



COMMUNITY ENVIRONMENTAL CENTER

A Not-for-Profit Professional Organization



Solar Thermal Hot Water Systems in New York City **A Strategy for Market Transformation** **6/24/2011**

Summary

Community Environmental Center (CEC) is a not-for-profit organization dedicated to improving the energy efficiency of our built environment and has worked extensively with Quixotic Systems Inc (QSI) and EarthKind Energy to improve the sustainability of New York City's buildings. Through the wider deployment of Solar Hot Water (SHW) systems in NYC buildings, we have installed a combined 18 systems in multifamily and commercial buildings with two more in the design phase. By pursuing these efforts we stand poised to contribute to many of the critical goals set out at the State and City levels including: mitigation of greenhouse gas emissions; green job creation; lower urban pollution; decreased reliance on fossil fuels; as well as improved stability of our energy infrastructure. As New York City moves away from highly-polluting heating oil, our natural gas infrastructure will become increasingly strained. By encouraging the adoption of solar hot water systems, this reliance on natural gas can be eased and reduce New York's exposure to the unknown and potentially dangerous consequences of continued natural gas drilling¹.

Looking at global installed capacity of solar thermal, it's evident that New York holds great potential. Contrasted with solar PV, SHW currently makes up more than 89% of the solar energy capacity installed around the world². Of 189 GW_{th}, the U.S. has about 7.6 GW_{th} (4%) and New York State has 6 MW_{th}³ (0.003%). For perspective, the installed capacity per capita in Germany is 100 W_{th} while in New York State it is only 0.3 W_{th}, over three hundred times smaller.

This paper will (1) provide a technical summary of SHW systems, (2) discuss benefits and obstacles facing these systems, (3) provide a brief overview of SHW programs and studies in Europe and Florida, and (4) discuss policy recommendations to encourage SHW adoption in NYC. We firmly believe that government has a societal obligation to encourage market transformation away from carbon-emitting fuel sources, and that action is required to spur the

¹ Specifically horizontal fracturing, a drilling method that many experts maintain requires more scientific study

² International Energy Agency, "Solar Heat Worldwide 2008."

³ Solar Thermal Roadmap

development of a self-supporting SHW market. The policy recommendations that we have concluded will make the biggest contribution to these goals are as follows:

- Create a SHW pilot program to gather data on system performance for at least 50 medium to large multifamily buildings;
- Revise rooftop construction permitting process to stream-line SHW systems and train Department of Building inspectors on solar hot water;
- Reduce the upfront costs of SHW systems by ensuring that energy efficiency financing tools (such as the loan fund being created through NYC's EECBG funding and NYSERDA's Green Jobs Green New York program) be applicable to SHW systems and by expanding photovoltaic (PV) incentives to encompass solar thermal;
- Include solar thermal feasibility checklist as a component of audits performed through Greener Greater Buildings Plan and install SHW systems in city-owned buildings that meet a determined Return on Investment cost;
- Support manufacturers of SHW systems in establishing NYC production capacity and leverage further private sector participation;

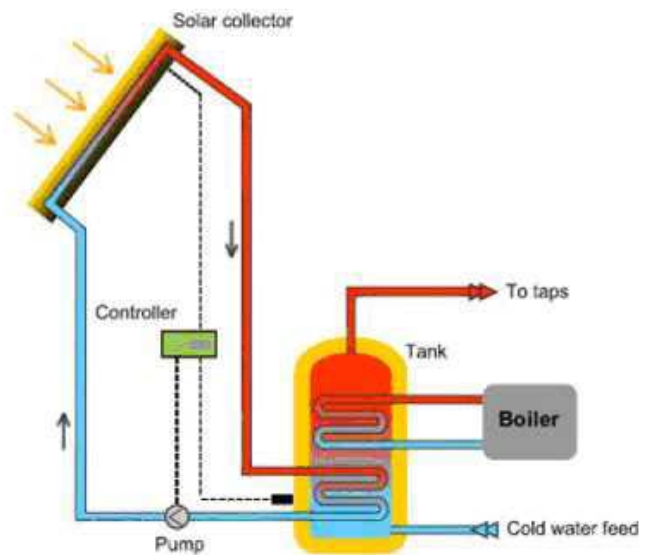
With the support of the environmental community, SHW manufacturers, and progressive contractors, CEC, QSI, and EarthKind hope to work with the City of New York to achieve sustainability through SHW systems.

