The Role of Energy Performance Contracting in Deployment of Nonresidential Solar Water Heating Systems

How Commercial and Industrial Entities Can Use Energy Performance Contracts for Solar Water Heating Systems

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One goal of the U.S. Environmental Protection Agency (EPA) Energy Supply and Industry Branch (ESIB) is to expand markets for clean energy and support cost-effective reductions in emissions of greenhouse gases and other pollutants. To meet this goal, EPA is seeking to advance best practices and standards for commercial- and industrial-scale renewable heating and cooling technologies. EPA developed this white paper to explore energy performance contracting with Energy Service Companies (ESCOs) and its potential to be a best practice for installing solar thermal water heating systems in the commercial and industrial (C&I) sector. Through energy performance contracts, an ESCO identifies potential energy conservation measures (ECMs) at the host institution, assists in acquiring financing for the institution to pay for the upgrades, and guarantees that the energy (and often, water) savings achieved will cover both the service on the debt and the fees charged by the ESCO. At the end of the energy performance contract term, the customer owns all of the improvements and receives all of the continuing savings.

This paper first provides an overview of solar water heating, including its potential market in the United States, the benefits of using solar water heating, and some issues with financing solar water heating projects. It then addresses options for solar water heating contracting with a focus on the use of energy performance contracts and how the specific terms of those agreements might be affected by the inclusion of solar water heating. The paper concludes with a discussion of alternative contract structures and the outlook for using energy performance contracts in the deployment of nonresidential solar water heating.

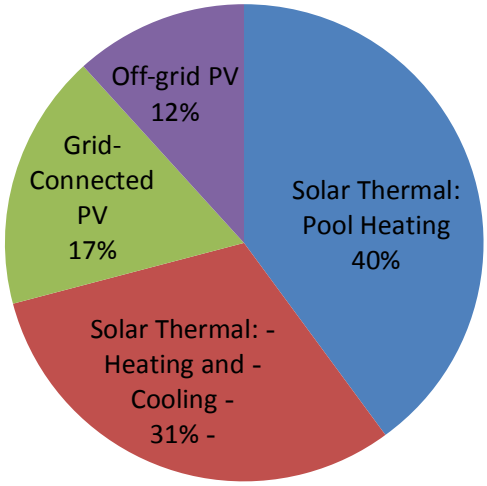
1. Status of Solar Water Heating in the U. S. Market

In 2003, commercial buildings in the United States consumed over 500 trillion Btu of energy for water heating. Water heating ranked behind only space heating, cooling, and lighting in terms of energy use in commercial buildings. Currently, water heating in the United States is dominated by conventional energy sources such as electricity, natural gas, propane, and oil. Other sources, including solar water heating, represent only 2 percent of water heating energy in the commercial sector[1]. Over 30 percent of non-mall commercial buildings, however, use large amounts of hot water, so a significant portion of the commercial building sector could benefit from reducing its hot water costs—while also reducing its carbon footprint. Furthermore, industrial sites with large hot water loads can also benefit from solar water heating systems.

Although the use of solar water heating appears to be growing in the United States, it is underutilized in the C&I sector, in which large amounts of energy are used to produce hot water. Figure 1 below illustrates the percentage of U.S. solar installations by category. While solar photovoltaic (PV) systems receive the most public attention, solar water heating represents a much higher percentage of total installations (i.e., 71 percent).

[1] Energy Information Administration, *Commercial Buildings Energy Consumption Survey*, 2003.

Figure 1. Percentage of U. S. Solar Installations from 1994-2010 (Source: IREC) -



Most of these installations (i.e., 84 percent) are in the residential sector[2] despite the high use of hot water in the C&I sector. Relatively high capital costs as well as lack of financing have been attributed as critical barriers for solar water heating[3].

[2] Interstate Renewable Energy Council, *U.S. Solar Market Trends 2010*, June 2011. -
[3] Guilford, David, "Breaking Solar Barriers in NYC: From Finance to Hot Water", presentation at NYC Solar Summit, Ney York City - Economic Development Corporation, June 2013. -

2. Benefits of Adopting Solar Water Heating

Solar water heating systems provide both economic and environmental benefits. Because these systems use the sun's energy to heat water, they displace purchased fuel or electricity (depending on the existing energy source used to heat water), thereby reducing both annual energy costs and greenhouse gas emissions. Because the use of solar hot water heating reduces the impact of fluctuating fuel prices, it can serve as a hedge against increasing energy costs and reduce energy budget uncertainty.

