A Guide To
Fee-for-Service
Solar Water Heating Programs
For
Caribbean Electric Utilities

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William Guiney is this document's lead author. William wrote the material on the fee-for-service business opportunity and program options and coordinated input from the others authors. John Harrison of the Florida Solar Energy Center prepared much of the content on the technical issues of solar water heating program implementation. Steven Kaufman and Samuel Milton of Green Markets prepared the material on carbon abatement and the role for carbon finance.

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Author's Comments

The world is facing some of the most challenging issues relating to the growth of populations, energy consumption, environmental degradation and the shifting of resources from the United States and Western Europe to the rapidly developing countries of China, India, Latin American, Eastern Europe and elsewhere.

The unstable and unpredictable cost of energy has been and will continue to be a major concern to countries dependent on petroleum resources for the generation of electricity. Prices not seen in recent times have forced electric utility companies to pass on the cost of generation to their customers. These record high prices for electricity are causing significant financial hardships to the residential and commercial sectors as well as the utilities and local governments. Paying the energy bills is becoming more difficult and diverting funds from other needs related to maintaining the level of economic status and to the addressing the never-ending demand for growth and development.

Island nations, especially in the Caribbean region, are caught in the middle of the energy crunch. The region's large dependence on diesel generation technologies for electricity has resulted in considerable price increases that are affecting the ability of the consumer and governments to maintain economic stability. Instability in the world's oil producing regions and the forecast for more devastating tropical storms that impact the delivery of petroleum resources to the Caribbean are not helping the situation or providing any hope of lower fuel prices in the near future.

As fuel imports and electricity demand increase in response to explosive residential and resort development throughout the region, utilities and governments are forced to expand generation capacity, slow the rate of growth, or turn to alternative solutions to meet the growing demand for electricity. The need for growth and economic development, combined with the desire to maintain the quality of life, necessitate new thinking about the role for renewable energy.

Renewable energy use is growing in the Caribbean region, and it is time for the electric utilities to explore how the available options can best serve their interests. This document outlines a fee-for-service business opportunity that offers utility managers a way to implement a cost-effective solar renewable energy program with minimum risks and high returns.

This document draws on material developed in 1997 by the Energy Alliance Group authored by Chet Lyons and Jerry Comer for the Utility Solar Water Heating (USH_2O) Initiative with the support of the Solar Energy Industries Association (SEIA), US Department of Energy and the National Renewable Energy Laboratory (NREL). This shows that good ideas, such as utility operated solar water heating fee-for-service programs, can be ahead of their time.

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Introduction

Purpose of the Guidebook

This Guidebook is intended to build knowledge about solar water heating fee-for-service program structures among electric utility companies and others, with the goal of facilitating such programs to increase solar water heating for residential, commercial, and industrial applications. It focuses on the Caribbean region, which is substantially endowed with solar energy but is generally lacking in hydrocarbon resources. Given the region's reliance on imported fossil fuels for power generation and the common use of electricity to heat water, solar energy represents a cost-effective solution. Still, higher upfront costs for solar versus conventional water heaters have kept the market share for solar heaters low in most of the Caribbean with the notable exception of Barbados, which has achieved high penetration levels through government subsidies.

This document will help utility companies evaluate, develop, and operate profitable solar water heating fee-for-service programs without government subsidies, providing cost savings to thermal energy consumers. It is designed to orient utility managers about solar water heating technology as well as the logistics of designing and implementing solar water heating fee-for-service programs. It also covers the benefits and practicalities of participating in markets for international carbon emission reductions to help finance solar water heating programs.

Structure of the Guidebook

The Guidebook covers the main elements necessary to design and implement a utility-operated solar water heating fee-for-service program in the Caribbean:

- Solar thermal water heating technologies
- Fee-for-service program options
- Financial and environmental benefits
- Program financing requirements and opportunities
- Solar water heating system component reliability, certifications, and installation

Section 1 covers the programmatic and financial components of a solar water heating fee-for-service business opportunity. After an overview of solar water heating technology, it outlines program options for solar water heating fee-for-service operations as well as financial aspects of program development and implementation. It also includes a discussion of the potential for environmental attribute sales (e.g., certified greenhouse gas emission reductions) to contribute to program financing.

Section 2 presents information about solar water heating system component reliability and other technical aspects of program operations. Two appendixes provide further technical information on system design and installation, training, and thermal metering. Appendix III provides detailed financial and cash flow projections.

Section 1: Fee-For-Service Business Opportunity

The "Fee-for Service" Business Opportunity

Faced with increasing generation costs attributed to the record high costs for oil, increasing demand for electricity due to the rapid commercial and high-end residential development and the per capita consumption increases of local populations, electric utilities are looking for ways to meet the growing demand for energy.

The electric utility is faced with a number of difficult challenges: providing base load and meeting the peak demand in the evenings, expanding the grid to provide services to new development, and finding ways to increase their environmental stewardship. Privately owned electric utilities must do all of this while returning a profit to the shareholders and keeping energy costs from rising, which directly impacts the host nation's ability to attract investment, foster tourism and further economic development. Government run national utility companies face similar pressures.

To say these conditions are challenging would be an understatement. To complicate the situation even more, utilities are being asked to allow consumers, both commercial and residential, to generate their own electricity with private generators and renewable energy technologies like wind and photovoltaics (PV). Private generation is not new, but is increasingly seen as competition and lost revenue by the utility.

Moreover, many utilities are under pressure to allow net-metering or to allow the customer to install wind and PV energy generation systems on their homes and businesses and feed renewable energy into the grid when the electricity produced by the renewable energy system is greater than the customer's demand. Net-metering allows the customer to store energy credits on the utility's grid for later use, banking their reserves or asking the utility to pay for their excess generation at the same retail rate the utility charges.

Net-metering is often seen as direct competition to the utility. In some countries local/customer generation is not legal, but due to the perceived need to reduce their dependence on imported oil and to guarantee electricity supply, governments are under pressure to change the laws in an attempt to encourage greater use of renewable energy. Net-metering is a valuable tool for integrating renewable energy into the energy mix but as seen in the United States, it may take prolonged legislative processes or very forward-thinking utilities before it is established throughout the region.

Utilities must integrate new products and services to increase revenues, improve customer loyalty and retention, and establish barriers to market erosion. In many countries, business expansion via new products and services is now a central goal for most utilities.

It may seem surprising that solar thermal energy as applied to heating domestic hot water – an idea that has been around for a long time – offers what electric utilities and their residential customers may want most in a new product and service.[1]

Distributed generation is a key element in de-centralizing the production of electricity for the security of the generation facilities, simultaneously reducing load impacts on the grid and reducing line losses. By generating energy at the customer's site, the utility is reducing the capacity needed for the distribution system, improving the reliability, and increasing the quality of the power.

"Generation Offset Equivalence" is being used to define the performance and value of Solar Thermal Energy technologies used for water heating, swimming pools, spas, and air-conditioning. Instead of using electricity from the grid to heat water, the abundant free energy of the sun is harnessed by the solar system owned by the utility to generate the electric equivalence necessary to provide hot water to their customer or the heat required to operate other systems used for manufacturing, process heat and air-conditioning.

A "solar energy system" is the hardware that uses sunlight for the production of thermal and/or electrical energy. Solar energy systems offset the consumption of thermal and electrical energy, which are often derived from fossil fuels.

Solar thermal systems will directly reduce consumption of electric grid power in exactly the same way as solar electric generation technologies increase useable energy at the customer's site. For example, where a solar water heater is used in place of an electric water heater, a solar water heater that offsets 3,000 kilowatt-hours of electricity per year has the same impact on grid power consumption as a photovoltaic system that produces 3,000 kilowatt-hours.

This document will show the utility how to establish a business unit dedicated to integrating renewable energy into the utility's product mix with a "Fee-for-Service" program that will increase revenues, meet the demand for lower energy costs by their customers and increase the capacity and reliability of the existing grid.

[1] Prospectus for Utilities in Solar Water Heating, June 1999 • NREL/EL-550-25976 Energy Alliance Group

Solar Water Heating Technology

Solar water heating systems are assigned to four different classifications.

System Types

- Active
- Passive
- Direct
- Indirect

Direct

Direct systems heat the potable water stored in the tank for use by the customer. Active and Passive systems can be a direct solar system. Most utility programs in the Caribbean will use direct systems because there are no freezing conditions and generally no limitations related to water quality. Direct systems are more efficient, have fewer components, are easier to maintain and have lower costs.

Indirect

Indirect systems utilize a heat exchanger to transfer the heat from the solar collector to the water in the storage tank. The heat exchanger separates the potable water in the storage tank form the non-potable heat transfer fluid in the solar collector loop.

