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Solar Water Heating in the Southeast

Identifying Commercial and Institutional Opportunities

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Solar water heating (SWH) uses energy from the sun to preheat water, reducing the conventional energy needed to supply hot water by 40% to 80%. This reduces energy costs and provides a number of other benefits. This document explores projects that are capitalizing on the benefits of SWH and share their strategies for success.

When to Consider Solar Water Heating

WHAT'S INSIDE

For more information, visit nicholasinstitute.duke.edu/se-chp-swh.

SWH can be cost-effective on buildings with unshaded, south-facing or near-south-facing roofs that regularly use hot water, such as hospitals, apartment buildings, hotels, cafeterias, schools, fire stations, and residences. According to the U.S. Department of Energy, the amount of money a building owner can save by adopting SWH depends on

- the amount of hot water used
- the existing water heating system's performance
- geographic location and solar resource
- available financing and incentives
- the cost of conventional fuels
- the cost of fuel for any backup water heating system[1]

In addition to energy cost savings, SWH can help public and commercial entities meet additional goals, such as hedging against potential future increases in utility energy rates, reducing GHG emissions, and publicly demonstrating a commitment to sustainability.

Potential in the Southeast

The Southeast has a strong solar resource,[2] suggesting that SWH opportunities exist for commercial and institutional buildings that meet the conditions noted above. A 2010 study by the National Renewable Energy Laboratory (NREL) estimated that with state and federal incentives available at that time SWH broke even with electric water heating at electricity rates of 7¢–9¢ per kilowatt-hour (kWh),[3] a level that many Southeastern commercial users pay today.[4] As electricity rates in all sectors are forecast to rise,[5] SWH will become an increasingly economical choice for customers looking to reduce energy costs. The following case studies show that SWH can also be a beneficial supplement to natural gas water heating systems, which are consistently cheaper to operate than electric systems.

Because studies of SWH potential have focused primarily on the residential sector, there are fewer economic assessments and other resources for commercial

WHO CAN BENEFIT FROM SWH

SWH systems can be appropriate for a variety of energy consumers. For example, SWH heats an olympic-sized swimming pool at the University of Arkansas (Fayetteville). In Mecklenburg County, North Carolina, it provides hot water to five county buildings including a fire station and a community college culinary arts facility. SWH also provides hot water to restaurants, including a Waffle House in Norcross, Georgia, and the cafe at IKEA Orlando.[6]

1. U.S. Department of Energy, "The Economics of a Solar Water Heater," accessed April 18, 2012, http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12860.
2. National Renewable Energy Laboratory, "Solar Maps," accessed April 18, 2012, http://www.nrel.gov/gis/solar.html.
3. Andy Walker, "Solar Water Heating," Whole Building Design Guide, National Institute of Buildings Sciences, accessed April 18, 2012, http://www.wbdg.org/resources/swheating.php.
4. U.S. Energy Information Administration, "Electric Power Monthly," accessed April 18, 2012, http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a.
5. U.S. Energy Information Administration, "Annual Energy Outlook 2011: Issues in Focus" (April 26, 2011).
6. Information on these SWH projects was obtained through personal communications with Max Light, Rick Gragg, and Scott Turley at University of Arkansas; Mark Hahn at Mecklenburg County; George Mori at First Century Energy (Waffle House project developer); and Alex Alaniz at IKEA Orlando during the period October 2011–February 2012.

and institutional energy consumers. To help build an understanding of the potential for SWH in these less-studied sectors, this document presents case studies of SWH at a commercial (Hilton Asheville) and an institutional (Guilford College) facility. These examples also show that SWH can make sense for new construction and retrofit projects, and can be a serious consideration for the region's many universities, restaurants, hotels, and more.

Case Study: Guilford College (Retrofit)[7]

Guilford College is an independent college in Greensboro, North Carolina. In 2006, the school's Sustainability Council decided to tap into renewable energy and make a visible statement about their commitment to sustainability by investing in a 12-collector SWH system for Shore Hall, a dormitory that serves approximately 50 students. As the only dormitory that used natural gas exclusively to heat water, Shore Hall allowed for the best comparison of energy use before and after the $30,000 installation. The system has yielded immediate results. Guilford's student and staff energy team has calculated an average monthly savings of 48% of historical natural gas consumption at Shore Hall, and expects the system to pay for itself in 10–12 years, even though as a nonprofit Guilford could not take advantage of tax credits.