Many facilities have shown proven benefits of solar water heating systems. As just one example, the New York City Economic Development Corporation (NYCEDC) launched its Solar Thermal Pilot Program in 2009 to explore the potential for solar water heating systems in New York City. More than 30 percent of energy used in New York City's buildings is to provide space heating and hot water, and fuel oil and natural gas are the primary fuels used for these purposes. Approximately 75 percent of the city's greenhouse gas emissions are from building energy use[4]. NYCEDC found that, on average, the four pilot building sites that adopted solar water heating systems were each able to achieve over $2,300 per year in fuel savings. Together, the four sites, which use from 200 to 2,000 gallons per day of hot water, avoid over 5 million pounds of carbon dioxide emissions annually. Furthermore, NYCEDC projected that if the 4,565 buildings in the city with high solar water heating potential were to adopt this technology, they could save more than $200 million in energy costs over 20 years[5] and avoid emissions of over 6 billion pounds of carbon dioxide.

These benefits are not limited to the buildings sector; solar water heating technologies can also be cost effective in industrial facilities that use significant hot water. For example, to provide hot water for its dairy operations, Oakhurst Dairy (Portland, Maine) installed a solar water heating system in 2008 that is projected to save over $340,000 in energy costs over the life of the system and reduce the dairy's emissions of carbon dioxide by over 220,000 pounds annually[6].

The inclusion of solar water heating as part of an energy performance contract can help organizations achieve broader energy, financial, and environmental goals. For example, organizations that have adopted net-zero energy goals seek to produce as much energy from renewable energy generation, or through the on-site use of renewable fuels, as they consume. Such goals are simply not achievable with the energy efficiency measures that are typically included in an energy performance contract. Including a solar water heating system within an energy performance contract is one means of reaching more

[4] New York City Economic Development Corporation, *Solar Thermal in New York City: Opportunities + Challenges*, June 2013. -
[5] NYCEDC has assumed a 20 financial life, which also corresponds to a 20 year system life as cited by the 2008 Solar Domestic - Hot Water Technologies Assessment Final Report 08-09 published by NYSERDA. -
[6] Innovation Center for U.S. Dairy, " Case Study—Solar Thermal Systems Dairy Processor Carbon Reduction through Energy - Efficiency (D-CREE), New England Dairy Taps Solar Energy And Hot Water Recovery To Reduce Energy Costs And Carbon - Footprint", 2009. -

intensive renewable energy and environmental goals while taking advantage of a proven contracting model that has been employed successfully for years.

A number of states have adopted Renewable Portfolio Standard (RPS). Utilities within these states must meet renewable energy and may provide funding or incentives to customers that install renewable energy technologies. In return, the utilities obtain credits from the customers enabling them to meet their targets. Currently, 11 states (Arizona, Hawaii, Maryland, Missouri, Nevada, New Hampshire, New York, North Carolina, Pennsylvania, Texas and Wisconsin) and the District of Colombia allow utilities to obtain credits from solar water heating technologies to meet their RPS requirements. Where available, these credits can be sold to utilities, and can therefore help solar water heating projects achieve more attractive returns on investment by providing a revenue stream to supplement fuel savings.

3. Financial Issues with Solar Water Heating in the U. S. Nonresidential Sector

Solar water heating systems generally have lengthier payback periods than more conventional ECMs, due to the high initial cost of solar water heating systems. For example, the four buildings in the NYCEDC Pilot Program discussed in Section 2 had an average payback period of 16.75 years before incentives were applied to reduce system cost. The Oakhurst Dairy project had an 8- to 10-year payback period, depending on the cost of heating oil. For many facilities, this lengthy payback period is the most significant barrier to adoption[7].

While the practice of energy performance contracting is well accepted in the marketplace, the use of this financing structure to deploy solar water heating projects in the C&I sector has not been widely used. Energy performance contracts offer a unique opportunity to install solar water heating systems at commercial and industrial facilities. By assembling a bundle of ECMs with relatively short payback periods, an ESCO can include a solar water heating system with a longer payback period and still provide enough energy savings so that the overall payback period is within lender financing requirements.