Indirect systems are usually used in areas with freezing climates or bad water quality, which causes corrosion, or significant mineral deposits in the solar collector.

Water that is corrosive to copper or has a high dissolved mineral content that could clog the tubing or waterways of the solar absorber should not come in contact with the solar system. A heat exchanger should be placed on the solar loop between the collector and the water heater to protect the system. It should be noted that if the water quality were bad for the collector it would also cause problems for the heat exchanger. In this rare case, a water conditioning system should be considered before installing the solar system.

Active

An active solar water heating system typically has a storage tank in the building lower than the elevation of the solar collectors that are installed on the roof of the building (Figure 1). Hot fluid is less dense or lighter than cold so the cold fluid will naturally fall or be pulled to the to the bottom of the storage tank due to gravity. The hot fluid, being lighter, stays in the collector and must be actively circulated to the tank in an active system. The process of collecting the heat from the solar collector defines the active system and requires a circulation pump (AC or DC) to actively circulate the heat transfer fluid from solar collector to the storage tank.

Differential Controlled- Active pumped system

A differential controller powered by conventional 110VAC or 220VAC electricity is used to activate the circulation pump any time the temperature in the collector is between 8^o-25^o Fahrenheit (*set at installation*) hotter than the temperature of the water in the bottom of the storage tank. The differential controller activates the pump until the temperature differential falls to 3^o-5^o F and turns off the pump.

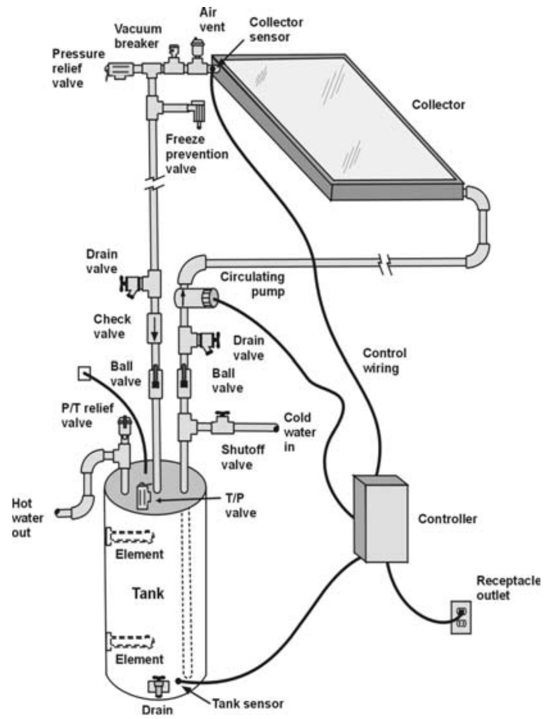

Figure 1

During the course of the day, the controller is constantly comparing the two sensor temperatures. In this way, water circulates through the collector only when sufficient solar energy is available to increase the water temperature.

Differential controllers are used on residential and commercial active system designs. Large active systems may require a motor starter and relay operated by the differential controller for controlling pumps larger than ½ HP.

Photovoltaic (PV) controlled–Active pumped system

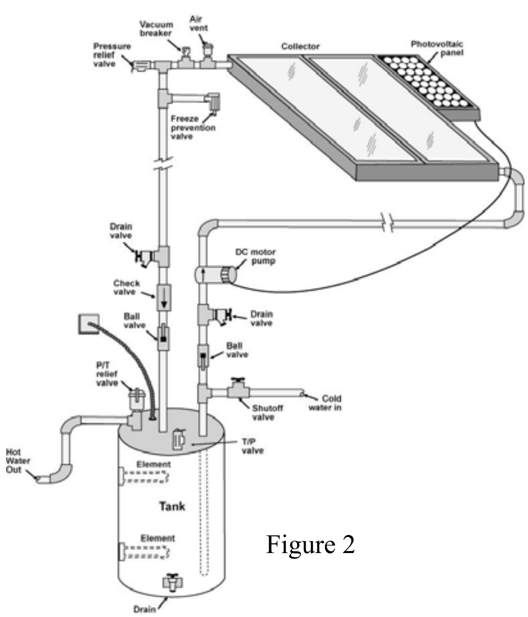

Figure 2

A Direct Current (DC) PV panel (typically 5-10 watts) is used as the controller on a PV controlled active system (Figure 2). As the sun heats the water in the collector, it also generates curent in the PV panel next to the collector. The PV panel converts the sun's energy into electricity, and is sized so that when there is enough electric energy to start spinning the pump, there will also be enough solar energy to heat the water in the collector. The pump sends cold water up to the collector, pushing the hot water out of the collector to the tank. This continues as long as there is sufficient sunlight to energize the PV panel. The PV system is proportional, which means intensity of the sun controls the output of the PV module and is directly related to the amount of heat energy in the thermal collector. As the intensity of the sun increases, the circulating volume of the pump increases. Likewise, when the intensity of the sun diminishes, the pumps will slow down. This variable speed allows the system to operate at its proportional outputs

As the pump is only circulating water, rather than lifting it, a small pump may only be needed. This will help reduce the cost of both the pump and the PV module required to power the circulator. The PV panel must be properly sized and matched to the pump or the system will not operate properly. A properly sized system will ensure that the system will not start too early in the morning or run too long into the evening resulting in energy losses at the collector. Most designs use city water directly in the collector loop. In areas with corrosive water, the same design could be used with a heat exchanger between the collector and the tank.

Passive

There are two main types of passive solar water heating systems: thermosiphon systems and integrated collector storage system. Each is described below.

Thermosiphon System

One of the most common system designs in the tropics is the thermosiphon system (Figure 3). It is perhaps the most widely used system design in the world. It makes use of natural convection to collect the sun's heat and store it in an insulated tank for later use. The sun's rays are absorbed by the metal plate, which heats the fluid inside the collector tubes. As the fluid is heated in the collector tubes, it becomes less dense and rises to the top of the tank. Cooler fluid from the tank drops down into the bottom of the collector to replace the rising heated fluid. This cycle continues as long as the sun is able to heat the fluid in the collector.

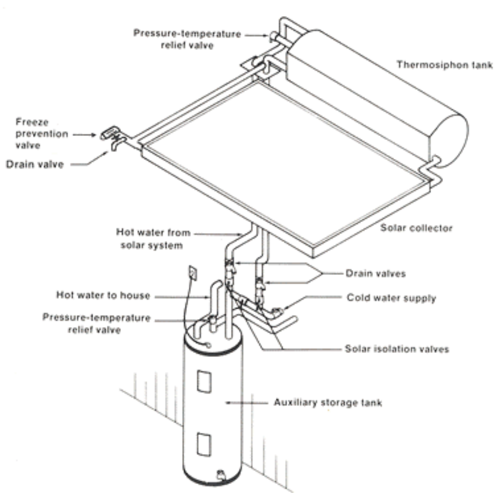

Figure 3

When the sun is <u>not</u> heating the collector, the natural circulation stops. At night, the cold fluid stays in the collector and the lighter heated water stays stored in the tank.

Insulation in the back and sides of the collector and the glazing in the front of the collector allow it to collect heat during the day at temperatures much higher than the surrounding ambient air. The insulated tank reduces heat loss so the heated water can be stored for long periods of time until it is needed. A filled 50-gallon (190 l) tank will weigh over 500 pounds (220 kg), while the weight of the collector will be approximately

90 pounds (41kg) for a single 21 square foot ($2m^2$) collector. An 80-gallon (300 l) storage tank can weigh more than 760 pounds (345 kg) and the 42 square feet ($4m^2$) collectors can weigh an additional 180 pounds (82 kg). The roof structure must be able to support this weight or an alternative installation area must be considered.

In order for the natural convection effect to work in a thermosiphon system, the storage tank must always be installed at a level above the top header of the collector.

Integral Collector Storage (ICS) System

The ICS design is the simplest system design (Figure 4). One common ICS system design uses a series of progressive 3" tubes that act as the solar absorber and the tank combined, or integrated into one unit. Each tube inside the collector box will hold approximately 5-gallons (19 l) of water. Systems using this design are available in 30, 40 and 50-gallon (115, 150, 190 l) sizes.

