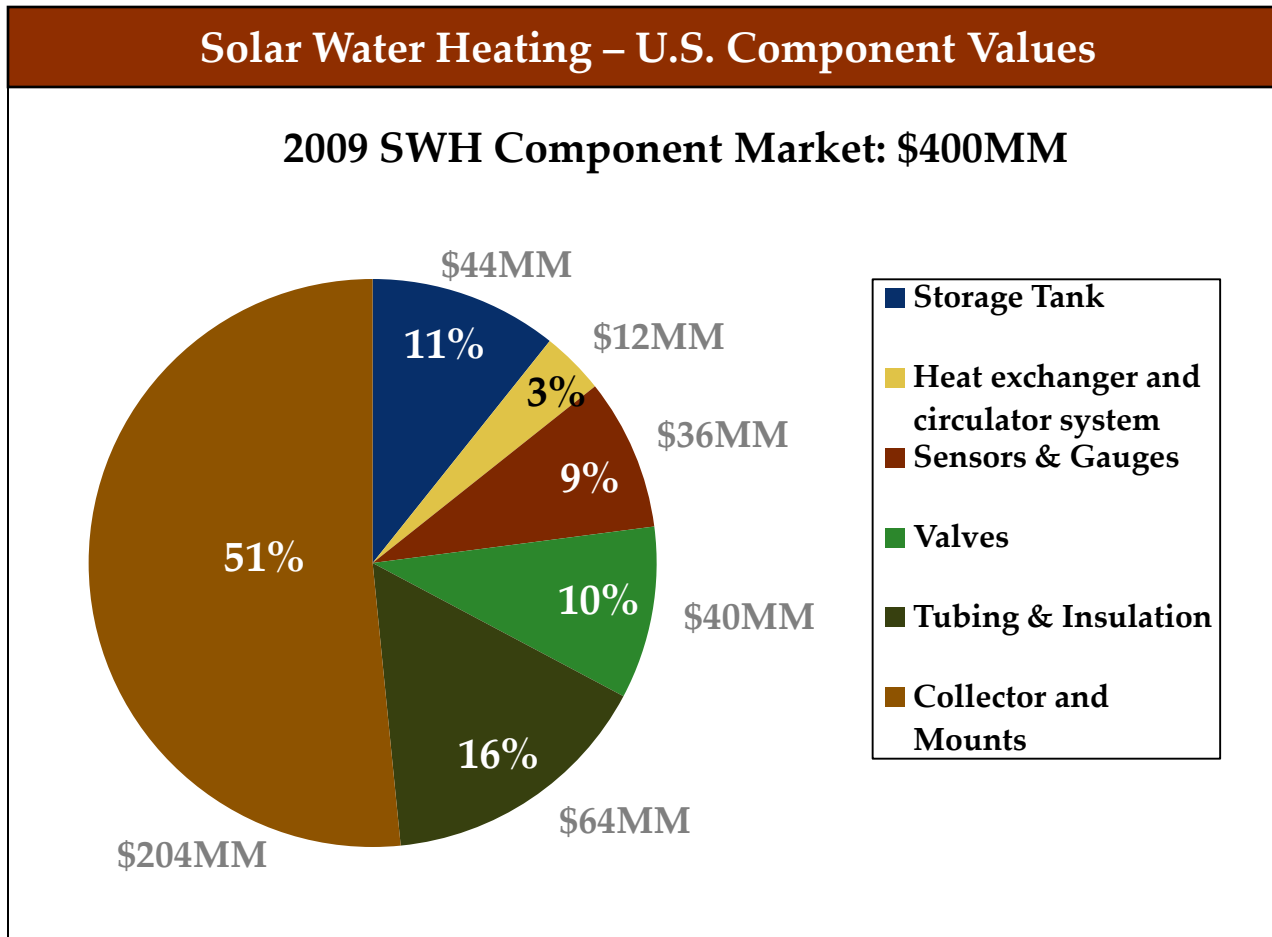
BAU – Business As Usual; CAGR – Compound Annual Growth Rate

Market Growth Assumptions

BAU: Pool CAGR 5%; other SWH CAGR 21%

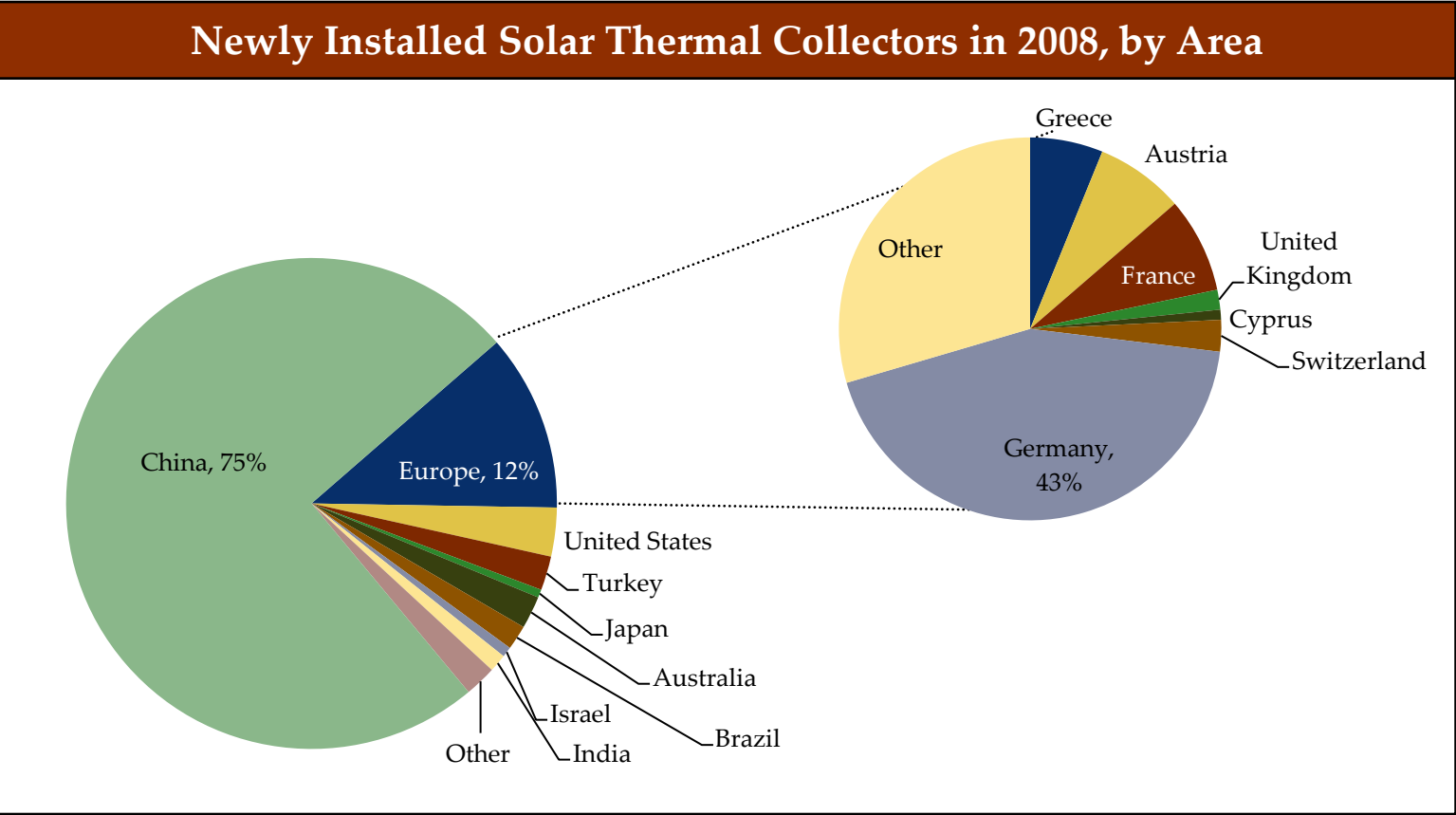
High: Pool CAGR 8%; other SWH CAGR 32%

The U.S. SWH market size was \$800MM in 2009. ~50% of the total value is material cost, which is dominated by collectors.



Source: RS Means, Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal and Photovoltaic Collector Manufacturing Activities 2008 and Renewable Energy Annual and Industry Interviews.

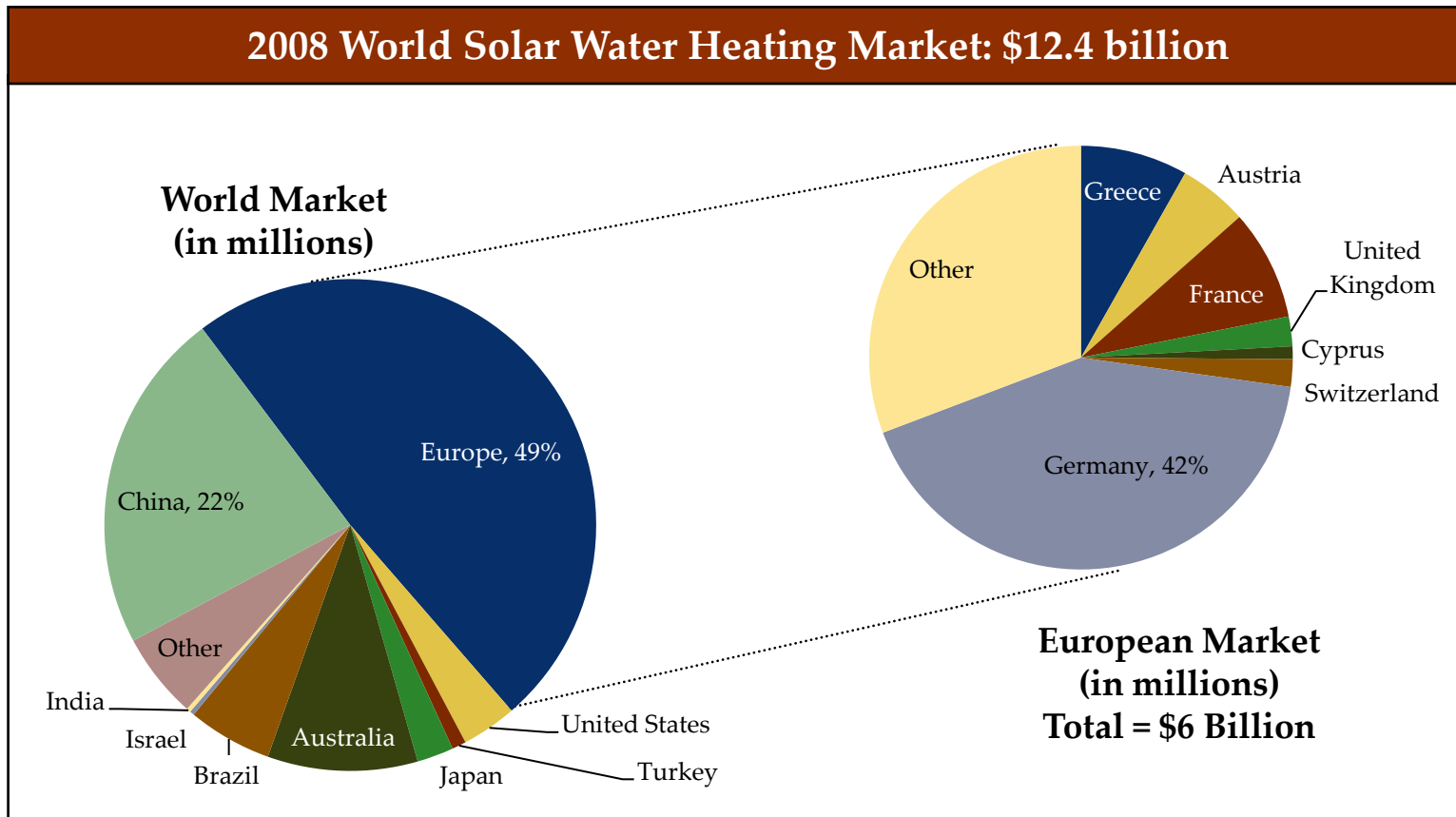
China overwhelmingly led 2008 installations with 75% of global installations....



Source: International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008, Edition 2010*. May, 2010.

Note: At the time of the writing of this report, complete global 2009 data was not yet available

...But Europe is the largest SWH market (in terms of revenue) with nearly half of global SWH market value.



Sources:

1. NCI Analysis
2. International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008, Edition 2010*. May, 2010.
3. Sensors Report, 2008. <http://www.mdpi.org/sensors/papers/s8021252.pdf>

China and Europe lead global demand for SWH systems, but for different reasons.

Europe	<ul style="list-style-type: none">• Continued long term support of SWH incentives. This helps industry plan long term• Performance based incentives. This encourages proper system design and sizing.• Education campaigns. Awareness for SWH systems is lacking in most markets, but campaigns raising awareness and pointing out the benefits of SWH systems create more customer demand.• Policy. Some municipalities are requiring SWH systems to be installed per local building codes.
China	<ul style="list-style-type: none">• Low cost systems and limited availability of electricity and natural gas have driven industry growth.<ul style="list-style-type: none">– The Chinese government does not offer incentives for manufacturers or end users.• There is often no need for freeze protection, thus helping to reduce system costs.

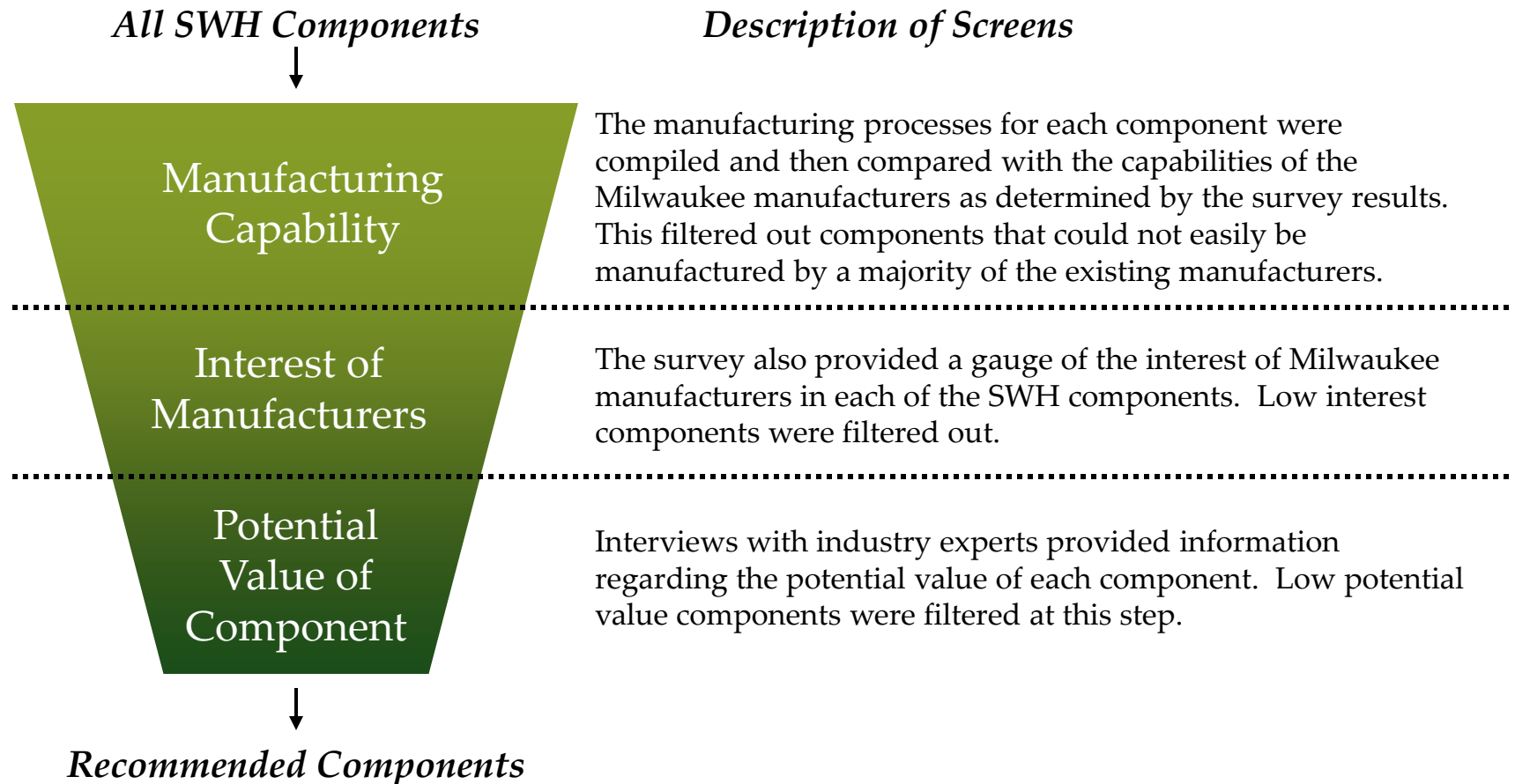
Below are some likely market trends impacting SWH.

Expected SWH U.S. Market Trends	
Increased Commercial Systems	<ul style="list-style-type: none"> • Larger commercial projects are expected to increase over the coming years. • American Recovery and Reinvestment Act (ARRA) funds are likely to impact the industry only in the short term until funds are depleted. • The market will depend on available financing for projects.
Reduced Natural Gas (NG) Prices	<ul style="list-style-type: none"> • NG prices drive electricity prices. Current forecasts are not as high as several years ago as a result of shale gas. Lower NG prices may not increase electricity prices as much as once expected. <ul style="list-style-type: none"> – A carbon tax/cap and trade could lead to an increase in electricity prices.
Reduced SWH System Prices	<ul style="list-style-type: none"> • As the industry matures and manufacturing volume grows, prices are likely to decline. • Streamlining installation costs and time is expected as installers gain more experience. <ul style="list-style-type: none"> – Innovative components and preassembly will also reduce cost.
Stricter Incentive Reporting Requirements	<ul style="list-style-type: none"> • More states may adopt strict incentive reporting requirements, similar to HI and CA, which may hinder market adoption by installers. <ul style="list-style-type: none"> – But, this will result in higher quality and better design installations.

Milwaukee provides significant resources to its manufacturers.

Milwaukee's Area Strengths	
Existing manufacturing and engineering base	Milwaukee's manufacturing employs 16% of areas workforce, the third highest percent of manufacturing employees in the country.
Skilled manufacturing workforce	Milwaukee is a leader in the production of medical electronics, mining machinery, power trains, forgings, and internal combustion engines.
University engineering programs	Marquette University, Milwaukee School of Engineering ,and University of Wisconsin Milwaukee are just three of the engineering schools in the Milwaukee area.
Abundant high-quality water supply	Located on the coast of Lake Michigan, Milwaukee has access to an abundance of usable water.
Competitive electrical rates	Wisconsin's electrical rates for industrial and commercial sectors are below the national average.
Good transportation/distribution channels and facilities	Lake Michigan provides water transport in addition to the railways and highway infrastructure to supports Milwaukee's distribution.
Public/private enthusiasm and support for creating solar product	Many stakeholders within the state support solar development.
Milwaukee-area companies already involved in solar product supply chain	Examples include: A.O.Smith, Caleffi, Helios USA, Hot Water Products, and Johnson Controls
We Energies committed to developing solar generation	We Energies supports the development of renewable energy and supports their manufacturers. Workforce, development and incentive programs are available to the SHW industry.
Federal, state and city incentives	Wisconsin offers property tax exemption on SWH systems. Focus on Energy offers utility incentives for SWH property to eligible customers, Federal incentives include tax credits, depreciation and loan programs.

Navigant applied a well-proven, multi-step screening process to identify the components most suited for Milwaukee manufacturers.



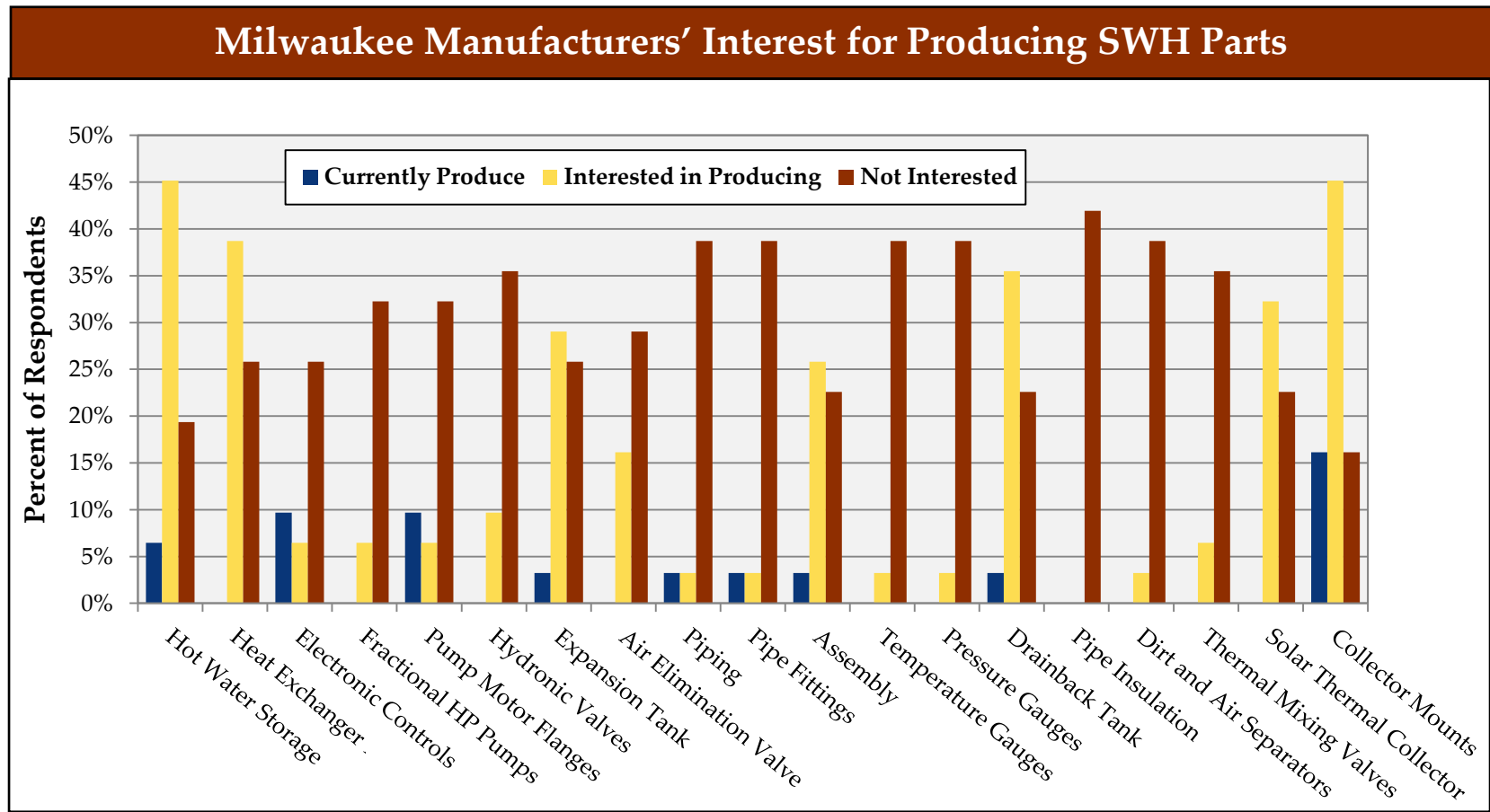
Milwaukee manufacturers have strong capabilities in machining, stamping, welding, and molding.

SWH Component	Machining	Stamping	Rolling	Turret Punch	Welding (TIG & MIG)	Laser Cutting	Casting	Pipe Bending	Sandblasting	Painting	Coating	Molding	Enamel Coating	Current Capabilities	
														High	
														Medium	
														Low	
SWH Water Storage Tank		X	X	X	X	X	X	X	X	X	X	X	X		
Heat Exchanger for potable water		X	X					X							
Electronic Controls												X			
Fractional Horsepower Pumps	X						X								
Pump Motor Flanges	X	X					X								
Hydronic Valves	X						X								
Expansion Tank		X													
Air Elimination Valve	X						X								
Piping			X												
Pipe Fittings		X													
Assembly – Pump Stations															
Temperature Gauges	X	X					X								
Pressure Gauges	X	X					X								
Drain back Tank		X	X	X	X	X	X	X	X	X	X	X	X		
Pipe Insulation															
Dirt and Air Separators	X	X					X								
Thermal Mixing Valves	X	X					X								
Solar Thermal Collector					X			X		X	X	X			
Solar Thermal Collector - Frame	X	X			X						X				
Collector Mounting system	X	X			X						X				

Current Capabilities	
High	
Medium	
Low	

X:
Manufacturing process or assembly needed for component

Milwaukee manufacturers are most interested in making subcomponents for hot water storage tanks and collector mounts.



Source: Survey conducted by Navigant Consulting in 2010.

Based on the Milwaukee area’s manufacturing capabilities & interest and the value-add ranking of the components, 7 components are worth considering for investment.

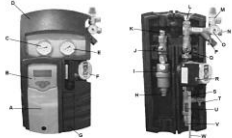

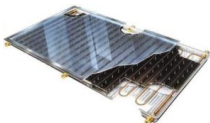

SWH Component	Capability	Interest	Value-Add
SWH Water Storage Tank	Medium	High	Medium
Heat Exchanger for Potable Water	High	High	Medium
Electronic Controls	Low	Low	High
Fractional Horsepower Pumps	Low	Low	Low
Pump Motor Flanges	Medium	Low	Low
Hydronic Valves	Low	Low	Low
Expansion Tank	High	Medium	Medium
Air Elimination Valve	Medium	Medium	Low
Piping	Medium	Low	Low
Pipe Fittings	Medium	Low	Low
Assembly – Pump Station	Medium	Medium	High
Temperature Gauges	Low	Low	Low
Pressure Gauges	Medium	Low	Low
Drain back Tank	Medium	High	Medium
Pipe Insulation	Low	Low	Low
Dirt and Air Separators	Medium	Low	Low
Thermal Mixing Valves	Medium	Low	Low
Solar Thermal Collector	Medium	High	Medium
Solar Thermal Collector Frame	High	High	High
Collector Mounting/Racking System	High	High	High



SWH Components
Assembly – Pump Station
Collector Mounting/Racking System
Solar Thermal Collector Frame
Expansion Tank
Heat Exchanger for Potable Water
Drain back Tank
SWH Water Storage Tank




The recommendations above are for the entire manufacturing base.
 Specific company recommendations will vary depending on interests and capabilities.

Below are components most suited to the Milwaukee manufacturers*.

Component	Picture	Comments
Assembly – Pump Station		<p>Pump stations are high value add components, as they reduce the installation costs of SWH systems which constitute nearly half of the total cost. The pump station is made up of manufactured parts and requires assembly, pipe brazing and a molded plastic case.</p>
Collector Mounting/ Racking System		<p>Collector racks are currently either made by the installer or collector manufacturer. A metal fabricating shop could easily produce collector racks using metal stamping and machining.</p>
Solar Thermal Collector Frame		<p>The collector frame is typically aluminum and serves to encase the absorbing pipes, glass and insulation. The frame could be made using sheet metal stamping.</p>
Expansion Tank		<p>Expansion tanks are another product currently made for the general water heating market. However, with the growing use of glycol, expansion tanks for the SWH industry must be manufactured with tougher inner bladders to resist deterioration due to the glycol. The tanks can be manufactured by stamping and assembly.</p>

*Based on value, capability and interest.

Milwaukee manufacturers are also suited to make subcomponents for tanks and heat exchangers.

Component	Picture	Comments
Specialty SWH Water Storage Tanks		<p>Although hot water storage tanks are currently made for the general water heating industry, some applications for the SWH industry may require tanks with two heat exchangers, one for the back up heater and one for the solar collectors. The major requirements for manufacturing are stamping, rolling, painting and assembly. However, coating techniques are a substantial barrier for entry.</p>
Drain-back Tank		<p>Drain-back tanks are used to drain the fluid out of the solar collectors when there is not enough sun to prevent freezing in cold weather. The tanks are specific to the SWH market. The major manufacturing requirements are stamping, rolling, machining, and painting.</p>
Heat Exchanger for Potable Water		<p>Heat exchangers are an important part of the SWH market and are required to be made out of stainless steel with the growing use of glycol. The plate exchangers can be manufactured using machining, stamping, rolling and welding, but are mostly used in double walled tanks that are mandated by building codes in certain areas.</p>

*Based on value, capability and interest.

Navigant believes the SWH market could be an attractive opportunity for Milwaukee manufacturers.




Navigant's Assessment of the SWH Opportunity for Milwaukee Manufacturers

- Milwaukee manufacturers have the capabilities to manufacture high quality components for the SWH industry.
- The size and highly fragmented nature of this emerging market presents opportunities for new players, but also risks.
- Navigant recommends Milwaukee manufacturers concentrate on producing high value components that customers are willing to pay a premium for such as components that are currently imported from Europe.
- In the past, Milwaukee manufacturers have focused on one customer. However, to be successful in the SWH market, Navigant recommends targeting multiple customers.
 - The SWH industry is more fragmented with smaller customers that could quickly exit and leave manufacturers with stranded assets.
- Local manufacturers could potentially capture about 2-5% of the total U.S. market share (\$10-20 million) in the short term.
- With increased market adoption and industry recognition, local manufacturers could potentially gain higher market shares of 5-10% in the medium to long term.

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix




SWH collectors provide water heating to residential, commercial and industrial customers.

Residential		<p>A portion or all of the water heating requirement for homes can be provided by solar thermal systems/SWH systems. SWH generally provides 50 – 70% with the remainder of the residence’s water heating needs met by an auxiliary heating system.</p>
Commercial		<p>Commercial buildings that have a large demand for water heating are the best candidates for SWH systems. The most common applications are in apartment buildings, nursing homes, hotels, hospitals, laundries, and restaurants.</p>
Industrial		<p>SWH can be integrated into some industrial processes. Some examples are meat processing, canned foods, and large-scale laundry.</p>

- Solar water heating systems are 5 times as efficient as PV systems
- 16% of US residential energy is used for hot water

Source: NREL

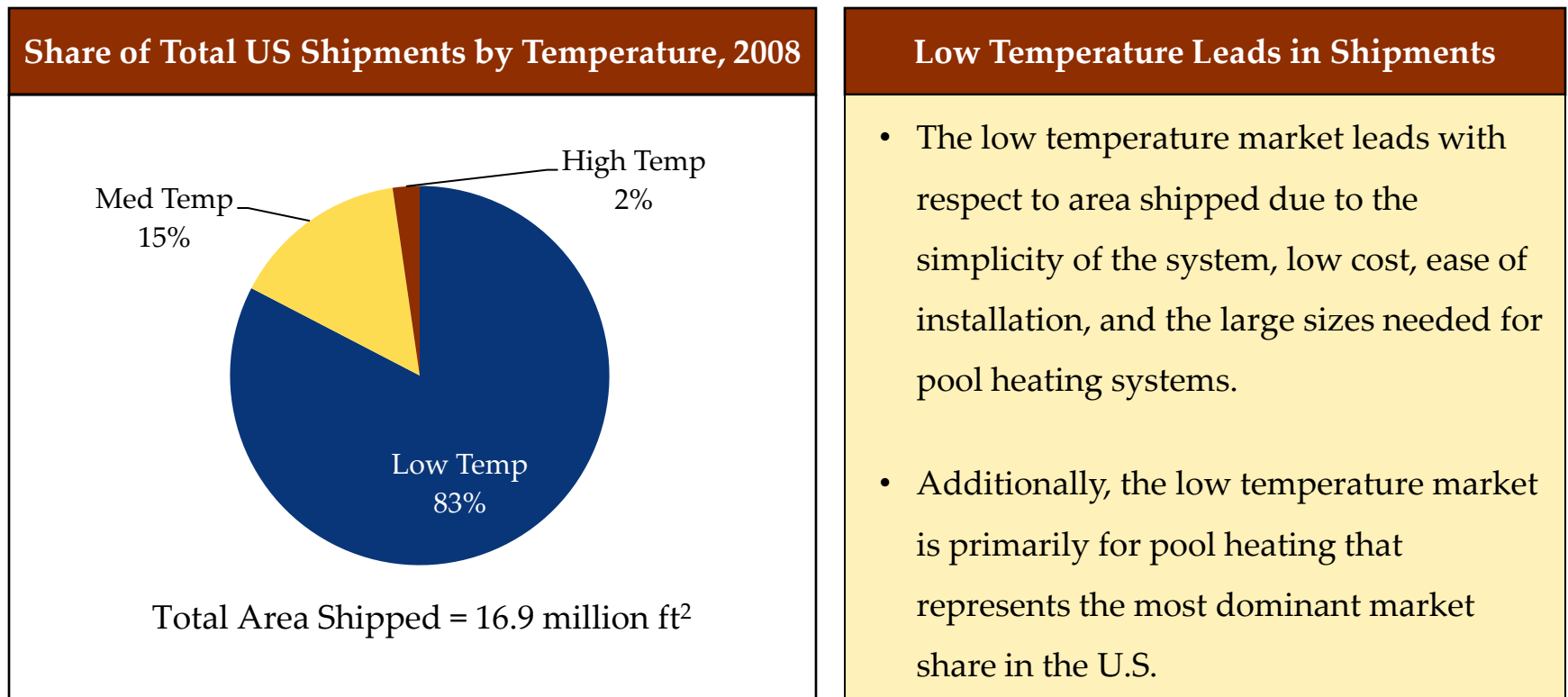
Collectors designed for solar water heating systems generally are either for low or medium temperature applications.

<p>Low Temperature (70 to 110° F)</p>		<p>Low temperature solar thermal collectors include an absorber material which is not covered by glass. A glass covering would prevent some heat loss and heat gains, but adds cost and rigidity. These “unglazed solar collectors” are most often associated with solar pool heating systems because of their low cost and the application’s modest temperature requirements.</p>
<p>Medium Temperature (110 to 180° F)</p>		<p>To obtain higher temperatures the absorber material is covered by glass to reduce heat losses. These “glazed collectors” are most commonly used to heat domestic water heating systems. Also included in this category are evacuated tube collectors and concentrating (focusing) collectors.</p>
<p>High Temperature (> 180° F)</p>		<p>High temperature solar thermal electric technologies concentrate large amounts of sunlight onto a smaller area to achieve high temperatures, which are then converted to electricity by various means, including conventional steam-cycle technology. Parabolic dish and trough collectors are the main type of high temperature collector.</p>

Note: High temperature CSP systems are used in area that receive direct sunlight radiation such as deserts. Attractive areas are in the U.S include AZ, NV, and southern CA. This technology will not work in the Wisconsin due to low direct sunlight conditions.




Source: NREL

Most of the U.S. market is dominated by low temperature systems due to low cost, simplicity, and solar resource quality.



Source: Energy Information Administration (EIA)

There are three types of collectors used in SWH applications: flat-plate, evacuated-tube, and concentrating collectors.

<p>Flat Plate Collector (70 to 110° F)</p>		<p>A flat-plate collector contains a dark absorber inside an insulated, weatherproofed box, under a transparent or translucent cover. The cover, or glazing, is used to minimize the amount of heat escaping, while still allowing sufficient sunlight to pass through and reach the absorber. This is the most prevalent type of solar thermal collector for water heating systems in the U.S.</p>
<p>Evacuated Tube Collector (110 to 180° F)</p>		<p>An evacuated-tube collector is made up of rows of parallel, transparent glass tubes. There are many different configurations used in ET design, but generally each tube consists of a glass outer tube with an absorber inside of the tube. Some models have a second, inner glass tube. A vacuum within, or between, the tubes inhibits heat loss, making this type of solar thermal collector less-restricted by ambient temperatures</p>
<p>Concentrating Collector (> 180° F)</p>		<p>A concentrating collector for residential applications utilizes a mirrored parabolic surface to concentrate the sun's energy on an absorber tube (called a receiver) containing a heat transfer fluid.</p>

Source: Homepower, NREL

There are three key benefits of SWH: reduced traditional energy consumption, reduced emissions, and lifecycle cost savings.

SWH Benefits	
Reduced traditional energy consumption	Reduced traditional energy consumption: The energy used by conventional water heating methods – electric, natural gas, or oil heat – is reduced by using a solar thermal system. For appropriately sized solar thermal collectors, a residential homeowner can expect to reduce their energy consumption by as much as two-thirds.
Reduced emissions	Reduced emissions: The conversion of solar energy to thermal energy does not produce emissions. By installing a SWH system, a customer avoids emitting carbon dioxide, nitrogen oxides, sulfur dioxide, and other air pollutants that are generated by traditional sources of energy.
Cost savings	Cost savings: Over the life of the SWH system, the customer will see a cost savings compared to conventional water heating systems because the fuel is free. In addition, solar energy can be used as a hedge against traditional sources of energy, which are subject to price fluctuations.

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis <ul style="list-style-type: none">Milwaukee AreaSWH ManufacturingMilwaukee Capabilities
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

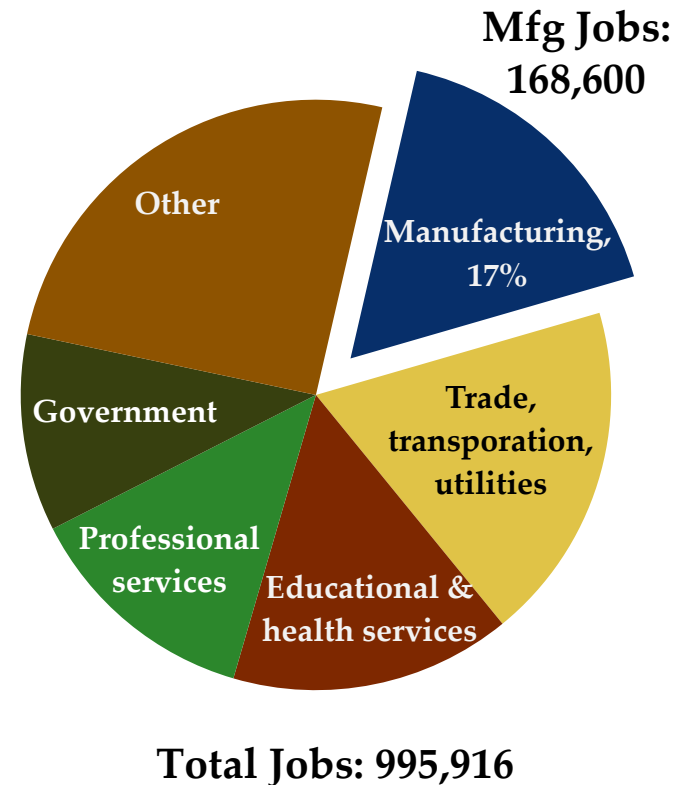
Milwaukee provides significant resources to its manufacturers.