In many facilities, however, a solar water heating system may compete against more urgent facility infrastructure needs that also have lengthy payback periods. In the municipalities, universities, schools, and hospitals (MUSH) sector where most energy performance contracts are executed, facilities tend to defer maintenance of their infrastructure, and critical systems are often in need of replacement. Furthermore, facilities in the MUSH sector may not have project budgets for longer-term payback measures, and therefore, the solar water heating system may be displaced by measures that serve more critical facility needs. Even though energy performance contracts that include solar water heating can be cost-effective, the facility might still need to make tough decisions to keep solar hot water in the project.

[7] "Public Perceptions of Solar Water Heating Systems: Survey Findings," Memorandum from Gotham Research Group for Solar Energy Industries Association, October 2011.

4. Solar Water Heating Contracting

A number of contracting options for solar water heating projects are available, but this paper focuses on energy performance contracts with an ESCO. These contracting vehicles can provide a number of advantages to help advance the adoption of solar water heating systems in the U.S. C&I sector. The energy purchase agreement option can also be a viable alternative in some cases, and is therefore also discussed in this section.

Basics of Energy Performance Contracts

Under an energy performance contract, an ESCO identifies potential ECMs when conducting an energy audit for the host facility. Water conservation measures may be included as well. Avoided future energy and maintenance costs are used to pay for the new ECMs. The ESCO arranges the financing, but the host facility owns any capital equipment associated with the ECMs and executes the financing agreement. The ESCO's services (e.g., measurement, monitoring and verification, and possibly a service contract), are also included in the project scope and costs. In this way, the host facility can obtain new lighting, cooling, and other equipment without incurring any up-front capital costs.

A critical component of the energy performance contract is that the ESCO provides a corporate guarantee that the energy and water savings will be high enough to cover financing and other project costs. The calculation of energy and water savings is based on the assumption that required operations and maintenance procedures are followed. These procedures may include contractually specified operating schedules, occupancy levels, and maintenance of control set points. The calculation of energy and water savings are not necessarily tied to cost savings alone, as utility rates may change over the contract period. If the energy and water savings do not materialize after adjusting for any changes in these conditions, the ESCO is under contract to pay the difference in cost based on a contractually agreed upon energy price structure. The ESCO performs measurement and verification throughout the contract term and can take remedial actions to ensure that the guaranteed energy and water savings are met.

Inclusion of Solar Water Heating in an Energy Performance Contract

Solar water heating may be included as one of many ECMs in an energy performance contract. The total potential project savings, however, will limit the capital cost of all measures to a certain budget, and solar water heating may have to be weighed against other ECMs for inclusion in the portfolio. The facility owner would have to consider both the financial impacts of solar water heating versus other ECMs as well as the benefit solar water heating could provide toward meeting the host institution's environmental or sustainability goals. Table 1 provides two examples of energy performance contracts that include solar water heating as an ECM within their contract scope.

Table 1. Examples of Energy Performance Contracts that Include Solar Water Heating[8]

Entity	City of Jacksonville	Florida Department of Corrections
Scope	Nineteen buildings, including city hall, police station, fire and rescue building, convention center, performing arts center, city services office, and library	Sixteen facilities
ECMs	• New energy management control systems • Lighting retrofits • Variable frequency drives on pumps and supply fans • Solar photovoltaic system for lighting • **Solar water heating** • Primary to secondary chilled water conversions • Outdoor air ventilation retrofits • Energy efficient HVAC condenser units • Water conservation retrofits • Web-based utility monitoring	• Lighting retrofits • Efficient fan motors • Chiller plant modifications, new chillers and HVAC replacement • New heat recovery unit • Programmable thermostats • **Solar water heating** • Energy management controls • Conversion of fuel oil-propane equipment to natural gas • Laundry equipment and systems upgrades • Replace windows in open dormitories • Boiler replacements and controls, repair steam leaks, stack economizers • New variable-speed drives

Energy performance contracts that include solar water heating are very similar to other energy performance contracts with respect to both the contract terms and the services provided by the ESCO: the customer owns the assets, and the ESCO performs the monitoring and verification and provides the savings guarantee. Including solar water heating among the other ECMs does not affect the contract term, which is generally somewhere between 7 and 20 years. The ESCO identifies ECMs to include in the energy performance contract to keep the payback shorter than the contract term; in this way, the ESCO can guarantee the savings with confidence.