1. Introduction to Solar Hot Water Systems

In NYC we have been working to pursue sustainable energy generation through Solar Hot Water systems in the existing building stock. We believe that multifamily buildings are the ripest opportunity for further expansion of the SHW market. Most commercial buildings simply don't have enough hot water consumption necessary to justify SHW installations, and small homes do not provide the same economies of scale as medium to large multifamily buildings.. Our experience with market transformation has so far been encouraging, and we have already streamlined installation processes and substantially reduced the overall costs of the multifamily SHW systems we install. We hope that through dissemination of this report that policy-makers and efficiency industry stakeholders will join us in pursuing this environmentally responsible technology as a widespread component of urban buildings' water-heating systems. Firstly though, it is important to briefly establish a technical understanding of SHW systems.

How do SHW systems work?

Generally, solar collectors (flat-plate or evacuated tube)⁴ are mounted on a sun-facing sloped or flat roof of a building that regularly provides an adequately high volume of heated water to occupants. A working fluid (water is used in warmer climates, a non-freezing glycol solution in colder climates) flows through the collector and is heated by the sun. It then circulates to a solar storage tank (diagram above⁵) connected to the existing hot water heater and provides a low-cost and sustainable supplement to fossil fuel or electric-based water heating. The pre-existing water heater only uses fossil fuels if the solar-heated water still needs



⁴ Evacuated tube systems achieve higher efficiencies, but are significantly more fragile.

⁵ Diagram courtesy of http://www.folkecenter.net/gb/rd/solar-energy/solar_collectors/

a temperature boost. Although SHW systems efficiently convert sunlight into heated water⁶, most require a conventional backup system for cloudy days or when demand for hot water is higher than normal. Conventional storage water heaters usually provide backup, but on-demand (tankless or instantaneous) water heaters should also be considered depending on the building. Ultimately, SHW systems reduce, but do not eliminate, the need for electric or fossil fuel water heating.

Advantages in NYC

One of the most important factors leading to cost-effective SHW systems is regular hot water usage by occupants. Multifamily buildings have generally high and consistent hot water usage patterns, and are therefore the most appropriate for SHW systems. Particularly in NYC, the vast numbers of medium and large-scale multifamily buildings that make up our city represent a valuable opportunity for SHW systems to be pioneered. The ideal candidate building for a SHW system is a multifamily building under six stories that currently uses *electricity* to heat water.⁷ It would have a roof that is easy to mount collectors on (such as a concrete deck) and have open exposure to the east, south and west. It would also have space to install the necessary hot water tanks and ultimately use enough hot water to need eight or more solar thermal panels. The high carbon-based fuel prices common in urban energy markets (especially in NYC) similarly go a long way toward ensuring that SHW systems are beneficial and appropriate energy generation strategies⁸. Lastly, NYC and Long Island have the advantage of being the sunniest locations in the state, making solar thermal systems that much more effective. Most buildings that meet this ideal description would find SHW to be cost-effective with little to no subsidy, however most buildings, especially those using natural gas, do in fact need extra financial assistance to satisfy an acceptable payback period, usually 5-7 years. This type of subsidy is needed now when fossil fuel prices are artificially low but as those prices rise and the SHW installation costs drop, government assistance can be gradually withdrawn.

⁶ SDHW systems can convert 65% of received sunlight to heat, compared to 15% of sunlight convertible to electricity through PV systems (Estif.org)

⁷ Although electric water heating is increasingly rare in NYC, significant cost-savings can be achieved with natural gas heated systems as well