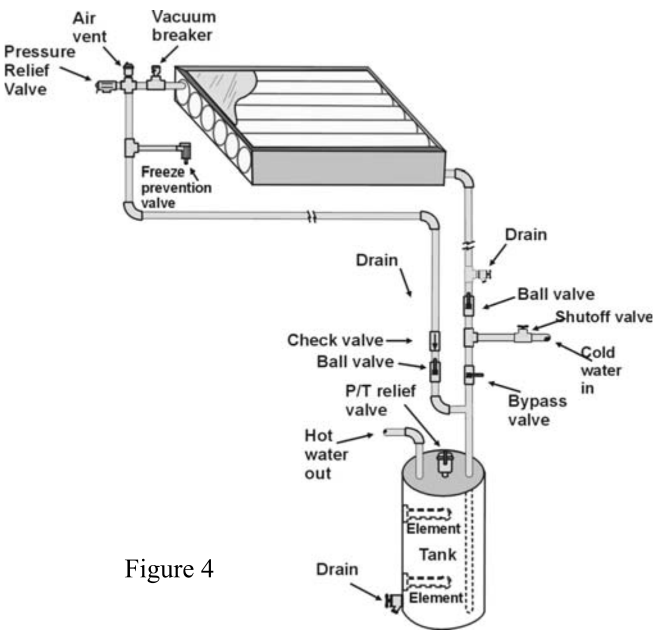

Figure 4

As the water sits in the tubes, it heats up over the day. The insulated box allows it to reach temperatures much higher than the surrounding ambient air. When there is a demand for hot water, the solar heated water leaves the top of the collector/tank and flows to the building, and cold water comes in at the bottom, replacing the hot water delivered to the building.

A filled 40-gallon (150 l) ICS system could easily weigh over 550 pounds (253 kg), with a relatively small footprint. Although this improves the odds that it will stay on the roof during a hurricane, it also means that the roof structure must be strong enough to hold all the weight. Three such systems are manufactured in the United States; two have only a single glazing of glass. The other, manufactured in Florida, is a double glazed system that reduces the heat loss on clear dark nights.

The ICS system is quite effective in the Caribbean. It is best used in applications where hot water use is in the evenings. Using the hot water before the end of the evening will reduce the potential for heat loss overnight, and in some cases where the customer has an existing electric water heater inside the building, evening use will transfer any remaining hot water in the solar system into the insulated water heater inside the building. Transferring any remaining hot water to the inside tank will maximize the performance of the ICS system. The ICS system has no moving parts and minimal balance of system components.

Service-Fee Program Options

For solar water heating fee-for-service programs, the two main options are sale-of-energy programs and system leasing or rental programs. As explained below, within each of these two main options, alternative configurations can be applied.

Sale-of-Energy

Sale of energy programs can be applied to any type of water heating customer. Applications can include residential, commercial and industrial users of hot water.

A sale-of-energy program does not require capital investment by the customer. The utility company or another energy service provider owns, installs and services the solar water heating system. A third party might also own the equipment, with the utility or energy service company managing the administration. The owner/utility sells the energy generated by the solar thermal system to the customer. These arrangements can be structured as a "shared savings" or "performance" contract whereby the utility will charge a rate lower than the conventional electricity costs for the solar energy generated and supplied to the customer. For example, the charge to the customer might range from 90% of current electricity costs to as low as 75% of current rates to heat the hot water. In that case, the customer would realize a 10-25% savings for water heating.

Experience in the United States indicates that the cost to the consumer for the solar generated hot water has a levelized cost of US$ 0.04 -0.08 per kWh.[2] Given the excellent solar resources in the Caribbean, it would likely be toward the lower end of this spectrum or less. A utility would need to evaluate their present cost of generation to determine if solar thermal is a favorable method for energy generation; the energy produced by solar thermal systems may cost substantially less than their base load generation costs.

The rate the utility charges for the energy sales can be fixed or tied to a percentage of the prevailing conventional electricity rates. The rates can be adjusted periodically, such as monthly or annually, or it could be fixed for the term of the contract. There may be an advantage to fixing the price at the start of the contract, as this could assist in the customer enrollment process by publishing the comparatively favorable fixed price.

For proper comparison, establishing a baseline efficiency of the conventional water heater is important to determine the present cost of energy to heat water. The lower the efficiency of the existing water heating system the more costly it is for the customer to heat water. As an example, the cost to heat 1,200-gallons per day of hot water in Jamaica with an electric heater that is rated at a theoretically optimal 100% efficiency factor (EF) would be US$600 per month at US$0.28/kWh. The same 1,200-gallons per day with an electric water heater operating at 70% EF would equal $855 per month. New high efficiency water heating technology today typically has no higher that an 81% EF and most water heaters in the Caribbean are much lower.

[2] USH$_2$0 Utility Success Stories In Solar Water Heating (Analyses from HECO, EWEB and WPSC)

One can measure the EF of an existing water heater and the cost of heating water with a conventional water heater by metering the cold water supplied to the conventional water heater and the total electric consumption of the heater to heat the water that is delivered to the building.

Under the fee-for-service sale-of-energy arrangement, the utility is responsible for ensuring that the system is performing. If the system is not functioning properly, the revenue stream is interrupted, reduced or completely stopped. The more heat generated by the solar system the greater the return to the utility/owner. Proper design and application are critical to the success of a sale-of-energy program, and maintenance is also paramount. The reliability of passive thermosiphon solar water heating systems generally used by the residential and light commercial customers is high but a comprehensive maintenance program should be considered an important component of any program to respond to systems identified as under-performing or in need of repair.

Any solar water heating system can easily be monitored for performance and metered to determine the kWh generation equivalent or BTU output of the system.

Metered Systems

The cost of metering equipment for solar thermal systems is approximately $200 for a residential or light commercial system. The cost of the computer and thermocouple sensors is $125 and the flow meter will cost $75. Larger commercial system that have greater flow rates and pipe sizing (1 ¼ " to 2") utilize the same data logging computer but will require a larger flow meter that will cost between $180-$260.

Due to the growth of metered sale-of-energy programs, "clean energy" programs, and performance-based production incentives in the EU and US, the cost of metering equipment is starting to come down. Some industry analysts estimate that the cost of metering solar water heating systems in the future will be less than $100 for residential and $300 for large commercial systems. Based on price structures in the Caribbean region, adding the metering equipment to a residential system will increase the cost of the installed system by 10-20%. The additional cost to a commercial system would be less than 2% or 3% of the installed system cost.

Lakeland, FL Municipal Electric is an example of a successful residential metered solar utility program. While residential system metering is clearly possible, commercial systems are ideally suited for the metered sale-of-energy option. These systems are larger than the typical residential system and the consumption of hot water is higher.

The computer used for metering the hot water generation is a data recorder that will display the energy production of the solar system in BTUs or kWhs produced. There are three methods of metering the production of a solar system for a sale-of-energy program.

One option is to meter the direct production of the solar system. The supply and return lines to the solar collectors from the storage tank are metered to determine the site-generated energy by the solar collector array. The utility will invoice the customer for the energy produced by the solar system. The customer pays for the supplemental energy required to heat the water to the delivery temperature and any storage tank heat loss. In this case, the utility bills the customer for the energy delivered to the storage tank, not the energy used by the customer. This method quantifies the production and operational status of the solar system. If there is no generation of energy by the solar system there will not be any metered energy gain registered by the meter.

The second option is to meter the actual use of hot water by the customer. Energy produced by the solar system and supplemental energy (electricity) required for heating the water is included in the charges to the customer. An example would be a residential solar water heating system with the metering equipment installed on the cold water supply to the heater and on the hot water service line from the heater to the building. The meter records the total hot water consumed by the customer and calculates the energy used for heating the water. It does not know whether the energy was supplied by the solar system or the electric element in the water heater.

In this case, the utility charges the customer for their consumption of hot water. The program absorbs the storage tank heat-losses. This method does not assist the utility in determining the operational status of the solar system because it is not known if the solar system or the electric element supplied the energy into the storage tank unless another watt-hour meter is installed on the electric element.

The third option is similar to the second, but includes an additional watt-hour meter connected directly to the electric element on the water heater to measure the actual electricity used for supplemental heat to increase the temperature to the thermostat set point and any electricity required to overcome heat loss of the storage tank. The addition of this second meter enables the utility to quantify the electricity used for water heating and assists the utility in determining the operational status and production of the solar system. This will enable the utility to determine how much energy was supplied by the electric element and how much energy was supplied by the solar system.