Milwaukee's Area Strengths	
Existing manufacturing and engineering base	Milwaukee's manufacturing employs 16% of areas workforce, the third highest percent of manufacturing employees in the country.
Skilled manufacturing workforce	Milwaukee is a leader in the production of medical electronics, mining machinery, power trains, forgings, and internal combustion engines.
University engineering programs	Marquette University, Milwaukee School of Engineering ,and University of Wisconsin Milwaukee are just three of the engineering schools in the Milwaukee area.
Abundant high-quality water supply	Located on the coast of Lake Michigan, Milwaukee has access to an abundance of usable water.
Competitive electrical rates	Wisconsin's electrical rates for industrial and commercial sectors are below the national average.
Good transportation/distribution channels and facilities	Lake Michigan provides water transport in addition to the railways and highway infrastructure to supports Milwaukee's distribution.
Public/private enthusiasm and support for creating solar product	Many stakeholders within the state support solar development.
Milwaukee-area companies already involved in solar product supply chain	Examples include: A.O.Smith, Caleffi, Helios USA, Hot Water Products, and Johnson Controls
We Energies committed to developing solar generation	We Energies supports the development of renewable energy and supports their manufacturers. Workforce, development and incentive programs are available to the SHW industry.
Federal, state and city incentives	Wisconsin offers property tax exemption on SWH systems. Focus on Energy offers utility incentives for SWH property to eligible customers, Federal incentives include tax credits, depreciation and loan programs.

Milwaukee has a very strong manufacturing and engineering base.

Manufacturing Industry's Share of Milwaukee Area Employees, 2007

- Nearly 17% percent of the region's workforce is employed in manufacturing, ranking second in the nation among the *top 50 metros* for manufacturing jobs.
- 11 locally based manufacturers are on the Fortune 1000 list – **A.O. Smith, Briggs & Stratton, Bucyrus International, Harley-Davidson, Johnson Controls, Diversey, Joy Global, Modine Manufacturing, Rexnord, Rockwell Automation and Snap-On.**
- There hundreds of small/medium size machine shops, foundries, and “metal benders” that are represent the manufacturing capabilities of Milwaukee and it's manufacturing heritage.



Source: Choose Milwaukee

Milwaukee has a highly skilled manufacturing workforce.

Milwaukee is Recognized for its Skilled Manufacturing Workforce

- The region is especially noted for engine and equipment manufacturing, automation and advanced manufacturing and medical technology.
- The Wisconsin Manufacturing Extension Partnership (WMEP) enhances the success of Wisconsin's small to mid-size manufacturers by providing real-world knowledge in continuous improvement, business strategies and best practices.
- MEP is also a strong advocate of manufacturing and provides information to those focused on the success of Wisconsin manufacturing.

Company	# of Global Employees	Products
A.O.Smith	16,800	Electric motors; commercial and residential water heating equipment; and copper-tube boilers
Briggs & Stratton	8,000	Air-cooled engines
Bucyrus International	7,200	Mining equipment and services
Harley-Davidson	9,800	Motorcycles and accessories
Johnson Controls	136,000	Automotive seating, batteries and industrial controls
JohnsonDiversey	11,500	Commercial cleaning, sanitation and hygiene solutions
Joy Global	9,200	Mining equipment and services
Modine Manufacturing	7,900	Thermal management technology
Rexnord	7,100	Industrial equipment and components
Rockwell Automation	20,000	Industrial controls and software
S.C. Johnson	12,000	Household products
Snap-On	11,600	Tool, diagnostic and equipment products

Source: Choose Milwaukee

Milwaukee’s technical and engineering universities support its manufacturing base.

Colleges/Universities	Research and Technology Centers	Center Sponsor
<ul style="list-style-type: none"> The region's technical colleges and universities provide training and research support to local manufacturers. Applied technology centers are used by manufacturers to test their designs and create prototypes. Local technology transfer programs support and assist companies turn ideas into marketable products. 	Applied Technology Center	Milwaukee School of Engineering
	Center for Biomelecular Modeling	Milwaukee School of Engineering
	Center for By Products Utilization	University of Wisconsin-Milwaukee
	Center for Intelligent Systems, Controls and Signal Processing	Marquette University
	Center for Materials Science and Technology	Marquette University
	Center for Supply Chain Management	Marquette University
	Engineering Research Center for Compact and Efficient Fluid Power	Milwaukee School of Engineering
	Fluid Power Institute	Milwaukee School of Engineering
	Nano Engineering Laboratory	Milwaukee School of Engineering
	Photonics and Applied Optics Center	Milwaukee School of Engineering
	Rapid Prototyping Center	Milwaukee School of Engineering
	Thermofluid Science and Energy Research Center	Marquette University

Source: Choose Milwaukee

Milwaukee has an abundant high quality water supply.

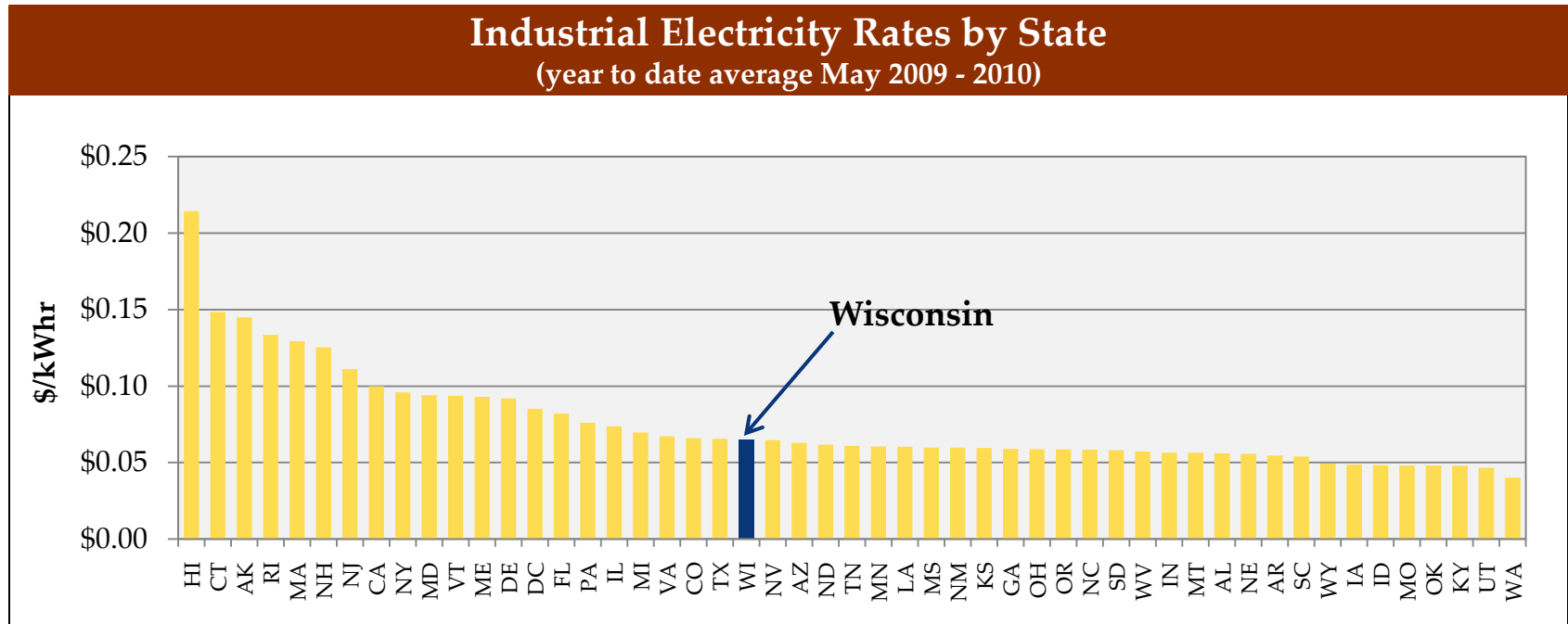
Milwaukee is located on coast of Lake Michigan

- The Milwaukee Region lies on the shores of the greatest single source of fresh water on the planet, the Great Lakes.
- The Milwaukee Region's water industry is a \$10.5 billion market, supporting 20,000 jobs and accounting for 4% of the total world water business.
- In 2009, Milwaukee joined an elite list of only 14 cities worldwide that have gained admission into the [United Nations Global Compact Cities Programme](#). With this designation, Milwaukee achieves international recognition for the area's expertise and global leadership in fresh water technology and science.



Source: Choose Milwaukee

Despite Wisconsin's average industrial electricity rates, Milwaukee has still been able to become a large manufacturing city.



Source: Energy Information Administration

Milwaukee's commercial and industrial electrical are below the national average and are at the mid-point in the group of comparable metro areas

Milwaukee has a strong infrastructure to support its manufacturing facilities. Local manufacturers serve markets throughout the U.S.

Milwaukee offers access multiple types of transportation	
Roads	Two interstates – I-94 and I-43 – intersect the region, and a third interstate – I-90 – passes nearby.
Air	The General Mitchell International Airport moved 9,967,129 lbs of cargo per 100,000 residents in the Milwaukee metro area.
Rail	Freight service is provided through the <u>Canadian Pacific Railway</u> , <u>Canadian National Railway</u> , <u>Union Pacific Railroad</u> and the <u>Wisconsin & Southern Railroad Company</u> .
Water	The <u>Port of Milwaukee</u> handles more than three million tons of cargo per year, serving both domestic and international locations through the Great Lakes, the St. Lawrence Seaway and the Gulf of Mexico, via the inland waterway system. Its 16 berths can accommodate vessels up to 1,000 feet long.

Source: Choose Milwaukee

- 25% percent of the nation's population is within 600 miles of the Milwaukee Region, which offers easy access to all major forms of transportation.
- Milwaukee manufacturers serve markets throughout the US. Shipping related issues and costs do not prevent local manufacturers from being competitive.

There is strong support for the SWH industry, both from the public as well as companies such as We Energies.

Milwaukee Shines

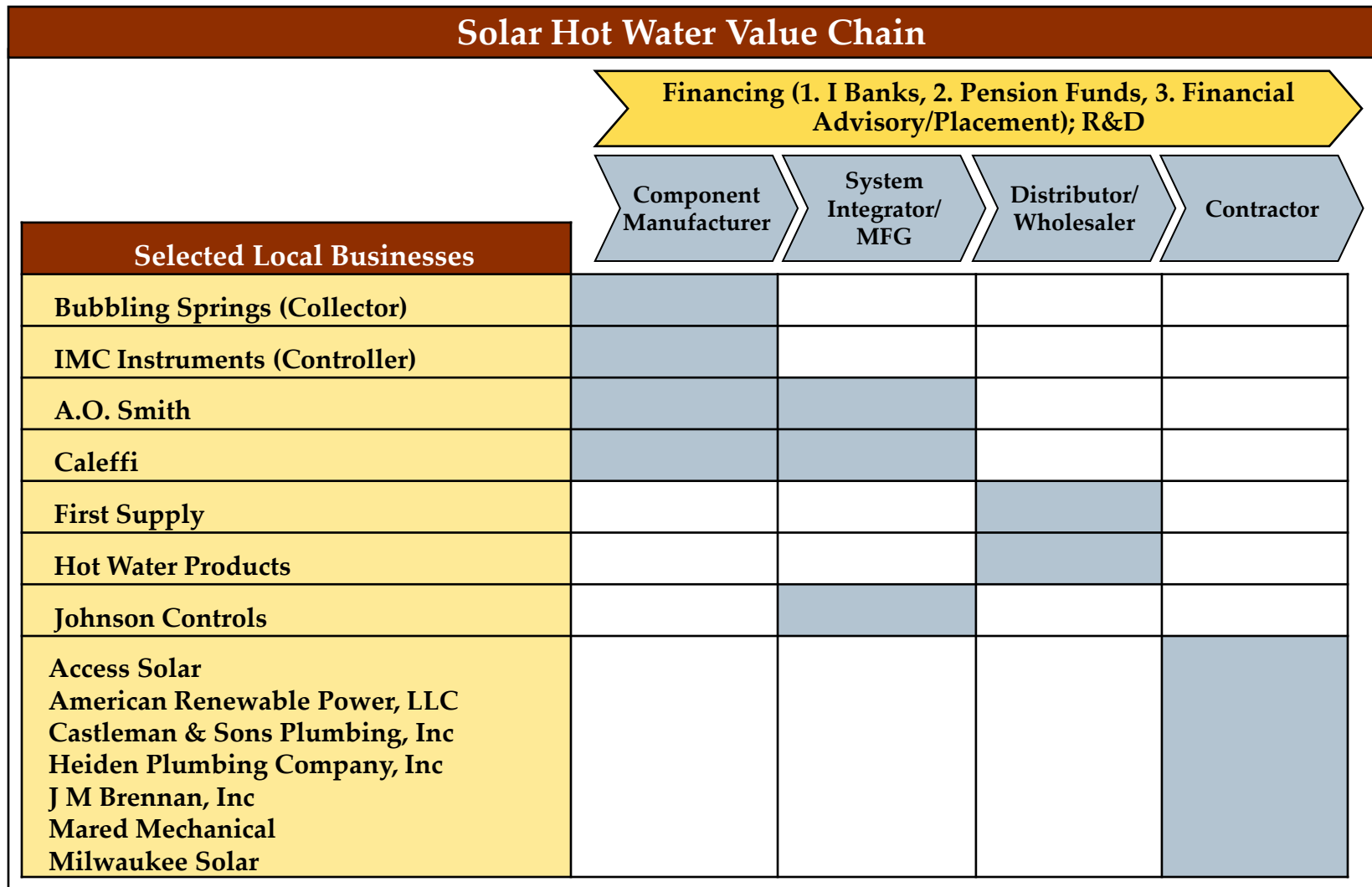
- The Milwaukee Shines organization has organized and helped fund previous studies to determine the opportunities within the SWH manufacturing industry
- The Solar Hot Water Business Council was formed to help the numerous manufacturing companies in the Milwaukee Area to tap into the growing solar hot water market.
- Current members include: Johnson Controls, Caleffi, A.O. Smith, Hot Water Products, American Renewable Power, UWM, Res
- Manufacturing and many others

We Energies

- We Energies is offering a 30%-100% match of the determined reward from Focus on Energy.
- We Energies is using the incentive to demonstrate to customers the benefits of solar water-heating energy systems as well as gain knowledge about the technical and economics aspects of a system installation.

Source: We Energies, Milwaukee Shines

The Milwaukee area has several SWH companies.



Milwaukee benefits from state and local SWH incentives.

Summary of Key Incentives and Policies for Solar Hot Water						
County or Agency	Program	Program Features			Budget	Description Or Other Notes
		Customer Class	Incentive Type	Max Incentive		
State	Industry Recruitment Loan	C, I	Loan	25% of project costs		Loans at 2% interest rate for 5-10 years (equipment) or 5-7 years (working capital) - EXPIRED
State	Energy Independence Fund Program	C, I	Loan/Grant	Unspecified	\$150 M (over 10 years)	Grants: 50% cost-share required; Loans: 4% interest rate for up to 15 years, maximum of 25% of project cost
Utility	Focus on Energy Incentives	Served by participating utility	Rebate	25% of costs	\$8.2 MM (2010, all RE)	Performance-based incentive
We Energies	RE Cash-Back Rewards (CBR)	All	Rebate	30 - 100% Match of FOE CBR	% Rebate Depending on Customer Class	Match of Focus on Energy (FOE) Programs for NFP or 7.5% bonus for R, C, I customers.

Source: DSIRE Database: September 2010

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

The state also offers general business incentives to encourage new growth and workforce development.

Summary of Key State Business Incentives				
Program	Program Features		Budget	Description Or Other Notes
	Incentive Type	Max Incentive		
Community Development Block Grant	Loan	N/A	\$ 50+ M	The average local RLF loan is about \$75,000; "tailor-made" loans, which may include deferred payments and interest rates.
Industrial Revenue Bond (IRB) program	Bonds	\$ 10 M	\$200 M	Interest rates may be 1.5-2.5% below corporate bond rates & payment term is negotiable.
Early Planning Grant (EPG) program	Grant	\$3,000	N/A	The program typically provides grants for 75% of eligible project costs up to \$3,000, there are limited funds available.
Economic Development Tax Credit	Tax Credit	N/A	N/A	Tax credits vary for businesses with the following eligible activities: job creation, capital investment, employee training, & corporate HQ location.
Green to Gold Fund	Loan	N/A	\$100 M	Revolving loan fund to help manufacturers move into clean energy production or improve their energy efficiency.

Source: State of Wisconsin: http://www.wisconsin.gov/state/core/wisconsin_business_incentives.html

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis <ul style="list-style-type: none">Milwaukee AreaSWH ManufacturingMilwaukee Capabilities
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

Machining, stamping and casting are the most common tools needed to make SWH components.

SWH Component	Machining	Stamping	Rolling	Turret Punch	Welding (TIG & MIG)	Laser Cutting	Casting	Pipe Bending	Sandblasting	Painting	Coating	Molding	Enamel Coating
SWH Water Storage Tank		X	X	X	X	X	X	X	X	X	X	X	X
Heat Exchanger for potable water		X	X					X					
Electronic Controls												X	
Fractional Horsepower Pumps	X						X						
Pump Motor Flanges	X	X					X						
Hydronic Valves	X						X						
Expansion Tank		X											
Air Elimination Valve	X						X						
Piping			X										
Pipe Fittings		X											
Assembly – Pump Stations													
Temperature Gauges	X	X					X						
Pressure Gauges	X	X					X						
Drain back Tank		X	X	X	X	X	X	X	X	X	X	X	X
Pipe Insulation													
Dirt and Air Separators	X	X					X						
Thermal Mixing Valves	X	X					X						
Solar Thermal Collector					X			X		X	X	X	

Source: NCI Analysis

**SWH manufacturing jobs are similar to most manufacturing jobs.
There are no exotic processes or materials required.**

SWH Labor Requirements	
Manufacturing	Sheet Metal Worker
	Technician
	Material handler
	Factory Supervisor
	MFG Engineer
	MFG Manager
Design	Material Science
	Mechanical Engineer
Admin/Support	Purchasing
	Quality Assurance
	Health and Safety
	Accounting
	Assistant
	IT Professional

**Raw material required for SWH components are:
Copper, Aluminum, Steel, Glass**

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis <ul style="list-style-type: none">Milwaukee AreaSWH ManufacturingMilwaukee Capabilities
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

Navigant conducted a survey of local Milwaukee manufactures to gain insight into their capabilities and threshold for re-tooling.

	Criteria	Average	Comments
Facility	Current Operating Capacity	50-75%	The majority of the companies that were interviewed were operating in the 50-75% range
	Facility Size (sq ft)	60,000	The average facility size was on the order of 60,000 square feet but ranged from 8,000 to 320,000 sq ft
	Design Capability		Most manufacturing facilities only have design for manufacture capability and do not have a significant in house design team
	Employees	90	The average number of employees was 90, however most of the companies were on the smaller side with around 25 employees.
Interest	General Interest in Manufacturing for the SWH Industry	High	The manufacturing companies we talked to generally were willing to make any type of product, including SWH parts as long as they had the capabilities and it was profitable
Criteria	Important Criteria for Retooling		The important criteria for re-tooling were generally, profit margin, production volume and sustainability. Although this depended on the type of company, for example manufacturers with short term contracts or “job shops” were less worried about production volume and sustainability.

Volume and profit margin are the most important criteria for a manufacturer when considering retooling.

Criteria	Average Ranking (1-5)	Comments
Potential production volume	4	More important to the larger contract manufacturers
Sustainability of the market	4	The sustainability of the market and the client is important as the manufacturers would like the clients to be able to pay.
Profit margin	4	Very Important
Capital required to retool	3	The capital required to retool was more important to the contract manufacturers as they could not as easily pass on the retooling cost
Level of foreign competition	2	This was of low concern, as most manufacturers were hired by clients and did not manufacture products of their own
Detailed market knowledge	2	Not important to manufacturers
Complexity of product	2	Not important,: either have or do not have the capability to produce a product, complexity is reflected in cost.
Location of the market	1	Not important to manufacturers

Ranking: 1 = less important → 5 = more important

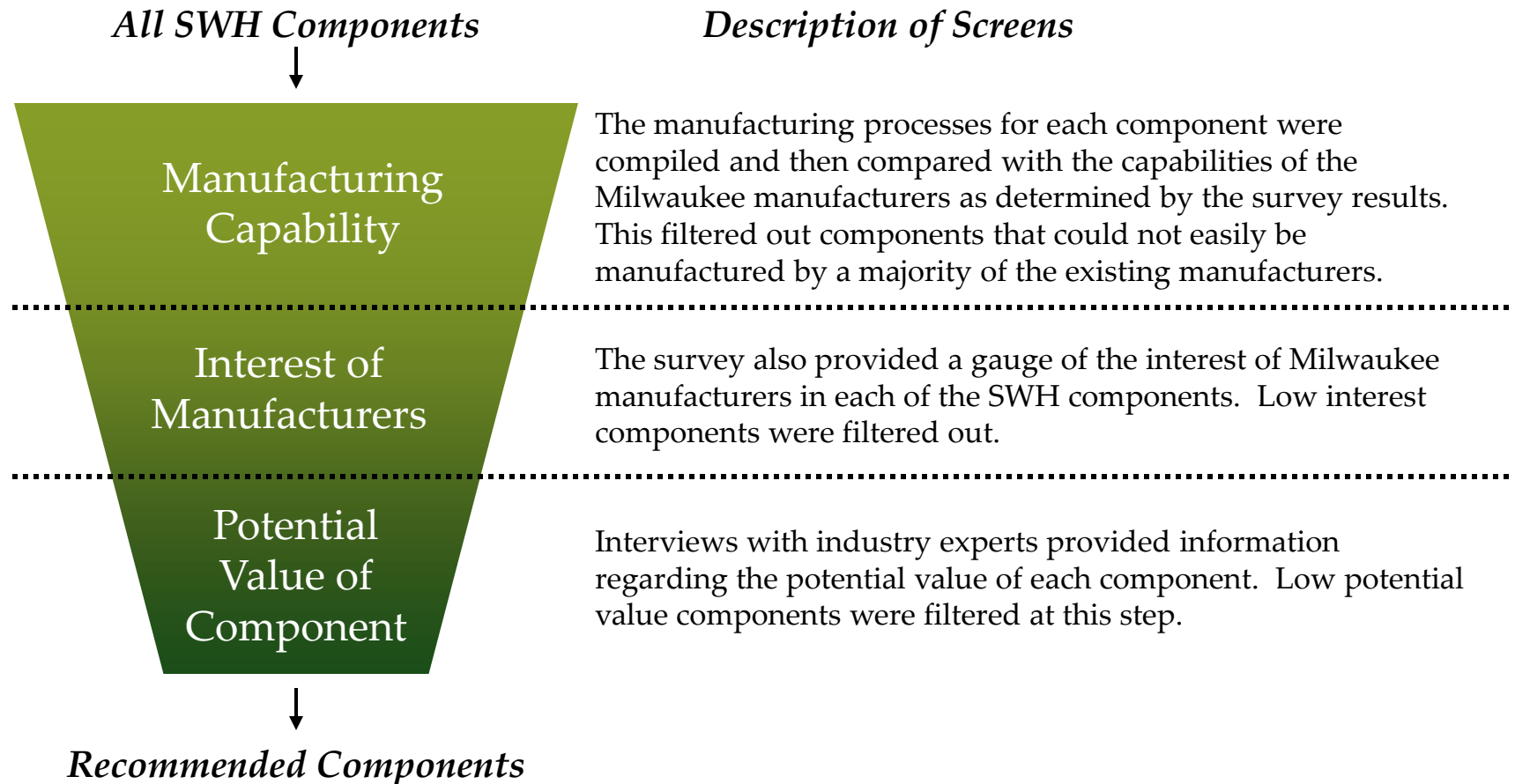
Company	Criteria	Comments
Sales volume for new market entry	Number of Products	Since most of the manufacturers interviewed were “job shops” the threshold for production was very low on the order of 10, however this would be reflected in high costs per part
	Annual Revenue	The average annual revenue was approximately \$1 million with most of the manufacturers just under this value

Milwaukee manufacturers currently have or plan to have capabilities to produce most components for the SWH industry.

Milwaukee Manufacturers Capabilities						
Process	Steel	Brass	Copper	Stainless Steel	Iron	Plastic
Machining	High	High	High	High	High	High
Stamping	High	High	High	High	High	High
Rolling	High	High	High	High	Medium	Low
Turret Punching	High	High	High	High	Medium	High
Welding (TIG & MIG)	High	High	High	High	Medium	Medium
Laser Cutting	High	High	High	High	Medium	Medium
Casting	Low	Low	Low	Low	Medium	Medium
Pipe Bending	High	High	High	High	Medium	Low
Sandblasting	High	High	High	High	High	Medium
Painting	High	High	High	High	Medium	Medium
Coating	High	Medium	Medium	Medium	Medium	Low
Molding	Low	Low	Low	Low	Low	High
Enamel Coating	Medium	Medium	Medium	Medium	Medium	Low

Current Capabilities	High	High
	Medium	Medium
	Low	Low
Next 1-3 Years		Low
No Current or Near-term		Low

Navigant applied a well-proven, multi-step screening process to identify the components most suited for Milwaukee manufacturers.



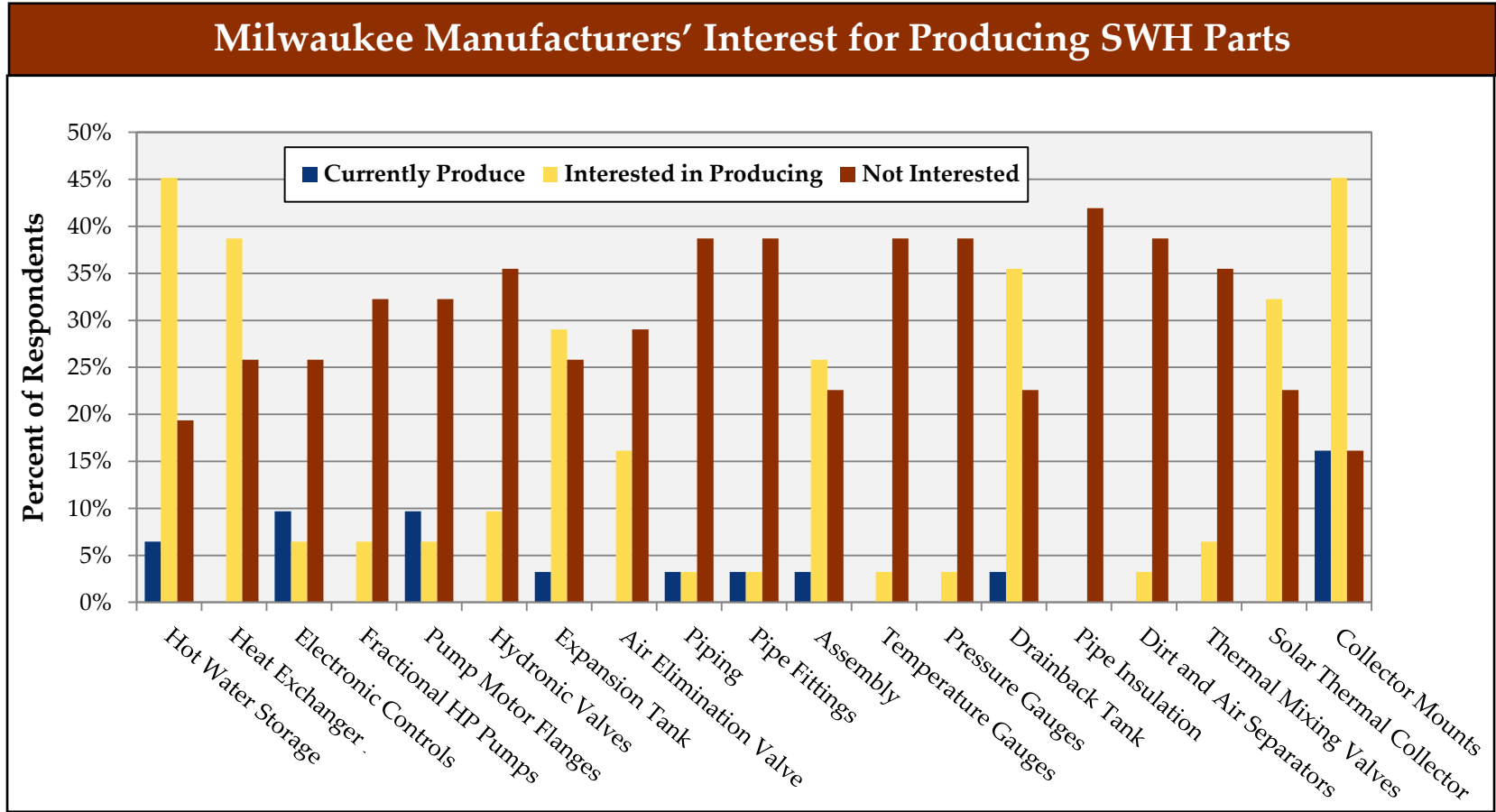
Milwaukee manufacturers have strong capabilities in machining, stamping, welding, and molding.

SWH Component	Machining	Stamping	Rolling	Turret Punch	Welding (TIG & MIG)	Laser Cutting	Casting	Pipe Bending	Sandblasting	Painting	Coating	Molding	Enamel Coating	Current Milwaukee Area Capabilities	
														High	Medium
SWH Water Storage Tank		X	X	X	X	X	X	X	X	X	X	X	X		
Heat Exchanger for potable water		X	X					X							
Electronic Controls												X			
Fractional Horsepower Pumps	X						X								
Pump Motor Flanges	X	X					X								
Hydronic Valves	X						X								
Expansion Tank		X													
Air Elimination Valve	X						X								
Piping			X												
Pipe Fittings		X													
Assembly – Pump Stations															
Temperature Gauges	X	X					X								
Pressure Gauges	X	X					X								
Drain back Tank		X	X	X	X	X	X	X	X	X	X	X	X		
Pipe Insulation															
Dirt and Air Separators	X	X					X								
Thermal Mixing Valves	X	X					X								
Solar Thermal Collector					X			X		X	X	X			
Solar Thermal Collector - Frame	X	X			X						X				
Collector Mounting system	X	X			X						X				

Current Milwaukee Area Capabilities	
High	
Medium	
Low	



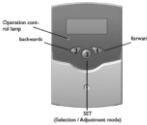


X: Manufacturing process or assembly needed for component

Milwaukee manufacturers are most interested in producing hot water storage tanks and collector mounts for the SWH industry.








Source: Survey conducted by NCI in 2010.

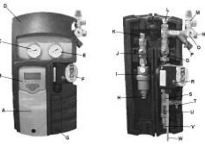



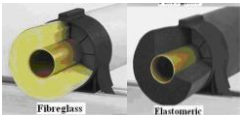
SWH systems share many components with conventional water heating systems. Highest value components are specific for SWH use.

Component	Picture	Details	Value-Add
Specialty SWH Water Storage Tank		<ul style="list-style-type: none"> • Manufacturing requires several tools • Currently made for the general hot water market – some SWH application may require dual heat exchangers • Advanced designs used in the EU market are likely to enter the US market 	Medium
Heat Exchanger for Potable Water		<ul style="list-style-type: none"> • Currently made for several industries, including the dairy and auto industries. • These could be adapted for the SWH market 	Medium
Electronic Controls / Monitoring		<ul style="list-style-type: none"> • Simple PCB (plastic) with a molded plastic shell 	High
Fractional Horsepower Pumps		<ul style="list-style-type: none"> • Requires a significant amount of intellectual property (IP) and manufacturing experience • Already manufactured for general hot water market 	Low
Pump Motor Flanges		<ul style="list-style-type: none"> • Simple design and manufacture • Currently made for the general hot water industry 	Low




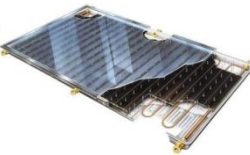

Continued...

Component	Picture	Details	Value-Add
Hydronic Valves	 <p>Shut-off valves</p>	Currently made on a large scale for the general hot water industry	Low
Expansion Tank		Currently made on a large scale for the general hot water industry, however bladders need to be made more durable for SWH industry	Medium
Air Elimination Valve		Currently made on a large scale for the general hot water industry	Low
Piping		Currently made on a large scale for the general plumbing industry	Low
Pipe Fittings		Currently made on a large scale for the general plumbing industry	Low

Continued...

Component	Picture	Details	Value-Add
<p>Assembly – Pump Stations</p>		<ul style="list-style-type: none"> • Requires brazing, plastic molding and assembly • Pre-packaged systems will help to lower the installation cost of SWH systems 	<p>High</p>
<p>Temperature Gauges</p>		<p>Currently made on a large scale for the general hot water industry</p>	<p>Low</p>
<p>Pressure Gauges</p>		<p>Currently made on a large scale for the general hot water industry</p>	<p>Low</p>
<p>Drain Back Tank</p>		<p>Made for the solar water heating market</p>	<p>Medium</p>
<p>Insulation</p>		<p>Currently made on a large scale for the general hot water industry</p>	<p>Low</p>

Continued...

Component	Picture	Details	Value-Add
Dirt and Air Separators		Currently made on a large scale for the general hot water industry	Low
Thermal Mixing Valves		Currently made on a large scale for the general hot water industry	Low
Solar Thermal Collector		Unique to the SWH industry	Medium
Collector Frame		<ul style="list-style-type: none"> • Simple design and manufacture • Made by the collector manufacturer 	High
Collector Mounts/Racks		<ul style="list-style-type: none"> • Simple design and manufacture. • Some designs are made custom by large installers or made by the collector manufacturer 	High

Based on the Milwaukee area’s manufacturing capabilities & interest and the value-add ranking of the components, 7 components are worth considering for investment.

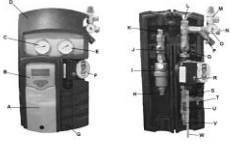

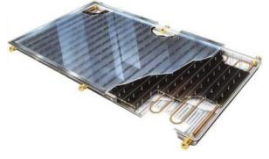

SWH Component	Capability	Interest	Value-Add
SWH Water Storage Tank	Medium	High	Medium
Heat Exchanger for Potable Water	High	High	Medium
Electronic Controls	Low	Low	High
Fractional Horsepower Pumps	Low	Low	Low
Pump Motor Flanges	Medium	Low	Low
Hydronic Valves	Low	Low	Low
Expansion Tank	High	Medium	Medium
Air Elimination Valve	Medium	Medium	Low
Piping	Medium	Low	Low
Pipe Fittings	Medium	Low	Low
Assembly – Pump Station	Medium	Medium	High
Temperature Gauges	Low	Low	Low
Pressure Gauges	Medium	Low	Low
Drain back Tank	Medium	High	Medium
Pipe Insulation	Low	Low	Low
Dirt and Air Separators	Medium	Low	Low
Thermal Mixing Valves	Medium	Low	Low
Solar Thermal Collector	Medium	High	Medium
Solar Thermal Collector Frame	High	High	High
Collector Mounting/Racking System	High	High	High



SWH Components
Assembly – Pump Station
Collector Mounting/Racking System
Solar Thermal Collector Frame
Expansion Tank
Heat Exchanger for Potable Water
Drain back Tank
SWH Water Storage Tank




The recommendations above are for the entire manufacturing base.
 Specific company recommendations will vary depending on interests and capabilities.

Below are components most suited to the Milwaukee manufacturers*.

	Component	Picture	Comments
Teir 1	Assembly – Pump Station		Pump stations are high value add components, as they reduce the installation costs of SWH systems which constitute nearly half of the total cost. The pump station is made up of manufactured parts and requires assembly, pipe brazing and a molded plastic case.
	Collector Mounting/ Racking System		Collector racks are currently made by the collector manufacturer. A metal fabricating shop could easily produce collector racks using metal stamping and machining.
	Solar Thermal Collector Frame		The collector frame is typically aluminum and serves to encase the absorbing pipes, glass and insulation. The frame could be made using sheet metal stamping.
	Expansion Tank		Expansion tanks are another product that is currently made for the general water heating market, however with the growing use of glycol, expansion tanks for the SWH industry must be manufactured with tougher inner bladders to resist deterioration due to the glycol. The tanks can be manufactured by stamping and assembly.

*Based on value, capability and interest.

Milwaukee manufacturers are also suited to make subcomponents for tanks and heat exchangers manufacturers.

	Component	Picture	Comments
Teir 2	Specialty SWH Water Storage Tanks		Although hot water storage tanks are currently made for the general water heating industry, some applications for the SWH industry may require tanks with two heat exchangers, one for the back up heater and one for the solar collectors. The major requirements for manufacturing are stamping, rolling, painting and assembly. However, coating techniques are a substantial barrier for entry
	Drain-back Tank		Drain-back tanks are used to drain the fluid out of the solar collectors when there is not enough sun to prevent freezing in cold weather. The tanks are specific to the SWH market. The major manufacturing requirements are stamping, rolling, machining, and painting.
	Heat Exchanger for Potable Water		Heat exchangers are an important part of the SWH market and are required to be made out of stainless steel with the growing use of glycol. The plate exchangers can be manufactured using machining, stamping, rolling and welding but are mostly used in double walled tanks that are mandated by building code in certain areas.

*Based on value, capability and interest.

Navigant believes the SWH market could be an attractive opportunity for Milwaukee manufacturers.

Navigant's Assessment of the SWH Opportunity for Milwaukee Manufacturers

- Milwaukee manufacturers have the capabilities to manufacture high quality components for the SWH industry.
- The size and highly fragmented nature of this emerging market presents opportunities for new players, but also risks.
- Navigant recommends Milwaukee manufacturers concentrate on producing high value components that customers are willing to pay a premium for; such as components that are currently imported from Europe.
- In the past, Milwaukee manufacturers have focused on one customer. However, to be successful in the SWH market, Navigant recommends targeting multiple customers.
 - The SWH industry is more fragmented with smaller customers that could quickly exit and leave manufacturers with stranded assets.
- Local manufacturers could potentially capture about 2-5% of the total U.S. market share (\$10 -20 million) in the short term.
- With increased market adoption and industry recognition local manufacturers could gain higher market shares of 5-10% in the medium to long term.