⁸ Brightpower report, pg S-4

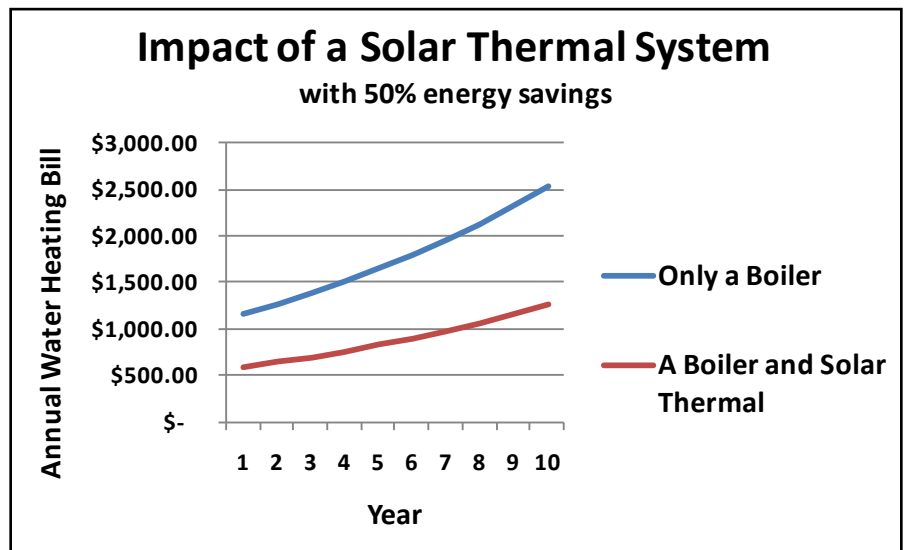
2. Benefits and Obstacles of Solar Hot Water

CEC, QSI, and EarthKind are each dedicated to providing triple-bottom-line returns through reliable retrofit technologies and progressive energy solutions. The triple-bottom-line philosophy is widely accepted and based on the idea that the true creation of value cannot be measured only by financial profit but must also include benefits and risk mitigation for people and the environment. However, despite the host of benefits and current enthusiasm at local levels for sustainable energy generation, insufficient performance data and regulatory burdens are among the number of factors holding back SHW and other renewable energy generation technologies in New York City and the US.

Benefits:

Price Stability: Because water heating in SHW systems is based on sunlight, there is almost zero marginal cost for energy consumption after initial installation and procurement costs. Even where systems are not deemed economically prudent at current carbon-based fuel prices, an

important consideration is the price stability associated with SHW systems. Although system benefit analyses often assume fuel costs will remain constant throughout the lifetime of the system, the fact that natural gas prices rose 10% over the last decade⁹ provides interesting context as to the



benefits of SHW systems. As the graph above demonstrates, when a SHW system is paired with a boiler, not only does the annual energy bill drop for a given year but the cost of heating ones

⁹ Solar Thermal Roadmap, pg 6

water will not rise as quickly¹⁰. When deciding to install a SHW system, building managers are not only making a likely substantial return on investment, but they are achieving fuel security by mitigating the effect of ever-rising costs of fossil-fuel based water heating.

Benefits to People: Solar hot water technology provides a number of benefits to the residents in the building SHW is located on and the surrounding community. Residents would immediately see their water heating bill drop, by as much as 50%, freeing up money for more important uses, and pollution from fuels used to heat water would also be cut in half. Because so much air pollution is a local phenomenon, this reduction in pollutants would help decrease the number of childhood asthma cases and emission-related deaths. These health benefits would also extend to the entire community and everyone downwind of the building on which the SHW system was installed. Another potent community benefit of SHW is that much of the work necessarily would generate quality jobs. Locally manufactured SHW panels and the installation work to put them on rooftops would create living wage, green collar jobs in New York City.

Environmental Sustainability: Although New Yorkers have a carbon footprint that is substantially lower than US citizens on average, the sheer number of NYC residents makes a large and unsustainable environmental impact on our region, and ultimately the global climate. According to the Solar Thermal Roadmap, if the average New York household had a solar thermal system, they would be keeping a little less than one ton of CO₂ out of the atmosphere every year¹¹. If just 10% of NYC households were supported by solar thermal systems, 240,000 tons of CO₂ would be kept out of the atmosphere, the equivalent of over 43,000 cars taken off the road¹².

¹⁰ Solar hot water can also be used to supplement space heating and therefore reduce fossil fuel use even further

¹¹ Solar Thermal Roadmap, pg 6 (based on natural gas use)

¹² EPA equivalent using 3.2M NYC households, .75 tons saved per household, and 5.5 metric tons per vehicle

Obstacles:

Limited Data: Although SHW systems were widely pursued in the 1970's due to the first oil crisis, many of the systems had substantial design and installation flaws. Unfortunately this led to the perception that SHW systems were an ineffective investment. Significant advances in SHW technology and installation methods have been achieved, but there have been few comprehensive studies performed on the effectiveness of modern SHW systems. This is particularly true with regards to multifamily residential buildings¹³. Additionally, research performed is not widely applicable since the effectiveness of SHW systems varies widely among climates – i.e. studies on the effectiveness of SHW systems in Denmark would under-represent the potential savings of a NY system.