Methodology - Solar Net Metering [3]

In a solar thermal net metering program implemented in Florida, metering was accomplished by the use of a thermal meter calculator and a dedicated rotary kWh meter shown in Figure 5. The thermal meter consists of a rotary vane flow meter installed at the cold-water inlet to the tank, and a pair of differential RTD temperature sensors. In standby mode, the battery-operated calculator display defaults to the total accumulated kWh. However, this total thermal energy includes both the solar energy and the auxiliary heating energy delivered to the customer. A second meter is used exclusively to record the energy consumption of the auxiliary heating element when in operation. In essence, the metering system consists of a dual meter system, where the electric energy portion is subtracted from the total energy. The resulting energy is referred to as the "Net Solar

[3] Solar Thermal Billing Program In Florida, Carlos J. Colon & Jeffry D. Curry

Energy." Net solar energy charges become a two-step task for the meter readers in the field. This in turn requires two entries into the billing process, the electric energy meter on the element and the solar meter.

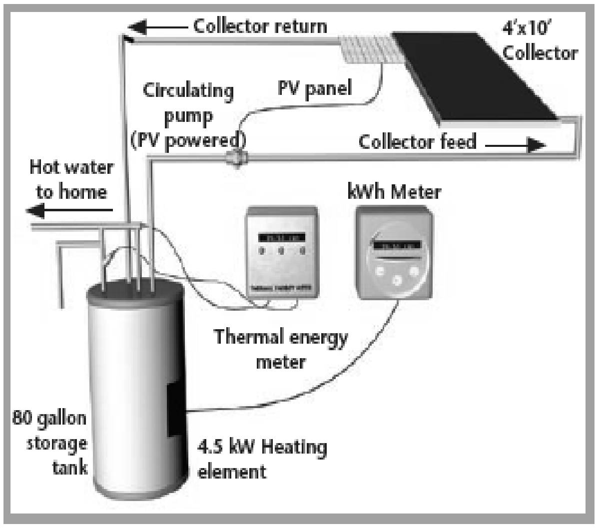

Figure 5 (USDOE State Energy Programs Case Studies)

Heat Meter Sources

There are a number of sources for heat metering and system performance data loggers. A list of suppliers is located in Appendix I in the back of this document. The listed suppliers have different methods of determining the performance and energy generation of a solar water heating system. It is important to select equipment that meets the (OIML) International Organization of Legal Metrology; OIML R 75-1: 2002 (E), International Standard for Heat Meters http://www.oiml.org/publications/R/R075-1-e02.pdf and OILM R 75-2 Part 2: Type approval tests and initial verification tests for Heat Meters http://www.oiml.org/publications/R/R075-2-e02.pdf

Leased and Rental Systems

As with the sale-of-energy option, under the leased and rental options the solar water heating systems are owned by the utility company or energy service provider, though the fee structure is not based on the metered sale of energy.

Leased Systems

Leasing equipment is common in the business sector and is used as a method of financing equipment purchases. In the US and some other jurisdictions, a leased item is owned or financed by a third party who will typically realize a tax advantage by depreciating the item while receiving a fair price for the use of the product being leased by the customer.

The value of a product both at the beginning of the lease term and the remaining value after the lease has expired are used to determine the cost of the lease. The consumer's payments cover the declining value of the product and a margin of profit for the leasing company. A solar water heater lease program operated by a utility company would work in a similar fashion.

In a program for leased solar water heating systems, the customer will sign a lease agreement with the utility allowing the utility to install a system on the property of the customer. The agreement will include language that does not allow a customer to remove, relocate or tamper with the system and any components installed by the utility.

As a common element of lease contracts that would also be helpful for SWH leasing programs, the contract could enable both parties to renew the lease for an additional period of time exceeding the initial term of the lease. Typically at the end of the lease, a purchase option is extended to the customer. They may pay the fair market value of the system at the end of the lease at which time the utility is no longer required to maintain or service the system. The customer receives title to the system and assumes ownership.

If the customer does not purchase the system, it may be removed from the property by the utility. However, this may not be in the best interest of the utility or the customer, even if there is no purchase agreement.

A long-term initial lease period of 10 years or more would possibly be the best approach from the utility's perspective and could also be viewed as mutually beneficial in some cases; while residential customers may be reluctant to make such a long term commitment, commercial customers may value the certainly and long term cost savings this option would provide.

Rental

A rental option would be similar to the leased program above except there would not be a transfer of title to the customer or predetermined value at the end of the rental period. (See "flat-fee" below)

Flat-Fee

The "flat-fee" approach may be the best option for a service-fee program in the Caribbean, especially for the residential sector. Under this option, the utility would own, install and service the solar water heating system located at the customers' home, hotel or business facility. The customer is charged a flat monthly fee for the use of the system. No metering equipment is installed in the system and the customer is responsible for any electricity used for supplemental heating of hot water. As with the sale-of-energy approach, third party ownership is also possible, with the utility managing the program's administration.

Under a flat fee fee-for–service program, all the hot water produced by the system is the customer's to use. If different systems are offered by the utility, the flat fee approach allows the customer to choose the system size that best fits their hot water needs or household budget. The utility may offer different types of systems. There may be a higher price for an active system than a passive system that has a lower potential for maintenance or service needs.

The customer may have an existing water heater, which may be retrofitted with a solar collector and circulation system to convert it to a solar water heating system. By utilizing the customer's water heater, the utility would not need to replace it. In this case, the program would need to clarify the terms of using the customer's existing water heater. For example, such terms should stipulate that the water heater must be serviceable and in good enough condition to allow the installers to retrofit the tank. It must also be made clear who would be responsible to replace the customer's existing water heater when it becomes unusable and needs to be replaced.

If the customer's existing water heating is in good condition, it may be advantageous for the utility to accept responsibility for the existing water heater. In that case, it may be best to have the customer transfer title or ownership of the water heater to the utility as a condition to enrolling in the program. The savings on the initial cost of solar storage can be financially beneficial to the program.

If the water heater is not in good condition or it appears that the water heater will need to be replaced within the first year of the program, it may be better to replace the existing water heater during the initial installation phase of the program. It is more cost-effective to replace any water heater in questionable shape during the initial installation. Returning to an installation site to replace a leaking tank during the first year will increase the cost to the utility.

The utility program may have the option of replacing any existing water heater during the enrollment period and tie the enrollment fee to the condition of the exiting water heater.

Flat Fee Option - Enrollment Fee

A flat fee program has considerable benefits for the utility's customer. For example, a fixed cost for hot water insulates the customer from energy cost escalations for the term of the contract. Because of the favorable terms for the consumer, the utility may consider charging an enrollment fee to sign up for the program. The enrollment fee can be tied to the different options offered by the utility. Options that cost the utility more may require a higher enrollment fee. As an example, a simple thermosiphon system preheating an existing electric water heater may be the lowest cost system to the utility and could thus have the lowest enrollment fee.

A thermosiphon system that requires a new conventional water heater to be installed will cost the utility more to prepare the customer for enrollment in the program, thereby requiring a higher enrollment fee than an installation that uses the customer's existing water heater that is in satisfactory condition and is expected to have more than 2-3 years of useful life. This 2-3 year timeframe is based on the cash flow analysis of the time required for the utility to recover their initial investment. There may be higher costs to installing larger systems or active systems verses passive systems.

The enrollment fee allows the utility to mitigate the initial installation cost and reduce the initial cost of the program to the utility. For cash flow considerations, the utility might consider charging an enrollment fee equal to the cost of the installation. Consideration must be given, however, to how enrollment fees will affect participation in the program. Customers will evaluate the initial cost to enroll and the monthly costs for the system to determine the value of participating in the program. To be successful, the program must be seen as having a cost savings and perhaps other benefits for the customer. A high enrollment fee could reduce the perceived value to the customer and negatively affect enrollment.

Green Pricing Programs have been a successful tool to increase the capacity of renewable energy supplies in the United Sates, but it is difficult to estimate the number of customers who would be willing to pay more for energy produced by renewable energy sources in the Caribbean. The programs described herein are predicated on the assumption that all of the "fee-for-service" options would offer solar heated water at a lower retail cost to the consumer than electrically heated water. Given the comparative cost advantages in cases where electricity is generated by high-cost fossil fuels, this arrangement should enable both the utility and its customers to benefit.

The utility may consider waiving the enrollment fee for a period of time to encourage customer enrollments in the program. Marketing the program by the utility and encouraging participation will be important to the success of the fee-for-service program. Promoting a lower cost for early entry in the program may have a positive effect on enrollments.

Another possibility or option for the utility would be an enrollment fee tied to the monthly charge for participation in the program. In this case, customers could elect to pay the enrollment fee at subscription and have a lower monthly charge. Other customers may choose to pay a higher monthly charge and not pay the initial enrollment fee.