Table of Contents

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

Navigant was asked to include a local/regional re-tooling case study as part of its study.

Scope

- Identify a local or regional company, if one exists, that has overcome barriers and successfully entered the SWH industry.
- Discuss the decision making process, steps to re-tool/reinvest and market success.
- Present best-practices and lessons learned for other companies considering a similar investment decision.

Approach

- Navigant worked with the City of Milwaukee to identify a local/regional company that fits the scope's definition; however, no such company could be identified.
- Per the City's request, Navigant selected a local company that is currently evaluating such a decision to re-tool, but has not fully committed yet.
- Navigant interviewed the candidate company, RES Manufacturing, and documented the key questions and answers the company is currently facing.

***Res Manufacturing* is a metal stamping manufacturer in the process of determining whether or not to enter the SWH component space.**

RES Manufacturing Company Background

- Metal stamping manufacturer founded in 1907
- Privately held organization owned by DLSM, Inc.
- Currently have about 75 employees
- Specializing in:
 - Progressive die stamping
 - Design assistance
 - Tool build
 - Prototypes
 - Heat treating, welding, tapping & machining, finished coating
 - Automated assembly

Current Situation

- Res has performed well in the past few years despite the recession.
- Currently, >80% of its business is based on automotive work; **Res wants to move towards a higher non-automotive mix.**
- Res is in the process of determining if the SWH market offers a strategic fit for their company.



Res's current capability and near-term interest in new capabilities is concentrated on stamping, welding, and machining processes.

Process	Steel	Brass	Copper	Stainless Steel	Iron	Plastic
Machining	Green	Green	Green	Green	Light Blue	Light Blue
Stamping	Green	Green	Green	Green	Light Blue	Light Blue
Rolling	Yellow	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Turret Punching	Yellow	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Welding (TIG & MIG)	Green	Yellow	Yellow	Yellow	Light Blue	Light Blue
Laser Cutting	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Casting	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Pipe Bending	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Sandblasting	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Painting	Green	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Coating	Green	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Molding	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Yellow
Enamel Coating	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue

Current Capabilities	Green
Near-term Interest	Yellow
No Capability/Interest	Light Blue


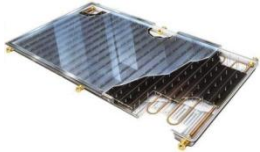

Based on Res’s process capabilities alone, 5 SWH components appear to be current or near-term opportunities.

SWH Component	Machining	Stamping	Rolling	Turret Punch	Welding (TIG & MIG)	Laser Cutting	Casting	Pipe Bending	Sandblasting	Painting	Coating	Molding	Enamel Coating
SWH Water Storage Tank		X	X	X	X	X	X	X	X	X	X	X	X
Heat Exchanger for potable water		X	X					X					
Electronic Controls												X	
Fractional Horsepower Pumps	X						X						
Pump Motor Flanges	X	X					X						
Hydronic Valves	X						X						
Expansion Tank		X											
Air Elimination Valve	X						X						
Piping			X										
Pipe Fittings		X											
Assembly – Pump Stations													
Temperature Gauges	X	X					X						
Pressure Gauges	X	X					X						
Drain back Tank		X	X	X	X	X	X	X	X	X	X	X	X
Pipe Insulation													
Dirt and Air Separators	X	X					X						
Thermal Mixing Valves	X	X					X						
Solar Thermal Collector					X			X		X	X	X	
Solar Thermal Collector - Frame	X	X			X						X		
Collector Mounting system/rack	X	X			X						X		

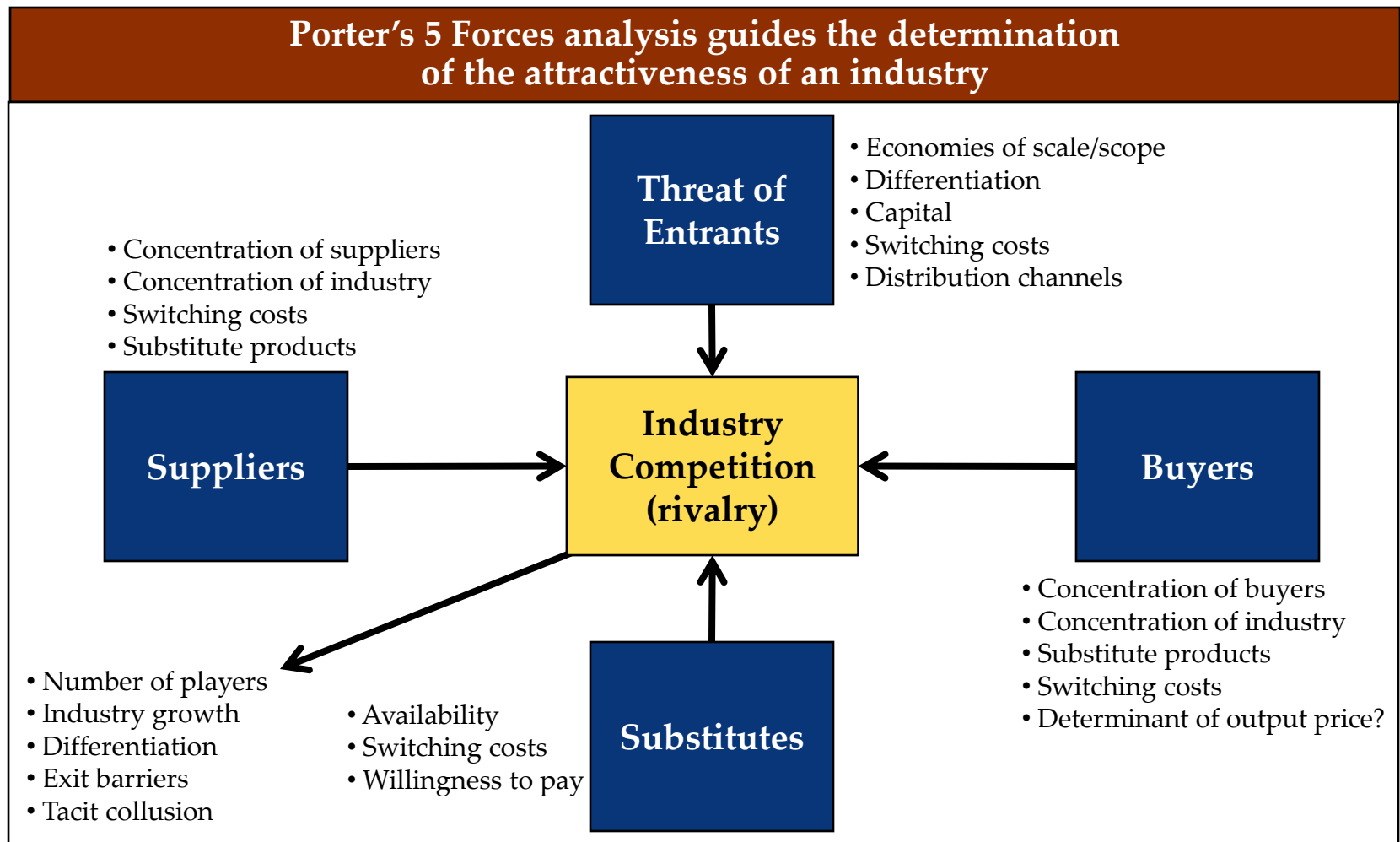
Current Opportunities	Current Capabilities	Near-term Interest	No Capability/Interest
-----------------------	----------------------	--------------------	------------------------

X = required process for component

Given Res's process capabilities and interests, attractive SWH components include collector frames, mounts and expansion tanks.

Potentially Attractive SWH Components for <i>Res Manufacturing</i>		
Component	Picture	Comments
Collector Mount/Rack		Collector mounts/racks are used to secure the solar collectors to the roof or ground. Res manufacturing would be able to make racks and mounts with its current stamping and machining capabilities.
Collector Frame		The collector frame is typically aluminum or steel and encases the absorbing pipes, glass and insulation. Res manufacturing could produce the collector frame with its current capabilities.
Expansion Tank		Expansion tanks are another product that is currently made for the general water heating market, however with the growing use of glycol in SWH systems, expansion tanks for the SWH industry must be manufactured with tougher inner bladders to resist deterioration due to the glycol. The tanks can be manufactured by stamping and assembly.

Res is currently evaluating the collector frame component & has used the Porter's 5 Forces analysis to evaluate the market opportunity.



Res is currently in the process of understanding whether the collector frame product for the industry fits with their core competencies.

Internal to Company	Strengths	<ul style="list-style-type: none"> • U.S.-based manufacturing company (supports re-shoring trend in U.S.) • Experience with lean manufacturing and efficient cost structures leveraged from success in the auto industry • Highly adaptable manufacturing capabilities • In house manufacturing design capabilities • Ability to attract highly qualified employees. 	Weaknesses	<ul style="list-style-type: none"> • Company is not located near major SWH markets (CA, HI, & FL). • No experience with channels to market in the industry. • Company is highly risk averse. While the technical aspects of the product are low risk market risk exists.
	External to Company	Opportunities	<ul style="list-style-type: none"> • Wisconsin has a commitment to supporting the SWH industry with incentives and other programs. • Strong Wisconsin-based manufacturing culture could provide partnership opportunities along SWH value chain. • High quality US based products are sought after in the SWH industry 	Threats

In addition to Res's SWOT analysis, Navigant notes the company's investment perspective.

Res's Investment Perspective

- The company expects a short time payback on investment
- Fairly risk averse.
- Has specific market share targets for each investment. A high level of confidence of obtaining revenue goals is required.

Based on Navigant's interview with Res and our understanding of the business opportunity...

Key Takeaways from *Res Manufacturing*

- Res is using a systematic approach to evaluating a new market, including:
 - understanding its own unique capabilities,
 - selecting a potential product for investment, and
 - evaluating the attractiveness of the industry.
- Payback and IRR threshold requirements are of utmost importance in determining the attractiveness of the investment.
- Investment in undifferentiated, low value-add products will not result in a sustained competitive advantage in a new market.

Table of Contents

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry <ul style="list-style-type: none">U.S. MarketGlobal MarketDrivers/BarriersEconomics
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

The U.S. SWH market has experienced cycles of strength and weakness due to inconsistent policy support.

U.S. SWH Policy Support

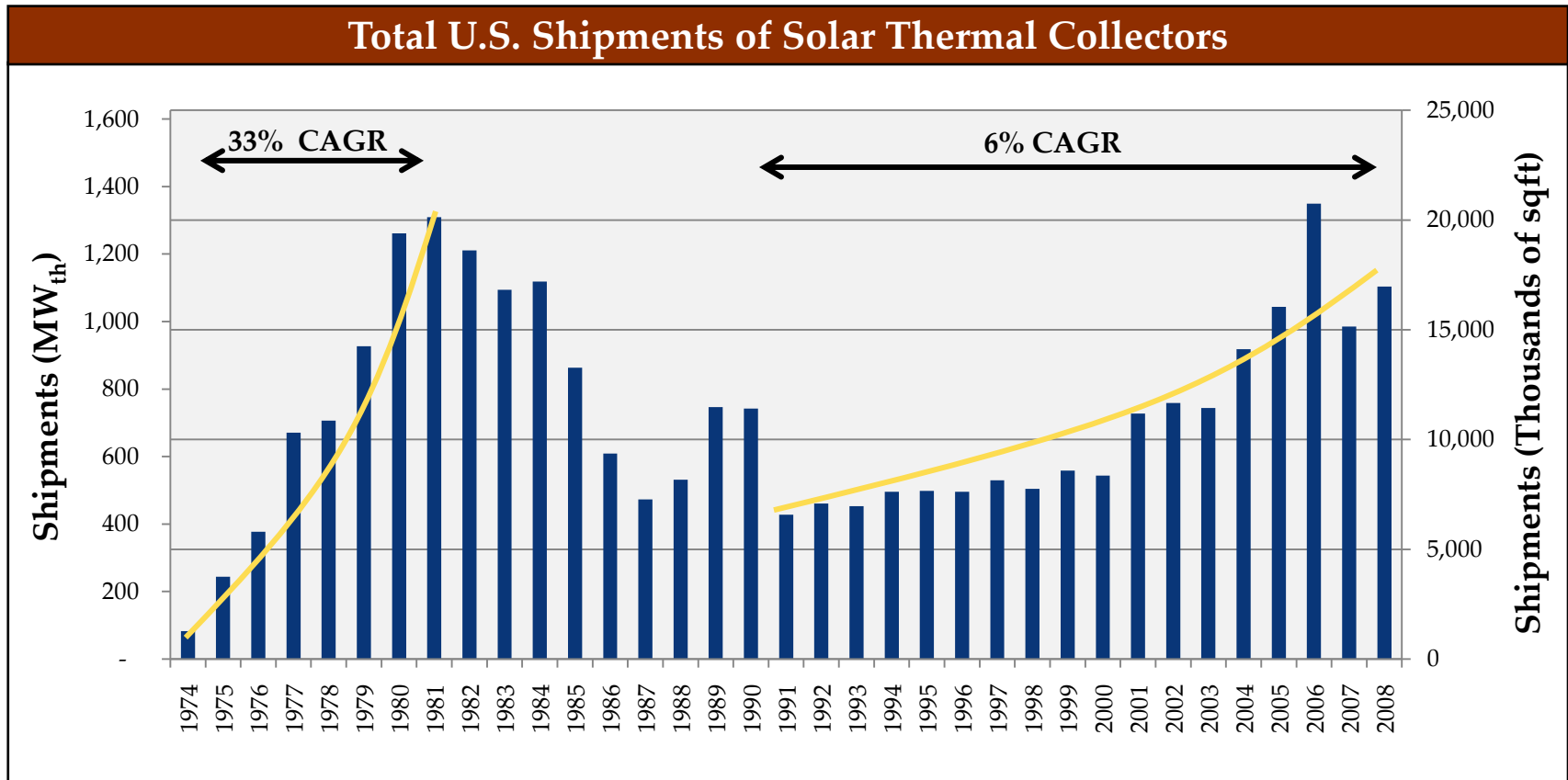
- The first U.S. installations were deployed to provide water heating in areas inaccessible to other energy supplies or to complement them, especially prior to World War II.
 - After World War II, consumers began to expect higher quality water heating (i.e. water of consistently high temperature that would be available at any time) and as a result, the US solar water heating market declined.
- With the energy crises of the 1970s, the SWH market rebounded and several hundred companies entered the industry.
 - The *Solar Heating and Cooling (SHAC)* program provided a 40% federal tax credit and state level incentives were available and helped jump start the industry. Unfortunately, the policy did not support long term sustainable development.
 - When the incentives were discontinued in 1986, the U.S. market quickly collapsed.
- The *Energy Policy Act of 2005* provided a 30% federal tax credit up to \$2,000 for residential SWH systems (no cap for commercial systems) that utilize panels certified by the Solar Rating and Certification Corporation (SRCC), through 2008.
 - This was extended through 2016 by the *Energy Improvement and Extension Act of 2008* and the \$2,000 cap on residential systems was lifted.
- In parallel with the recent federal tax credits, several utilities and states have introduced SWH programs (either incentive or building code based) that have driven renewed interest in the industry.

The pool heating market has grown with the number of pools in the country.

U.S. Pool Heater Market Development

- Given the lower cost of pool heating systems (i.e. unglazed collectors and no storage tanks) relative to domestic water heating systems, pool heating systems have not been dependent on incentives.
- The growth has been driven by the growth in the number of pools in regions of the country with enough solar insolation to yield a 2 to 4 year pay-back.
 - In years with strong growth in pool installations, the solar pool heating market does well and vice versa.

After 33% average annual growth prior to 1981, the U.S. market declined. Since 1991, there has been a 6% compounded annual growth rate (CAGR).

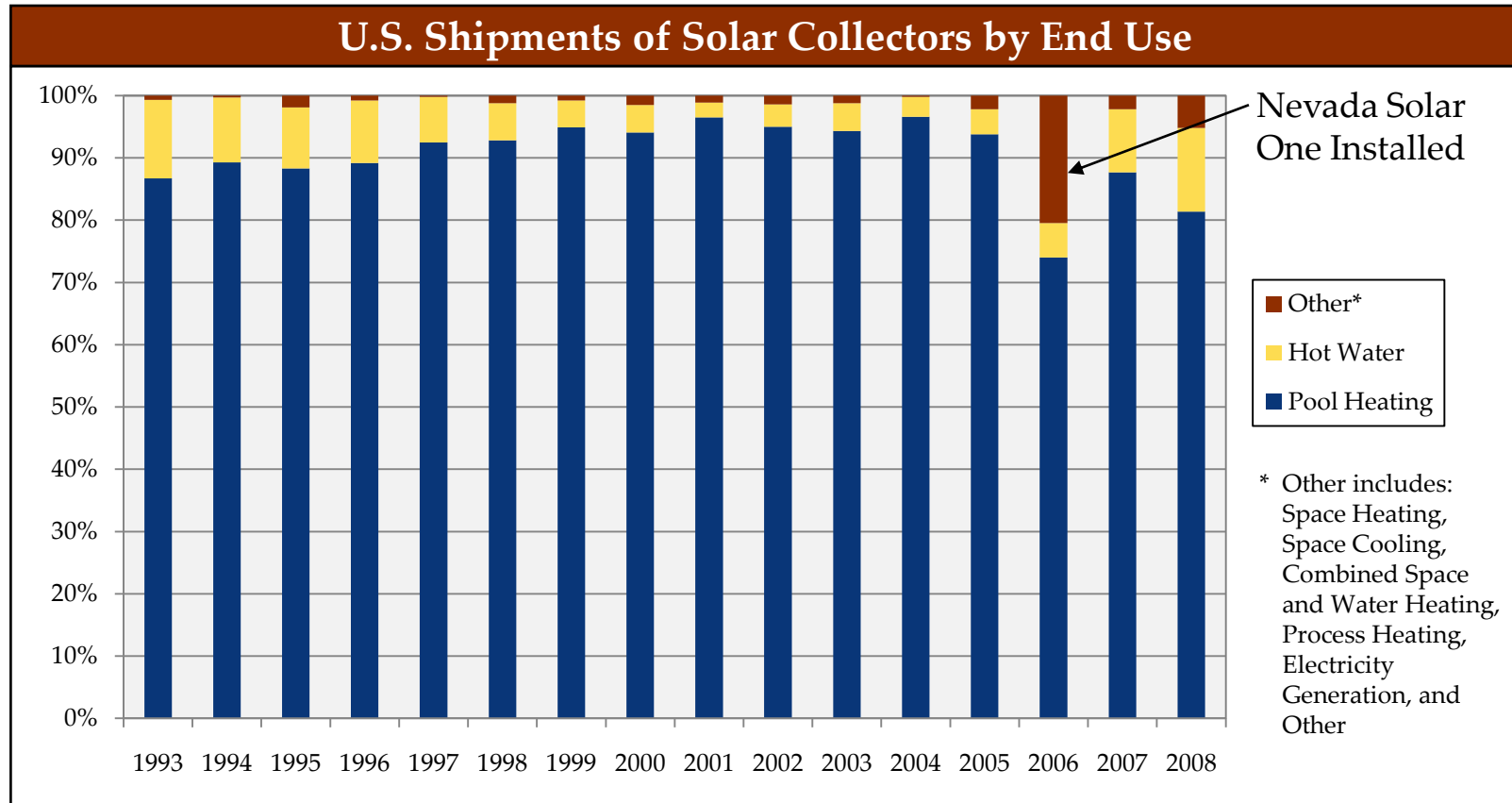


*Data reported in 1000's of sq.ft. MW_{th} is calculated based upon an internationally agreed upon conversion factor of 0.7 kW_{th}/m².

Source: International Energy Agency's Solar Cooling and Heating Program, Solar Heating Worldwide 2008 Edition, Industry Interviews, Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal Collector Manufacturing Activities 2008 & Renewable Energy Annual. Annual installations domestic production and imports of low, medium and high temperature collectors.

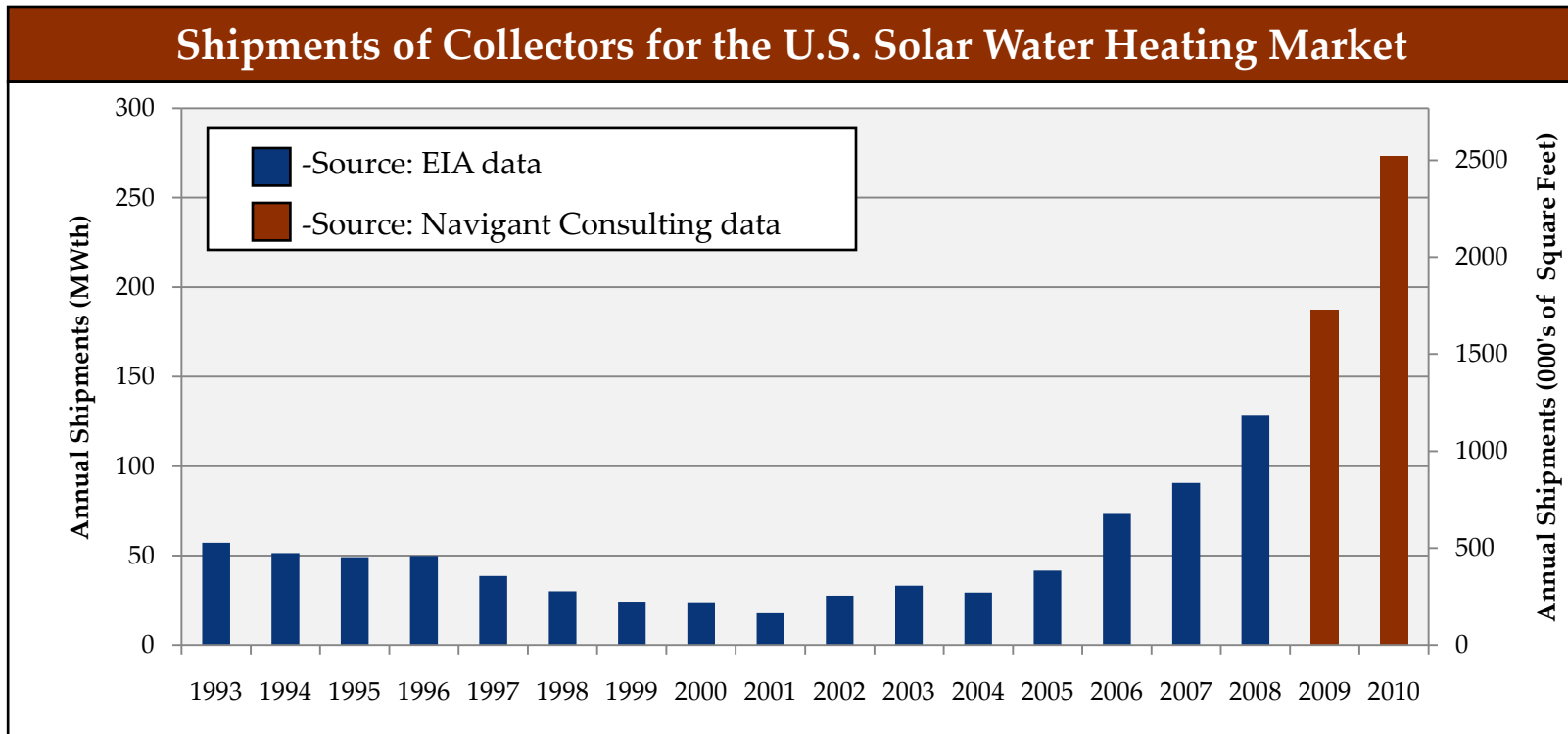
CAGR: Compound Annual Growth Rate

The majority of solar thermal collectors in the U.S. are used for pool heating.



Source: Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal and Photovoltaic Collector Manufacturing Activities 2008 and Renewable Energy Annual, Industry Interviews.

According to EIA, the U.S. SWH market declined annually at 13% from 1993 to 2001, but there was a growth rate of 40% from 2004-2008.

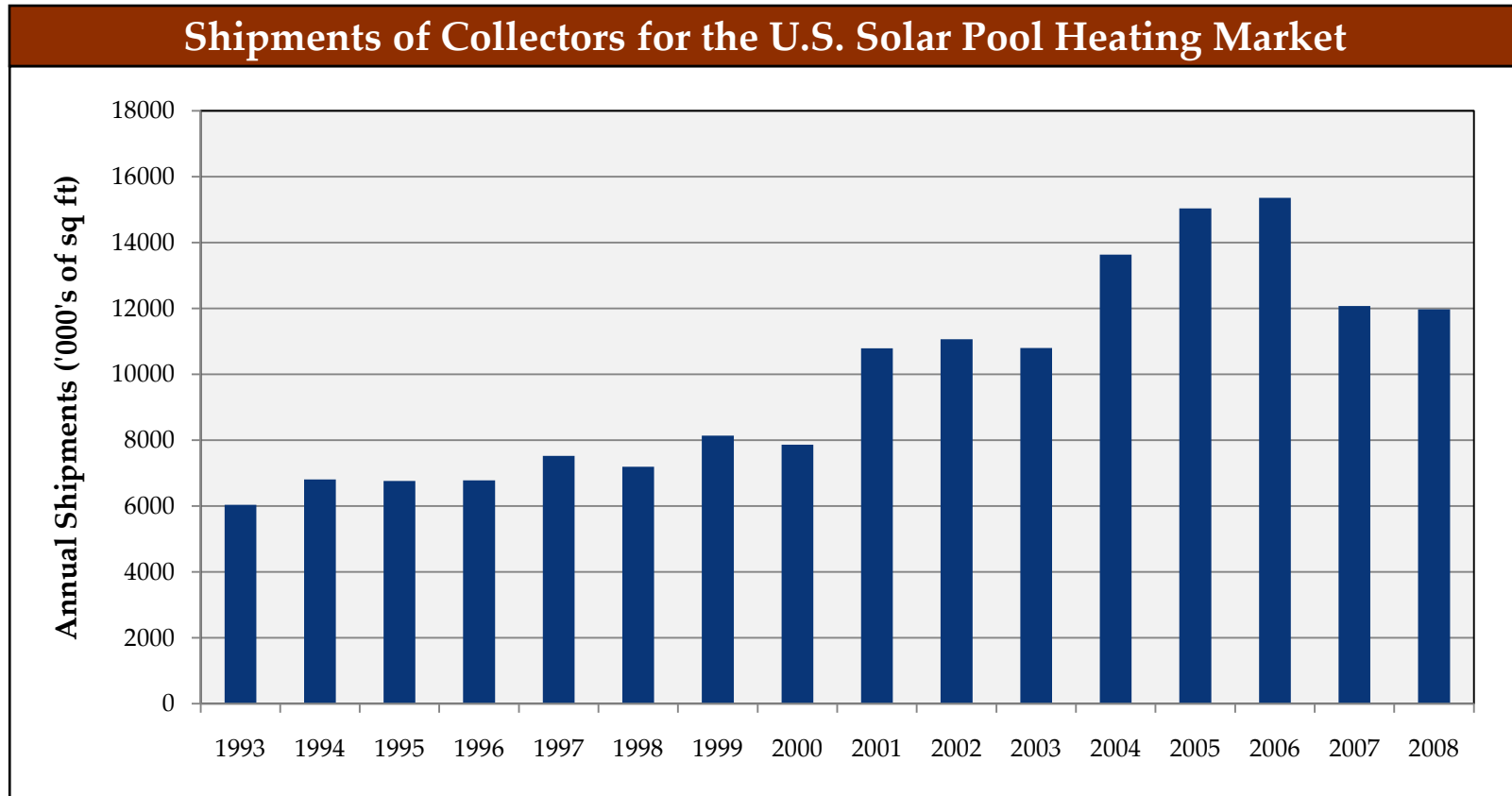


Source: Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal and Photovoltaic Collector Manufacturing Activities 2006 and Renewable Energy Annual.

Source: Navigant Consulting, Inc. 2008 SWH manufacturer survey and market analysis

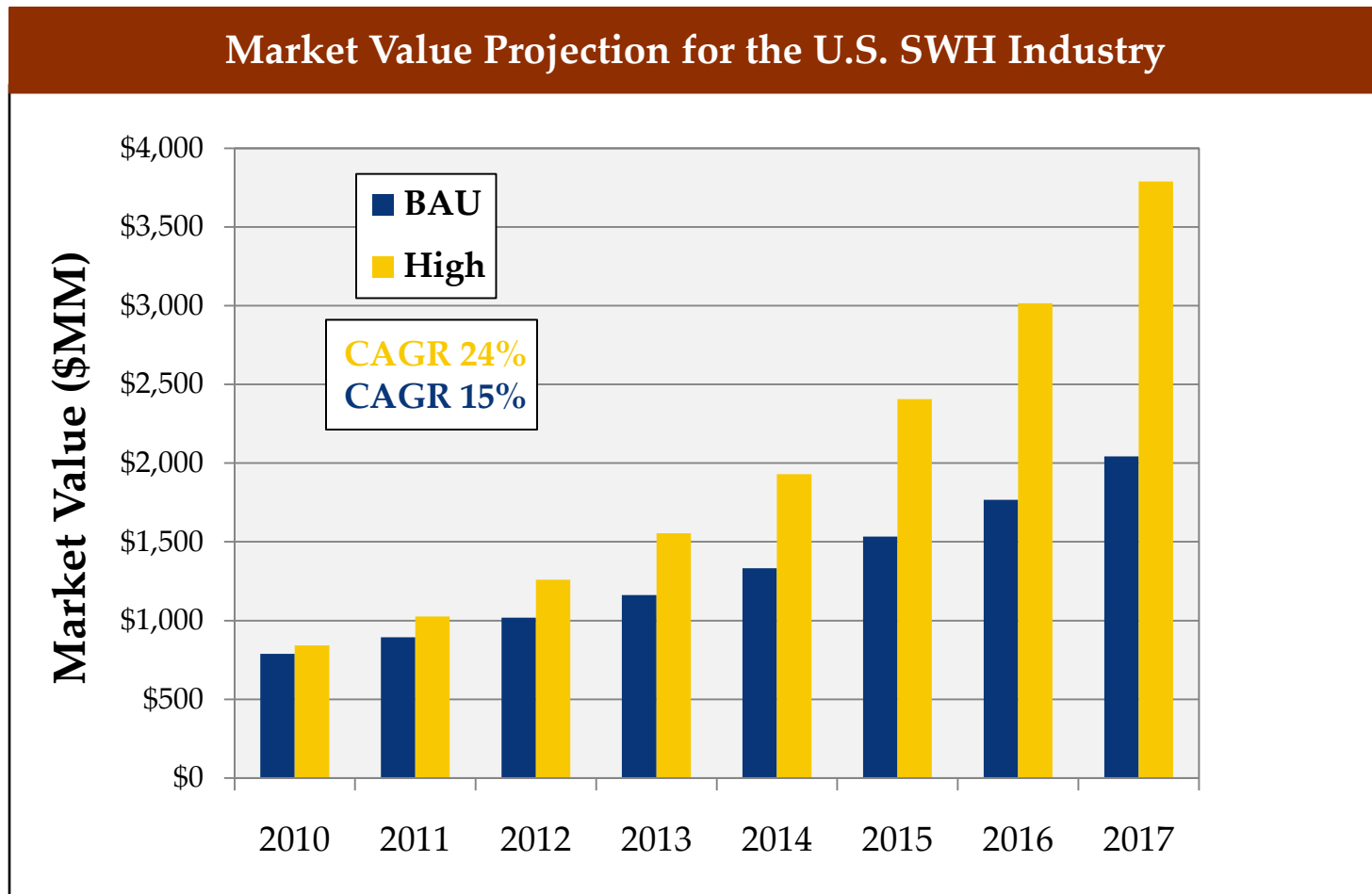
According to Navigant's 2008 manufacturer survey and analysis, imports of SWH collectors account for 17% of shipments. The share of the market served by foreign manufacturers is likely to increase in the U.S. market matures.

The U.S. solar pool heating market has grown largely without incentives.



Source: Navigant Consulting, Inc based on Energy Information Administration, Solar Thermal and Photovoltaic Collector Manufacturing Activities 2008 and Renewable Energy Annual, Industry Interviews.

Even with optimistic U.S. market growth, the total value of the market remains modest between 2010-2017.



Source: NCI Analysis.

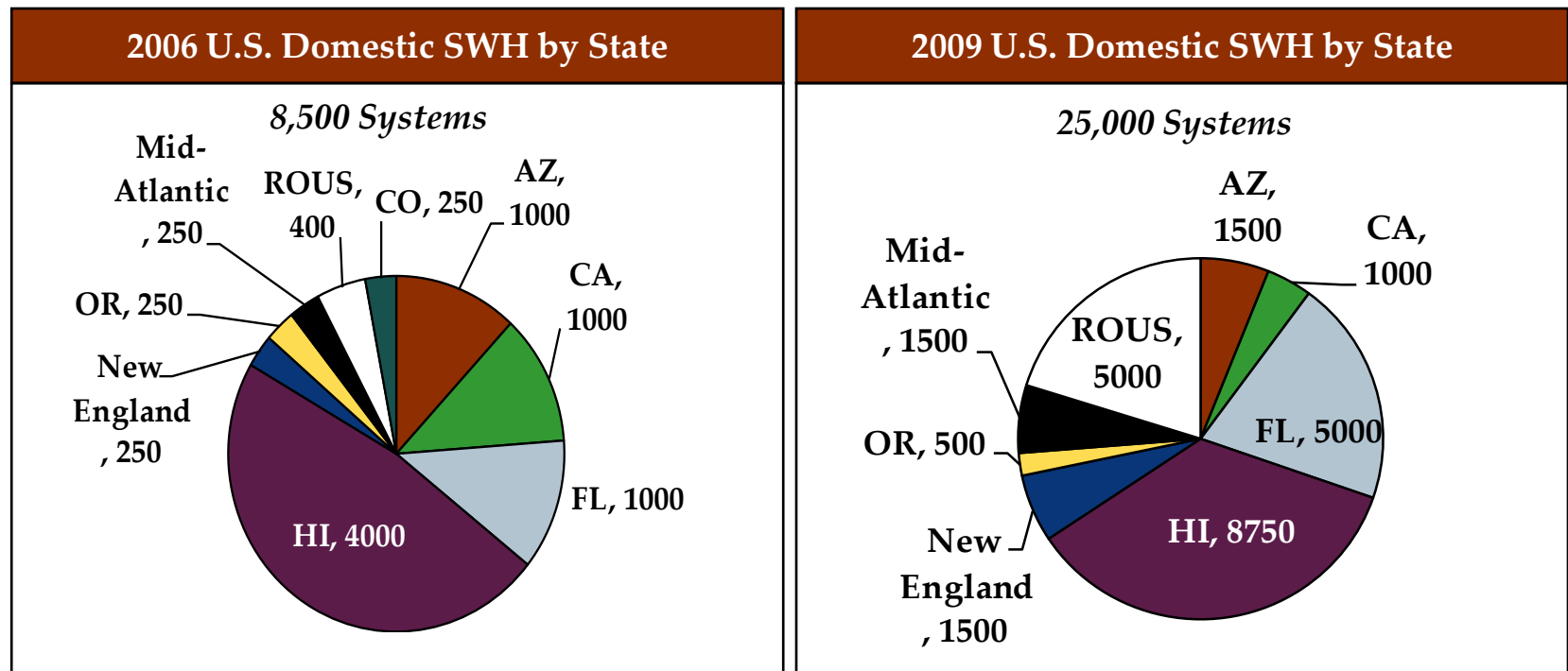
System Size: domestic SWH system 40sqft; Pool system 400 sqft;

Market Growth Assumptions

BAU: Pool CAGR 5%; other SWH CAGR 21%

High: Pool CAGR 8%; other SWH CAGR 32%

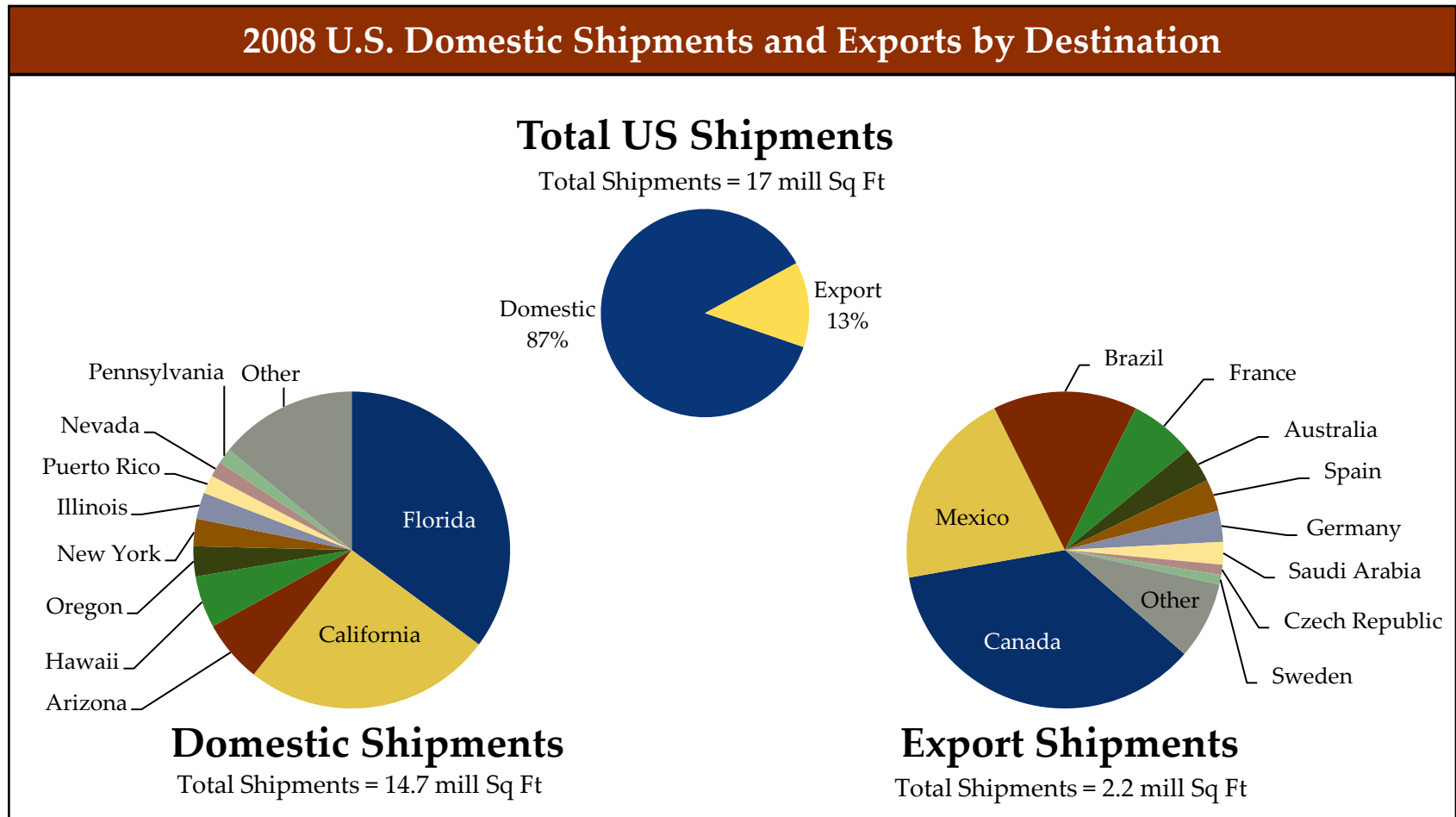
A small number of states dominate the SWH market.