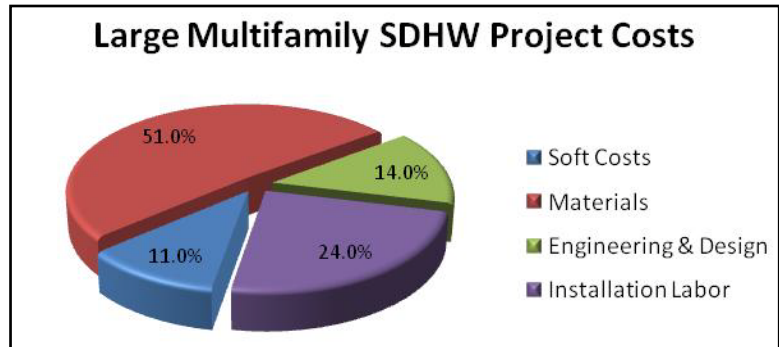
The lack of detailed, NYC-focused performance-data has led to slower market adoption of solar thermal technologies than would be expected if customers had reliable information on the savings they can expect. On a single-building scale, our experience so far has demonstrated that simple year-by-year comparisons of utility bills are insufficient to meaningfully assess savings from SHW systems. QSI and CEC are therefore working to ensure that systems we install are connected to remote monitoring devices. Unfortunately, this has been difficult to date; some building owners have been resistant to remote performance monitoring devices and a number of monitoring systems have simply measured whether liquid is flowing or not, as opposed to how much heated water is actually used. Having explored a wide range of performance monitoring systems, CEC and QSI now stand poised to expand our SHW work to a wide range of buildings that will allow us to meaningfully demonstrate the achievable savings of Solar Thermal.

Prohibitive Costs and Fees: The fees associated with installing a solar thermal system in New York City are for a certified plumber (\$1,500), structural engineer (\$1,500), expeditor (\$1,500),

¹³ The European Solarge report is a notable exception, discussed later in this report

and the Department of Buildings (DOB) filing fee (\$1,000-\$4,000)¹⁴. While the plumber and engineer are definitely necessary and the expeditor is typically unavoidable, the DOB filing fees could easily be waived for all SHW projects just as they currently are for non-profit buildings.

Although in large multifamily projects SHW installation fees compose a smaller proportion of the overall cost (though removing them would undoubtedly help), the challenge for these large buildings is more with the



large upfront costs of SHW, and the lack of key incentives, notably the NYC property tax abatement currently in place only for solar PV, and the NYSERDA rebate program that only applies to electrically heated water thus excluding most of NYC.

There is also a transportation cost for SHW panels because many are not manufactured in the United States. EarthKind ships panels in from Germany and transportation accounts for 6% of the total cost¹⁵. Were these panels to be made here in NYC, this cost would virtually disappear.

3. SHW Experience around the World

SHW installations and studies worldwide have provided valuable information on the benefits of solar thermal technology. Two studies in particular highlight the potential of SHW systems. Although carried out on widely different scales, the results and differences in implementation of SHW systems in Europe and Florida provide an interesting perspective on the future of this technology in NYC.

¹⁴ For a 1-4 Family building installing a small \$12,000 system (including materials and labor), these extra fees can account for a full third of the total project cost

¹⁵ Ron Kamen, EarthKind – some system manufacturers have been willing to share the costs of transportation in order to support market transformation