Program Benefits

Utility Benefits

A fee-for-service solar water heating program can provide significant benefits to a utility company, including revenue and profits from the service fees charged to solar thermal customers and revenue from the sale of environmental attributes such as emission reductions (covered in the financing section of the Guidebook) as well as reduced peak demand and fuel cost savings. As seen in the table below, solar thermal can generate energy for water heating for as little as US$ 0.013 – 0.044 per kWh. This is far less than the typical cost for diesel generation per kWh and also offers a very low risk as it relates to fuel cost stabilization, production and resource reliability.

Attribute	Coal	Natural Gas	Solar Thermal	Wind	Solar Thermal Electric	Solar PV	Biomass	Biogas	Geo Thermal	Hydro
Typical Size MW	500-2000	150-600	0.0005	10	1.2-80	.01-1	50	5-10	25-50	1-1500
Capacity Factor (%)	70-85	20-80	20-30	30-35	20-30	15-20	60-80	80-90	90	60-80
Capital Cost ($/KW)	1000-1600	200-600	1500-3500	1000-1400	2700-4000	7000-9500	2000-3450	1600-2400	2500-3500	1300-6000
Energy Costs cUS$/kwh	2.0-3.5	3.0-7.5	1.3-4.4	4.1-6.0	11-41	25-50	8.0-13.0	2.7-6.0	3.7-6.0	2.4-12
Risk	Med	HIGH	Very LOW	Low	LOW	LOW	MED	MED	MED	MED

Production Capacity and Demand Reduction

Ratings of collectors and systems, along with other information specific to the local area, can be used to calculate the specific reduction in a utility's peak demand. On average, for every 4 m^2 solar water heating system that is installed, 0.5 kilowatts of peak demand is deferred from a utility's load.[4]

With regard to energy demand reduction, a realistic indication of solar thermal system performance can be estimated from the rated daily energy output of the collectors or system. Using this method, in the Caribbean region, a typical residential SWHS with 4 m^2 of collector surface contributes 7 to 10 kilowatt-hours per day, depending on the solar resource in the exact location and type of collector. Electric water heating for residential applications typically consumes about 12 kilowatt-hours per day, depending on ground water temperature. Annual, site-specific energy savings for domestic water heating systems are available at http://www.solar-rating.org/ for all systems certified by Solar Rating and Certification Corporation (SRCC), which developed a technique for estimating the capacity and energy production of solar thermal systems in electrical terms. Using this data, a typical SWHS produces about 3,400 kilowatt-hours per year, again depending on local conditions and type of collector.[5]

Conversion of Thermal Energy to Equivalent Electrical Terms

When thermal resources are included in programs that target reduction of electricity consumption, conversion of thermal energy production into electrical units is often a challenging point. For solar thermal, this issue has been addressed by several organizations.

In September 2004, the International Energy Agency's (IEA) Solar Heating and Cooling Program agreed on a conversion factor that expresses the capacity of solar thermal systems in equivalent electrical terms: 0.7 kilowatt thermal (kWt) per m^2 of collector

[4] Solar Thermal Collector Energy Production, Solar Rating and Certification Corporation - Jim Huggins
[5] See http://www.solar-rating.org/solarfacts/energyproduction20011017.pdf

area. Using this conversion factor, the IEA methodology estimates the global installed capacity to be 70 GWt (70,000 MWt), making solar thermal one of the leading sources of renewable energy worldwide. These values are similar to the peak output ratings published for photovoltaic modules.[6]

The Nevada Public Service Commission has developed a methodology for estimating the output from small un-metered solar thermal systems and converting this to electrical terms. Results are used by the utilities to compute the number of renewable energy credits (RECs) that qualify under Nevada's Renewable Portfolio Standard (RPS) program and that system owners can thus sell.

Examples of Utility Solar Water Heating Programs

There are many examples of successful utility operated solar water heating programs. The Utility Solar Water Heating Initiative (USH$_2$O), funded and supported by the US Department of Energy, has brought together a diverse group of partners that include solar thermal program managers from investor-owned utilities, municipal and other publicly owned utilities, manufacturers, distributors, and installers of solar water heating systems.

USH$_2$O's mission is to facilitate the successful implementation of utility solar water heating programs and to educate stakeholders about the potential of solar thermal technologies.

One example is the Hawaiian Electric Company's (HECO) program, which has generated the following benefits to the utility:

HECO Solar Water Heating Program Impacts[7]

Number of Systems: **>27,000**
System Life: **15 years minimum**
Barrels of Oil Saved: **1.8 million**
Generating Capacity Deferred: **17.7 MW**
Customer Energy Savings: **66.5 GWh**
Emissions Avoided:
CO_2: **975,000 tons**
SO_2: **4,050 tons**
NO_x: **3,140 tons**

The 1.8 million barrels of oil saved by the utility represents more than US$ 113 million at the March 2006 price of over $63/barrel.

Other examples of successful solar water heating programs and assistance can be found on the USH$_2$O web site http://www1.eere.energy.gov/solar/ush2o/about.html

[6] See http://www.iea-shc.org/welcome/Technical note - new solar thermal statistics conversion.pdf

[7] *Utility Success Stories in Solar Water Heating,* Chip Bircher, Solar Power 2005, October 6, 2005.

Customer Benefits

The primary benefit to the consumer is the fixed cost or benchmarking of the current cost to provide hot water to their residences, hotel, restaurant, laundry or commercial building. As water heating is the second largest user of electricity in the Caribbean, reducing that cost and protecting the customer from future energy price increases allows all socio-economic classes to have hot water at a very affordable price.

Financing

Financing for a fee-for-service program could come from a number of sources. The utility's general fund may be capable of supporting a fee-for-service program's implementation or the implementation of a pilot program. The cost will be directly related to the size and scope of the program. A pilot program may also be a vehicle to demonstrate the viability of a fee-for-service program, determine operational characteristics, and prepare for the implementation of a full-scale program, which would require an additional internal investment or external financing.

Many of the current financing schemes for renewable energy in the Caribbean region are focused toward small-scale or micro-finance and private sector business development. A fee-for-service program that has significant participation of the private sector may have a better opportunity for accessing external financing. Solar water heating programs are labor intensive and generate many types of jobs, including in the sales, design, installation, and the service sector.

The design or make-up of the fee-for-service program may offer different options for financial support. The listed options below offer a brief overview of some of the public and multi-lateral financing options that may be available to a utility. Others options are also under development and may be available to provide additional sources of equity, debt, loan guarantees, or grants.

The International Finance Corporation

The International Finance Corporation (IFC) of the World Bank Group has been actively seeking to finance a greater number of renewable energy (RE) and energy efficiency (EE) projects and is developing special initiatives to accelerate the market penetration and commercialization of these technologies. While it is unlikely that they have provided financing for a fee-for-service solar water heating program to date, it is quite likely that they would be interested in looking at the possibility. Their web site states "IFC has and will continue utilize limited - and carefully targeted - concessional funding to support worthwhile projects that are likely to accelerate the application of RE and EE technologies in developing countries." Solar water heating fee-for-service program would certainly fit the description of a program that would accelerate the application of renewable energy technologies and could also be interpreted as an energy efficiency demand-side technology.

As a member of the World Bank group, the IFC can access funds from the Global Environment Facility (GEF) under the GEF's operational program to mitigate the effects of global climate change. The contribution of solar thermal in reducing emissions and contribution to global climate change is well documented thereby improves the possibilities for financing. Their web site also states the IFC intends to "target its efforts to develop new RE and EE projects toward countries where RE can provide the lowest cost power (i.e. where fossil fuels are expensive, for example, on islands)."

Inter-American Development Bank

The Inter-American Development Bank (IADB) and its Multilateral Investment Fund (MIF) are encouraging private sector development the Caribbean. MIF assists private sector development through its Small Enterprise Investment Facility that uses a range of investment tools such as loans or equity to broaden the economic participation of small business. A fee-for-service program that is weighted toward development of a private sector solar industry may be eligible for MIF financing or grants. The fee-for-service solar water heating program would be attractive as it involves an innovative and new approach to private sector engagement. It also offers the potential to be replicated in other sectors and in multiple countries in the Caribbean, but there must be some assurance of the program's sustainability. MIF has accepted the higher risks associated with small, early-stage investments and may consider the solar water heating program to be a good investment considering the effects of the current cost of oil and the negative impacts on the Caribbean.

Caribbean Renewable Energy Development Program

Caribbean Renewable Energy Development Program (CREDP), a Caribbean Community (CARICOM) program, is looking to remove barriers to the increased use of renewable energy and the continued dependence on fossil fuels while reducing greenhouse gas emissions. Solar water heating projects are eligible for financing consideration. As part of CREDP the Caribbean Renewable Energy Fund provides equity and debt financing to renewable energy projects as a co-investor with regional financial institutions.