WHAT MAKES IT WORK

- Achieves multiple goals: sustainability, energy cost savings
- Smaller initial investment demonstrated benefits
- Public-private partnership allows access to tax incentives
- Creative financing through utility-like financing model

After a positive experience with the Shore Hall system, Guilford in 2010 partnered with FLS Energy to become home to the largest university SWH installation in the country at that time. The expansion consisted of 190 solar collectors on five residence halls, a student center, and a recreation facility. Although the Shore Hall system had demonstrated SWH could save money on natural gas and required relatively little maintenance, scaling up to the larger system would have been too great a one-time expense without creative financing and the partnership with FLS. The company offered Guilford a Solar Energy Purchase Agreement (SEPA), which was a new financing model to provide SWH to customers with little to no upfront investment. In this model, FLS designs and builds a SWH system and then owns and maintains the system for 6 to 10 years. During that time, FLS Energy operates like a small utility and sells its customers the energy it needs to heat water. At the end of the contract, the building owner may continue purchasing energy from FLS Energy or buy the system at its depreciated value.

Guilford's energy team calculated a monthly savings of 48% of historical natural gas consumption at Shore Hall.

This financing model not only overcame Guilford's capital constraints, but also allowed for the parties to benefit from a 30% federal tax credit and a 35% state tax credit. Guilford College—like other nonprofit and public sector entities—has no tax liability and cannot directly benefit from such tax incentives, but as a private firm, FLS Energy was eligible for the incentives and is passing some of those savings on to Guilford through a lower rate for purchased solar energy. A $200,000 federal stimulus grant obtained by FLS Energy further reduced the company's capital costs and enabled an even lower rate for Guilford College. Without the right combination of incentives, the school would have been more likely to move forward with SWH one building at a time over many years.

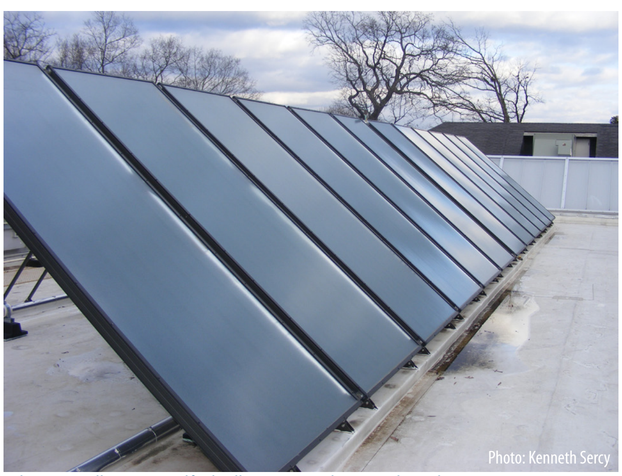
Photo: Kenneth Sercy

Solar water collectors at Guilford College in Greensboro, North Carolina

7. This case study was developed through personal communications with Jim Dees, Dan Young, David Petree, and student members of their energy team at Guilford College, and Joanna Baker at FLS Energy during the winter of 2011–2012.

Case Study: Hilton Asheville (New Construction)[8]

The Hilton Asheville is a LEED Silver–certified hotel in a mixed-use, master-planned urban village development in Asheville, North Carolina, owned by Biltmore Farms. As owner of multiple hotels, Biltmore Farms is well aware of a hotel's large and consistent demand for hot water. For that reason, they looked to SWH as one strategy to save energy and to meet the LEED standard. In 2009, they installed 70 solar panels to heat most of the 2,000 gallons per day of hot water that the hotel uses for showers, banquet facilities, a swimming pool, and a restaurant, avoiding 12,700 metric tons of carbon dioxide (CO_2) emissions annually.

WHAT MAKES IT WORK

- Achieves multiple goals: sustainability and energy cost savings
- Long-term investment will allow developer to realize savings
- State and federal tax credits, plus renewable energy credits to sell into NC market
- High hot water use: showers, restaurant, and swimming pools

The hotel's large and consistent demand for hot water makes SWH a smart investment.

As the owner/operator, Biltmore Farms will own the building long enough to realize the full stream of the energy savings, which made the upfront investment for the SWH system sensible financially. Biltmore Farms was also eligible for state and federal tax credits and able to sell Renewable Energy Credits into North Carolina's market. While these financial incentives were critical to offset the upfront costs of this SWH installation, they also reduced the perceived risk associated with investing in an unfamiliar technology. Today, the SWH system saves the Hilton Asheville more than $10,000 in energy costs annually. Biltmore Farms would have preferred a payback period of 7 years or less, but the expected payback of 8.4 years was deemed acceptable because of the sustainability and marketing benefits of this LEED-certified project.

Tips to Make It Work

Project managers have noted several lessons they have learned through their experiences with SWH projects, which those considering their own installations might consider:

Design to track energy savings. Across the board, project managers emphasized the importance of having the right tools to monitor SWH system performance, yet most have learned this lesson after systems were installed. For example, Guilford College did not install submeters along with the SWH systems on buildings with central boilers and have therefore found it difficult to calculate energy savings. The Hilton Asheville did install a meter on the solar collectors to track energy generation and sell renewable energy credits, but it is not compatible with energy dashboard software that allows for easy real-time monitoring. As a result, it took hotel engineers more than a month to detect an insulation problem. Today, monitoring is easier because the meter sends data to a laptop in the basement, but dashboard technology would make performance data even more accessible.