Source: Navigant Consulting, Inc. based on interview with Les Nelson, SRCC, State Incentive Programs (CA, HI, FL)

- On the order of 35% of all new U.S. solar domestic water heating systems are installed in Hawaii.
- Six states continue to account for almost 70% of all domestic SWH systems.
- On the order of ~8,500 SWH systems were sold in the U.S. in 2006, and ~25,000 in 2009.

U.S. collector exports primarily go to Canada, Mexico, Brazil, and France.



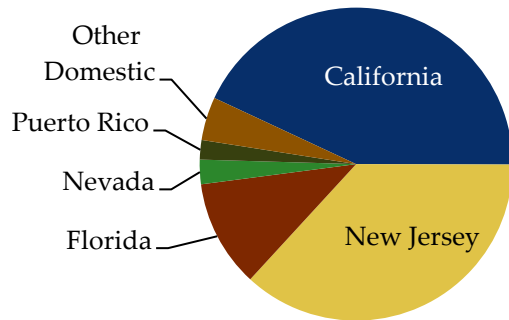
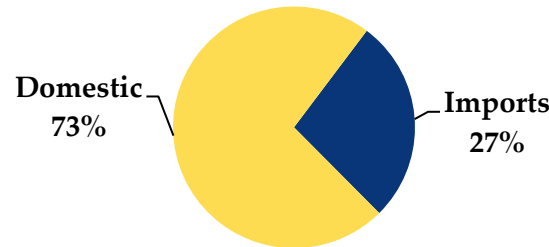
Source: Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal and Photovoltaic Collector Manufacturing Activities 2008 and Renewable Energy Annual, Industry Interviews.

73% of U.S. solar collectors are domestic, and the majority of imports come from Israel.

2008 U.S. Domestic Production and Imports by Origin

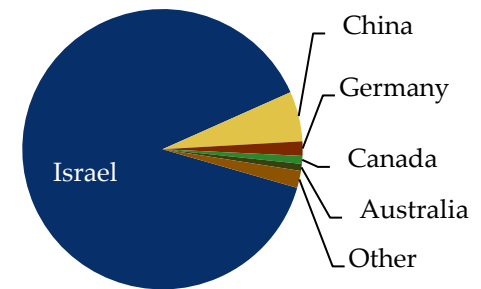
Origin of US Solar Collector Shipments

Total shipments = 17 mill Sq Ft



Top 5 States for Solar Thermal Collector Production

Total shipments = 11.4 mill Sq Ft

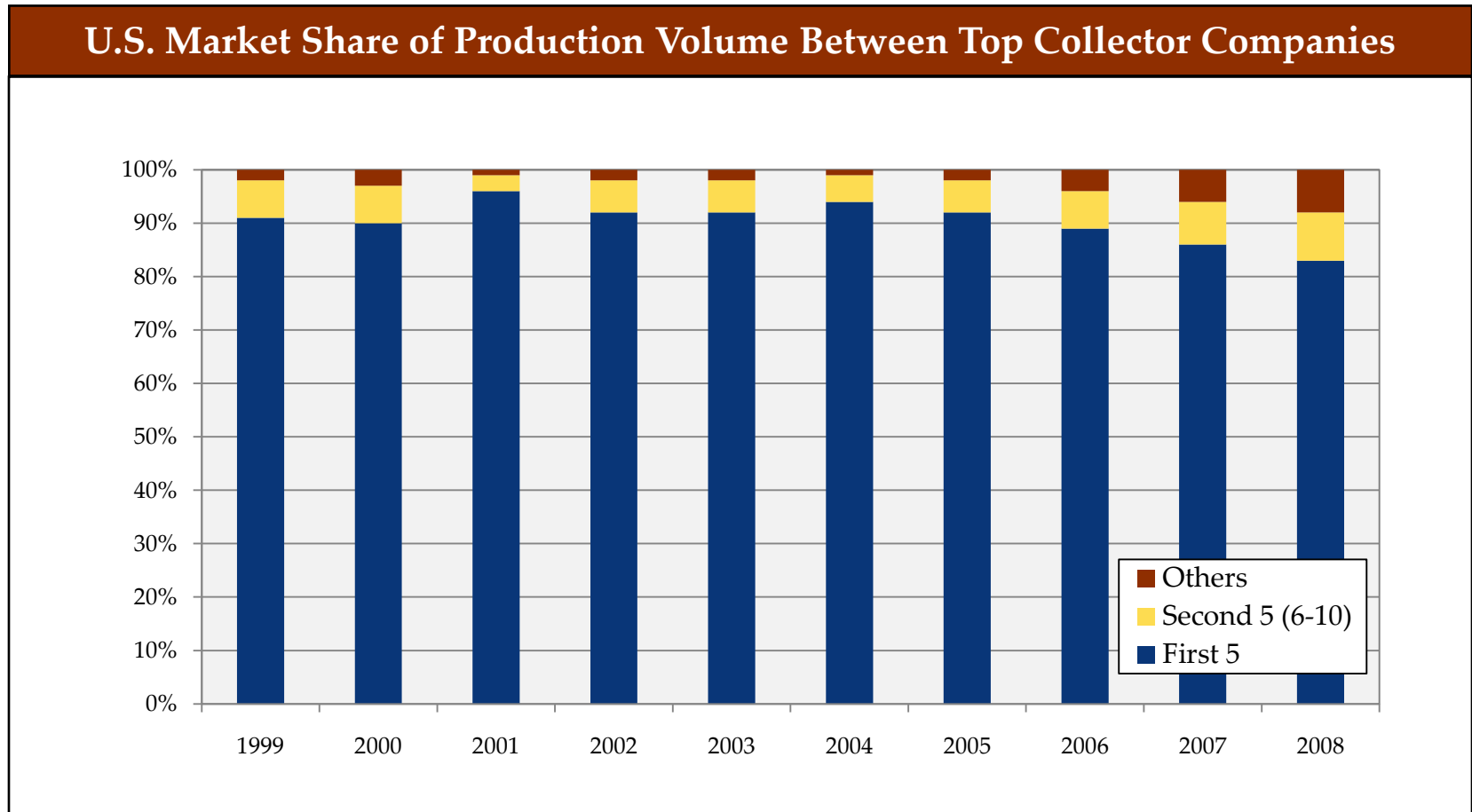


Origin of US Solar Collector Imports

Total shipments = 5.5 mill Sq

Source: Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal and Photovoltaic Collector Manufacturing Activities 2008 and Renewable Energy Annual, Industry Interviews.

The market share of the Top 5 companies is declining due to the growth of companies outside the top 10.

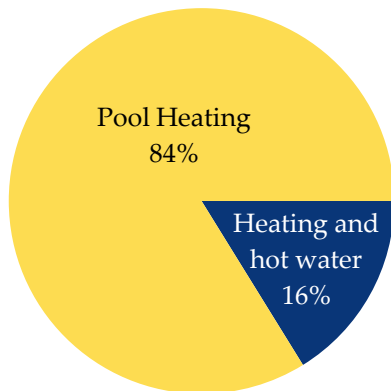


Source: EIA

The hot water and heating market represents nearly 70% of the market value, but only 16% of the area of collectors shipped.

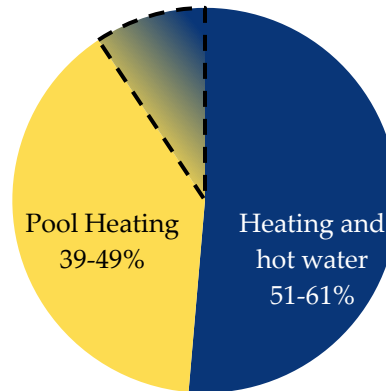
Domestic Air and Water Heating vs. Pool Heating, 2008

Area of Collectors Shipped by Use



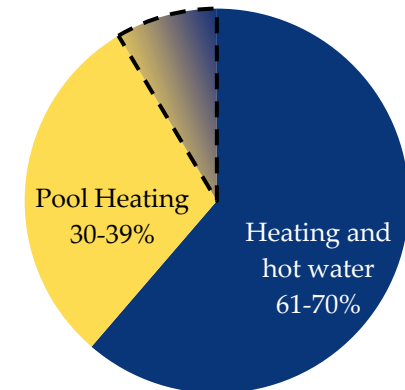
Total area shipped
17 mill Sq Ft

Number of Systems Shipped by Use



Total number of Systems shipped
64,000-82,000

Market Value by Use

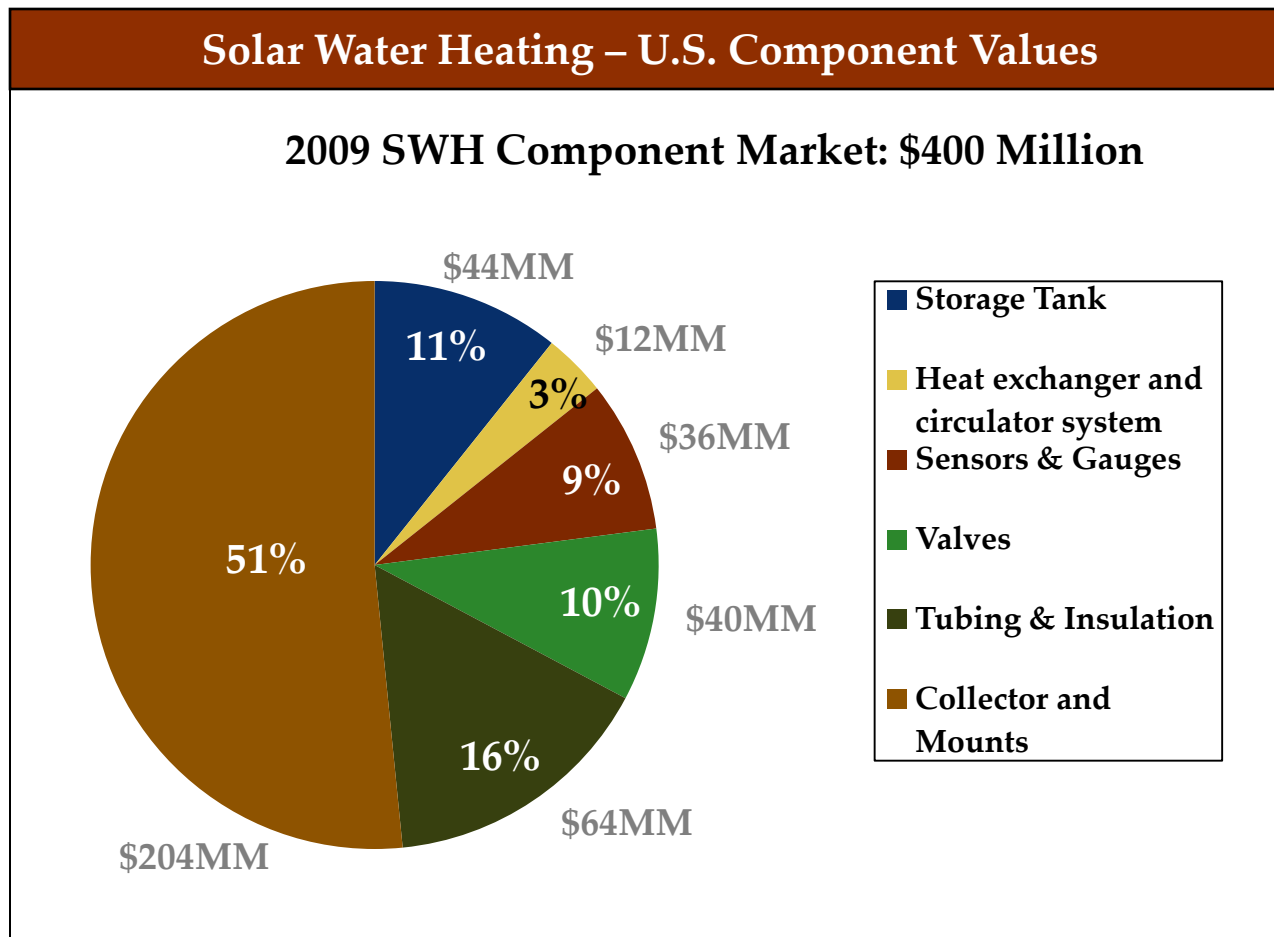


Total Market Value
\$260-\$495 million

Source: Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal and Photovoltaic Collector Manufacturing Activities 2008 and Renewable Energy Annual.

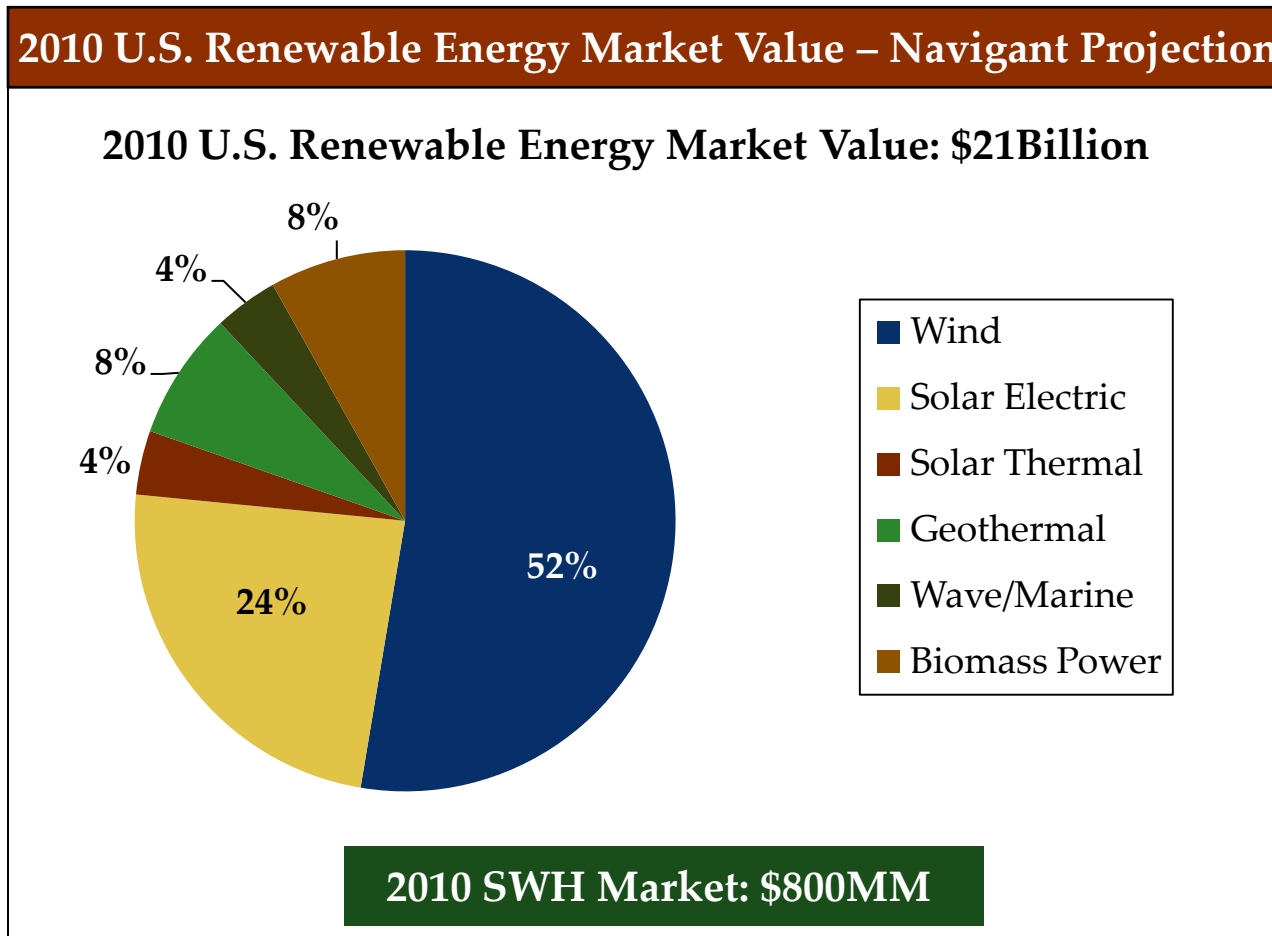
Note: Pool Heating System size was assumed to be 350-400sqft; Non-pool heating systems were assumed to be 50-64sqft. The dashed line represents the level of uncertainty in the calculations and should be considered as a range.

The U.S. SWH market size was \$800MM in 2009. ~50% of the total value is material cost, which is dominated by collectors.



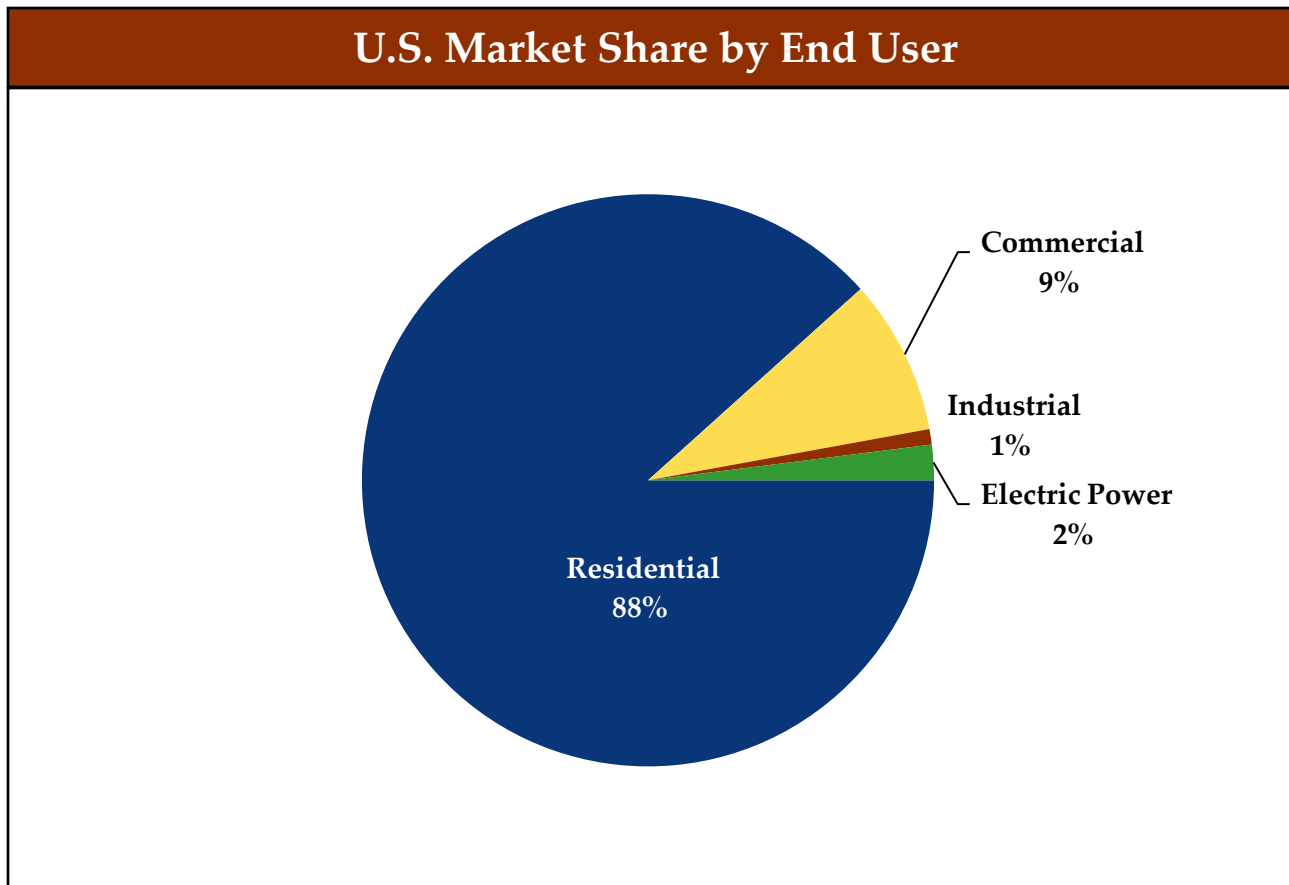
Source: RS Means, Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal and Photovoltaic Collector Manufacturing Activities 2008 and Renewable Energy Annual and Industry Interviews.

The U.S. renewable energy market value was ~\$21 billion in 2008; most of the value went to PV and wind. ~4% was SWH.



Source: NCI analysis

The residential market made up almost 90% of solar thermal collector shipments in the U.S. in 2008.



Source: Navigant Consulting, Inc. based on data from Energy Information Administration, Solar Thermal and Photovoltaic Collector Manufacturing Activities 2008 and Renewable Energy Annual.

The U.S. market is experiencing near-term growth because of the emergence of new incentives at the state and federal levels.

Current Policy for SWH

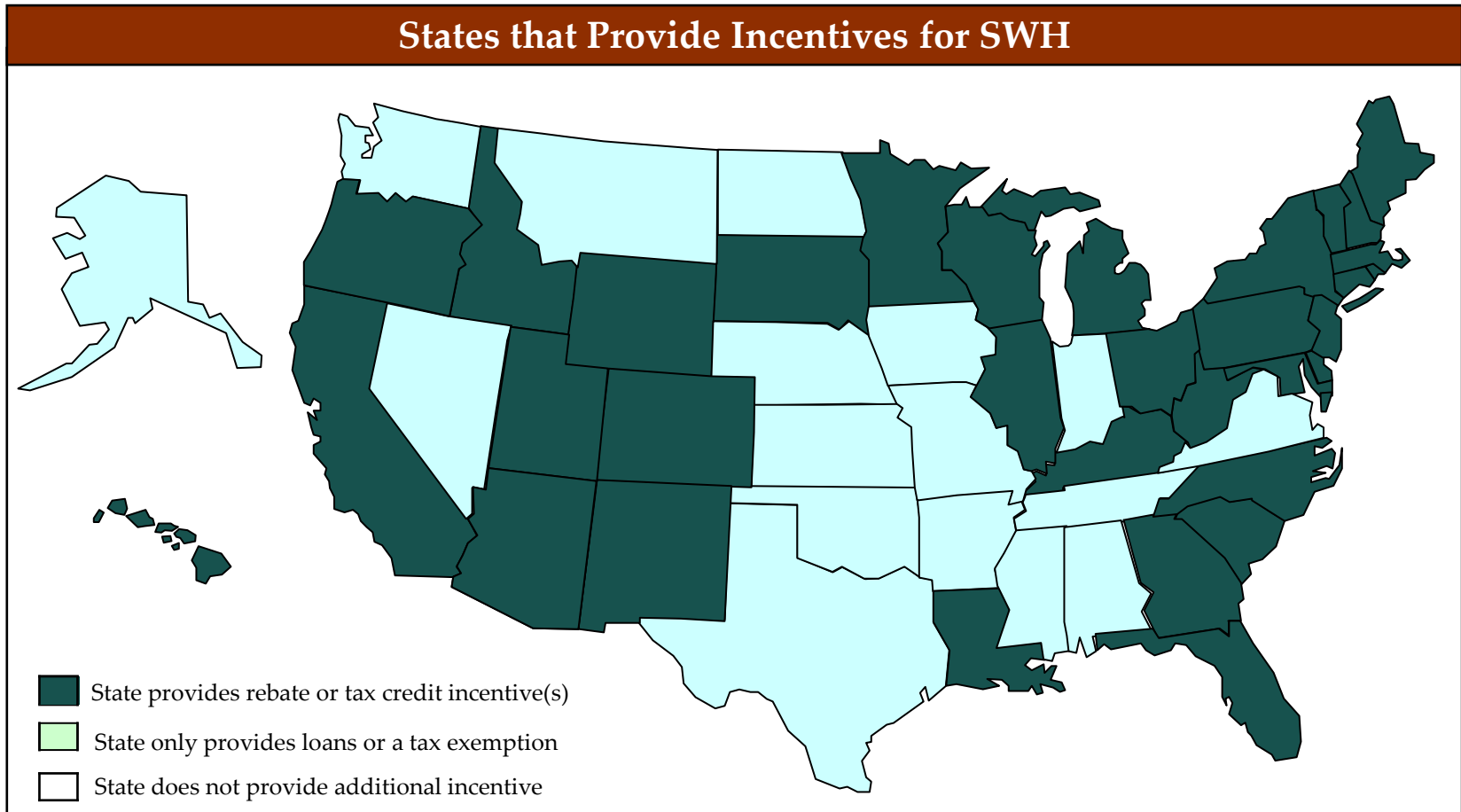
A U.S. federal tax credit is available for SWH systems installed through December, 31 2016.

- Consumers can claim a tax credit equal to 30 percent of the costs, with no cap for commercial or residential systems.
- The SWH systems must: be used exclusively for purposes other than heating swimming pools and hot tubs, be certified by the Solar Rating and Certification Corporation (SRCC), and produce 50 percent or more of the water heating needed by the residence.

In addition, 30 states have one or more incentives for SWH. The types of incentives include: (number of states)

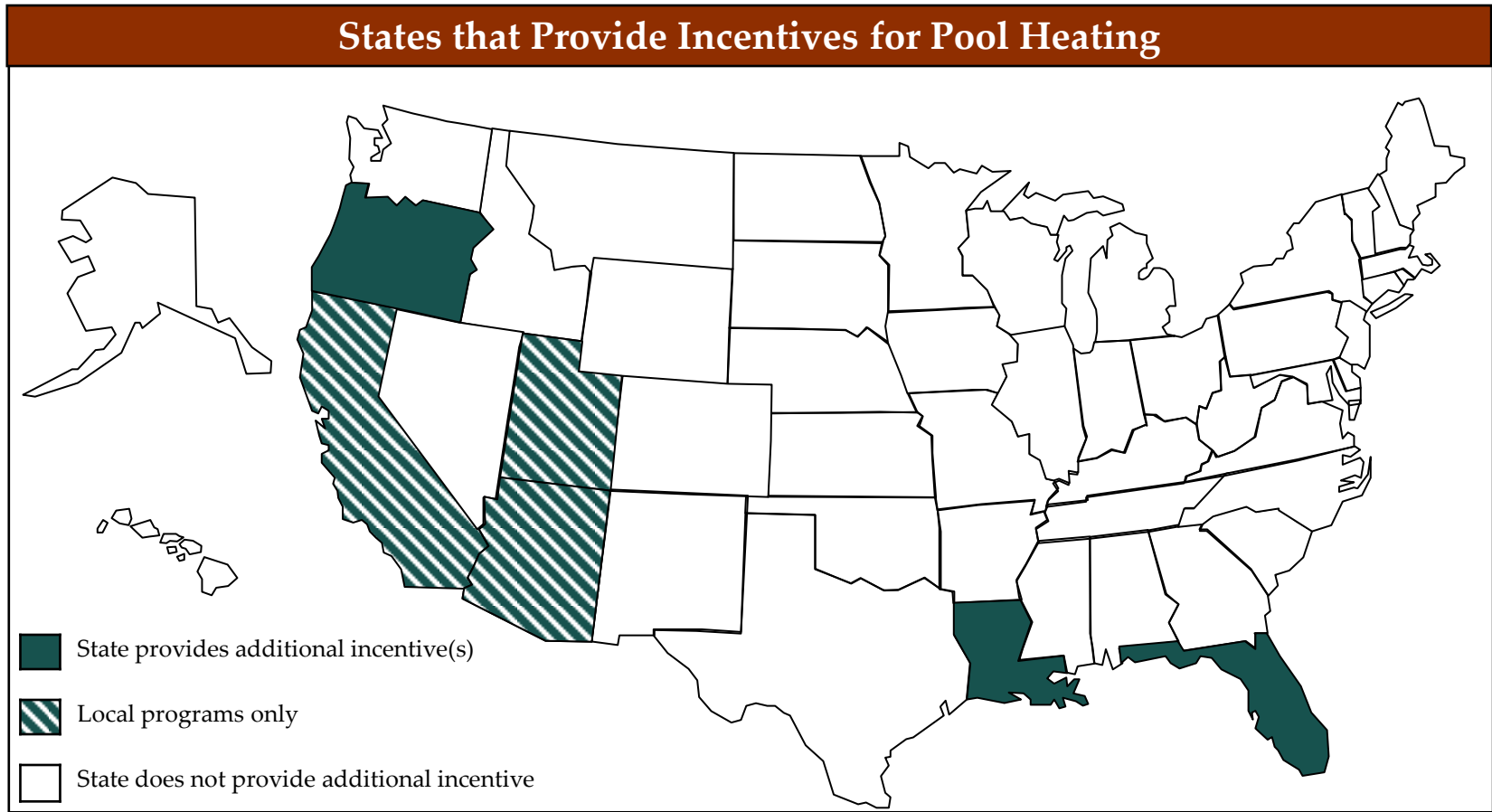
- Income tax credit (11)
- Rebate (21) or Production incentive (2)
- Sales tax exemption (7). Sales taxes range from 4-7% of the system cost.
- Grant Programs (4)
- Loan options (11)
- Other programs include: Building requirements (1) and Leasing program (1)

In addition to the federal tax credit, all states provide incentives for SWH, in addition to loan programs.



Source: <http://www.dsireusa.org> database of RE incentives, Jan. 2009

13 states provide incentives for solar pool heating.



Source: <http://www.dsireusa.org> database of RE incentives, Jan. 2009

The largest SWH markets correspond to states with the highest incentives and insolation.

State	Incentive
Arizona	Tax credits: 25% of install cost, NTE \$1,000 (residential); 10% of install cost, NTE \$25,000 for one building and \$50,000 max/yr, with \$1MM program cap per year (commercial). Sales & property tax exempt. Utility rebates: up to 50% project costs (residential & commercial).
California	State Rebate: New CSI SWH program with a \$350 MM budget until 2017. Utility rebates: SMUD \$1,500, Palo Alto \$1,500-\$75k, Redding \$1,750; utility loan program: Santa Clara
Hawaii	Tax credits: 35% of install cost, NTE \$2,250 (residential); 35% of install cost, NTE \$350/unit (multifamily); 35% of install cost tax credit, NTE \$250K (commercial). State rebate: \$750 – Residential; No limit - Commercial. Utility rebates & zero-interest loans. Construction Requirement: Solar water heating required on all new residential construction, starting 1/1/2010
Florida	State rebates Sales tax exemption.; Local rebate of \$200-\$450; Utility rebates: \$0-\$800; utility locks in a portion of energy costs at lower rate; Utility performance-incentives and SWH loans.
Oregon	Tax credit: \$0.15/kWh saved (pool); \$0.60/kWh SWH, NTE \$1,500; 50% of project costs, distributed over five years (commercial, multifamily). Property tax exemption. State rebate: \$1,500 for solar water heating, \$1,000 for pool heater (residential); 35% of install cost (commercial) Utility rebates: up to \$600 SWH, up to \$1,100 pool heaters
Nevada	1 Portfolio Energy Credit / 3412 BTU of solar heat generated can be sold to utilities. 100% property tax exemption, including pool heaters.

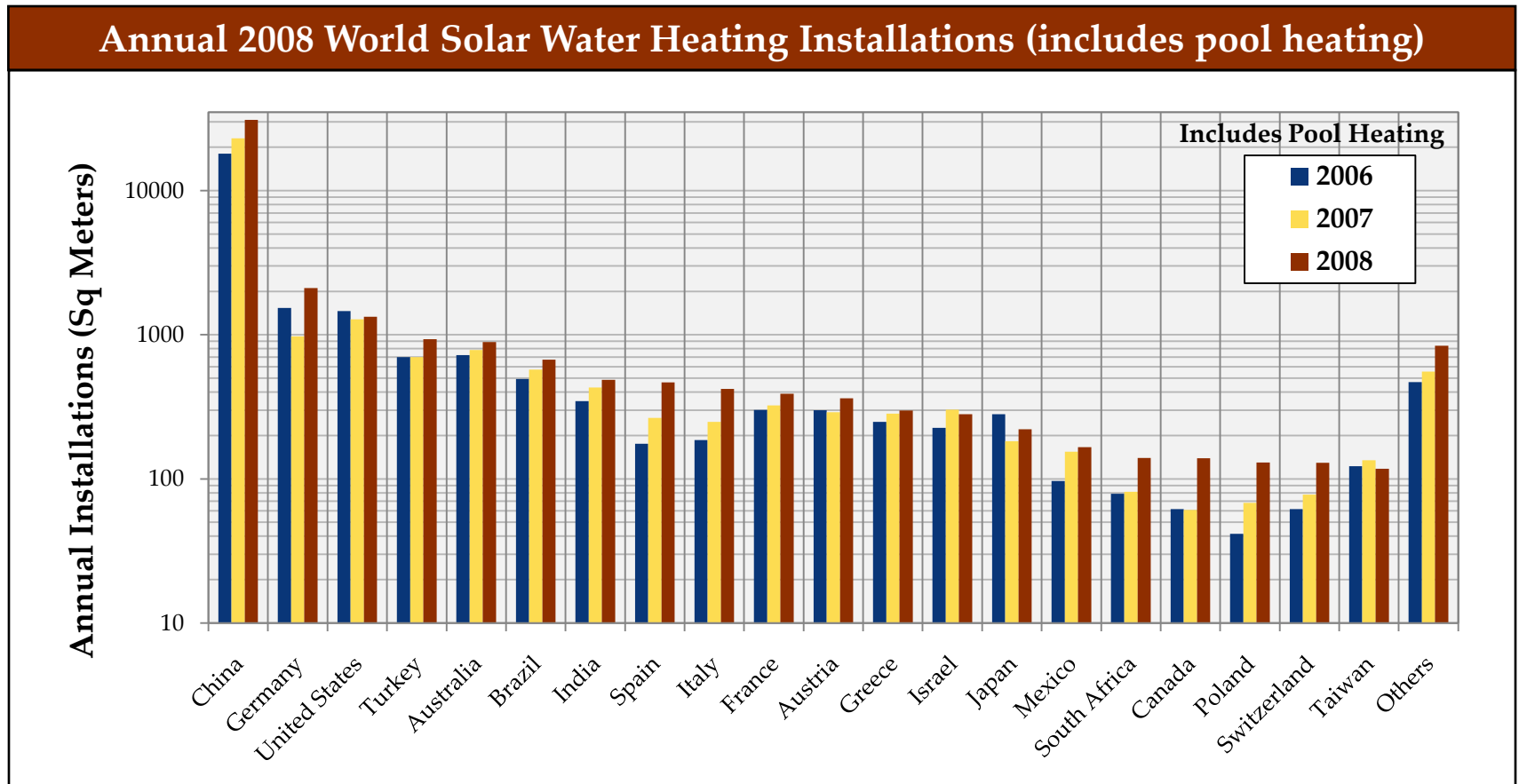
Source: <http://www.dsireusa.org> database of RE incentives

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry <ul style="list-style-type: none">U.S. MarketGlobal MarketDrivers/BarriersEconomics
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

China and Europe lead the global demand for SWH systems for different reasons.

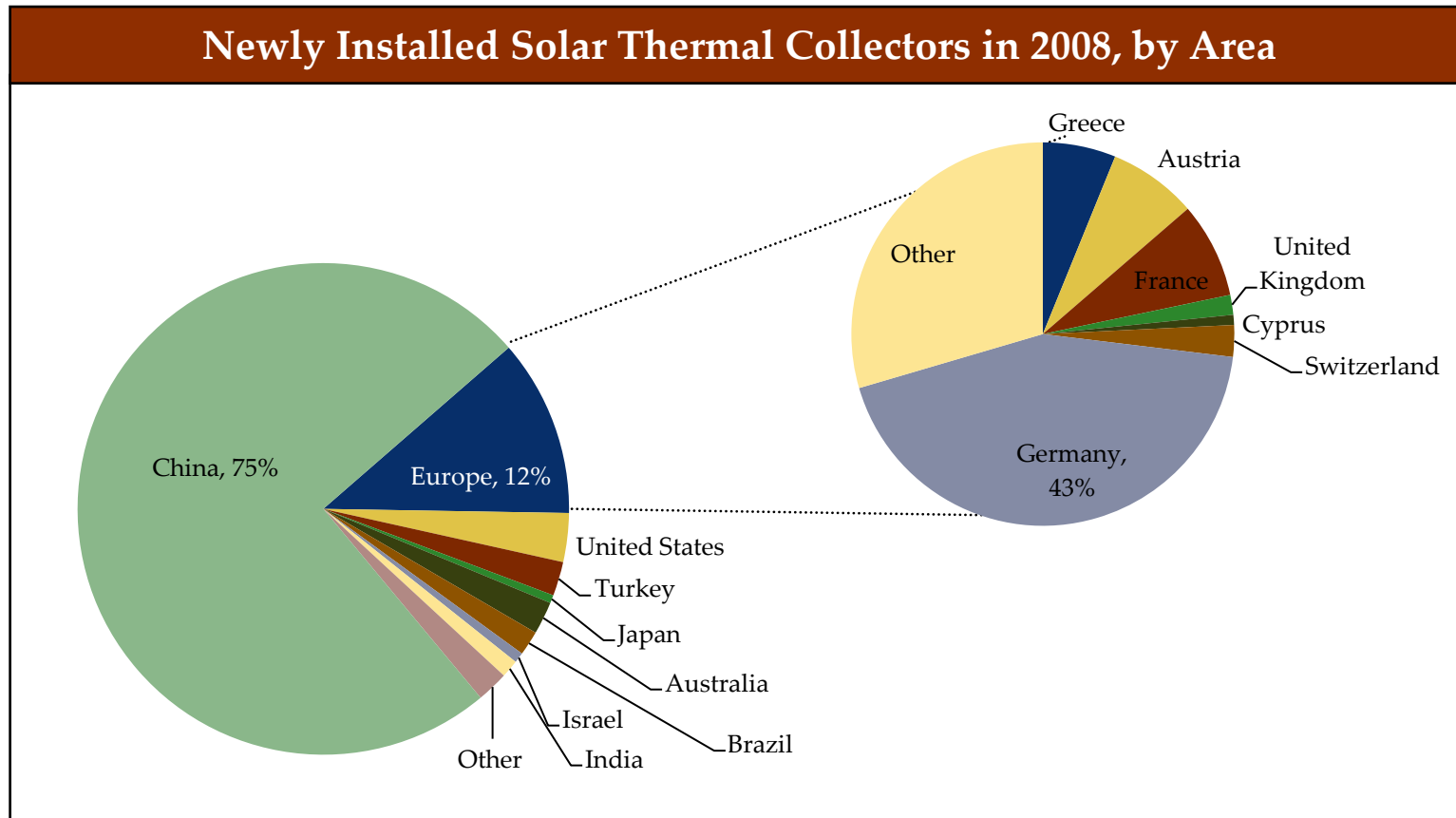
Europe	<p>Many countries in Europe have successfully implemented SWH incentive programs.</p> <p><u>The main factors for successful programs are:</u></p> <ol style="list-style-type: none">1. Continued long term support of SWH incentives. This helps industry plan long term, reducing the risk that the incentive program will disappear.2. Education campaigns. Awareness for SWH system is lacking in most markets. Campaigns targeted at raising awareness and pointing out the benefits of SWH systems create more demand from costumers.3. Performance based incentives. This encourages proper system design and sizing and puts the need of the costumer first.4. Policy. Some municipalities are requiring SWH systems to be installed in local building codes.
China	<ul style="list-style-type: none">• In China SWH adoption has growth with limited intervention by the government. Low cost systems and limited availability of electricity and natural gas around the country have driven industry growth. The Chinese government does not offer incentives for manufacturers or end users• The Chinese market accounts for most global installations.• Industry growth in countries that have limited incentive programs usually occurs in mild climates where the solar resource is good and there is no need for freeze protection.