Energy Facility for African, Pacific and Caribbean Countries

Other options may include an expansion of the Caribbean Renewable Energy Fund to apply capital available from the Energy Facility for African, Pacific and Caribbean Countries (APC-EU) to full-scale fee-for-service solar water heating programs. The Energy Facility is a funding mechanism component of EuroAid.

Donor or third-party finance options may also be available to the utility. The donor or third party financer may be interested in the environmental attributes of the solar water heating program. In this scenario, the lender or donor might acquire the emission reductions and other environmental attributes for reasons similar to, though also perhaps distinct from, those listed in the Carbon Finance section of this document.

US Export Import Bank/ OPIC

The US Export Import Bank (EximBank) has special funding mechanisms for extended term financing for US-made products used in a solar water heating program. Funding may also extend to the raw materials used for assembly or manufacturing of solar water heating systems for a utility program. The Overseas Private Investment Corporation (OPIC) may be another option to secure project financing when a US partner is involved in the fee-for-service project. The program may need to be a joint venture project with the host utility and a US company that supplies systems to the program or participates in the operation or administration of the program in the host country.

Sustainable Energy Finance Directory

The Sustainable Energy Finance Directory is an online database of lenders and investors who actively provide finance for renewable energy and energy efficiency activities worldwide, including in the Caribbean region. Managed by the Sustainable Energy Finance Initiative of the United Nations Environment Programme and others, the database is available free of charge to registered visitors at www.sef-directory.net, and provides project developers and entrepreneurs with information on a range of financing entities and tools.

Financial Projections

Systems Installed			Income (U.S.$000's)			
Year	Systems Installed	Cumulative Number of Systems	Current Year	Cumulative	Cumulative Present Value	Internal Rate of Return
0		0	(70)	(70)	(70)	
1	300	300	(639)	(709)	(630)	NA
2	600	900	(694)	(1,403)	(1,164)	NA
3	1,500	2,400	(1,118)	(2,521)	(1,919)	NA
4	2,600	5,000	(994)	(3,515)	(2,508)	NA
5		5,000	3,894	379	(485)	4.4%
10		5,000	4,403	18,443	5,579	46%
15		5,000	4,476	40,819	9,723	49.6%
20		5,000	4,476	63,200	11,846	50%

The financial projections above are based on a program of 5,000 systems installed over a four-year period, showing the potential revenue stream and cash flow of a fee-for-service operation.[8] As indicated in the "General Information" tables of assumptions, below, the systems in the program represent an equal mix of 40 gallon (150 liter) and 80 gallon (300

[8] Projections are based on an adapted version of a financial modeling spreadsheet developed by the Energy Alliance Group for the Utility Solar Water Heating (USH$_2$O) Initiative with support from the Solar Energy Industries Association, United States Department of Energy, and National Renewable Energy Laboratory.

liter) sizes. The annual hot water load is the estimated average of the two solar system sizes. Monthly customer savings and the customer charge were blended averages. The customer and the environmental revenues are shown as the total savings. All revenue is applied to debt during the first five years of the program. The 5,000 systems consist of 15,000 m^2 of solar thermal, which represents a reduction of approximately 3,750MW of demand. The complete financial statements are included in Appendix 3.

General Information	
Organization/Program	Caribbean Utility Solar Program
Discount Rate (Financial)	14.0%
Finance Mechanism	Debt – Interest Rate 5.0%
Country	Generic Example - Caribbean
Weather Data Site	Kingston Jamaica
System Size	50/50 Mix 40 Gallon & 80 Gallon
Electric Rate, US$ per kWh	0.330
Customer Fee/Savings Ratio	90%
Annual Hot Water Load, kWh	2,177
Water Heater Efficiency	70%
Annual Solar Fraction	90%
Monthly Customer Savings	76.95
Monthly Customer Charge	69.26
Sales Tax	0
Net Service Fee Revenue	69.26
CO_2 Reduction Price	$12.50
Emissions Baseline ($kgCO_2/hWh$)	0.8

In a sensitivity analysis varying some key assumptions, the program produces an internal rate of return (IRR) of 32.2% after twenty years when passing a 30% cost savings on to customers, as opposed to 10% savings in the base case. The base case also assumes carbon reduction sales revenue at $12.50 per ton of CO_2, which adds about 3.7% to the IRR after ten years and 3.2% after twenty. Varying the financial discount rate impacts the project's present value; for example, changing the discount rate from 14% to 7% brings the project's present value to over $26 million after twenty years. Clearly, as modeled the program has the potential to provide attractive returns to the utility and substantial savings to customers.

Carbon Finance

In addition to the sources of underlying project finance discussed under Financing above, "carbon finance" from the sale of greenhouse gas emission reductions can help to support solar water heating programs and enhance their ability to move forward.

Electric utilities in the Caribbean have a growing range of options available to market the greenhouse gas emission reductions stemming from fee-for-service solar water heating programs and other renewable energy activities. As explained below, the specific options available will differ by country or territory, as the ability to participate in carbon trading under the Kyoto Protocol will vary depending on the jurisdiction's ratification status and other considerations. Still, voluntary markets will be open for all sellers of qualifying greenhouse gas emission reductions from solar and other renewable energy activities.

Global markets for greenhouse gas reductions are large and rapidly growing. These markets more than tripled in size between 2002 and 2004. Motivated by factors ranging from regulations to internal decisions, governments and private companies in industrial countries have already committed billions of dollars for emission reductions from projects outside their borders, with the pace of investments accelerating quickly. The international carbon market offers an important opportunity to help boost renewable energy activities in the Caribbean.

The Kyoto Protocol of United Nations Framework Convention on Climate Change established three mechanisms for international greenhouse gas reduction trading, two of which enable the creation of tradable emissions reduction credits at the project level: Joint Implementation (JI) which pertains to projects in emissions capped countries, and the Clean Development Mechanism (CDM) which pertains to projects in countries without emissions caps. Additional regulatory programs such as the European Union's Emissions Trading System (EU ETS) and many voluntary programs are now in place, providing participants with flexibility in meeting their emission reduction commitments.

Regulatory Markets

The CDM allows the generation and transfer of Certified Emission Reductions (CERs) from projects in developing countries that are Parties to the Kyoto Protocol for use in achieving emissions compliance in countries with emissions caps under Kyoto, as long as the emission reduction activities contribute to sustainable development in the host country. This allows participants to purchase emission reductions from locations where they can sometimes be achieved more cost-effectively. Of the Kyoto Protocol's three trading mechanisms, only the CDM enables projects to accrue CERs prior to the first emission reduction commitment period of 2008-2012. Joint implementation is similar to the CDM in its overall function; the main distinction is that JI permits trade of emission reduction credit between emissions-capped industrialized countries.

Nearly all independent Caribbean nations have ratified the Kyoto Protocol and can thus generate CERs from projects qualifying under the CDM. British territories in the West

Indies and Overseas Departments of France could become eligible to participate in JI. Dutch territories in the West Indies are not Parties to the Kyoto Protocol independently and may not have the option to join the Netherlands for purposes of Kyoto, so these territories along with Puerto Rico and the US Virgin Islands cannot, at present, participate in the Kyoto Protocol's trading mechanisms.

Voluntary Markets

There are scores of emissions market programs that operate on a voluntary basis. Examples include the Chicago Climate Exchange, the Partnership for Climate Action, and other programs organized by non-profit and commercial enterprises in the US, Europe, and elsewhere. Since 1998, trades of emission reductions on voluntary markets equaled roughly 100,000,000 tCO_2equivelent (CO_2e), or about one third of all project-based reductions traded. In recent years however, the market for emission reductions for compliance has skyrocketed while voluntary markets have become comparatively less prominent, and in some cases have contracted.

A Verified Emission Reduction (VER) is the typical commodity that is traded on the voluntary carbon market. VERs differs from CERs mainly because they require far less oversight. Consequently, VERs are easier to generate than CERs and in some programs their average prices tend to be lower. In some cases though, VERs from projects with attractive or exceptional characteristics, such as those that have considerable sustainable development benefits, can obtain a higher price, sometimes exceeding what is paid in the compliance market. Retail markets for relatively small quantities of VERs are growing in size and number. Retail buyers are typically either too small to be regulated by domestic carbon reduction regimes in their jurisdiction or are otherwise unregulated but seek carbon reductions to demonstrate their commitment to environmental protection or for other reasons. Individuals even make up a fair portion of VER buyers on the retail market.