ESCOs typically identify opportunities for hot water conservation in advance of sizing any solar water heating system. Hot water conservation measures improve the economic performance of the energy performance contract. When bundled with solar water heating systems, hot water conservation measures, which tend to be lower in cost and have shorter paybacks, make the project more viable by lowering the overall project payback period.

[8] Florida Department of Environmental Protection, Energy Performance Contracting Manual, July 2003.

Key elements of an energy performance contract that could be affected by inclusion of a solar water heating system are highlighted in Table 2.

Table 2. Key Elements of Energy Performance Contracts That Address Solar Water Heating

Contract Element	How Solar Water Heating Could be Addressed
Delivery Guarantees	An energy performance contract with a solar water heating system would focus on a specific quantity of energy delivered or fuel saved by the solar water heating system. The system would include metering to monitor and verify the unit's performance. Should there be a shortfall in energy delivered or in fuel saved, the ESCO would compare weather and building operations with baseline period data to ensure that these were not the cause. Extended periods of snow cover could have an impact on the system's operations beyond the ESCO's control; therefore, snowfall might be included as a contractual condition, and be monitored to account for any potential shortfall.
Pricing and Escalators/Indices	For solar water heating systems included in an energy performance contract, the ESCO would estimate, monitor, and verify the energy savings throughout the contract term. Because ESCOs do not take on fuel price risk, the ESCO would not absorb any change in cost savings due to fluctuations in fuel prices. Fuel prices (or a fuel price index) would be factored into the cost savings calculations.
Environmental Attributes	Solar water heating projects (unlike most conventional ECMs) often involve environmental attributes such as Renewable Energy Certificates (RECs). The ownership and/or sale of these attribute can be negotiated as part of an energy performance contract, depending on the goals of the of the host institution. For instance, institutions such as universities may view owning the environmental attributes as important in advancing their internal environmental goals. Other facilities may choose to sell the environmental attributes of a solar water heating project to help make the project more economically viable. The ESCOs contacted in connection with developing this paper, however, commented that the revenue stream from the attributes may be relatively insignificant. Currently, 11 states and the District of Columbia have renewable portfolio standards (RPS) or requirements that include solar hot water among their qualifying resources.[9] Utilities in these states may pay a premium to own the environmental attributes to help them meet their RPS targets.
Incentives	Incentives are typically applied up front to reduce the capital cost of the system, provided they can be incorporated into the arrangement before construction starts. Many projects, however, are designed to quickly get permits and begin installation, while incentive applications often require a permit for submission. Therefore, construction often proceeds before the incentive is received. If this occurs, the customer would still receive the incentive but it would not available at the time of construction to reduce the initial project cost.

[9] North Carolina Solar Center, Database of State Incentives for Renewables and Energy Efficiency (DSIRE), 2013.

Contract Element	How Solar Water Heating Could be Addressed
Invoicing	The customer makes the loan payment to the bank each month. Any ongoing payments to the ESCO for monitoring and verification or possibly service contract fees would be on a negotiated basis. The payments may be included as an annual cost, or as part of the initial project cost that is paid to the ESCO upfront as part of the financing.
Minimum Purchasing of Output	The contract would likely contain clauses to cover changes in hot water load. For example, the ESCO would want to protect itself against a college cancelling its athletic program and thus reducing its hot water load below what the system produces. An energy performance contract would typically address changes in occupancy or other factors that would affect energy consumption, and the guaranteed savings target would likely be reduced if certain building activities factors change.
Compensation and Remedies if System Does Not Perform	ESCOs are responsible for verifying savings. If savings do not materialize as guaranteed, the ESCO would then be required to make a payment to the customer. However, the ESCO will seek to remediate any deficiency after monitoring the equipment performance and correcting any issues as they arise. Often, ESCOs will look to the equipment manufacturer to remedy problems, and they will try to obtain longer warranty periods if available. In addition, the ESCO might insist that the customer take on service contracts for key equipment, such as HVAC systems. While an ESCO must stand behind the savings guarantees, it will take a number of steps to ensure that the savings are always realized by the customer.
Measurement and Verification of Output	Measurement and verification is typically accomplished through use of a Btu meter and flow sensor. The temperature differential and flow rate are calculated by the Btu meter or a heat meter built into the differential controller, similar to those used for district heating systems. In some cases, the meters will indicate the total energy supplied to the storage tank, while others will measure the energy delivered to the building. Alternatively, the building automation system can be used to monitor the pump that circulates glycol through the solar collectors, thereby ensuring that the system is capturing thermal energy. Some buildings may just verify the system is working initially and not on an ongoing basis to avoid ongoing costs.
Maintenance Responsibilities	Maintenance responsibilities are usually shared by the ESCO and the system host. If the ESCO holds a service contract with the system host, the ESCO will either service the equipment or outsource the service. The energy performance contract may specify service actions and service intervals to ensure that the equipment is properly maintained.
Insurance Issues	When an energy performance contract is employed, the customer owns the equipment and will therefore need to incorporate the property into its insurance policies.