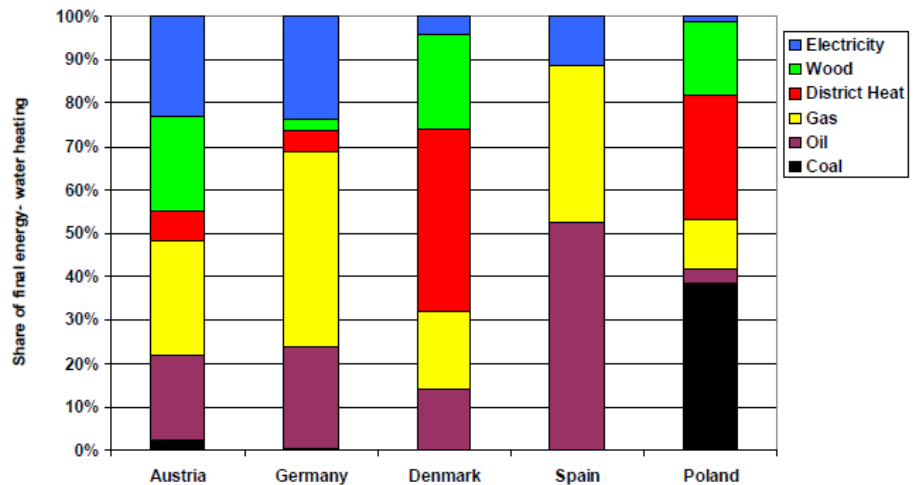
SDHW Project Costs chart is based on CEC and QSI projects in NYC

Europe:

The European market for solar technologies has made great strides in the recent years and there is a wealth of information appearing from case studies and pilot projects across the continent. In particular, the organization SOLARGE carried out a three-year program (from 2005 through 2007) to assess the European market for large SHW systems and create a cost and energy savings database¹⁶. From

the SOLARGE database, it was established that the average price of installation for a multifamily SHW system was \$255,099 for a 154 unit building (not including incentives) or \$1,657 per unit, and that on average, SHW systems saved

buildings 5,799 therms per year¹⁷, a 30% reduction¹⁸ in consumption, and a cost-effective investment for building owners. As shown in the chart above, solar water heating systems primarily supplemented gas and oil, similar to NYC.¹⁹ In addition, New York receives a higher level of solar radiation than many countries in the SOLARGE study meaning energy consumption savings will likely be higher²⁰.



Florida:

Florida's Solar Weatherization Assistance Program (SWAP) pilot provided very detailed data on the costs and benefits of solar thermal water systems in the single-family residences studied. In total, 801 systems were installed across Florida at an average cost of \$1,555 per single-family

¹⁶ Final report and case studies can be accessed at www.solarge.org

¹⁷ Solarge Report

¹⁸ Many SDHW systems are undersized to increase cost-effectiveness, so this proportion of energy production for SDHW may be under-representative.

¹⁹ Weiss, "Potential of Solar Thermal" pg 33

²⁰ National Renewable Energy Laboratory

building²¹. In 30 of these homes, sophisticated flow rate monitoring and water temperature measurements were used to determine the energy offset by the SHW systems. In the remainder of the homes utility bills were compared to past years to provide a “soft estimate” of energy reduction. For all 801 households, it was found that these SHW systems were able to reduce electric water heating bills by an average of 50%. Although the famously sunny climate of Florida does not allow these results to be meaningfully transposed to NYC building stocks, the importance of this study is in the highly detailed monitoring systems pioneered by the evaluation team on a wide scale. In order to instill confidence in the wider market, detailed performance-monitoring strategies should be installed alongside all SHW systems – especially when projects make use of governmental funding support.

4. Policy Recommendations

The worldwide experience with SHW has proven the technology to be a low-cost source of renewable energy. The next step is to develop the industry in New York City. In order to bring solar hot water technology to the mainstream in New York City, we recommend a multi-faceted policy approach. These recommendations will help fill the information gap about SHW performance in New York City, facilitate private sector implementation through streamlining the regulatory process and expanding financial incentives, and encourage the local growth of this industry. Clearly many of these special considerations are not meant to last forever, but they are needed to help SHW become a mature industry and help NYC boost its energy independence.

Install a variety of demonstration projects to gather data on SHW use and effectiveness for both 1-4 family and large, multifamily buildings

There has been insufficient performance monitoring of the impact SHW systems have in NYC buildings. The scarce, existing data indicates considerable potential savings but in order to

²¹ Systems did not require glycol because there was not a danger of freezing, thus they could be much simpler and cheaper than in NYC

properly understand the advantage of these systems and to instill confidence in multifamily building owners and managers, more information must be gathered. *NYSERDA, in collaboration with the NYC Dept. of Environmental Protection and Dept. of Buildings, should pilot a minimum of 50 SHW systems in medium to large multifamily buildings with the explicit goal of collecting meaningful data through flow-rate, water temperature, and utility bill measurements.*