Most global markets have seen recent growth.



Source: International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008*, Edition 2010. May, 2010.

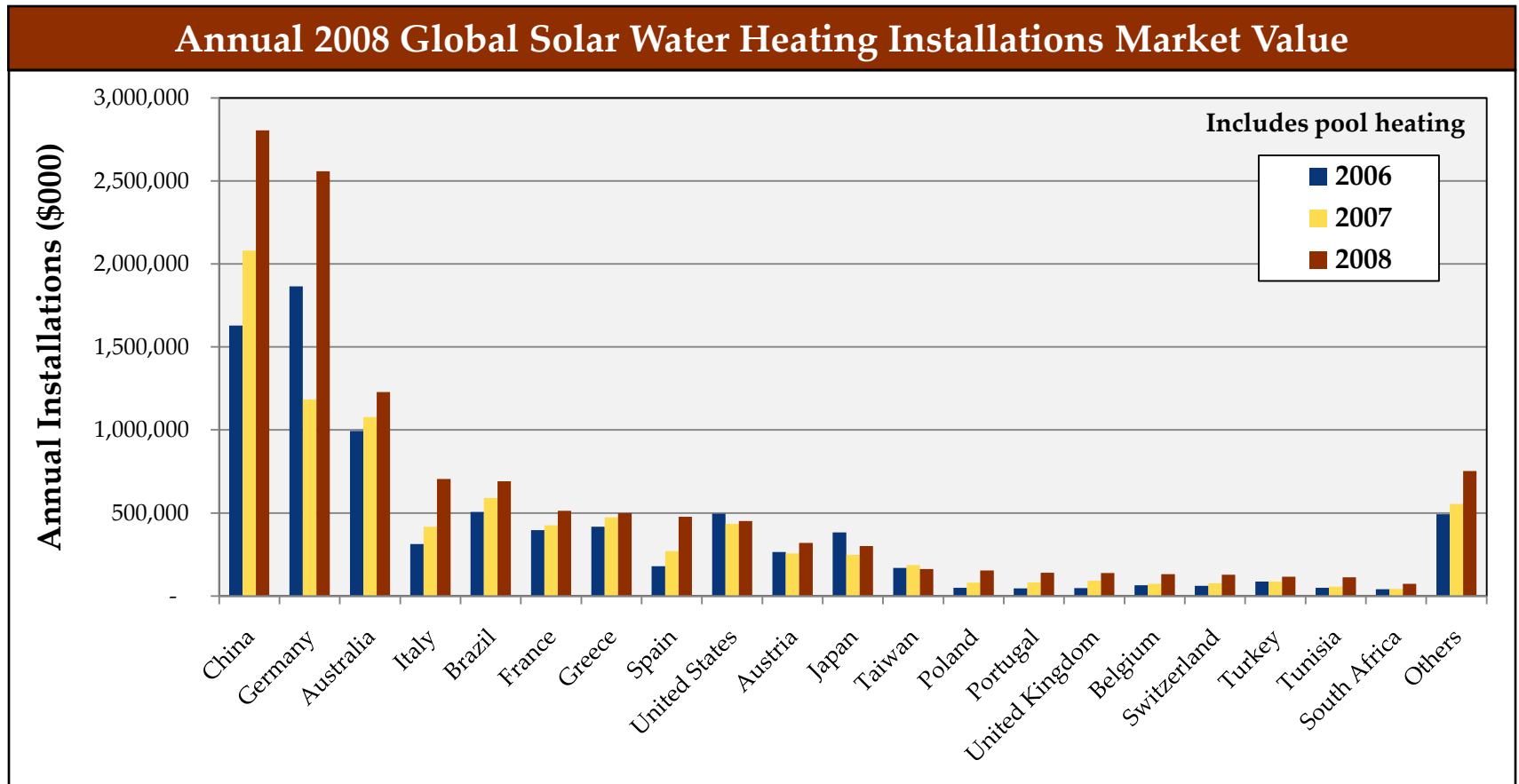
China overwhelmingly led 2008 installations with 75% of global installations.



Source: International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008, Edition 2010*. May, 2010.

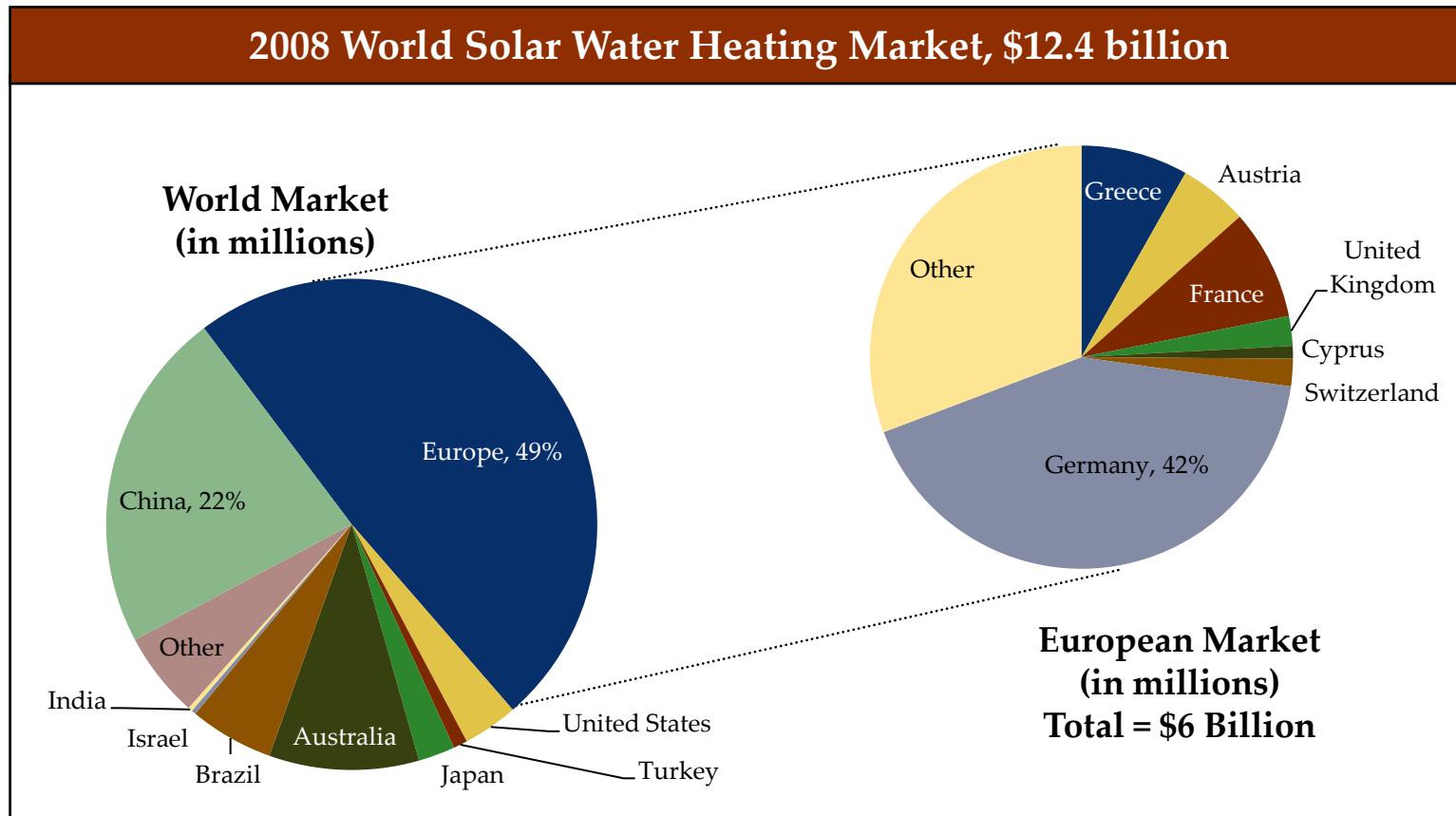
Note: At the time of the writing of this report, complete global 2009 data was not yet available

However, cheap systems dominate the Chinese market and market value is on par with Germany, the second largest market.



Source: NCI Analysis based upon internal data and International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008, Edition 2010*. May, 2010.

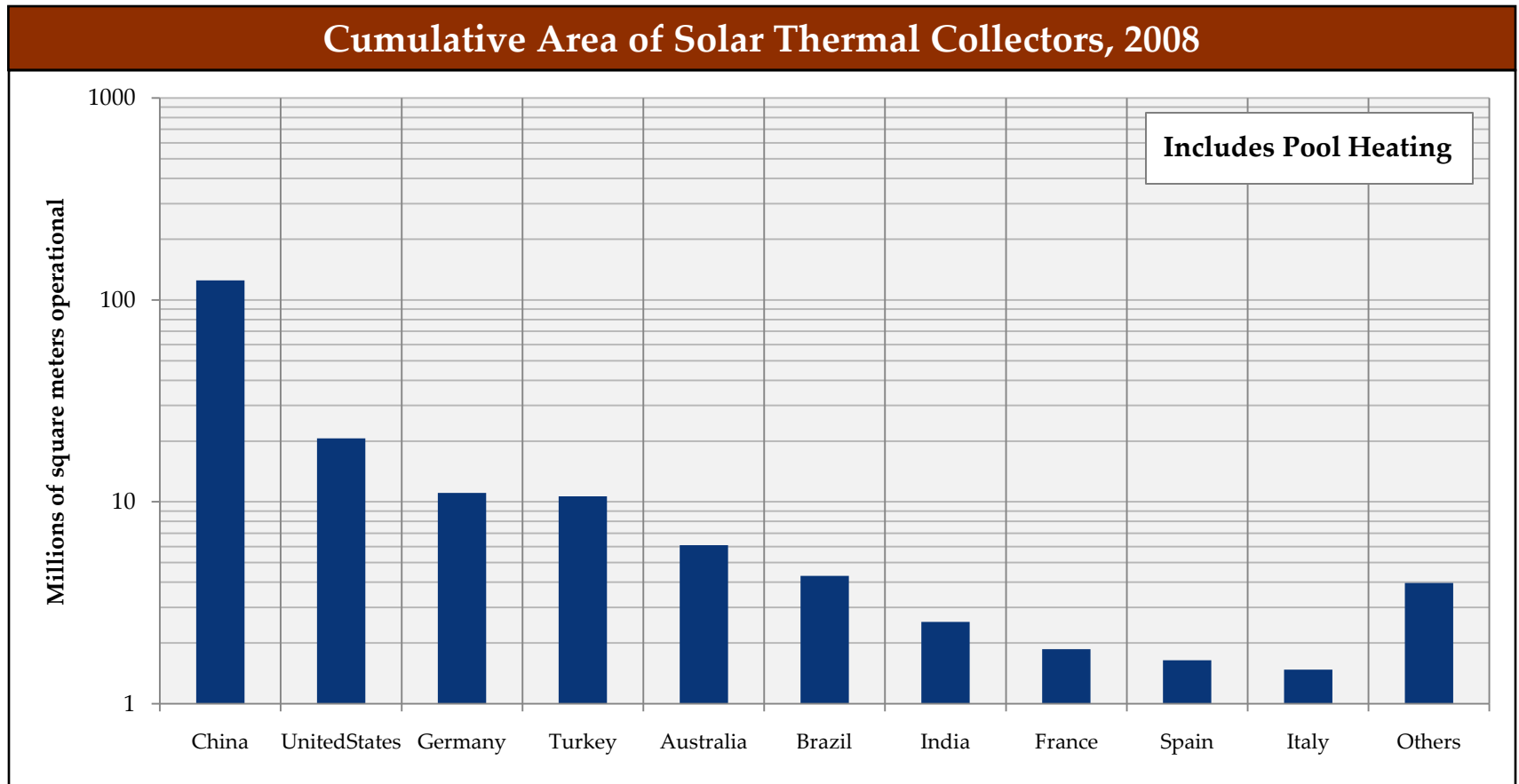
Europe is the largest SWH market with nearly half (\$6 billion) of the global SWH market value.



Source:

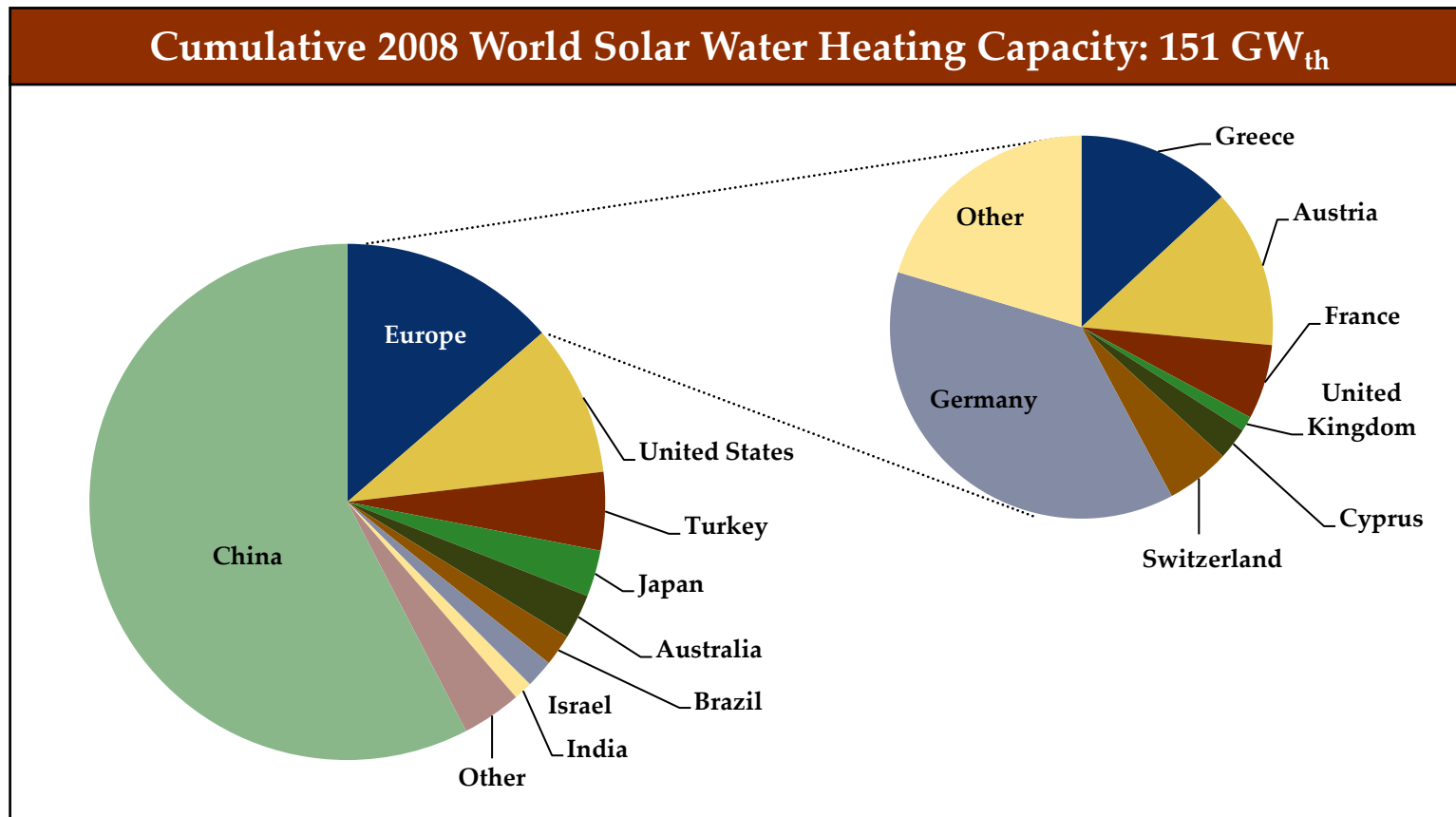
1. International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008, Edition 2010*. May, 2010.
2. Sensors Report, 2008. <http://www.mdpi.org/sensors/papers/s8021252.pdf>
3. NCI analysis

China leads with respect to operational square meters of SWH collectors.



Source: International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008, Edition 2010*. May, 2010.

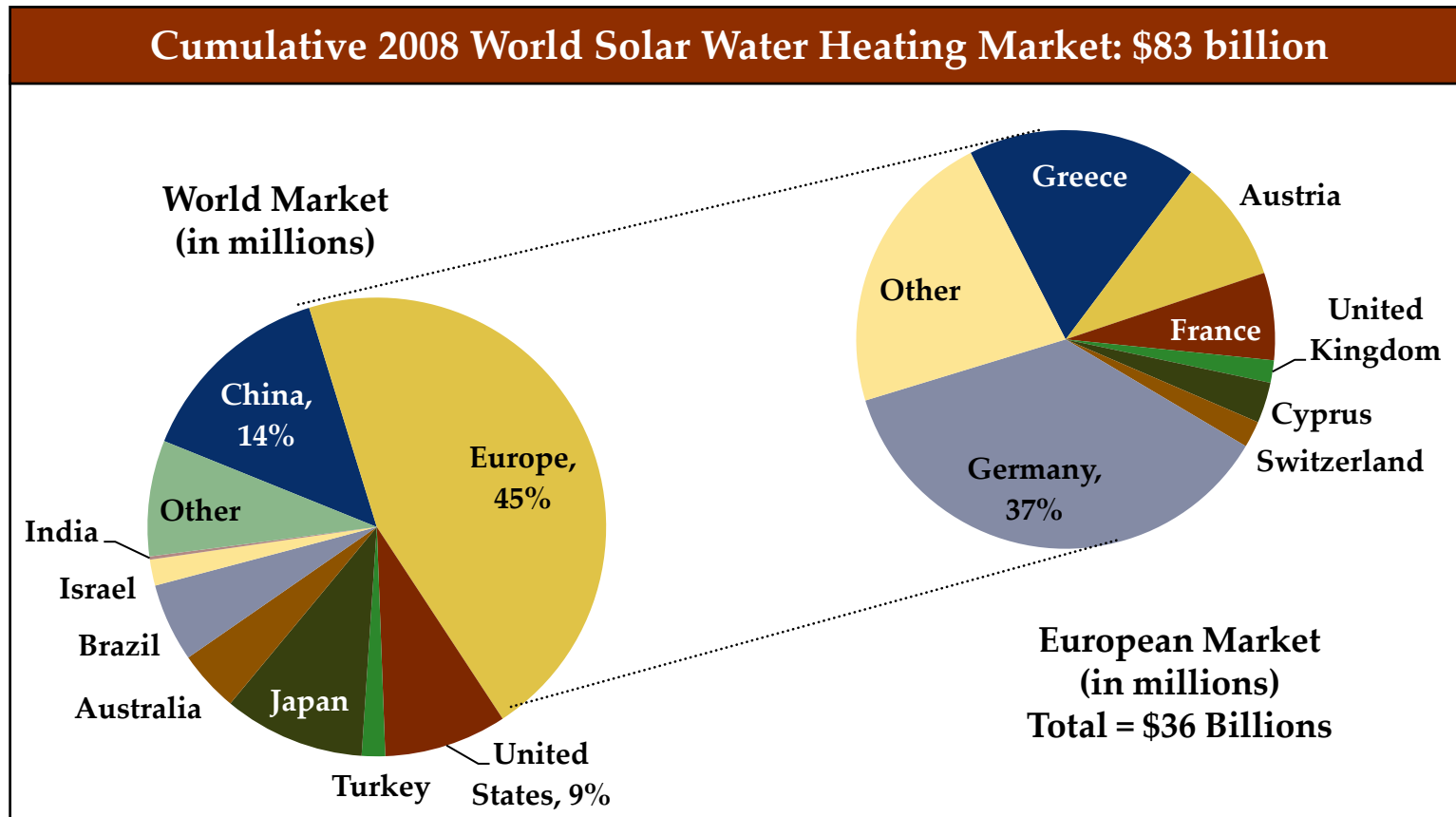
China, with low cost installations, has roughly 2/3 of global capacity.



Source: International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008*, Edition 2010. May, 2010.

Note: At the time of the writing of this report, complete global 2009 data was not yet available

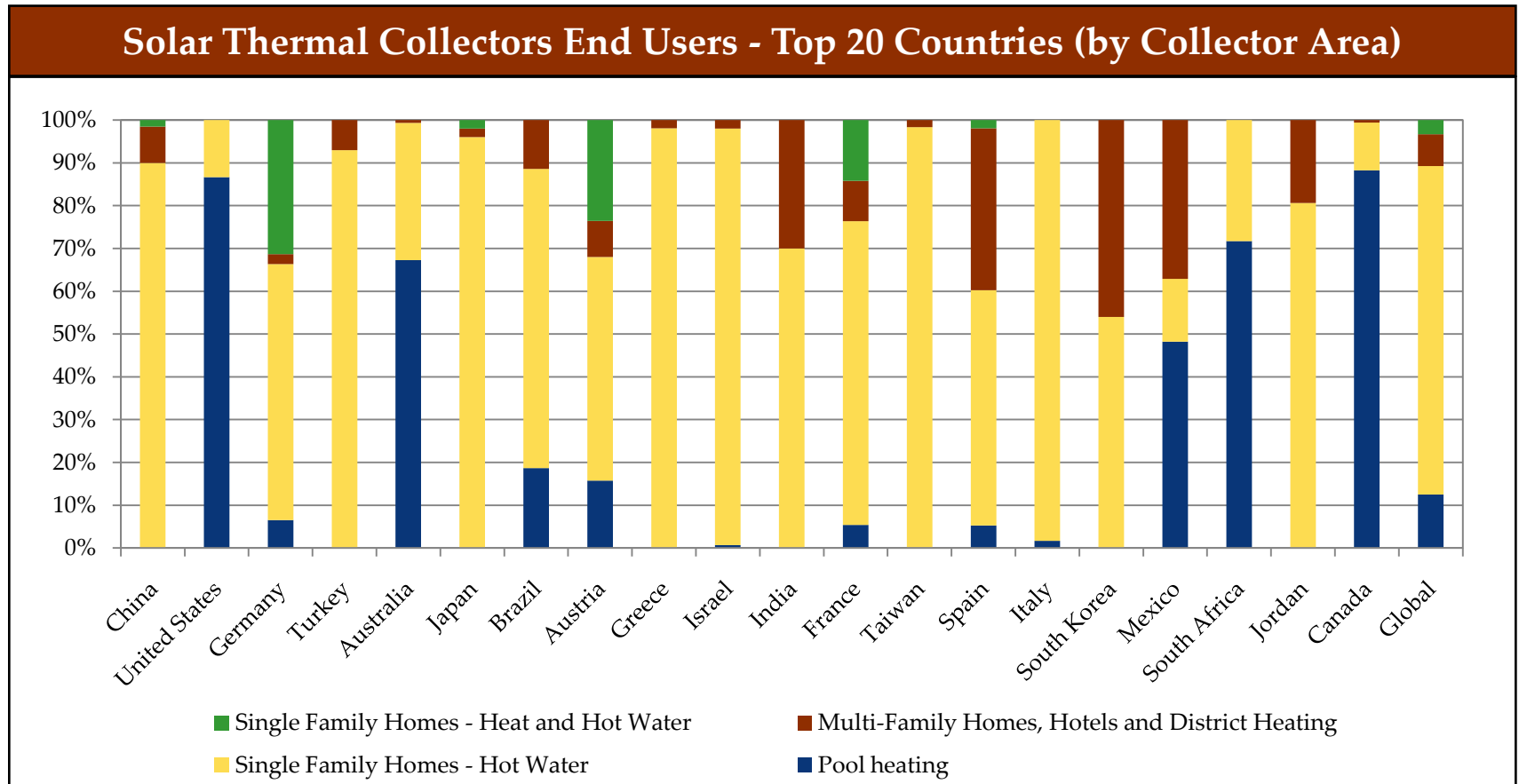
Europe is the largest SWH market (\$36 billion cumulative sales) with nearly half of the global SWH market value.



Source:

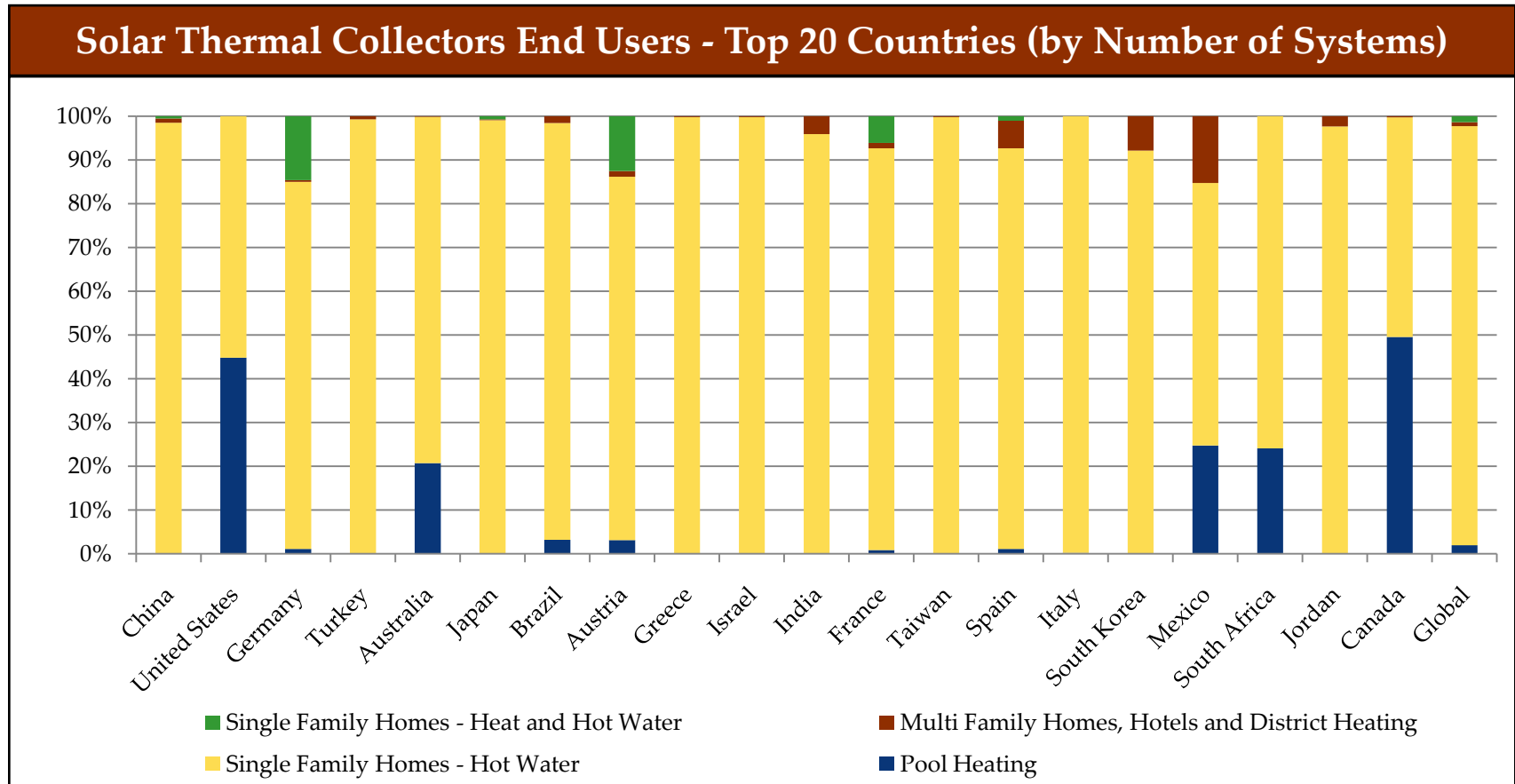
1. International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008, Edition 2010*. May, 2010.
2. Sensors Report, 2008. <http://www.mdpi.org/sensors/papers/s8021252.pdf>

The majority of solar thermal collector area is used for single family houses. The U.S. market is dominated by pool systems.



Source: International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008, Edition 2010*. May, 2010.

Most installed systems are single family home SHW systems which dominate the global market.



Source: International Energy Agency Solar Heating and Cooling Programme, *Solar Heat Worldwide – Market and Contributions to the Energy Supply 2008, Edition 2010*. May, 2010.

Notes: This assumed that the Average sizes of the systems were: 150 sqft for SFH – Heat and Hot Water; 500 sqft for Multi Family Homes, Hotels and District Heating; 50 sqft for SFH – Hot Water; and 400 for Pool Heating

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry <ul style="list-style-type: none">U.S. MarketGlobal MarketDrivers/BarriersEconomics
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

A variety of drivers influence global SWH markets....

Key Drivers	Incentives	<ul style="list-style-type: none"> To counter high paybacks* in some areas, governments have established capacity-based (i.e. \$/kWth) or performance-based (i.e. \$/kWhth or \$/MMBtu) incentives to encourage adoption.
	Regulation	<ul style="list-style-type: none"> Several jurisdictions (e.g. Hawaii, Israel, and Spain) have created SWH regulations, often taking the form of building code requirements that SWH be included in a certain percentage of new construction.
	Marketing	<ul style="list-style-type: none"> To counter lack of consumer awareness, governments or national trade groups have conducted large marketing campaigns, for example in Austria.
	Lack of Infrastructure	<ul style="list-style-type: none"> Rural areas in some countries have no access to electricity or natural gas for water heating, so SWH systems are the only option for domestic hot water (beyond boiling over a fireplace).

* Given large variations in price and insulation levels around the world, some markets have relatively short payback periods without incentives.

.... But they are countered by several barriers.

Key Barriers	Consumer Awareness	<ul style="list-style-type: none"> • Most consumers are not aware that SWH is an option for their home or business – they mostly associate “solar energy” with photovoltaics.
	Labor Supply	<ul style="list-style-type: none"> • SWH installation requires skills of plumbers and roofers, but many contractors are not trained in both.
	Economic	<ul style="list-style-type: none"> • Water heaters are typically replaced when one breaks. Since the building owner is not expecting this expense, they opt for a regular water heater with a lower up-front costs (~\$1,000 vs. ~\$6,000). • Many potential customers focus solely on pay back and these are greater than 7 years in most of the US.
	Regulations	<ul style="list-style-type: none"> • Many incentive programs require system level SRCC OG-300 certification in the U.S.: <ul style="list-style-type: none"> - The certification is for a fixed set of components, so an installer would have to get certification for every variation in component choice. - The certification process currently takes 12 to 18 months.

Improving economics have driven success in the past.

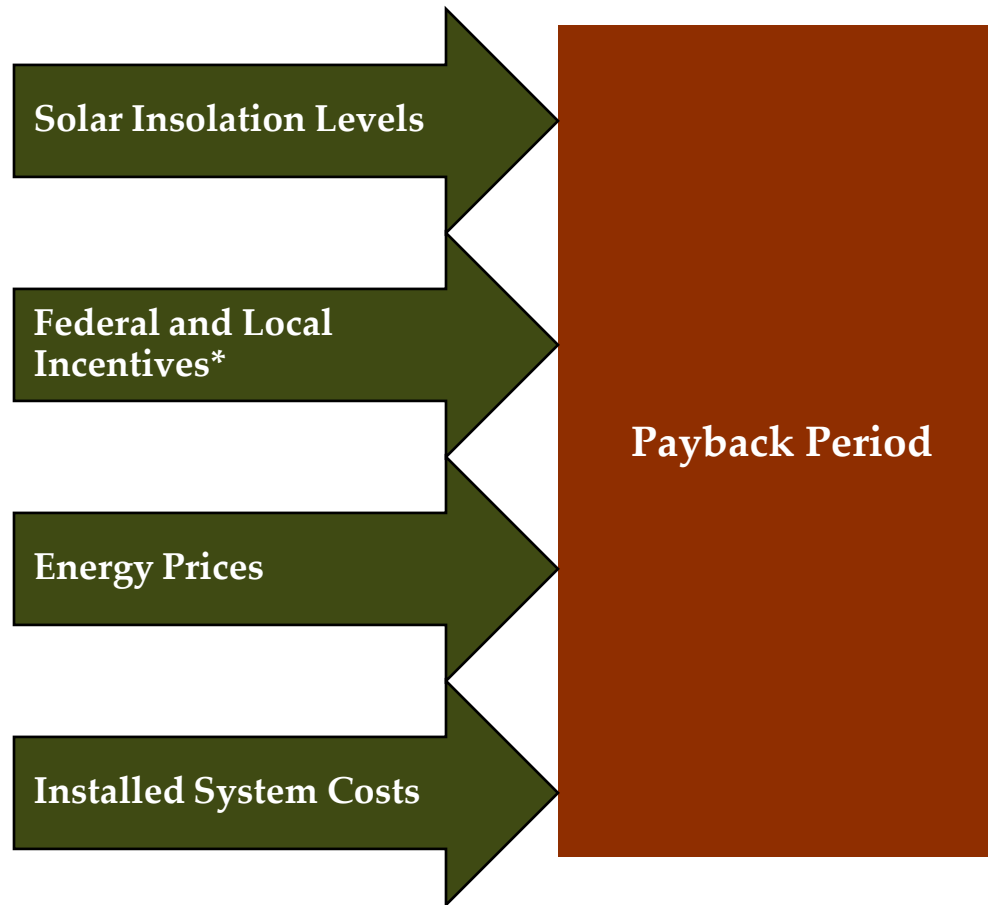
SWH Industry Reasons for Past Successes		
	Success Factors	Reasons
Solar Water Heating	<ul style="list-style-type: none"> • Incentives • High Electricity Prices • High Insolation 	<ul style="list-style-type: none"> • SWH adoptions has been successful in places where a combination of high energy costs, high insolation, and attractive/long-term incentives exist. • Payback is most attractive in places were water is heated using electricity, as it is more expensive than natural gas.
Solar Pool Heating	<ul style="list-style-type: none"> • System Cost 	<ul style="list-style-type: none"> • Pool heating economics are more favorable than for SWH. Recirculation pumps are included in most pools, so one simply has to pay for a few un-shaded collectors (1/2 – 1 times the pool area) to obtain 3-4 year simple paybacks. • However, solar collectors are 10 times more expensive than electric heaters. This high up-front cost limits market penetration. • Solar pool heating systems do not qualify for the federal investment tax credit.

Below are some expected market trends for SWH.

Expected SWH Market Trends	
Increased Commercial Systems	<ul style="list-style-type: none"> • Larger commercial projects are expected to increase over the coming years. • Funding from the American Recovery and Reinvestment Act (ARRA) is being used to finance many energy efficiency and alternative energy generation projects. While these projects are typically larger government or public facilities, ARRA funds are likely to impact the industry only in the short term until funds are depleted. • As system prices decrease and the SWH industry matures, project economics will become more attractive. • The market will depend on available financing for projects
Reduced Natural Gas Prices	<ul style="list-style-type: none"> • Natural gas (NG) prices drive electricity prices. Current forecasts are not as high as several years ago as a result of shale gas. Lower NG prices may not increase electricity prices as much as once expected. • Carbon tax or cap and trade could lead to an increase in electricity prices.
Reduced SWH System Prices	<ul style="list-style-type: none"> • As the industry matures and manufacturing volume grows, prices are likely to decline. • Streamlining installation cost and time is expected as installers gain more experience. Innovative components and preassembly will also reduce cost.
Stricter Incentive Reporting Requirements	<ul style="list-style-type: none"> • More states may adopt strict incentive reporting requirements, similar to HI and CA. These programs require the system be inspected and approved before paying out rebates. • In the short term this may hinder market adoption as some installers may not want to risk failing inspections. • In the long term this will result in higher quality and better design installations.