Emission reduction volumes in voluntary market transactions rarely exceed several thousand tons of CO_2e; this is small compared to most transactions in the compliance market but it is still quite substantial for projects involving solar energy applications. All CARLIEC members can sell carbon reductions on the voluntary market, regardless of the Kyoto status of their jurisdiction.

Market Prices for Carbon Reductions

While early transactions in the carbon market involved prices that many observers believed were too low to make a meaningful difference for many types of renewable energy activities, prices in both the compliance and voluntary carbon market have now reached levels that can make a significant difference for projects involving solar energy and other renewable energy applications. Many carbon market transactions in the 1990s involved prices of just a dollar or two per ton CO_2, or less. Prices for carbon reduction credits remained fairly low for several years. But now, after the Kyoto Protocol's entry into force and with its first commitment period approaching, prices have been rising substantially.

According to information from the carbon market reports published by Point Carbon and other sources, CER transactions during the later part of 2005 saw prices in the range of US$6 and $15 per ton CO_2e; VER prices were in the estimated range of $3 to $20 for the same time period. For CERs, the large variation in purchase prices reflects different allocations of risk between buyers and sellers. For example, some buyers will establish contracts for an intended CDM project's emission reductions before the project has been registered with the CDM; in such cases, the buyer takes the risk that the project will not get registered with the CDM and thus they pay less for the emission reductions. In cases where a project is already CDM-registered, it can sell emission reductions for a higher price. Projects that guarantee the delivery of emission reductions also get a higher price.

Emissions Baselines

Most electric grid systems in the Caribbean region are supplied predominantly by fuel oil and/or diesel fueled power plants. As such, a typical emissions baseline for grid-connected renewable energy projects in the Caribbean will be around 0.8 kg CO_2 per kWh. The actual emissions factor will vary depending on power plant efficiencies and on the other types of generation sources that comprise a specific grid's supply mix.

Solar water heating projects involving installations whose capacity totals less than 15 MW of thermal equivalent qualify for the CDM's small-scale (SSC) classification; this enables the use of simplified procedures for the CDM project approval process. One key benefit is the ability to make baseline calculations using pre-approved baseline and monitoring procedures specified in "Appendix B of the simplified modalities and procedures for small-scale CDM project activities: indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories."[9] Qualifying solar water heating projects are covered in this document under project category I.C. "thermal energy for the user."

Where projects that qualify for the CDM's small-scale category displace electricity from grid systems that use only fuel oil and diesel plants, the project developers can select a baseline emissions factor from a table in the Appendix B document that uses a factor of 0.8 kg CO_2 per kWh for plants with generation capacity above 200 kW. In cases where the small-scale CDM project displaces electricity from a grid system that includes other types of generation facilities, the baseline can be calculated using either a) an average of the "approximate operating margin" and the "build margin", where: (i) The "approximate operating margin" is the weighted average emissions (in kg CO_2equ/kWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation; (ii) The "build margin" is the weighted average emissions (in kg CO_2equ/kWh) of recent capacity additions to the system, which capacity additions are defined as the greater (in MWh) of most recent 20% of existing plants or the

[9] Appendix B of the simplified modalities and procedures for small-scale CDM project activities. See http://cdm.unfccc.int/Projects/pac/ssclistmeth.pdf.

5 most recent plants."; OR, b) The weighted average emissions (in kg CO_2equ/kWh) of the current generation mix.[10]"

For CDM projects that do not qualify as small-scale, the developers must choose an existing CDM baseline methodology, or propose a new one. At the time this document was written, no methodology existed for full-scale CDM projects involving solar water heating, so such projects exceeding the thermal equivalent of 15MW would require a new methodology. Information on approved methodologies, including for renewable energy projects that do not qualify as small-scale, and on the procedures for submitting a proposed new methodology, can be found on the official CDM website at http://cdm.unfccc.int/ and from other sources.

Emission Reduction Projections

Assuming a baseline of 0.8 kgCO_2 per kWh, a reasonable reflection of conditions in much of the Caribbean, in cases where water would have otherwise been heated using electricity, it is possible to estimate carbon displacement from solar water heating based on projected kWh of electricity savings. One approach would derive such estimates from the number of m^2 of solar thermal collector area installed, based on assumptions regarding the performance of the solar water heating system and the efficiency of the water heater it would typically replace.

Energy system performance software models such as RETScreen's solar water heating software can be used to estimate the anticipated performance of solar water heating systems based on different configurations and on weather data for locations in the Caribbean region. Based on model runs for residential systems using weather data for Kingston, Jamaica, and various assumptions about system sizing and hot water consumption patterns, one could estimate a rough approximate average of the equivalent of 0.65 MWh of thermal energy delivered per year to the user per m^2 of solar thermal collector surface. To provide the same quantity of thermal energy to the end user using an existing electric water heater of 65% efficiency would require 1.0 MWh of electricity, without accounting for line losses. Based on these assumptions, it is possible to estimate that each m^2 of solar thermal collector surface in a properly sized residential solar water heating system in the Caribbean region would displace about 0.8 tons of CO_2 year, as a rough approximation.

To make customized and more accurate estimates of anticipated emissions abatement, one would need to use an emissions factor reflecting the baseline situation in the particular location; still, certain assumptions might apply across the region, such as the efficiency of the electric water heater that solar water heaters would typically replace. While actual efficiencies for installed water heaters will vary, one could make a conservative estimate based on efficiencies typical of new electric water heaters, which

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[10] See the Appendix B document http://cdm.unfccc.int/Projects/pac/ssclistmeth.pdf. for the exact and up-to-date baselines rules for small-scale projects; this document in updated periodically based on CDM Executive Board decisions.

will tend to be higher than older systems that have been in operation for some time. For example, 70% might be a reasonable, if somewhat conservative selection.

For purposes of CDM participation, the assumptions used to estimate baseline emissions and details about various other aspects of the project must be specified in what is called a Project Design Document (PDD), which in turn must be validated by a CDM-authorized Designated Operational Entity. Information about the CDM participation process, as well as PDD forms for small-scale and large CDM projects and a list of Designated Operational Entities can all be found on the CDM website at http://cdm.unfccc.int.

Benefits of Carbon Reduction Sales for Solar Water Heating

Carbon reduction sales can have a significant financial value for solar water heating programs in the Caribbean region and can potentially help to overcome various barriers that would otherwise impede growth in the deployment of solar water heating systems. In fee-for-service operations, emission reductions sales can provide a second revenue stream to complement revenue from the sale of energy. Other types of solar water heating initiatives can also potentially qualify for carbon market participation.

In addition to providing a second revenue stream for solar water heating fee-for-service programs, establishing an emission reduction purchase agreement could help to leverage underlying investment capital for utility operated solar water heating programs. For example, the documented interest in an emission reduction purchase from a creditworthy buyer such as the World Bank or a private company, expressed in a letter of intent, could help to build investor confidence in a proposed solar water heating fee-for service operation and thus help to facilitate underlying investments.

Section 2: Solar Water Heating Technical Issues

Component Reliability

The reliability of solar water heating systems has proven to be very good in the Caribbean region and in many other parts of the world. The reliability of solar thermal systems relates far less to the technology than it does to system design and installation. Solar water heating systems have been used for hundreds of years. Commercially available systems have been produced for over a century. Clarence Kemp, of Baltimore, Maryland, invented what was to become the first residential solar water heating equipment in 1891. Kemp patented a way to combine the old practice of exposing metal tanks to the sun with the scientific principle of the hot box, thereby increasing the capability of the tank to collect and retain solar heat. He called his new solar water heater the Climax - the world's first commercial solar water heater. Successor designs of the ICS system he developed are still in production and widely used today.

There are two different market approaches or models that relate to the quality and long-term reliability of solar water heating systems. One model encompasses the types of systems used in the US and most of Europe. The solar collectors are typically made of aluminum, copper, stainless steel and tempered glass for glazing - good quality materials that will have a 20-30 year life cycle.

The other approach or industry model encompasses the types of systems commonly used in China, parts of the Middle East, Africa and the Mediterranean. The components are typically made of painted steel, galvanized steel, fragile glass tubes and window glass or plastic glazing. Lower quality component materials degrade more rapidly in the harsh, humid and saline environment of the Caribbean. These materials have a much shorter life cycle in the region. This does not mean that all solar collectors from China, the Middle East and Mediterranean are manufactured with lower quality components. Many of the manufacturers assemble systems for export markets in the US and Europe.

In one approach, the systems are made of high quality components that are designed to last for 20-30 years, whereas in the other approach they are produced from locally available materials and are designed to be a low-cost, disposable short-term appliance. Each model has its advantages but they must be clearly understood by the consumer. The low-cost appliance systems are generally replaced every three to five years, readily available, and sold as a cash and carry product or with the installation for a reasonably low cost because the major components are easily exchanged out or replaced by a choice of local contractors.