Contract Element	How Solar Water Heating Could be Addressed
Liability and Warranties	Under an energy performance contract, the ESCO provides the savings guarantee; therefore, if the equipment fails, the ESCO may be at risk. Typically, standard warranties are about 1 year in length, although controls may be warranted for up to 5 years and the collector itself for up to 10 years. The ESCO will seek extended warranties, if available, in order to protect itself. Service contracts with the ESCO could also be used to make any repairs required during the term of the financing. The ESCO may set aside reserves to cover potential major maintenance items.
Termination and Disputes	Energy performance contracts generally contain limited termination conditions, because the customer owns the equipment as soon as it is installed. The customer is protected by the ESCO's guarantee of savings, which ensures that the savings are greater than the loan payment.

Alternative Contract Structures

An ***energy purchase agreement*** is probably the most attractive alternative to an energy performance contract. With an energy purchase agreement, a third party owns and maintains the solar water heating system and the host facility purchases the hot water on a contractual basis. The output is priced either on a dollar-per-gallon of hot water basis or a Btu basis. Energy purchase agreements are similar to power purchase agreements used for PV projects. Generally, these arrangements allow non-taxable entities to capture the tax benefits offered to solar water heating projects by having a taxable third party entity own the unit and claim the tax credits. For non-taxable host facilities, another advantage of an energy purchase agreement is that the third party owner must assume risks of ownership in order to qualify for the tax credits. In this way, the third party owner takes on the risk of low periods of solar irradiance (i.e., the "sunshine" risk) and the host facility pays only for hot water delivered. In addition the contract will usually include provisions to either renew the contract at the end of its term or provide the host facility with a buyout option priced at fair market value, which would likely be very low due to costs of removal and relocation.

Third-party shared savings are similar to energy purchase agreements in that a third party owns and maintains the asset, claims the tax credits and any incentives, and provides the output to the host facility. Instead of paying a price per output, the host facility shares the savings relative to their previous hot water costs, with the balance going to the third party. When the contract is complete, the system is offered to the host facility at a fair market value, which could be very low at that time. This arrangement is being implemented at sites with high hot water demand, such as multi-family housing[10].

[10]Cliburn, Jill, Heating Up: The Impact of Third-Party Business Models on the U. S. Market for Solar Water and Space Heating, prepared Solar Electric Power Association, 2012.

Generally, these alternative contract structures offer stronger guarantees of delivery, but are likely to include "take or pay" provisions. These provisions require the facility to accept and use the system's output at the price determined by the contract, or pay for the contracted output anyway. They also ensure that the third party collects enough revenue from the host to provide adequate returns on its investment.

These alternative contract structures also tend to include an initial price for the output coupled with an escalator or index used to adjust for fluctuations in fuel price or market conditions. Invoices are based on a price such as dollars-per-gallon hot water or Btu, and multiplied by the quantity delivered. In these arrangements, invoices are often submitted on an estimated basis, with a true-up invoice submitted later in the year as actual meter readings are obtained. In general, these contracts are developed specifically to capture the benefits of solar water heating, and thus may be more beneficial to a customer looking to implement solar water heating only and not a bundle of conservation measures.

Table 3 highlights key differences between an energy performance contract and an energy purchase agreement.