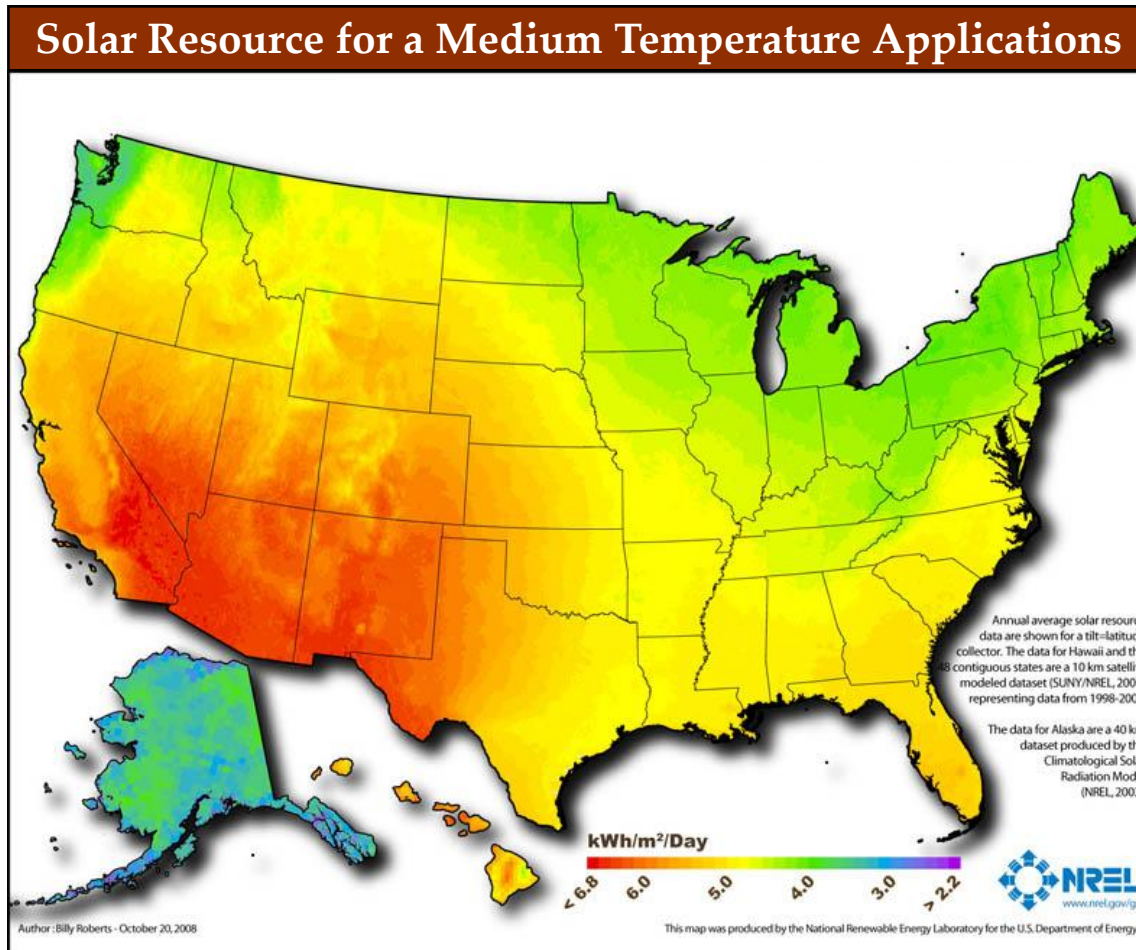
1	Introduction
2	Milwaukee Area SWH Opportunities Analysis
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry <ul style="list-style-type: none">U.S. MarketGlobal MarketDrivers/BarriersEconomics
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

Most consumers evaluate SWH purchase decisions on payback period and 4 variables dominate payback periods.



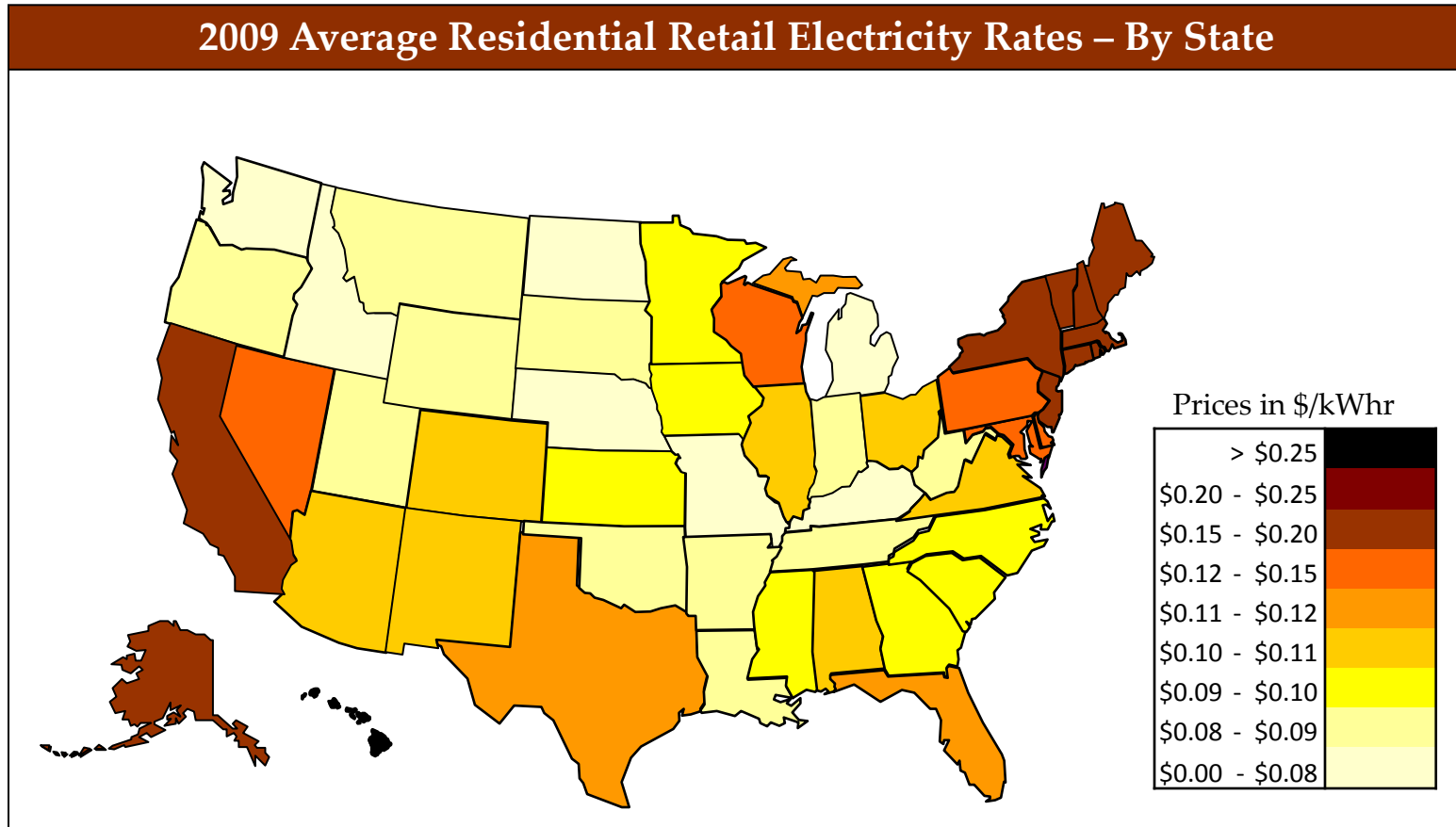
* Federal and Local Incentives are discussed earlier in this section.

The southwestern U.S. has the best solar resources for SWH systems.



Source: National Renewable Energy Laboratory

Hawaii has the highest residential electricity price in the U.S.; New England, California, Texas, Nevada and Alaska follow.

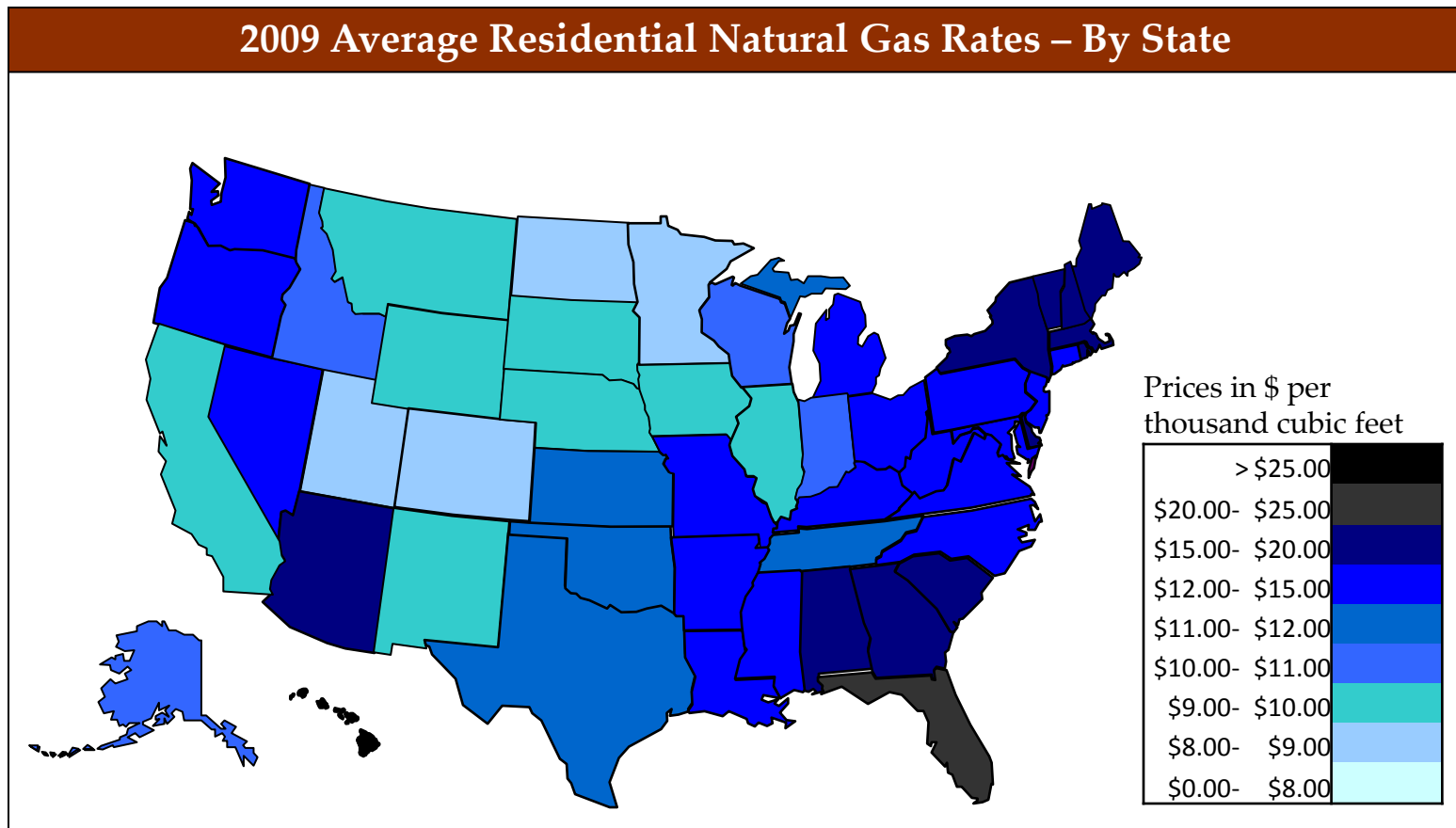


*Rate averages are year-to-date as of May 2010.

Source: EIA http://www.eia.doe.gov/cneaf/electricity/epm/table5_3.html

Note: NCI used residential electricity prices as a proxy for commercial natural gas prices as well.

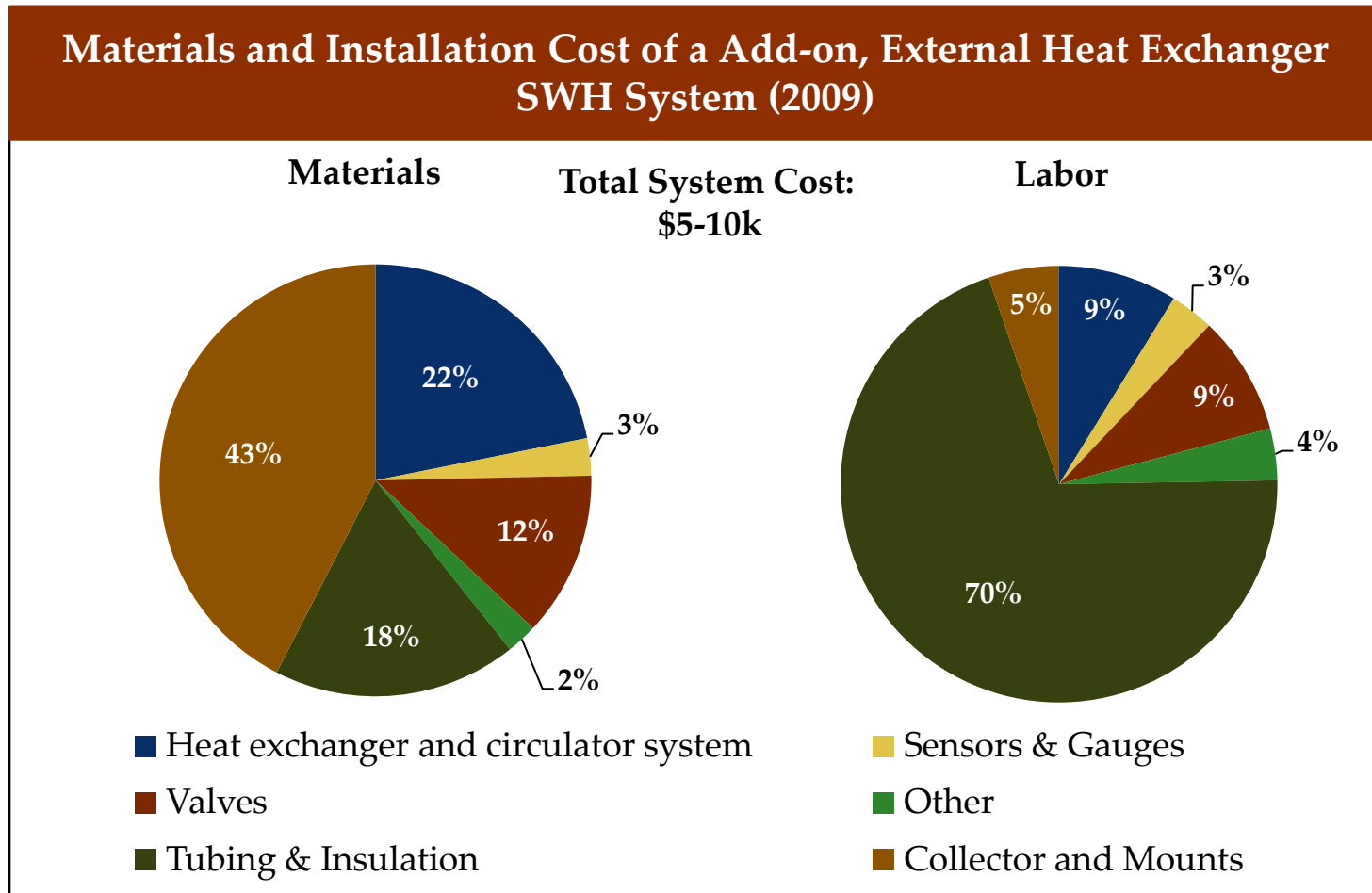
Hawaii has the highest residential natural gas prices in the U.S.; Florida, Alabama, Georgia, Arizona and northeastern states follow.



*Source: Reflects most recently available EIA data by state. Where 2009 data was not available (DE, FL, KY, NH and OH), 2008 data was used. http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_a_EPG0_PRS_DMcf_a.htm

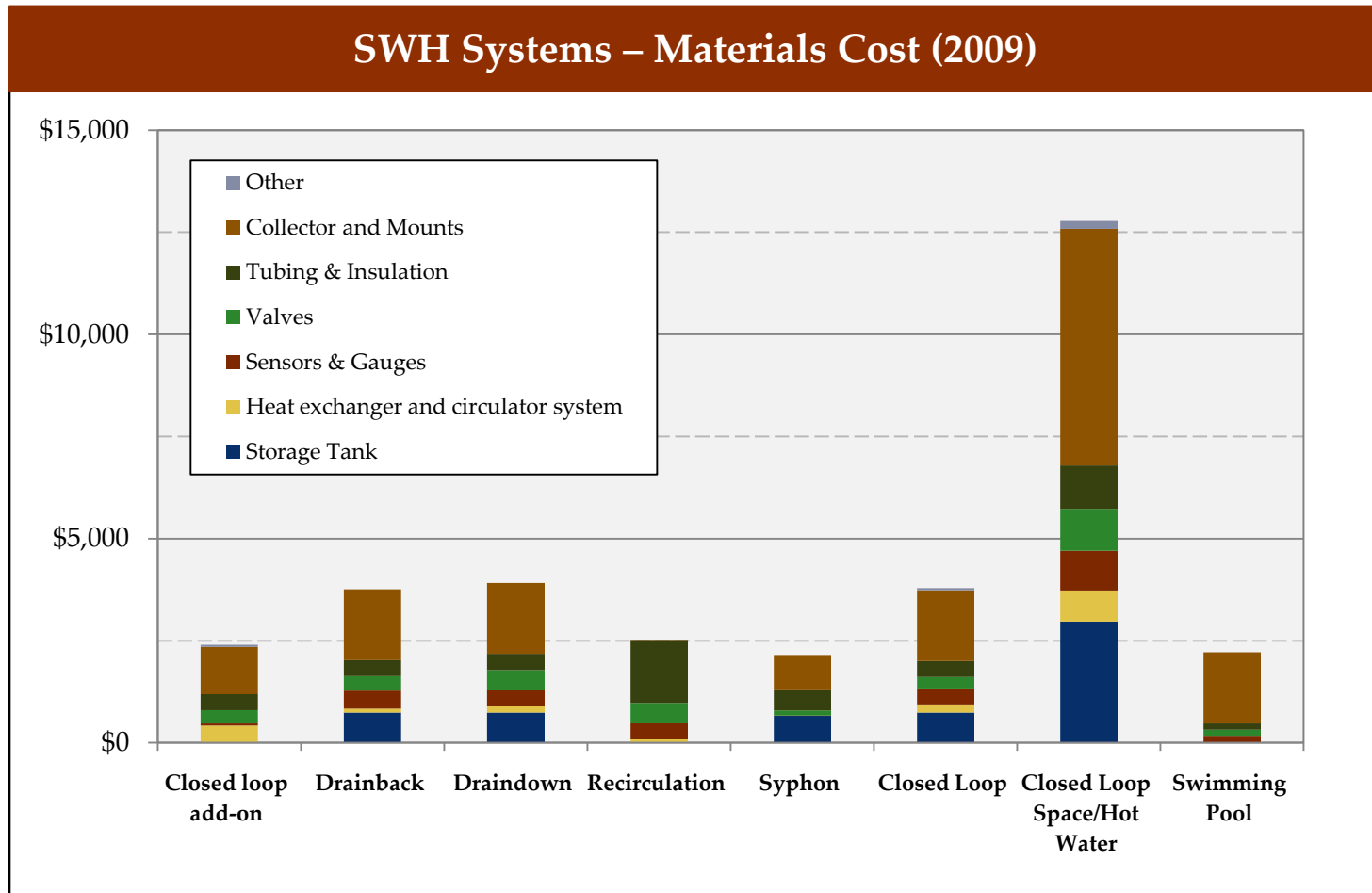
Note: NCI used residential gas prices as a proxy for commercial natural gas prices as well.

System costs vary and are generally between \$5-10k. The majority of costs are in the collector and installation of the tubing and insulation.



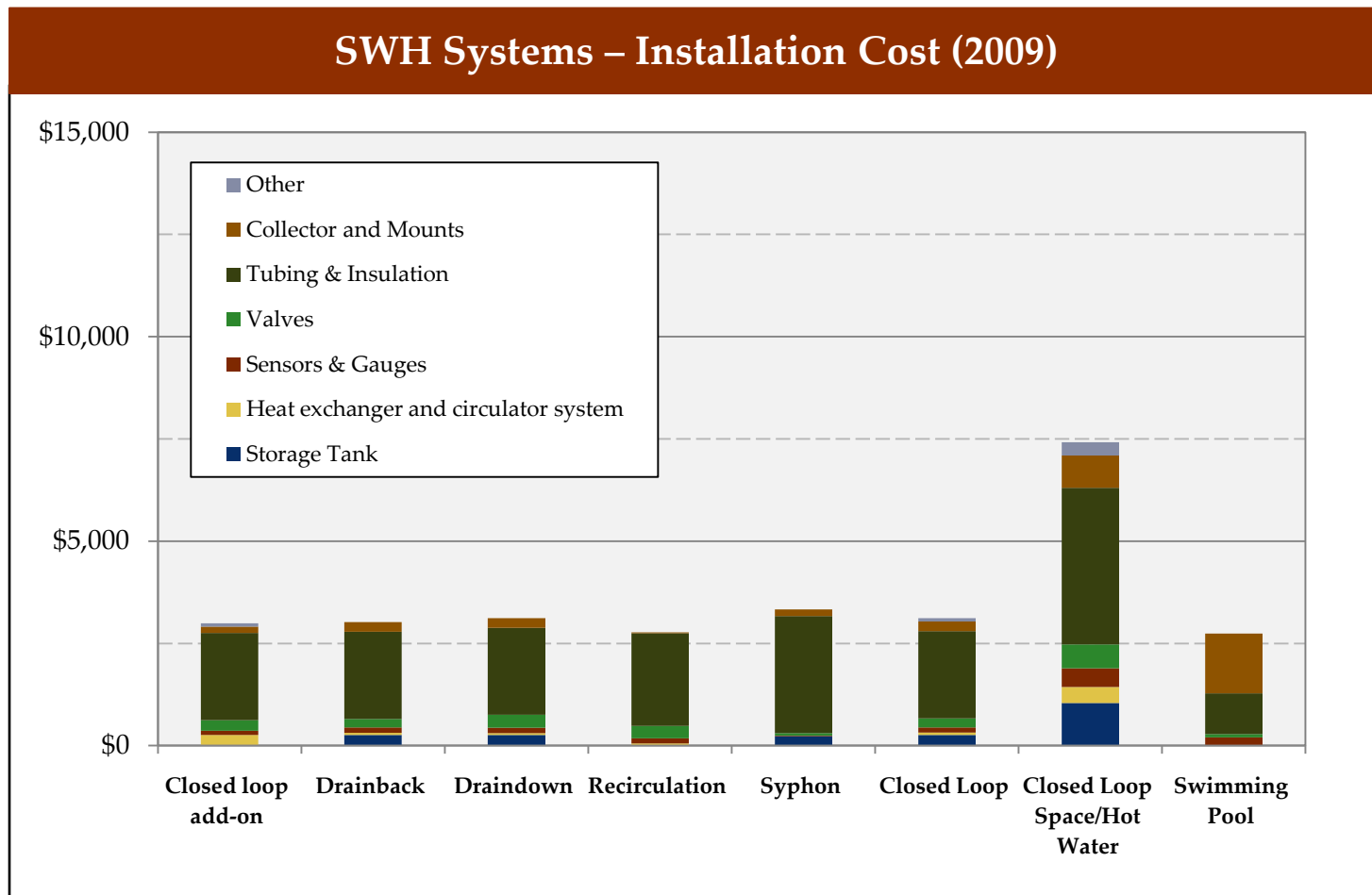
Source: RS Means and NCI Analysis
 System Size: 40sqft; 80 gallon tank

The collector and mounts are the largest materials costs.



Source: RS Means, CSI database, NCI Analysis

Assembling and joining tubing and insulation are the largest installation costs.



Source: RS Means, CSI database, NCI Analysis

The focus area for cost reductions has been the installation of tubing.

Top Methods of Cost Reduction

Pre-packaged systems

- In order to reduce the cost of installation, companies have begun creating pre-packaged pump and control systems or “pump stations”. This reduces the installation time as well as insuring quality construction. Currently, these types of systems are only available for antifreeze applications.
- Pool heating is such a large market in the US because it is cheap and because it consists of simple packaged systems that are easy to specify and install

Solder less pipe fittings

- With pipe installation as a significant portion of the total cost, it is an obvious target for cost reduction. Pipe manufacturers have created fittings that have a gasket that is compressed onto the pipes to form a seal. The seal is compressed using commercially available power tools. The fittings are expensive so they are mainly used on larger pipe applications.

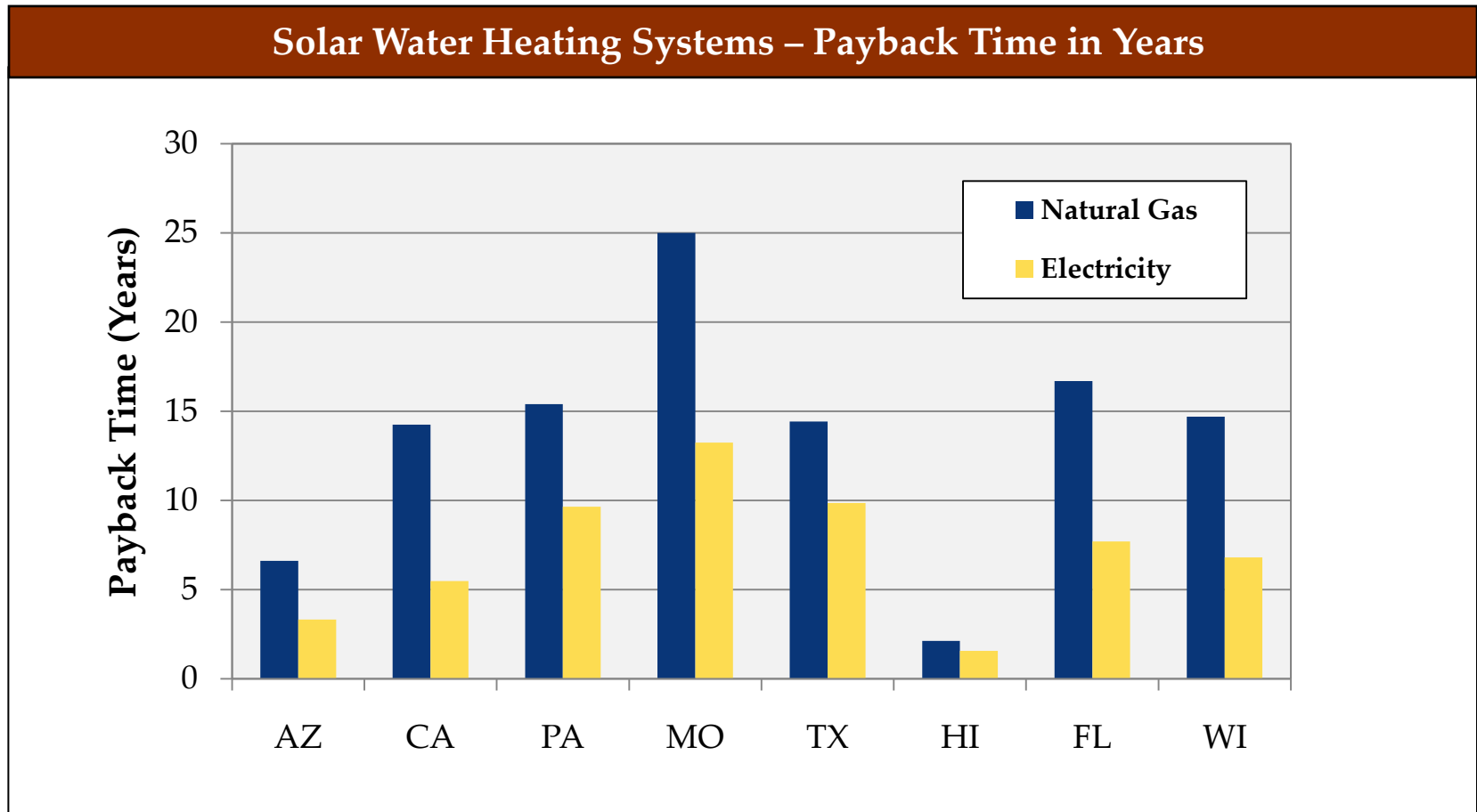
Flex Piping

- Flex piping typically consists of two flexible stainless steel tubes insulated and connected together with a sensor wire sandwiched in between. Flex pipe reduces the need for brazing rigid pipes making it easier to run piping through confined areas. This greatly reduces the installation costs of systems especially in retro-fit applications.

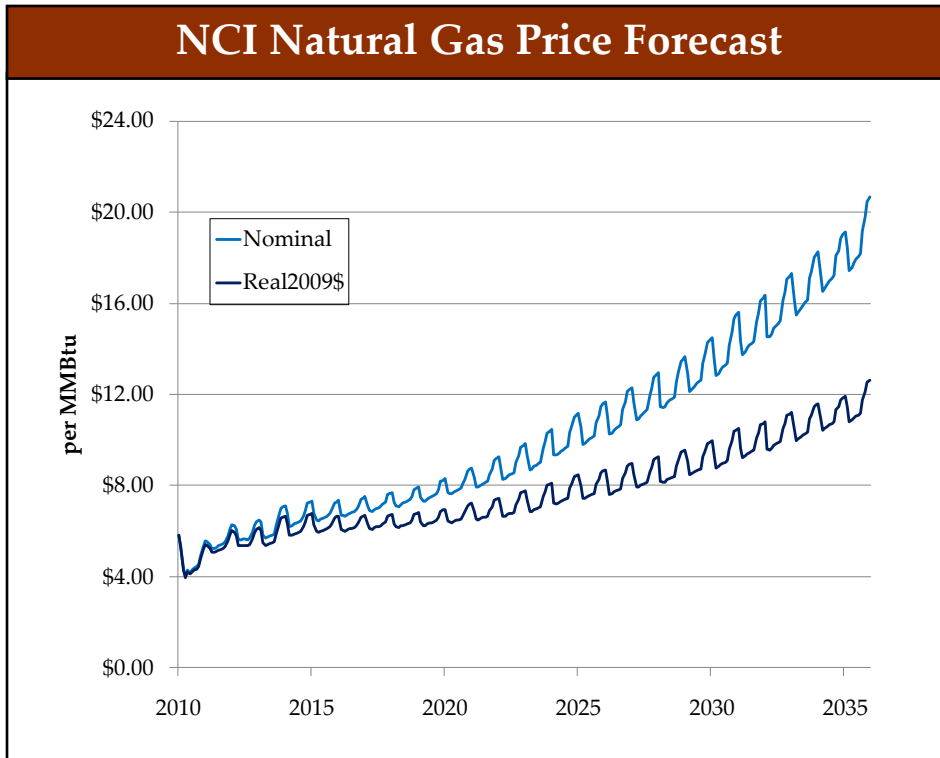


Source: NCI and SoloPro Magazine (SolarThermal and Streamlining)

Buildings with electric water heating in states that have high solar insolation and high electric rates will have the best payback with SWH.



Going forward, Navigant predicts NG prices are not likely to increase significantly over the coming years.

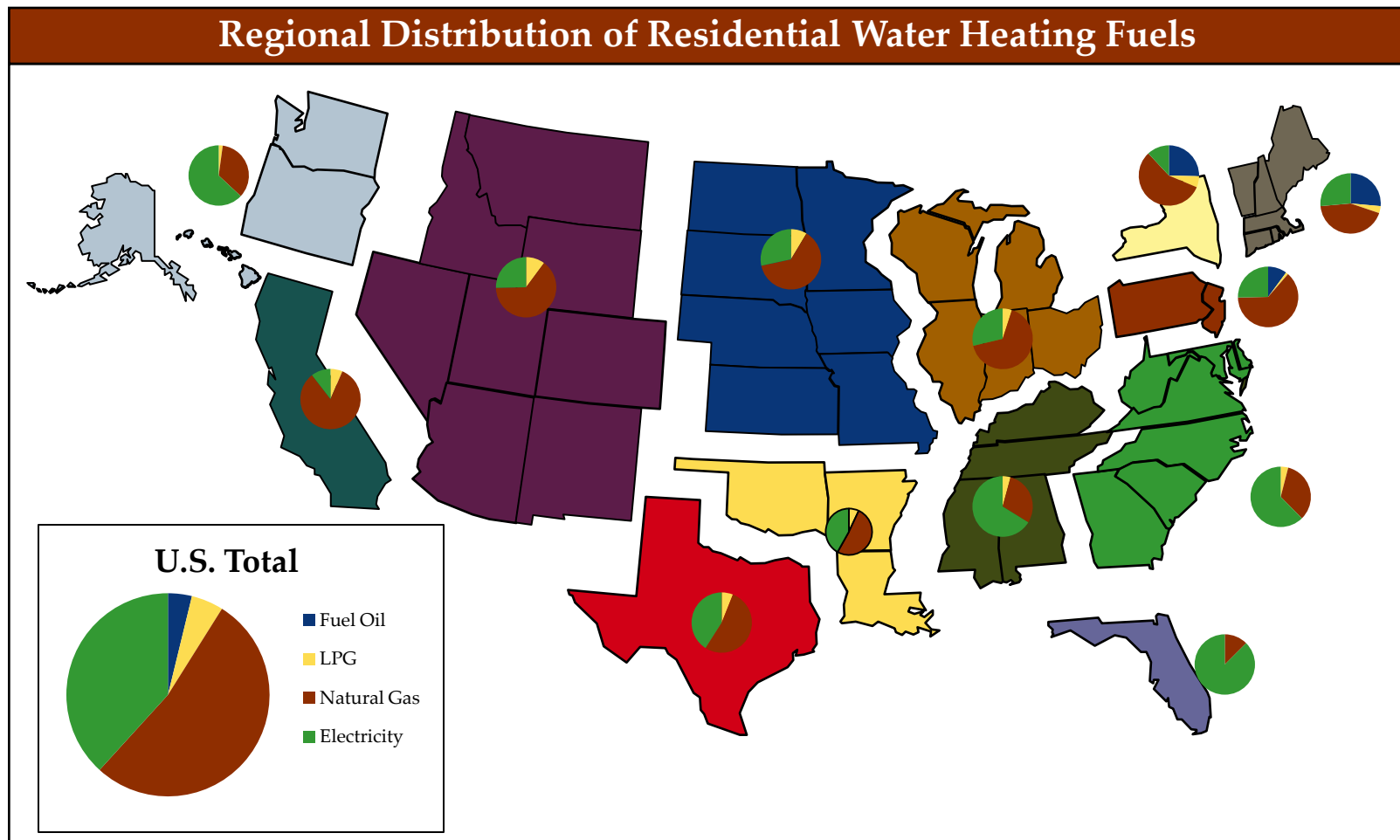


Source: NCI Natural Gas Price Forecast, Spring 2010

	Real 2009\$/MMBtu	Nom \$/MMBtu
2010 Q2	4.09	4.14
2010 Q3	4.28	4.37
2010 Q4	4.81	4.93
2010	4.57	4.65
2015	6.26	6.80
2020	6.66	8.01
2025	7.93	10.54
2030	9.44	13.87
2035	11.53	18.72

As a result, buildings with electric water heating will be more likely to adopt solar water heating going forward.

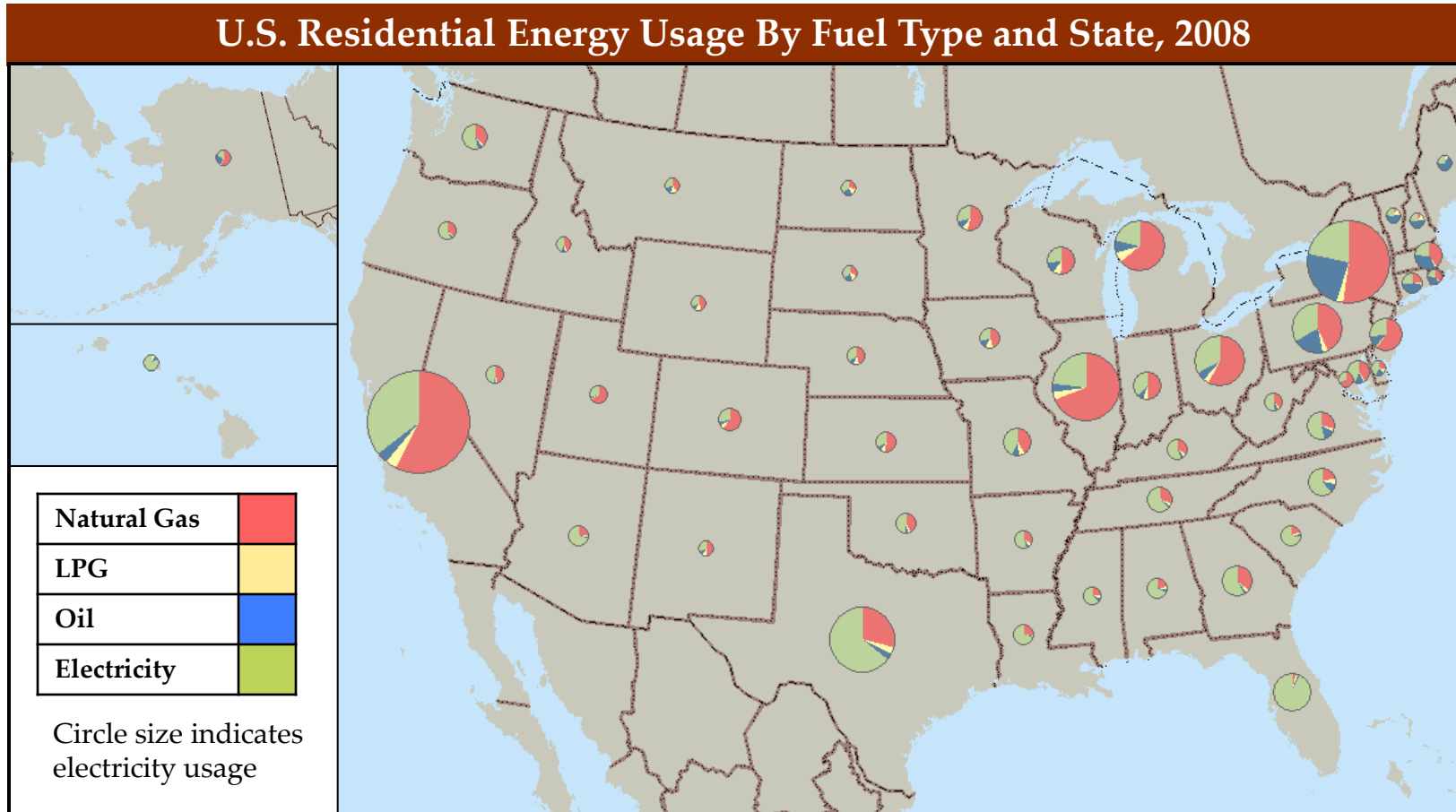
The Pacific Northwest, Southeast, New England* and Mid-Atlantic states have high proportions of electric water heating.