Revise solar thermal permitting process to stream-line SHW systems and ensure all inspectors are adequately trained

The permitting process and associated fees are the low hanging fruit for encouraging more solar thermal in New York City. This lengthy process raises project fees in part because inspectors are not consistent with their understanding of SHW systems. In addition, because DOB filing fees typically amount to about a year and a half's worth of energy savings, removing them would alone reduce the payback by 18 months. *The permitting process should waive fees and allow fast-tracking for solar thermal projects in order to more quickly bring projects to completion. DOB inspectors should also be trained to understand SHW systems in order to bring more uniformity to the installation and approval process.*

Decrease the upfront cost of a SHW installation by ensuring that governmental loan funds are applicable to SHW systems and expanding solar incentives to support NYC systems.

Although SHW systems are generally understood firstly as an energy generation strategy, solar thermal technology is also a viable and cost-effective method for improving energy efficiency. *With the award of Department of Energy funding through EECBG and the strength of NYSERDA's GJGNY program, New York should ensure SHW systems are eligible for low-interest financing managed by the city and state. Additionally, the New York City property tax abatement for solar PV should be renewed and expanded to include solar thermal projects and NYSERDA's Solar Thermal rebate program should be expanded to include more money for systems that supplement natural gas heaters.*

Include a Solar Thermal feasibility checklist as a component of audits performed through Greener Greater Buildings Plan (GGBP)

The goal of GGBP is to reduce greenhouse gas emissions from NYC's building stock. This can be accomplished through energy efficiency measures combined with renewable energy technologies such as SHW. *An easy checklist for determining whether a building is suitable for SHW should be included in GGBP energy audit requirements, facilitating solar thermal installations and the GGBP energy reduction goals.*

Support manufacturers of SHW systems in establishing NYC-based businesses

In order to thoroughly capture the benefits associated with SHW market transformation, NYC should seek to encourage green industry development and leverage further private sector investment. SHW manufacturing work provides sustainable living-wage employment that cannot be shipped overseas and as the market grows, so will the market for SHW installers, another boon to NYC's job market. *The NYC Economic Development Corporation and Empire State Development Corporation should support green job development through implementation of light-industry incentives for SHW manufacturers.*

Conclusion

Many of the obstacles CEC, QSI, and EarthKind have encountered with installing and monitoring SHW systems in NYC are related to the inevitable challenges faced by new technologies in the context of existing permitting processes and building management strategies. Despite these hurdles, we continue to believe in the value solar thermal technology holds for New York City and the state as a whole. The potential consequences of the climate crisis make it especially important to reduce our CO₂ emissions and achieve a more respectful relationship with the environment. Natural gas drilling is becoming more and more dangerous potentially threatening the very water we drink. Quality jobs for New Yorkers are heading overseas and this technology presents an opportunity to manufacture and install these systems right in our own backyards. With solar thermal, we can reduce our impact on the natural world, create living wage jobs, and lower our energy costs. SHW is a win-win for New York's economy and the global climate.

New York's sought-after environmental and energy improvements will not appear overnight, nor is there a single, easy solution. Solar Hot Water systems are one piece of that puzzle and represent a valuable opportunity to demonstrate a commitment to an advanced energy economy. The recommendations outlined here can be the beginning of making these initiatives a reality.

References

- California Center for Sustainable Energy (CCSE). <https://energycenter.org/>. Accessed April 2011.
- Database of State Incentives for Renewables and Efficiency. www.dsire.org. Accessed April 2011.
- National Renewable Energy Laboratory
- New York Solar Thermal Consortium. "New York's Solar Thermal Roadmap." 2010.
- Nordisk Folkecenter. <http://www.folkecenter.net/gb/>. Accessed April 2011.
- Perlman, Jeffrey and Andrew McNamara. "Solar Domestic Hot Water Technologies Assessment." Brightpower. 2008.
- SOLARGE. "Market Report for Enlarging Solar Thermal Systems in Multi-Family-Houses and Hotels in Europe." Accessed April 2011.
- Weiss, Werner. "Potential of Solar Thermal in Europe." Institute for Sustainable Technologies, University of Vienna. 2009.
- Weiss, Werner and Franz Mauthner. "Solar Heat Worldwide." International Energy Agency. 2008.