Hire experts and integrate the system into larger projects from the beginning. Choosing contractors with sufficient experience can ensure that projects will be properly designed and installed. Inexperienced contractors may install a system that is inappropriately sized, inefficient, or not maintenance-friendly. And all SWH installations—whether for retrofits or new construction—work better and are less costly when carefully planned from the outset, considered in the context of other renovations or construction, and not treated as an afterthought.

Plan rooftop systems carefully. Roof maintenance and integrity, building character, and other design details are important. Practical use of roof space is key: the roof of the Hilton Asheville is so crowded with panels, elevators, and HVAC equipment that a catwalk was needed to allow full access. If solar energy is a future possibility, leaving open roof space makes it easier to add solar panels. For an existing building, a SWH installation should be timed appropriately with roof and other building maintenance. In all cases, roofing materials must be strong enough to support the operating SWH collectors, which can add 6–8 pounds per square foot and affect the roof's wind load.

8. This case study was developed through personal communications with Hobie Orton of Biltmore Farms during winter 2012.

Policy Opportunities

A previous joint report by the Nicholas Institute and Georgia Tech found that with supportive policies, renewable energy could provide a large portion of the region's electricity at competitive rates within a decade.[9] By lowering demand, customer-owned clean energy projects like SWH mitigate the need for new generation, the demand for natural gas, the power losses and congestion associated with transmission and distribution, and the air pollution associated with conventional energy production.

As creative project managers find ways to work around common obstacles to SWH development, they are demonstrating that viable opportunities exist in the Southeast and revealing niches where policy can encourage further development. Interested policy makers could consider the following critical entry points to influence clean energy development—particularly SWH—by commercial and institutional entities.

MITIGATE UPFRONT COSTS

Investing in clean energy often means spending more now in order to save money later, but upfront capital can be difficult to secure. Recouping this investment through utility bill savings can take longer in the Southeast, where energy prices are low. Policy tools such as grants, tax credits, loan programs, and energy portfolio standards can help provide capital and spread out upfront costs.

Financial incentives can overcome upfront cost constraints for many projects. In a previous collaboration with Georgia Tech focusing on residential SWH, the Nicholas Institute found that extending the existing 30% federal tax incentive would avoid the equivalent of 21 billion kWh of generation in the South in 2030 alone.[10] Although there is no assessment of the impact this incentive could have on public and commercial entities, project managers in both case studies pursued the federal (and state) tax credits, and it is likely that project managers will continue to rely on similar incentives.

Incentives in Southeastern states are less common and typically less aggressive than in other regions, presenting a key opportunity for policy makers seeking to facilitate SWH development. In developing policies to support SWH adoption, policy makers should understand how various incentive structures enable different types of projects to move forward. For example, SWH tax credits are not directed towards public and nonprofit entities, which lack tax liability to offset. These sectors can only benefit from tax credits indirectly by partnering with private investors. Setting clear standards for public-private partnerships can facilitate public-sector clean energy projects, and both public and nonprofit energy consumers may benefit even more from grants and low-interest loan programs.

FACILITATE ACCESS TO INFORMATION

A lack of information can be a major barrier to development. Potential beneficiaries of SWH often do not know enough about it to evaluate the investment, identify reliable contractors, or feel confident in operating and maintaining a system. Moreover, SWH projects are not always designed with submeters to clearly measure hot water produced and energy saved, making it difficult for interested stakeholders to use others' experiences to understand their own potential benefits.

Policy makers can play a role in ensuring that adequate information is generated and shared. For example, requiring publicly funded projects to use submeters that clearly track energy and cost savings could build confidence in the technology. Outreach efforts by state energy offices or demonstration projects could increase familiarity with SWH technology. This has proven successful in Florida where demonstration projects, including one at the IKEA store in Orlando, have generated interest from other businesses seeking to learn more about SWH.[11]

9. Marilyn A. Brown et al., "Renewable Energy in the South" (Atlanta: Southeast Energy Efficiency Alliance, 2010).
10. Ibid.
11. Personal communication Alex Alaniz of IKEA Orlando, January 6, 2012.

The **Nicholas Institute for Environmental Policy Solutions** at Duke University is a nonpartisan institute founded in 2005 to help decision makers in government, the private sector, and the nonprofit community address critical environmental challenges. The Institute responds to the demand for high-quality and timely data and acts as an "honest broker" in policy debates by convening and fostering open, ongoing dialogue between stakeholders on all sides of the issues and providing policy-relevant analysis based on academic research. The Institute's leadership and staff leverage the broad expertise of Duke University as well as public and private partners worldwide. Since its inception, the Institute has earned a distinguished reputation for its innovative approach to developing multilateral, nonpartisan, and economically viable solutions to pressing environmental challenges.
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