Source: EIA's 2005 Residential Energy Consumption Survey

* While New England does not have majority of residences with electric water heating, it has a high number of residences that use fuel oil and fuel oil is much more expensive than natural gas.

States with higher electricity usage are more likely to adopt SWH systems due to more favorable payback periods.



Source: Energy Information Agency

Electric water heaters users are far more likely to convert to SWH than NG heaters, due to the high cost of electricity.

Conclusions on SWH System Economics

- Buildings with electric water heating will have a better payback with solar water heating than buildings with natural gas fired water heating because of the relatively higher costs of electricity.
- Higher solar insolation results in a lower payback because more energy is generated per fixed cost investment.
- As a result, states with high electric rates, high solar insolation, and a large number of buildings with electric water heating will be good markets for SWH.
- Going forward, installed costs should fall, but natural gas prices will likely not rise enough to make buildings with natural gas fired water heating as attractive for SWH.

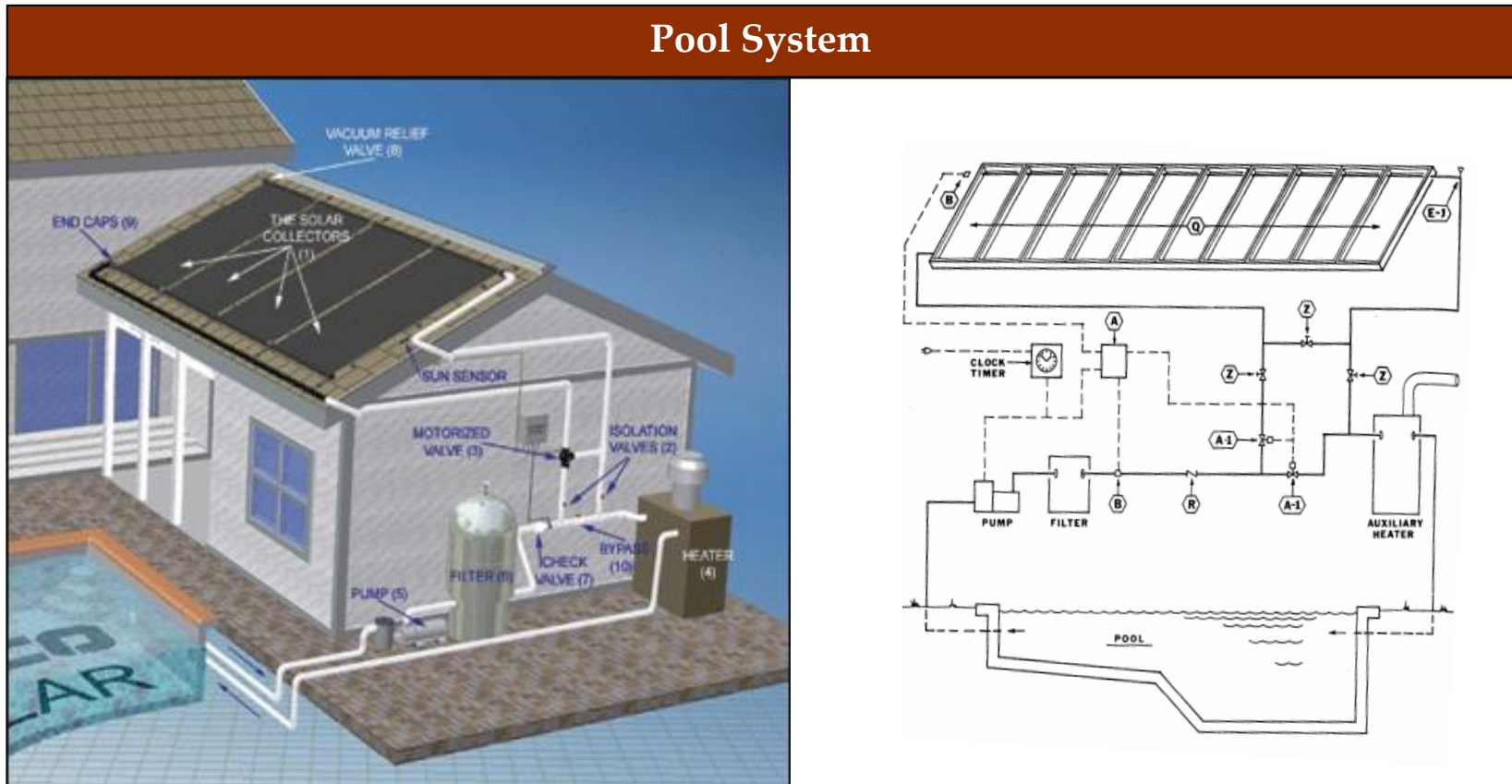
Table of Contents

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

There are six main types of solar thermal system architectures:

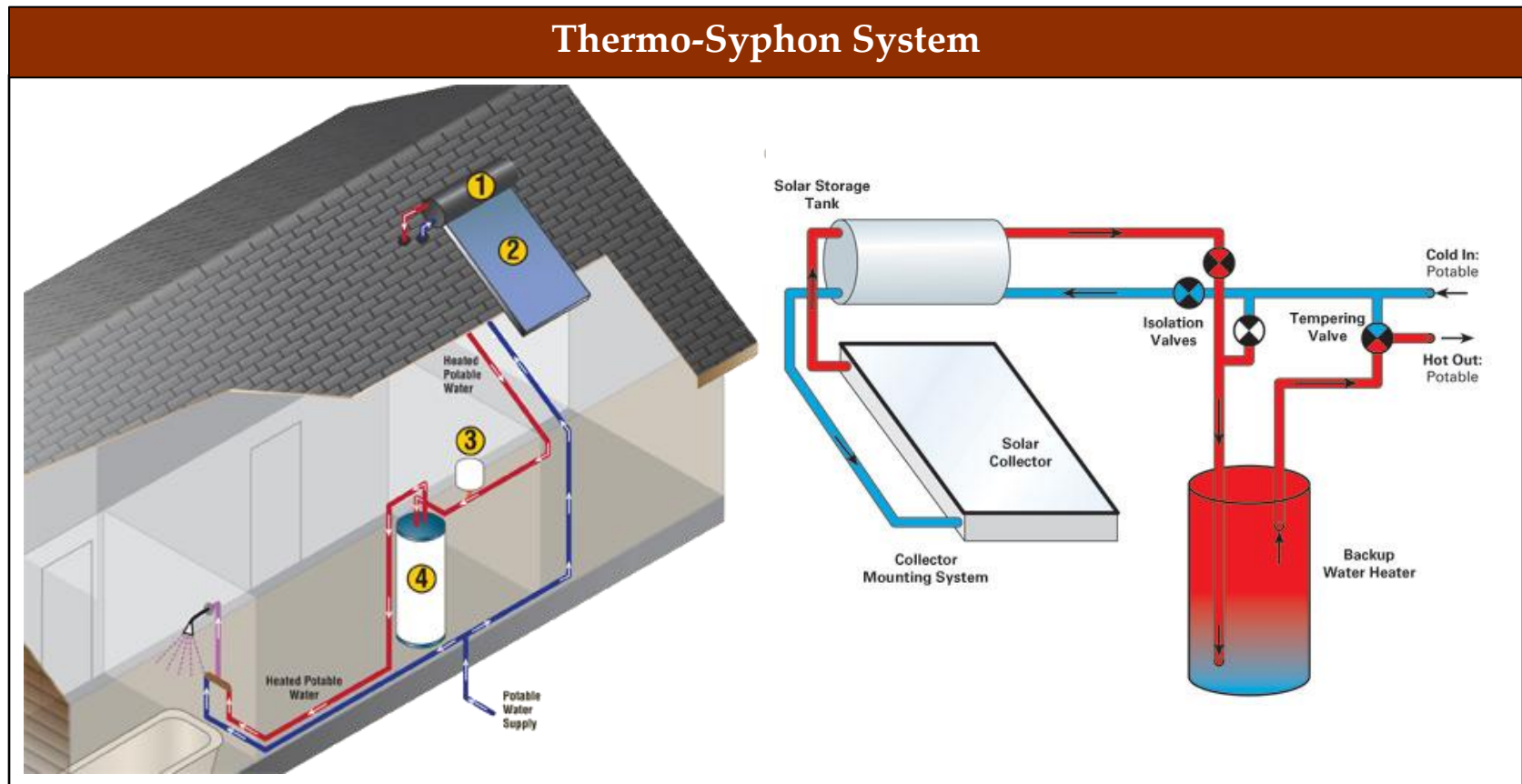
SWH – System Architectures	
Pool Heating	Large area collectors, with auxiliary heater and pump. The pool is the storage tank. The pool is drained in winter, so freezing is not an issue.
Batch – (or integral collector storage)	Light shines directly on the storage tank, which is the collector. Water moves via home water pressure.
Thermo-Syphon	Separate storage tank located above the collector. Water moves via thermal convection.
Open-Loop Direct	A collector feeds and heats water in a storage tank, preheating water fed to a backup water heater.
Pressurized Glycol	Same as open-loop direct, but the collector circuit uses glycol antifreeze and a heat exchanger to preheat the water in the storage tank.
Closed-Loop Drainback	Same as pressurized glycol, but instead of using antifreeze, the collector drains back to a reservoir to prevent freezing.

Solar Pool Heating systems are simple due to low temperature requirements and use of the pool as a drain-back tank.



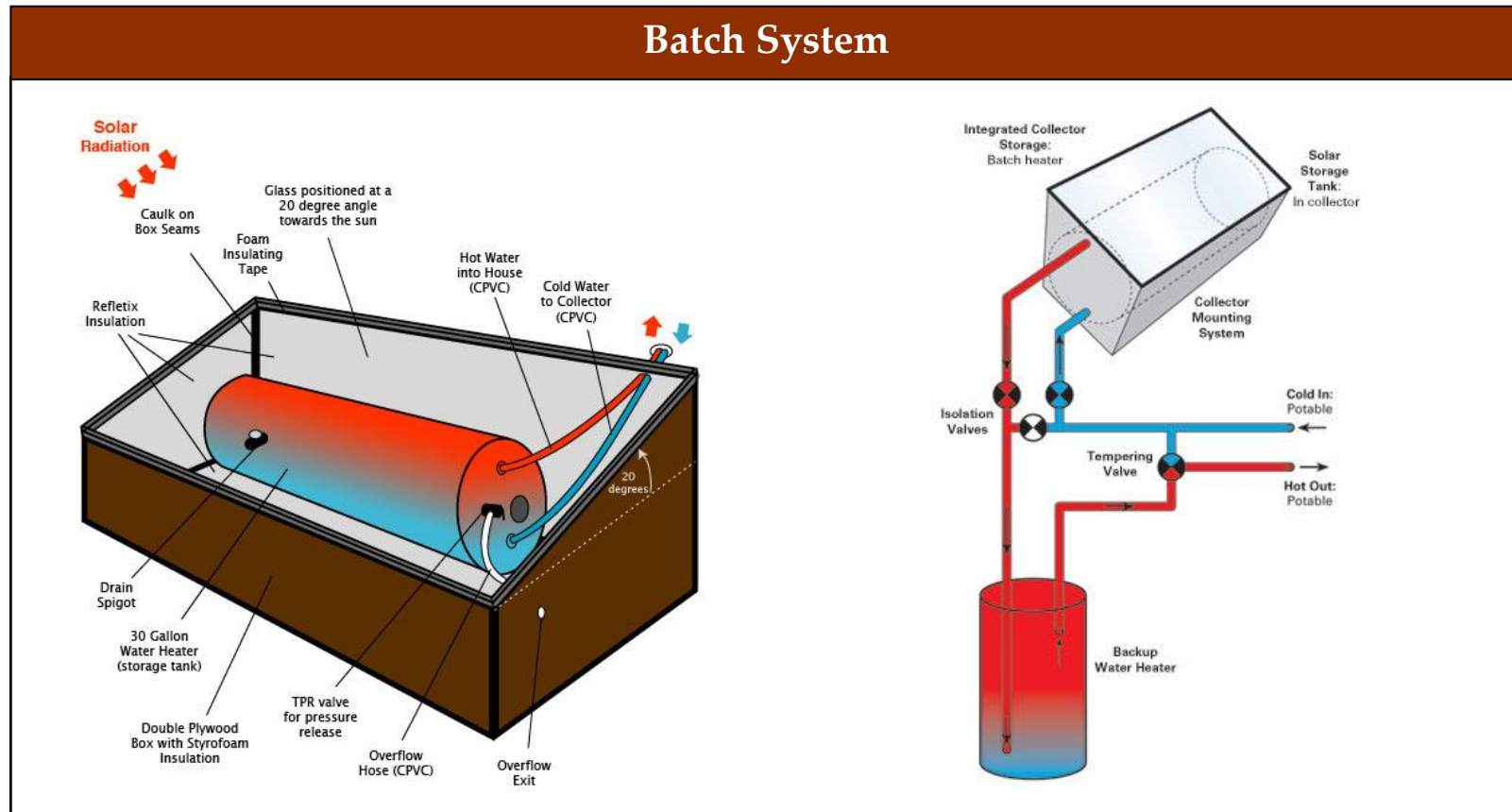
Source: Northern Lights Solar Solutions and RS Means

Thermo-Syphon Systems have achieved high market penetration in areas with high insolation and little risk of freezing.



Source: Homepower, June/July 2005; www.homepower.com

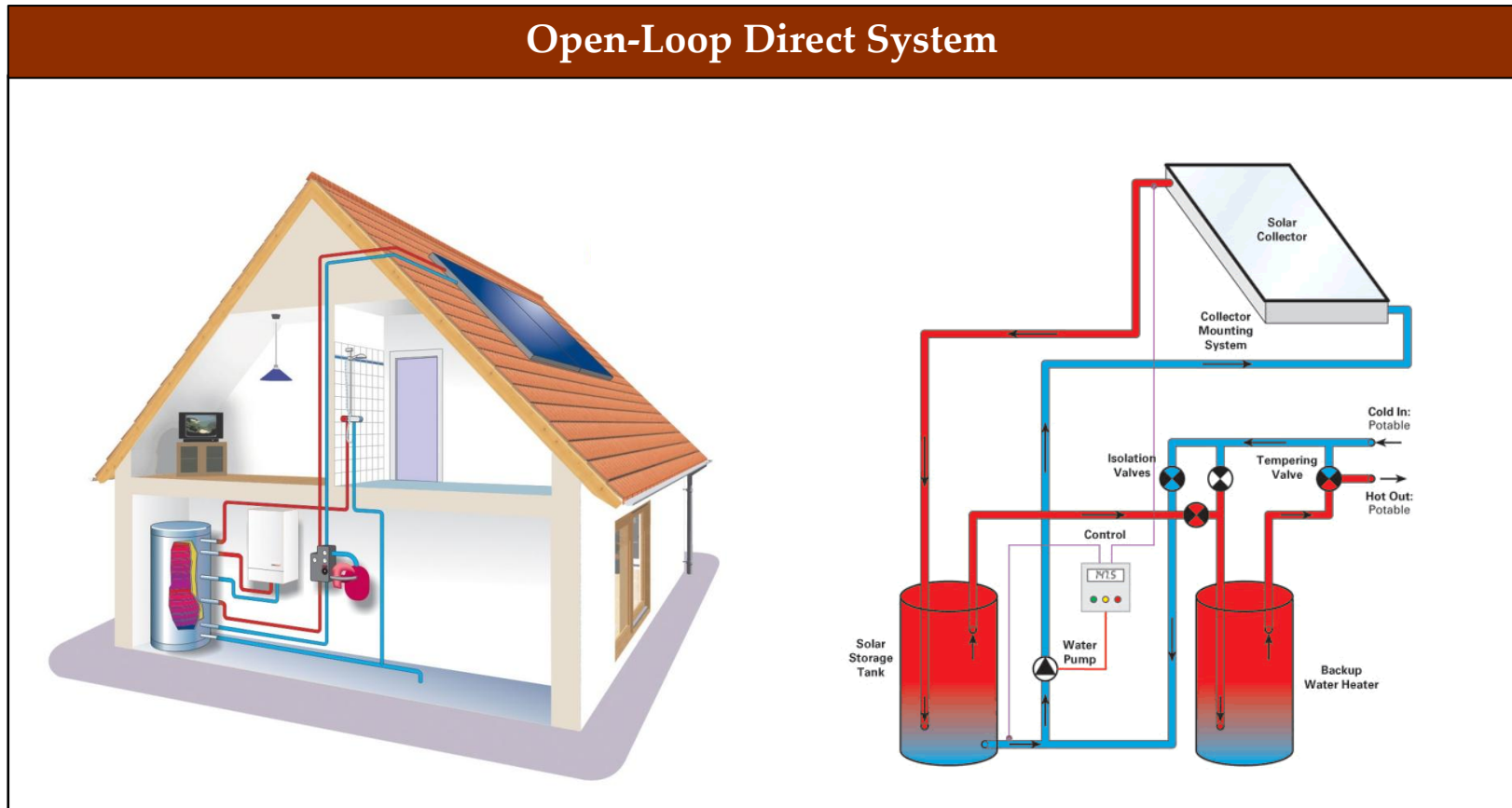
Batch systems are the lowest cost option, with the fewest components.



Source: Homepower, June/July 2005; www.homepower.com

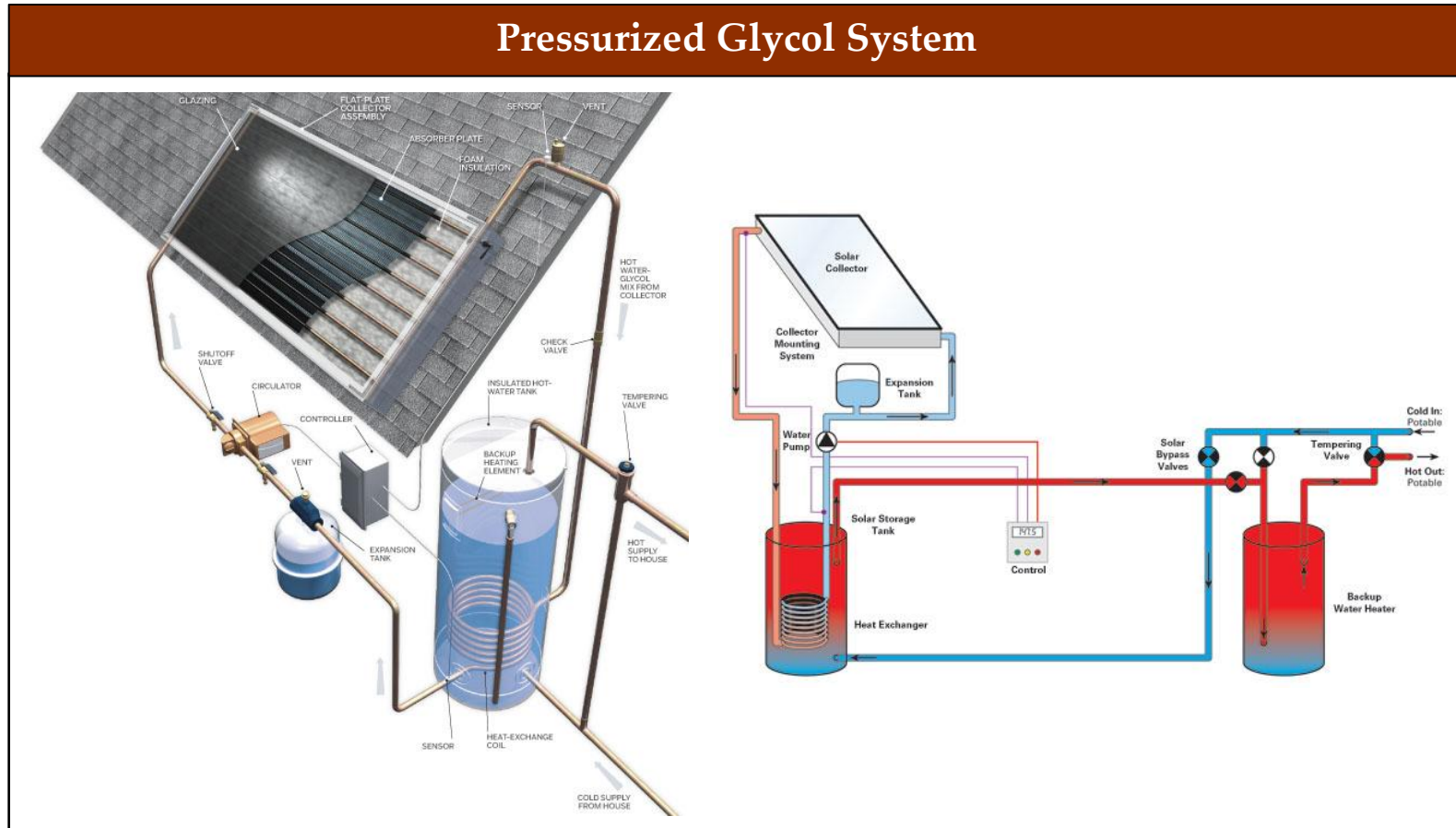
Batch systems have achieved strong market penetration in areas with high insolation and little risk of freezing; pumps are not used.

Open-loop Direct systems directly heat the water that is going to be used in the solar panels, eliminating the need for a heat exchanger.



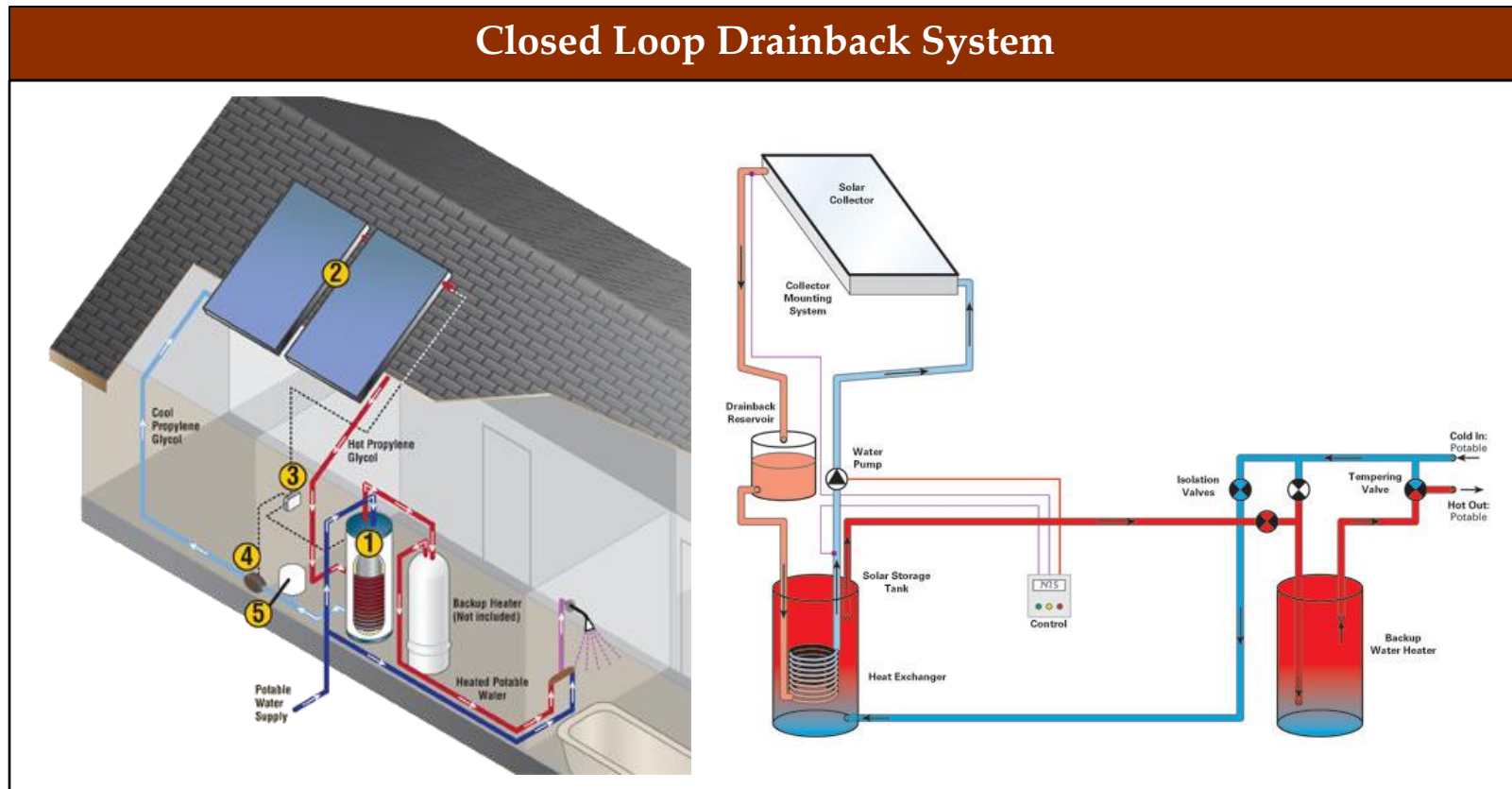
Source: homepower, June/July 2005; www.homepower.com

Pressurized Glycol systems are popular in regions with high risk of freezing, but lose efficiency due to a heat exchanger.



Source: homepower, June/July 2005; www.homepower.com

Closed Loop Drain-back systems are similar to pressurized glycol—except that water drains to an insulated reservoir to prevent freezing.



Source: homepower, June/July 2005; www.homepower.com

Weather tends to dictate the costs and complexity of the systems.

System Type	Strengths	Weaknesses
Pool Heating	Simple, cheap	Low temperature, inefficient
Batch	Cheap, energy efficient	Warm weather only
Thermo-syphon	Cheap, energy efficient	Warm weather only
Open-loop Direct	Cheap	Warm weather only
Pressurized Glycol	Cold weather compatible	Expensive, complicated
Closed-loop Drain-back	Cold weather compatible	Expensive, complicated

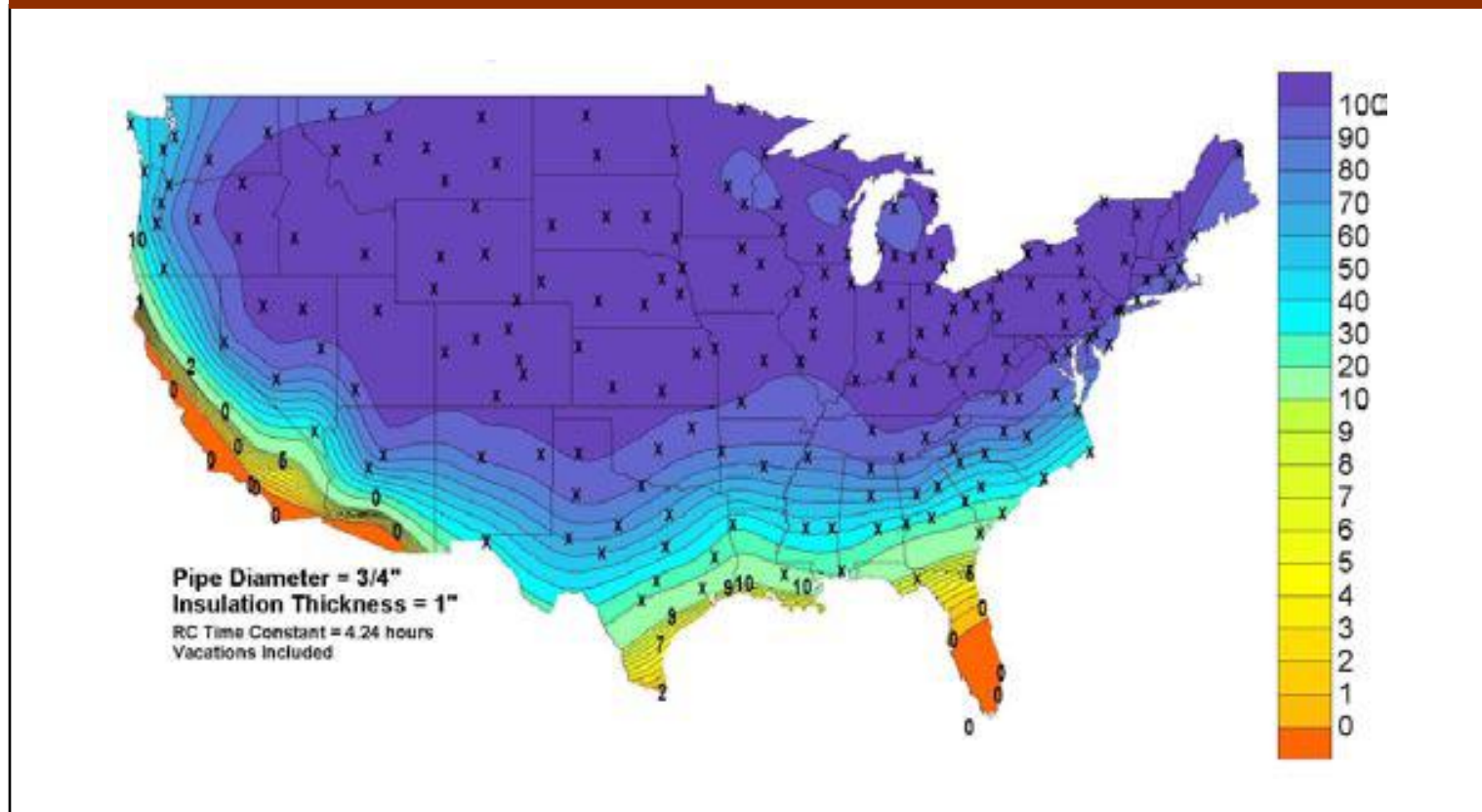
Source: NCI 2008. Analysis done with representative systems using SRCC performance data.

Cold weather systems prevent exposed areas of the systems from freeze failure at the cost of complexity and price.

Climate Variations	
Cold Weather Systems	<p>Purpose: Prevent the freezing and failure of exposed areas of the system</p> <p>Types: Glycol and Drain back systems are the two main methods of preventing freezing</p> <p>Glycol Systems: These systems utilize a mixture of propylene glycol and water to prevent freezing. The system uses a heat exchanger to deliver the heat to the potable water without contaminating it with glycol. The heat exchanger does hinder the performance of the system and adds to its complexity which increases the price.</p> <p>Drain Back systems: These systems can either be direct or indirect (heat the potable water directly vs. utilizing a heat exchanger). The system prevents freezing using a valve that drains the water out of the exposed areas when the temperature gets too low. The drained water is stored in a tank that is sheltered from the cold weather (usually indoors).</p>
Warm Weather Systems	<p>Warm weather systems tend to be much simpler and cheaper as there is not need to worry about freezing. These systems can utilize direct heating (no heat exchanger) which is more efficient and less complex. These systems tend are cheaper and easier to install.</p> <p>Batch or Thermo-syphon: These systems are popular in war weather areas due to their simplicity, low cost and efficiency. They do not utilize pumps which increases efficiency while also reducing costs.</p>

The majority of the U.S. would require a “cold weather” system that would prevent pipe freezing.

Probability One Pipe will Freeze in 20 Years



Source: Figure courtesy of Jay Burch of NREL.

Table of Contents

1	Introduction
2	Milwaukee Area SWH Opportunities Analysis
3	Milwaukee Area Case Study
4	The Solar Water Heating Industry
5	Solar Water Heating System Types
6	SWH Components and Supply Chain
7	Appendix

Most system architectures use a consistent set of components.

SWH System Components	Variants
Storage Tank	With heating element
	Without heating element
	With direct inlet
	With indirect coils
Heat exchanger	Plates
	Finned
	Copper tubing
Circulating pump	AC and DC
Manual valve shut off	
Thermostat	
Pressure Gauge	
Temperature gauge	
Zone control valve	
Pressure relief valve	
Expansion tank	
Overheat protection	
Drainback valve	
Drainback storage tank	
Collector	

SWH System Components	Variants
Collect mount	Flat plate glazed
	Flat plate unglazed
	Evacuated tube
Pipe	Copper tubing
	PEX
Insulation	
T, elbow and other fittings	
Control System	
All in one control, pump and valve unit	
Anti freeze	
Radiant heat tubing	
Mixing, tempering valve	
Air and dirt seperators	

Thermal systems use similar components to heat and store water.

Components	Types	Pool	Batch	Thermo-syphon	OL Direct	Press. Glycol	CL Drain-back
Solar Collector	Flat plate Evacuated tube ICS	X	X	X	X	X	X
Collector Mounting System	Roof Ground Awning	X	X	X	X	X	X
Solar Storage Tank	Insulated	Pool	X	X	X	X	X
Water Pump	AC DC (solar)	X			X	X	X
Heat Exchanger	Coil Pipe in pipe					X	X
Expansion Tank	Air bladder					X	
Controls	Thermostat	X			X	X	X
Isolation Valve	3-/2- port 3- bi-valves	X	X	X	X	X	X
Backup Water Heater	Tank Tankless	X	X	X	X	X	X
Tempering Valve	Mixing		X	X	X	X	X

Source: homepower, June/July 2005; www.homepower.com

Each component has a diverse set of suppliers.

2010 SWH Leading Component Manufacturers			
Collectors	Alternate Energy Technologies		A.O. Smith
	Corona		American
	Chromagen		Bradford White
	Heliodyne		Lochinvar Corp
	R & R Services		Radco Products Inc.
	Radco Products Inc.		Rheem
	Solahart		Richmond
	SunEarth		Ruud
	Solene		Solahart Industries
	Solar Skies		Solar Edwards
Pumps – AC and DC	Bell & Gossett		State Industries
	Grundfos		SunEarth
	Hartell		Heliotrope Thermal
	Ivan Labs Inc		Goldline Controls
	Laing Thermotech		SunEarth
	March Manufacturing		Caleffi
	Taco		PAW
	Bell & Gossett		
	Grundfos		
Storage Tanks and Heaters			
Pump Controls			

Leading US component manufacturers were compiled using authorized manufacturers for leading state incentive programs

A mix of domestic and international manufacturers supply the US market.

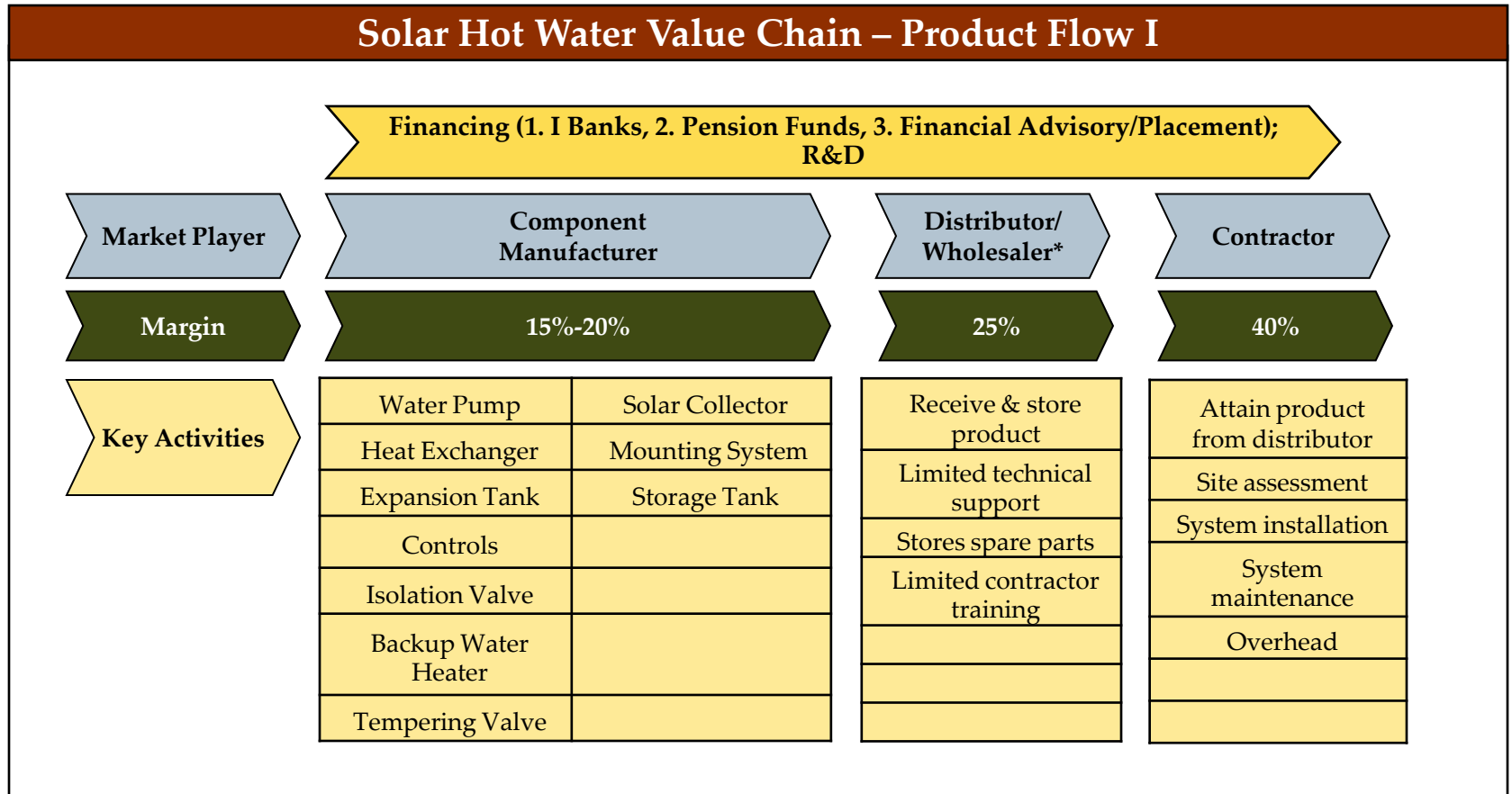
2010 SWH Leading Component Manufacturers				
Valves	American Valve		Piping Insulation	Aeroflex International
	Arrowhead Brass			Aramcell LLC
	B&K Industries			Bridging China International
	Cash ACME			Mueller Industries
	Erie Manufacturing Co			Namaco K-Flex
	Familian Northwest Inc		Temperature Gauges	Clifton Industrial
	Grundfos			Dasco
	Hammond Valve			Heliotrope General
	Heliodyne			Goldine Controls
	Mueller Industries			Grainger
	Nibco inc			Letro Products Inc
	Premier			Pasco
	Red-White Valve Corp			Winter's Thermogauges
	solar Edwards		Time Switches	BRK Electronics
	SunEarth			Intermatic Inc.
	Taco			M.H. Rhodes
	Watts Regulator			Paragon Electric
Webstone	Solahart			
Zurn/Wilkins	BRK Electronics			

Leading US component manufacturers were compiled using authorized manufacturers for leading state incentive programs

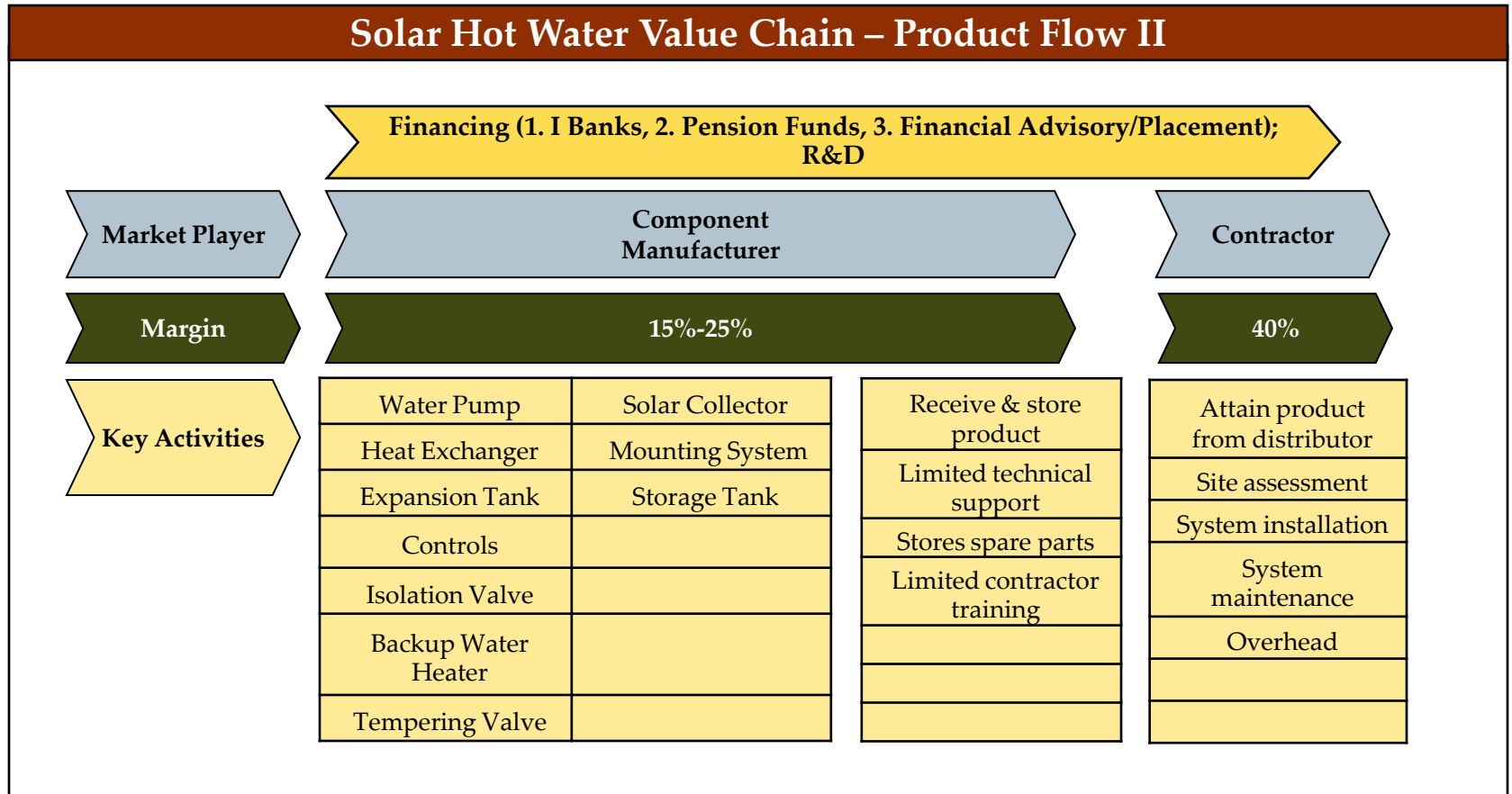
There are several ways SWH products flow to market, these depend on the maturity of the local market, project size, and customer type.