Table 3. Key Differences Between Energy Performance Contracts and Energy Purchase Agreements

	Energy Performance Contract	Energy Purchase Agreement
Who Owns, Maintains, and Insures System	Customer	Third party
Tax Treatment	For-profit companies are eligible for tax credits, but not-for-profit entities are not	Third party takes tax benefit
Project Scope	Included with numerous efficiency measures such as lighting and HVAC	Solar water heating system only
Payment	Customer makes fixed monthly lease payments to bank	Customer pays monthly charges for hot water delivered, may be indexed to fuel pricing

While an ESCO could employ an energy purchase agreement to satisfy a client that wanted a solar water heating system, this practice has not been common. The ESCOs contacted indicated that if an energy purchase agreement was used, the project could be split into two contracts: an energy performance contract for the conventional ECMs and a third-party contract for the solar thermal system. Generally, energy purchase agreements are being developed by specialized entities that have raised investment capital specifically for funding solar projects.

5. Outlook for Energy Performance Contracts in Deployment of Nonresidential Solar Water Heating

There are significant benefits to using an energy performance contract to install a solar water heating system for a commercial or industrial facility:

- The solar water heating system can be combined with numerous ECMs that will enable the facility to realize broader energy savings while modernizing its energy systems. The facility can combine these ECMs with solar water heating to reach an acceptable payback period.
- If the facility is in the MUSH or federal sector, it will be able to obtain low-interest financing through an ESCO, which will result in lower monthly payments.
- Various state and federal laws and regulations have been enacted to authorize use of energy performance contracts to give facilities access to new equipment and the associated energy savings.

If a facility is interested in solar water heating and also has a need for a number of conventional ECMs, it should explore the energy performance contract process and ask about including an evaluation of a solar water heating system during the initial energy audit conducted by an ESCO. Many states have published guidelines and procedures for procuring ESCO services through an energy performance contract process.

Some potential drawbacks to energy performance contracting include:

- Tax benefits, which are often significant and help reduce the costs to a facility, are not available to a non-taxable host facility if the host owns the system.
- Some of the risks of ownership fall on the host facility (e.g., the cost of paying for conventional hot water during periods of low sunshine, the cost of insurance).

Because an energy purchase agreement is tailored to the specific benefits of solar water heating systems, it allows for capture of tax benefits and protection against certain risks such as sunshine risk. In addition, the host facility will pay only for the energy it uses. This contracting mechanism is specialized for renewable options. For entities looking at installing solar water heating only, an energy purchase agreement might be the best approach.

The choice between these two options might come down to characteristics of the host facility. If the facility is in the MUSH sectors or the federal government, the energy performance contract option may have a clear advantage in that it can be bundled with other needed measures and easily financed. If the facility is a for-profit entity, the energy performance contract advantages are not nearly as clear, and other contracting options, such as an energy purchase agreement, might be more attractive. For non-profit host facilities looking to adopt solar water heating systems, decrease their carbon footprint, or

save money on hot water production, energy performance contracts with solar hot water heating systems are worthy of evaluation as a significant step in their energy and sustainability planning.

6. Resources

U.S. Environmental Protection Agency, Solar Heating and Cooling: Contractual Best Practices for Third-Party Financed Commercial- and Industrial-Scale Projects, December 2012.

ICF International and National Association of Energy Services Companies, ENERGY STAR Performance Contracting Best Practices, prepared for U.S. Environmental Protection Agency ENERGY STAR Buildings, May 2008. (https://www.naesco.org/data/industryreports/2008-05.pdf)

U. S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Federal Energy Management Program, Energy Savings Performance Contracts (ESPCs), DOE/GO-102012-37, September 2012. (http://www.nrel.gov/docs/fy12osti/55891.pdf)

National Association of Energy Services Companies, www.naesco.com.

Florida Department of Community Affairs and Department of Environmental Protection, Energy Performance Contracting Guide, July 2003. (http://www.energyservicescoalition.org/chapters/FL/resources.htm)

State of Hawaii Department of Business, Economic Development, & Tourism, Guide To

Energy Performance Contracting (EPC), 2011. (http://energy.hawaii.gov/wp-content/uploads/2012/06/HawaiiEPCGuide-20111.pdf)

New York City Economic Development Corporation, Solar Thermal in New York City: Opportunities + Challenges, June 2013. (http://www.nycedc.com/system/files/files/resource/SolarThermalUpdateOp.pdf)