Solar Hot Water Value Chain – Product Flow	
Product Flow I	<pre> graph LR A[Component Manufacturer] --> B[Distributor/Wholesaler*] B --> C[Contractor] </pre>
	<p>This supply chain is found in more mature markets where channels to market have been established and product flows through distributors to the contractors.</p>
Product Flow II	<pre> graph LR A[Component Manufacturer] --> B[Contractor] </pre>
	<p>This supply chain is found in smaller, less mature, markets. In these markets product volume is low and distributors cannot afford to stock products. While channels to market are still being developed, manufacturers will sell directly to contractors.</p>
Product Flow III	<pre> graph LR A[Component Manufacturer] --> B[System Integrator] B --> C[Contractor] </pre>
	<p>This supply chain is found in larger, more complex, projects. System integrators may take roles of other market players such as contractors to increase margin. For example, larger system integrators may contract out specific component manufacturing or leverage own in-house installation capabilities and contract work to external installers only as needed.</p>

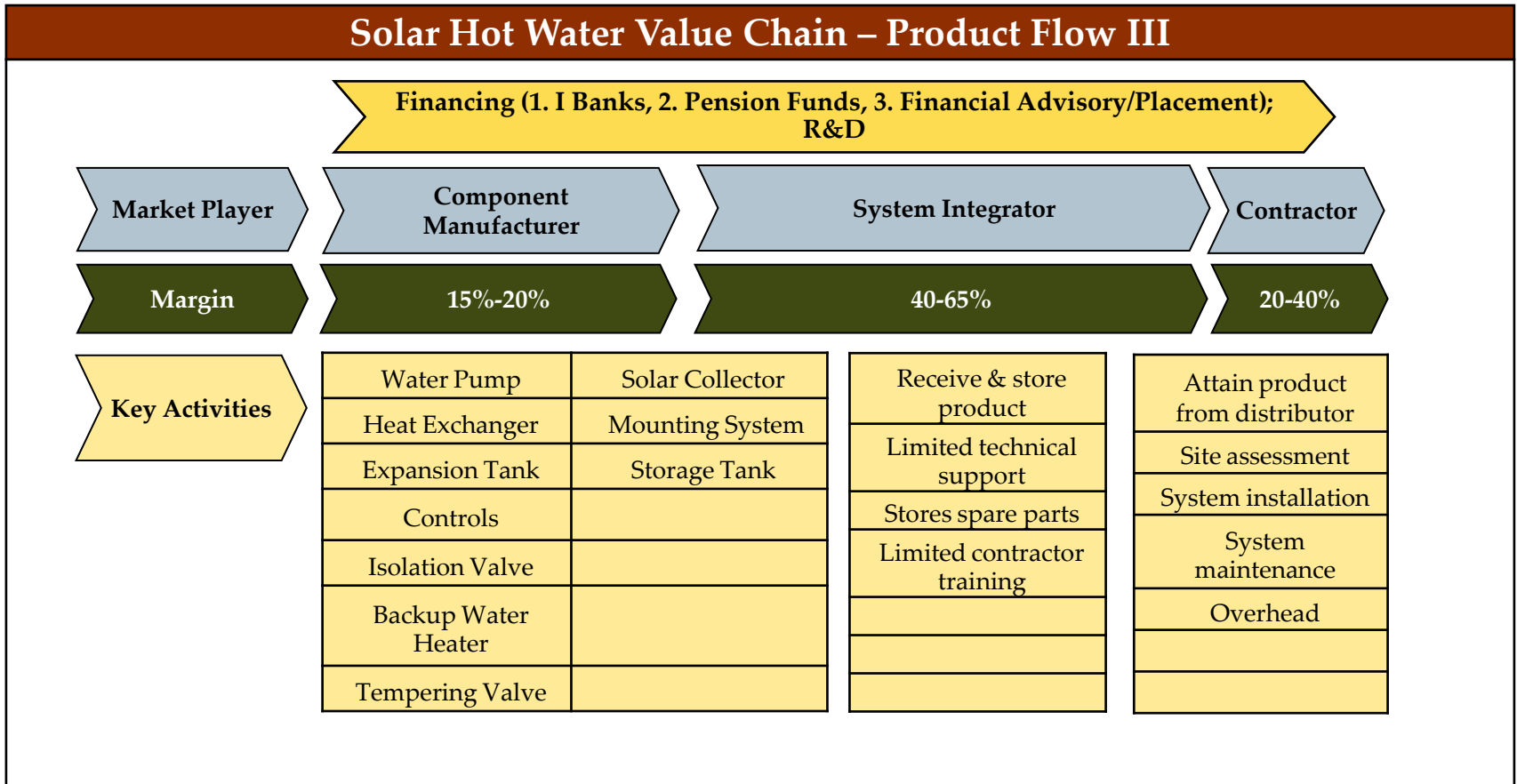
In more mature markets product flows through distributors to the contractors.



In less mature markets product volume is low and distributors cannot afford to stock product. Manufacturers sell directly to the contractors.



For larger more complex projects, system integrators may take part in several segments of the value chain to maximize their profit margin.



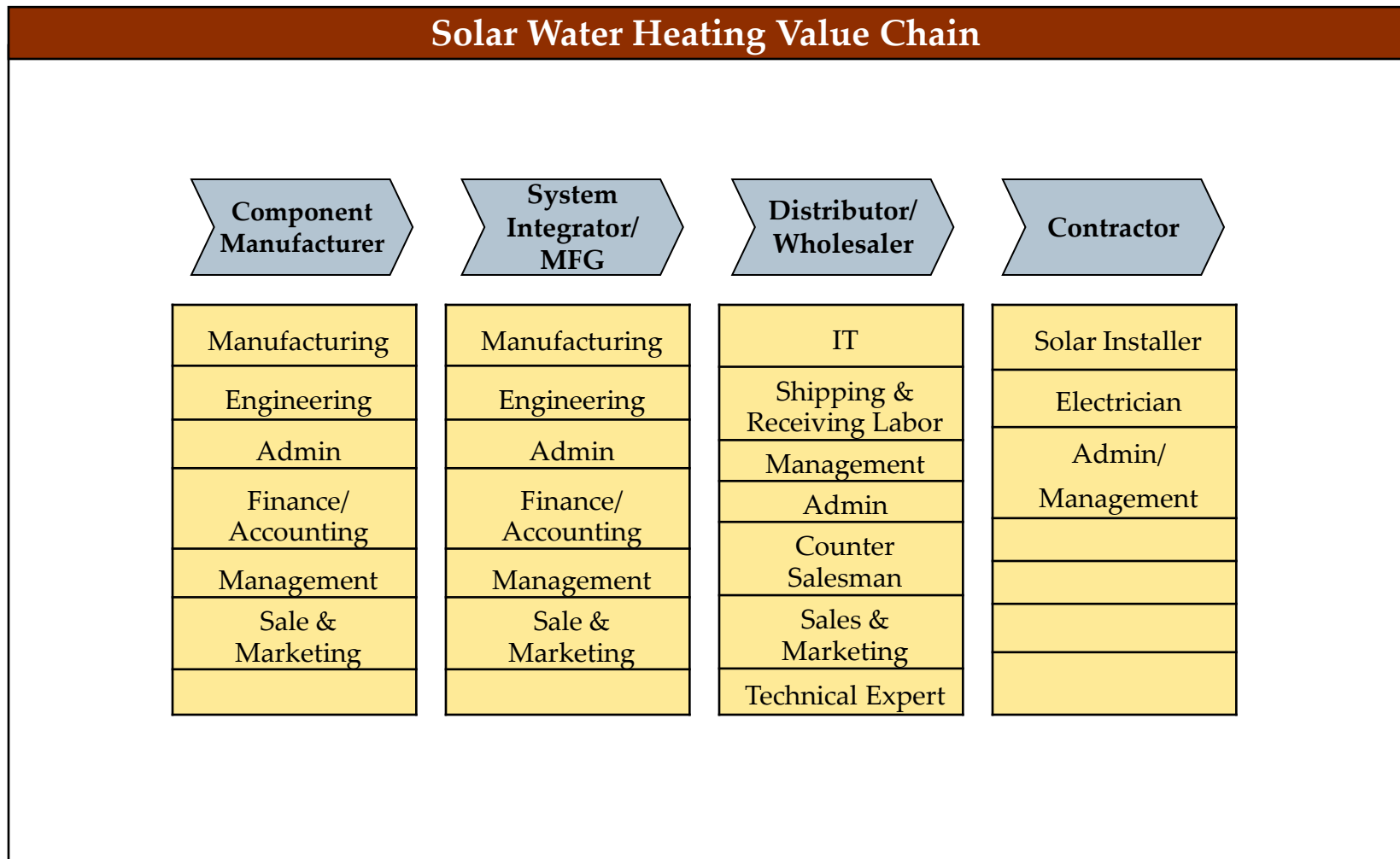
The SWH industry is very fragmented. Systems are not standardized and purchasing decisions are made based on existing relationships.

SWH Supply Chain – Decision Drivers	
Suppliers	Installers usually work with a limited number of suppliers, usually ones they have long-standing relationships with and are comfortable using their products.
Decision Makers	The SWH market is still very fragmented, purchasing decisions are usually made based on existing relationships with manufacturer’s representative.
Key Drivers and Competitive Advantages	<p>Overall system cost reduction is very important moving forward.</p> <ul style="list-style-type: none"> • Pump stations and preassembled systems will reduce installation cost. • Larger system will benefit from economics of scale and capitalize on cost reduction. However, additional engineering/permitting costs are usually needed. • Many SWH system components are shared with the general water heating and plumbing industry. Increasing volumes in the SWH industry are not likely to have large impact on prices of these components.

SWH components are usually manufactured/assembled locally with the exception of premium products that may be imported.

SWH Component Exports		
U.S.	Exports	<ul style="list-style-type: none"> Some US manufacturers sell into international markets such as South America, the Caribbean, and the Pacific Rim.
	Exporting to Europe	<ul style="list-style-type: none"> Selling into the high value European market is more difficult, mainly due to regulatory issues and shipping costs. The accepted certification in Europe is the Solar Keymark certification. To date no US manufacturer has gained this certification. The certification process and shipping costs do not allow for US products to be price competitive with local manufacturers.
EU	Exporting	<ul style="list-style-type: none"> European companies have established themselves as exporters outside their domestic market. Successful products are high quality with advanced product design such as tanks, controllers, and pumps. European products have established SRCC OG300 certification for their products to be sold in the US. Companies also assemble and manufacture locally in the US.
China	Exporting	<ul style="list-style-type: none"> Chinese products are mostly used in the local Chinese market. Due to Chinese reputation for low quality products exports to EU and US markets include many sub-components that are later repackaged and rebranded by local companies.

SWH requires a broad set of educational and skill set backgrounds.





Key Contacts

Lisa Frantzis
Managing Director
Burlington, MA
(781) 270-8314
lfrantzis@navigantconsulting.com

Jay Paidipati
Associate Director
San Francisco, MA
(415) 399-2191
jpaidipati@navigantconsulting.com

Shalom Goffri (Day-to-Day Program Manager)
Managing Consultant
Burlington, MA
(781) 270-8374
shalom.goffri@navigantconsulting.com

Haley Sawyer
Senior Consultant
Burlington, MA
(781) 270-8369
hsawyer@navigantconsulting.com

Tucker Moffat
Consultant
Burlington, MA
(781) 270-8367
Tucker.moffat@navigantconsulting.com

Other Report Contributors:
Constantine Von Wentzel
William Goetzler

Table of Contents

1	Introduction
2	The Solar Hot Water Industry
3	Solar Hot Water System Types
4	SWH Components and Supply Chain
5	Milwaukee Area SWH Opportunities Analysis
6	Milwaukee Area Case Study
7	Appendix

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description or Other Notes
			Customer Class	Incentive Type	Max Incentive		
AK	State	RE Grant Program	C, G, Utility	Grant		\$25-50MM/yr	20% of funding towards studies/80% toward projects
AL	State	Revolving loan program	G, S	Loan	\$500K		0% for up to 10 years, with a 3% management fee
AR	State	Rebate program	C, R, NP, G	Rebate		\$1,780,000 for 2 years	\$30/sq. ft. for systems 320 sq. ft. or less, \$15/sq. ft. for systems over 320 sq. ft. ; ARRA funded.
AZ	SRP	Earthwise	C, R	Rebate	C: \$250,000 or 60% of the total cost; Pool heating: \$100,000		R, C (small), - SWH: \$0.50/kWh for first year; C (large) - \$0.08/kWh for first 10 years; Pool: C (Pool) - \$0.25/kWh for first year metered energy savings
AZ	APS	Renewable Incentive Program	C, R	Rebate	50% of system cost		R, C, - SWH: \$0.50 (R) or \$0.75 (C)/kWh of estimated 1 st -yr savings
AZ	TEP	REC Purchase Program	C, R	Rebate	\$1,750		R - \$0.25/kWh + \$750 up to \$1750 C - \$0.50/kWh-equivalent + \$750
AZ	Trico Electric Co-op	SunWatts Incentive Program	C, R	Rebate	50% of system cost		\$0.50/kWh of expected first year savings

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description or Other Notes
			Customer Class	Incentive Type	Max Incentive		
AZ	State	Solar Energy Credit	R	Tax Credit	\$1,000		•25% of costs taken against personal income tax burden
AZ	State	Income Tax Credit	C, I	Credit	up to 10% of the taxpayer's total capital investment	state-wide: \$70 million per taxable year	• Incentive varies but the minimum criteria is: 51% or more of the new full-time employees must be paid a wage that equals or exceeds 125% of the median income in Arizona, and the employer must pay 80% or more of the premium for all full-time employees health insurance.
AZ	State	Property Tax Incentive	C, I	Tax rate reduction			<ul style="list-style-type: none"> • Tax rate of 5% as opposed to 22% • To be eligible, the business must invest at least \$25 million in facilities, equipment, land and infrastructure.
AZ	State	Solar & Wind Tax Credit	Non-R	Tax Credit	\$25k or \$50k	\$1 million annually	• 10% of installed cost; \$25,000 for any one building in the same year and \$50,000 per business

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
CA	SMUD	Solar Water Heater Rebate /Loan	R	Rebate, Loan	\$1500	N/A	\$500 <=1300 kWh savings; \$1000 <= 2199 kWh; \$1500 >=2200 kWh, loan financing available for balance
CA	CSI (3 IOUs)	California Solar Initiative	R	Rebate	natural gas replacement: \$1,875 electricity: \$1,250	\$350 million until 7/2017	\$12.82 per estimated therm displaced or \$0.37 per estimated kWh displaced – incentives vary depending on the energy source displaced
CA	Palo Alto Utilities	Solar Water Heating Program	C, I, R	Rebate	R - \$1500 C,I - \$75,000		Incentive amount calculated Through various methods
CA	Santa Clara Water & Sewer	Solar Water Heating Program	C, R, G	Leasing			Installation fee: Pool: \$1,125 plus \$50 per panel; Domestic: N/A Monthly fee: N/A
CA	Redding Electric	Earth Advantage Rebate Program	C, R	Rebate	\$1750		50% of system costs, less for 2 nd and 3 rd panel; Solar water heaters must replace electric water heating systems
CA	Santa Monica	Green Building Incentive	C, R	Fee Waiver			The city has waived the building permit fee for solar systems

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
CO	State	Solar Water Heating Rebate	R	Rebate	\$3,000	Renewed annually	
CO	City of Boulder	ClimateSmart Grant Program	NP, R	Grant	50% of project cost		\$65,000 awarded in first cycle; 2 grant cycles per year
CO	City of Boulder	Solar Sales Tax Exemption	R, C	Tax Refund	~15% refund on sales tax		City estimates the refund equates to approximately 1% of "average" PV system costs.
CO	State/Local	Sales & Use Tax Exemption	R, C	Tax Exemption	100%/Varies		State: 100% sales & use tax exemption; Local: varies
CT	State	Solar Thermal Incentive Program	R, C, NP, G	Rebate	\$2,400-4,800 - R \$50,000 - C \$82,500 - NP/G	\$4 million until 3/2012	C,R: \$500/MMBtu for predicted sys output; NP/G: \$900/MMBtu
CT	Local - NP	Community Lending Program	R, C, I, NP, A, S	Loan	\$100,000		Loans of \$5,000 to \$100,000 for 1-10 yrs at 5% (varies over time).
CT	State	Solar Sales & Property Tax Exemption	All	Tax Exemption			100% exemption from state sales & property tax
DE	State	Green Energy Program	C, I, R, A, S, NP, G	Rebate	R - \$5,000 C - \$250,000	Varies by Utility region	amounts vary up to, R - \$3,000; C - \$250,000 \$2,000 extra for systems integrated into radiant heating

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
FL	State	Renewable Energy Sales Tax Exemption	All	Tax Exemption			100% exemption from state sales tax, includes pool heating
FL	Local – Orange County	OCHEEP	R	Rebate	\$200	\$600,000 (total, not just SWH)	\$200 for SWH system if replacing electric water heater
FL	Clay Electric Co-op	Energy Conservation Loan	R	Loan	\$5,000		\$1,000 - \$5,000 at a rate of 8-10%
FL	JEA	Solar Incentive Program	C, R, S	Rebate	R - \$800 C - \$5,000 or 30%		R - \$400 to \$800 C - 15% to 30% up to \$2,500 or \$5,000 Higher rates apply to systems installed by local vendors
FL	Orlando Utilities	Pilot Solar Program	C, R	Production Incentive	R:1.2 MW; C:2 MW		\$0.03/kWh for 5 years w/option for renewal
FL	Orlando Utilities	Residential Solar Loan Program	R	Loan	\$7,500		loan for up to \$7,500 0% to 4% interest 3-yr to 7-yr term

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
FL	Progress Energy	EnergyWise	R	Utility Credit	\$450	FDEP Budget	\$450 credit on electric bill for installation of SWH system; additional \$30-\$60/yr credits for participating in load control and pool pump programs
FL	City of Tallahassee	Solar Water Heating Rebate	R	Rebate	\$450		Required Energy Audit
FL	City of Tallahassee	Solar Water Heating Loans	R	Loan			5% interest loan
FL	Lakeland Electric	Solar Water Heating Program	R	Fixed, long-term rates			3 rd -party owned, customer cited Systems; customer pays fixed monthly charge for water bill.
FL	Gainesville Regional Utilities	Solar Water Heating Rebate Program	R	Rebate	\$500		\$500 rebate
GA	State	Corporate Tax Credit	C, I, A	Tax Credit	\$100,000	\$2.5MM/yr	35% of system cost, expires 12/2012
GA	GreyStone Power	Utility SWH Rebate	R	Rebate	\$500		\$500/system

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S – Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
HI	KIUC	Solar Water Heating Rebate	R, C	Rebate	\$800 or 80% of costs		R - \$800 rebate C - 50% to 80% of equip costs
HI	State	Tax Credit	C, R, MF	Tax Credit	R - \$2,250 C - \$250,000		35% state tax credit capped at R - \$2,250; MF - \$350/unit C - \$250,000
HI	State	High Tech Business ITC	I	Mn'ft Incentive	\$2-million or 80% of tax liability		100% investment tax credit take over 5-years; Expires 12/31/2010
HI	KIUC	Solar Water Heating Loan	R, MF	Loan	No limit		60-month interest free loan
HI	State	Building Code	R	Building Standard			Solar Water Heaters required on all new residential construction beginning 1/1/2010
HI	State/Utility:HECO, MECO, HELCO	HI Energy Efficiency Program	C, R	Rebate	R - \$750 C - No limit		R - \$750 (retrofit only) C - \$125/kW deferred; Additional - \$0.05/kWh for retrofit, \$0.06/kWh for new construction
HI	Maui County	Solar Roofs Initiative Roof Program	R	Loan		\$450,000	Zero interest loans, 35% of after rebate cost as down payment
HI	Isl of Oahu	Honolulu Solar Roofs Loan Program	R	Loan	\$80,000/dwelling or \$125,000/property		Low Interest loan of 0% or 2% (depending on income)

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
IA	State	Revolving Loan Program	C, R, I, Utility	Loan	\$1 MM		50% of project costs at 0% interest for a maximum of 20 yrs
IA	Idependence P&L	Rebate Program	C, R	Rebate	\$3,500 or 35% of project cost		\$30/sq. foot of collector area
ID	State	Residential EE Rebate Program	R	Rebate	\$150	\$1.3MM	\$150/system
IL	State	Clean Energy Community Foundation	NP, G, S	Grant	Varies		Bi-annual grant application deadlines for clean energy projects
IL	State	Solar Energy Rebate Program	C, R, I, NP	Rebate	\$10,000	\$1 MM	30% of cost (private); 50%: NP/G Fully subscribed for 2010
IN	State	Property Tax Exemption	C, R I	Tax Exemption			100% property tax exemption
KS	State	Solar/Wind Mfg Incentive	Mfg	Financing	\$5 MM		R&D or Engineering/Mfg project must provide \$30 MM in new investment & create a minimum number of jobs
KY	Various counties	Solar Water Heater Loan Program	C, R	Loan	100% of equip/labor		Flexible rates; Approved loans require a 5% down payment

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
KY	State	Energy Tax Credit	R, MF, C, I, A	Tax Credit	\$500 /\$1000		30% income tax credit up to \$500 for single-family; \$1000 for MF
LA	State	Tax Credit for Solar on Res Property	C, I, R, MF	Tax Credit	\$12,500		50% of first \$25,000 Must be installed on a residence; excess credit is refundable
LA	State	Home Energy Loan Program	R	Loan	\$6,000 , 5 year term		50% of costs up to \$6,000 subsidized at 2%
LA	State	Solar Property Tax Exemption	R	Tax Exemption	100%		Includes both domestic and pool SWH
MA	State	Patent Exemption	General public	Tax Exemption	100% for 5 yrs		Excise tax deduction on income associated with eligible patents
MA	Utilities	MassSave HEAT Loan	R	Loan	\$15,000		\$2,000-\$15,000 at 0% rate; maximum term of seven years
MA	National Grid Gas	Rebate	C, I	Rebate	\$100k		50% of project costs up to \$100k (\$250k new construction)
MD	State	Solar Energy Grant Program	C, R, NP, G	Rebate	\$2,000	FY10: \$5.8 M	30% of the installed cost

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
ME	State	Home Energy Loan Program	R	Loan	\$35,000		fixed rate of 1%; For companies with < \$50MM sales or <50 FT employees
ME	State	Solar and Wind Energy Rebate Program	All	Rebate	R - \$3,000 C - \$10,500	\$ 500K- \$1MM/year	R - 30% of cost up to \$2,500 or 35% up to \$3,000; C - 35% up to \$10,500
MI	State	NextEnergy Tax Credit	C, I (Mfg, R&D)	Tax Credit	Varies		Credit is based upon the tax liability associated with new, qualified business activity (mfg, R&D)
MI	WI Public Power	Renewable Energy Rebates	C, R,	Rebate	\$3,500		\$30/sq.ft up to \$3,500 or 35% of system cost
MI	State	EE Appliance Rebate	R	Rebate	\$2,500	\$8.82 MM	25% of installed cost ARRA funded
MI	State	Solar sales tax exemption	All	Tax Exemption			100% exemption from state sales tax
MN	State	Solar Hot Water Rebate Program	R, MF, C	Rebate	25% or R-2.5k; MF-4k; C- \$25k	\$500,000 for 2010	\$25/sq.ft up to maximums

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
MN	State	Solar sales tax exemption	All	Tax Exemption			100% exemption from state sales tax
MO	State	State Loan Program	NP, G	Loan	\$1 million	\$10 MM (2010)	0% interest, 1% loan origination fee ; term up to 10 yrs
MO	Columbia Water & Light	Solar & Efficiency Rebates	C, R	Rebate	\$800		\$400 to \$800 rebates
MS	State	Industry Recruitment Tax Exemption	C, I	Tax Exemption			100% exemption from income, franchise, and sales & use tax for 10 years; minimum investment of \$50 million and create 250 full-time jobs
MT	State	Industry Recruitment Tax Exemption	Mfg, C, I	Tax Abatement	50%		50% tax abatement for up to 19 yrs for new Mfg and R&D
MT	State	Revolving Loan Program	C, R, NP, S, G	Loan	\$60k		Amt varies; up to 15 years; 4.0% interest rate for 2010

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
NC	State	Renewable Energy Tax Credit	C, R, MF	Tax Credit	R - \$1,400 C - \$2.5 Million		35% of system cost
NC	Progress Energy	SunSense Commercial SWH Incentive	All Non-R	Performance-based Incentive	4,000 sqft of collectors		\$20/MWh equivalent (3,412,000 BTUs) for 10 years; utility takes REC ownership
NC	Progress Energy	Pilot SWH Rebate Program	R	Rebate	\$1,000	150 systems	\$1,000 per system, utility takes REC ownership
ND	State	Tax Credit	C, I	Tax Credit			15% (3% per year for five years); expires 2015
NE	State	Dollar & Energy Loans	C, R, NP, A	Loan	R-\$75k; C-\$125k		Loans vary by sector, rate of 2.5-5% for 5-15 yrs
NH	NH Electric Co-Op	Solar and Wind Energy Rebate Program	C, R, NP, S, A	Rebate	\$1,500		25% of system costs project expires end of 2008
NH	State	PUC SWH Rebate Program	R	Rebate	\$1,650	\$995,000	\$750 + \$600 for rated output 6 - 19.9 MMBTU; \$750 for 20 - 29.9 MMBTU; \$900 for 30+ MMBTU.

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
NH	National Grid	Solar Thermal Rebate Program	C, I	Rebate	\$100,000 or 50% of costs		\$3/therm based on estimated first-year savings
NJ	State	SWH Pilot Program	R	Rebate	\$1,200		
NM	State	EE/ RE Bond Program	G, S	Bond		\$20 MM	bonds are exempt from taxation by the state; paid back via energy bill savings
NM	State	Solar Market Development Tax Credit	C, R, A	Tax Credit	\$9,000		30% tax credit beyond federal \$2,000 cap
NV	State	Tax Exemption	C, R, I	Tax Exemption			100% property
NV	Southwest Gas Corp	Solar Thermal Advantage	R	Rebate	\$1,500		30% of eligible installed costs; expires 2011
NY	State	Solar and Fuel Cell Tax Credit	R, MF	Tax Credit	\$5,000		25% of costs
NY	State	Solar sales tax exemption	R	Tax Exemption			100% exemption from state sales tax
NY	State	NYSERDA Industry	C, I	Grants	\$1.5 million per project	\$4.5 million	Grants vary by phase of RFP; designed to promote new mfg

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S – Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
OH	State	Industry Recruitment	C, I	Grants	\$2 MM		\$50,000 to \$2 million for commercialization projects
OH	State/NP	GEO Solar Thermal Rebate	R, S	Rebate	\$2,400		\$30 per kBtu/day
OK	State	Loan Program	S	Loan	\$200k/school district	\$1MM	3% interest rate, for up to six years
OR	EPUD	Solar Water Heater Rebate	R	Rebate, Loan	\$600	\$18,000 per year	\$600 rebate, zero interest loan for balance up to \$7,500
OR	State	Energy Trust, Solar Water Heating Buy Down	C, I, R, NP, S, G, A	Rebate	R - \$1,500/ \$1,000 pool Non-R-35% of sys cost		For gas customers: R - SWH: \$0.30/kWh C - SWH: \$6.00/therm; For electric: \$0.30 per first-year kWh savings
OR	Salem Electric	Solar Water Heater Rebate	R	Rebate, Loan	\$600 /\$10,000		\$600 rebate or \$500-\$10,000 loan at 5% for 60 months.
OR	Central Electric Co-op	Solar Water Heater Rebate	R	Rebate	\$500		\$375 to \$500 depending upon orientation
OR	Central Electric Co-op	Solar Water Heater Loan	R	Loan	\$5,000		Larger than \$5,000 interest 2% above prime

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
OR	EWEB	Bright Way to Heat Water Rebate	R	Rebate	\$600		SWH up to \$600 rebate; Pool up to \$1,100
OR	Douglas Electric Co-op	Solar Water Heater Rebate	R	Rebate	\$500		Must meet technical guidelines
OR	EWEB	Bright Way to Heat Water Loan	R	Loan	\$4,000		0% interest and up to 5 year repayment; Includes Bright Way rebates
OR	State	Energy Tax Credit	R, C, I, A, Mfg	Tax Credit	R-\$1,500 Non-R-\$20M		R - \$0.60/kWh saved in first Year; 0.15/kWh (pool); Non-R - 10%/yr for 5 yrs
OR	Consumers Power Inc.	Solar Energy System Rebate	R	Rebate	\$500		Systems must be >31sq.ft
OR	State	Small-Scale Energy Loan Program	C, R, I, NP, S, G	Loan	No limit		Amounts vary
PA	Industry Recruitment	Solar Energy Incentives	C, I, NP, S, G	Loan/Grant	Varies		Loans/Grants available depending on value chain sector
PA	State	Sunshine Solar Rebate	R	Rebate	R-\$2k; C-\$20k	\$100 MM	25% of installed costs

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
RI	State	Renewable Energy Tax Credit	R	Tax Credit	25%		up to 25% of costs (max sys cost of \$7000); minimum 34sq.ft sys
RI	National Grid	Solar Thermal Rebate Program	C, I, MF	Rebate	\$100,000		\$3/Therm estimated first year savings, capped at 50% of costs or \$100,000
SC	State	ConserFund Loan Program	NP, G, S	Loan	\$500,000		\$25,000 to \$500,000 at rate below WSJ-listed prime rate, 10 yrs
SC	State	Personal Tax Credit	R, C	Tax Credit	\$3,500 or 50% of tax liability		25% of eligible costs, can be carried forward for 10 yrs
SC	Progress Energy	SunSense Commercial SWH Incentive	All Non-R	Performance-based Incentive	4,000 sqft of collectors		\$20/MWh equivalent (3,412,000 BTUs) for 10 years; utility takes REC ownership
SC	Progress Energy	Pilot SWH Rebate Program	R	Rebate	\$1,000	150 systems	\$1,000 per system, utility takes REC ownership
SD	State	Property Tax Exemption	C, R, I, A	Tax Exemption			\$50,000 or 70% of the assessed value of eligible property
TN	State	Revolving Loan Program	S, G	Loan	\$5 MM	\$98.6MM	3% loans up to \$5 MM
TX	Austin Energy	Solar Water Heating Rebate	C, R, NP, S, G	Rebate	\$2,000	\$50,000 Assessed annually	R - \$2,000 for existing homes, \$1,500 for new homes C - Custom

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
TX	Austin Energy	Solar Water Heating Loans	C, R, NP, S, G	Loan	\$10,000		various low or no interest loans available
TX	CPS Energy	Solar Hot Water Rebate Program	C, I, R, NP	Rebate	\$2,000/account	\$2.5 MM (PV & SWH)	\$0.60/kWh saved annually; CPS assumes REC ownership
UT	Questar Gas	SWH Rebate Program	R	Rebate	\$750		\$750 rebate for SWH, \$50 rebate for water tank; includes pools
UT	State	Rebate Program	All	Rebate	25% of costs	\$3 MM	\$30/sq ft net aperture; Max of 25% or \$2500 (R); \$10K (Non-R)
UT	State	Corporate Tax Credit	C, R	Tax Credit	R-\$2000; C-\$50K		R-25% of costs (4 yr carry fwd); C-10% of costs (no carry fwd)
VA	State	Green Jobs Tax Credit	C, I	Recruitment Credit	\$175k		\$500 tax credit for 5 years per job created
VT	State	Clean Energy Development Fund Grants	C, R, S, G, MF, A	Grant	Varies	\$2.5 MM/round	\$50K to \$500K depending on the project; cost-sharing is required
VT	State	Corporate Tax Credit for Solar	C, I	Tax Credit	No limit		30% state tax credit; expires 2011
WA	Snohomish PUD	Solar Express Rebate	C, R, G	Rebate	\$500		\$500 per system; minimum sys of 35 sqft or 40% of water needs
WA	Grays Harbor PUD	Solar Water Heater Incentive	C, I, R	Rebate or Loan	\$600	Varies	\$600 rebate or loan up to unspecified amt at 4%

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
WA	Clark Public Utilities	Solar Energy Loan/Rebate	C, R	Loan	\$2,000 rebate/\$6,000 loan		Low interest loans up to \$6,000 at 0% for 3 yrs ; additional rebate of \$2,000
WA	Franklin County PUD	Solar Energy System Rebate	R, MF	Rebate	\$500		\$500 rebate, or loan option
WA	Franklin County PUD	Solar Energy System Loan	R, MF	Loan	\$10,000		3% APR, incentive up to R - \$7,000; MF - \$10,000
WA	Port Angeles Public Works & Utilities	Solar Energy System Rebates	C, R,	Rebate	\$1,000		\$500 for each 31sq.ft of solar collector
WA	Callam PUD	Residential Solar Rebate Program	R	Rebate	\$500		\$500 per system; min sys size of 40 sqft
WA	State	Sales and Use Tax Exemption	All	Tax Exemption			100% exemption from sales and use tax on systems
WI	State	Industry Recruitment Loan	C, I	Loan	25% of project costs		Loans at 2% interest rate for 5-10 years (equipment) or 5-7 years (working capital)

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools

Appendix: Solar Hot Water Incentives by State

Summary of Key Incentives and Policies for Solar Hot Water							
State	County or Agency	Program	Program Features			Budget	Description Or Other Notes
			Customer Class	Incentive Type	Max Incentive		
WI	Utility	Focus on Energy Incentives	Served by participating utility	Rebate	25% of costs	\$8.2 MM (2010, all RE)	Performance-based incentive
WI	We Energies	RE Cash-Back Rewards (CBR)	All	Rebate	30 - 100% Match of FOE CBR	% Rebate Depending on Customer Class	Match of Focus on Energy (FOE) Programs for NFP or 7.5% bonus for R, C, I customers.
WV	State	Solar Energy Tax Credit	R	Tax Credit	\$2,000		30% tax credit; SWH systems must be sized to >=50% needs
WY	State	EE Appliance Rebate Program	R	Rebate	\$150	\$511k	\$150 per system

R – Residential, C – Commercial, I – Industrial, NP – Non-Profit, A – Agricultural, MF – Multi-Family, G – Government, S - Schools