The high quality system model is generally preferred in the Caribbean. Still, low-cost systems have been used in the region in the past, and have contributed to the perception that solar water heating systems are unreliable, perform poorly, and have a short life span.

Typical Component Reliability

The reliability and durability of a solar water heating system will vary depending on the type and composition of its component parts. For example, the reliability and useful life of active systems using certain types of glass lined storage tanks and having a differential thermostatic controller and pump will be less than a passive system utilizing a stainless-steel storage tank. The list below shows the typical component life as determined by the Florida Solar Energy Center (Survey of the Florida Solar Industry, 1994) and the results of a warranty claims.

Component	**Years** [11]
Collector	29
Pump	12
Storage tank	9.4 (electric heater)
Controller	8.9
Vents & Valves	4.3 - 13.7

The Hawaiian Electric Company, an investor-owned electric utility with over 350,000 customers, has operated a solar water heating rebate program for many years. Their program offered a 5-year parts and labor warranty. They have monitored the performance and reliability of the products approved for use in their program, which now includes over 27,000 solar water heater installations, and has documented the following results.

Preliminary Research Findings (1995)

Component	**Est. Life**	**Warranty**	**Claims**
Collectors	>20	5 & 10	<0.1%
Tanks	>15	5	<1.5%
Pumps			
AC	>10	1 & 1.5	<1.0%
DC	>5	1	<3.0%
Controllers	>10	10	<1.0%

Hawaiian Electric Company Warranty Claims (1996-2004)[12]

Equipment	**Claims**	
Collectors ~40,000	63	0.16%
Tanks ~27,000	21	0.08%
Pumps ~27,000	38	0.14%
Controllers ~25,000	36	0.14%

[11] John Harrison- Senior Analyst- Florida Solar Energy Center

[12] 20th Century SHW Hardware for 21st Century Applications, Solar Power 2005, October 12, 2005, Ron Richmond, Hawaiian Electric Company

Collectors

Solar collectors capture the sun's energy and convert it to heat energy. While most direct and indirect active systems use flat-plate collectors, some systems employ evacuated tube collectors, or collectors that incorporate one or several storage tanks.

There have been considerable improvements in solar thermal collector technology in the last five years. New absorber coatings, advanced welding technologies and the introduction of a Compound Parabolic Collector (CPC) with non-imaging optics technology, have allowed solar thermal collectors to operate at higher temperatures, have smaller areas or foot-prints, and have expanded the applications to include space conditioning like absorption or adsorption cooling and desiccant cooling.

The advanced technologies are not required for conventional water heating in the Caribbean, but they do provide more options for the utility to provide more technologies and flexibility in their programs now and in the future.

Expanding a solar water heating program to include solar air-conditioning and other advanced systems will allow the utility to offer more and higher revenue services in the future. There could be important benefits for utility companies to prepare now for these emerging technologies, so that they will have the expertise to apply these technologies as they become commercially available. Advanced preparation will allow the utility to gain the experience and develop a trained staff to support their evolving programs.

Flat-Plate Collector[13]

Flat plate collectors are designed to heat water to medium temperatures (approximately 140º F). As shown in Figure 6, flat-plate collectors typically include the following components:

Enclosure: A box or frame that holds all the components together. The material is chosen for its environmental durability as well as its structural characteristics.

Glazing: A transparent cover over the enclosure that allows the sun's rays to pass through to the absorber and conversely prevents some of the rays from escaping out the collector once they have entered. In general, the sun's heat energy passes quite easily through the glazing in short waves. Heat energy that re-radiates from the collector absorber is in long waves. The glazing prevents them from passing back through the glazing.

Glazing also blocks air movement across the absorber, thereby reducing heat loss through convection. The glazing also serves as a transparent insulation that can be a single layer or multiple layers to reduce heat loss from the solar collector. The more layers, the greater the insulation value, but multiple layers also decrease the amount of light that is

[13] Solar Water and Pool Heating Manual, Design and Installation & Repair and Maintenance January 2006

transmitted through the layers of glazing onto the absorber surface.

Glazing frame: Attaches the glazing to the enclosure. Glazing gaskets prevent leakage around the glazing frame and allow for contraction and expansion.

Insulation: Material between the absorber and the surfaces it touches that blocks heat loss by conduction, thereby reducing the heat loss from the collector enclosure. The insulation must be able to withstand extremely high temperatures.

Absorber: A flat, usually metal, surface inside the enclosure that, because of its physical properties, can absorb and transfer high levels of solar energy. The absorber material may be painted black with a semi-selective coating or it may be electroplated or chemically coated with a spectrally selective material that increases its solar absorption capacity by preventing heat from re-radiating from the absorber.

Flow tubes: Highly conductive metal tubes across the absorber through which fluid flows, transferring heat from the absorber to the fluid. The heat transfer fluid tubes remove heat from the absorber. The collector also incorporates headers, which are the fluid inlet and outlet tubes.

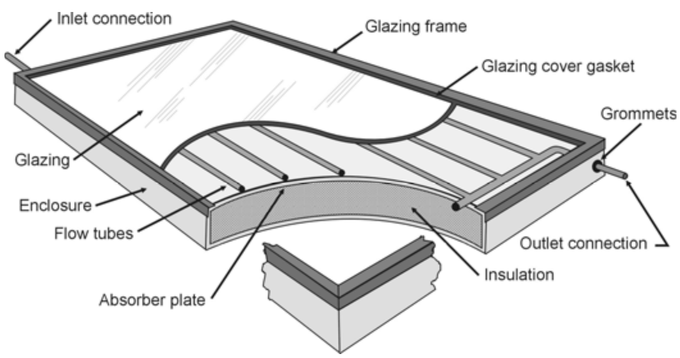

Figure 6
Flat Plate Solar Thermal Collector

The useful life of the solar collector is typically 25 to 30 years. Most of the materials in the solar collector have little or no residual value and are recyclable at the end of their useful life. It is conceivable the solar collector will last longer than 30 years, if it is not destroyed in a storm from debris.

The durability of the collector will vary from one manufacturer to another. Some manufacturers will use a strong tempered extruded aluminum to construct the frame wall of the collector. The extruded and tempered aluminum can withstand higher wind loads and therefore have the capability of surviving the wind buffeting of many tropical storms better than other materials used in the assembly of products. Wind load testing of at least 160mph should be required for any solar collectors used in a utility solar thermal program in the Caribbean.

Mounting hardware and the method used for attaching the solar collector to the mounting assembly should also be part of the wind load testing. If the mounting hardware separates from the collector in a storm, the durability of the collector is immaterial. The complete assembly of the collector frame wall and mounting hardware must be integral, not separated.

If mounting hardware is attached with screws into a thin aluminum frame wall the wind buffeting and vibration will eventually cause the screws to loosen and easily tear out of the collector frame in the wind.

The components with the shortest useful life expectancy are the vents and valves and differential controller. Technology improvements and reliability have extended the life expectancy of the controllers manufactured today. The vents and valve may still have the shortest life expectancy but are generally items that can be serviced and replaced at a low cost.

The tanks in the reliability study above were glass lined electric water heaters. Stainless-steel tanks will have a longer life and are readily available from many companies that manufacture thermosiphon systems.

System Durability

System durability is dependent on the materials used in the solar system components as described above. The materials used for the installation including the piping, fittings insulation, sensor wiring, sealants and miscellaneous trade materials.

Materials Used[14]

Materials for solar energy systems must be chosen carefully. The most important factors are safety, performance, durability and cost.

The materials must retain their shape and strength during repeated thermal expansion and contraction – all the while being exposed to the weather. Collector materials lead hard lives. The collector is exposed to wind, rain, temperature extremes and ultraviolet radiation. Untreated plastics, woods and synthetic boards deteriorate rapidly under such conditions. To reduce corrosion and rust, steel components used in a solar collector must be protected from the elements by plating, galvanizing or painting the part. Using stainless steel would be a better choice. The collectors must be able to tolerate stagnation temperatures. This can be as high as 400°F for some solar collectors. Durability is important in all materials used in a solar system because the cost-effectiveness varies directly with their life expectancy.

[14] Solar Water and Pool Heating Manual, Design and Installation & Repair and Maintenance January 2006

Installation

Another critical part of system durability is the installation. Proper training of the installers, supervision and system commissioning can reduce the number of installation errors and improve the reliability of installed systems. While simplicity is the key to operating a successful program, installation errors have been identified as one of the major causes of system failures.

It is recommended that all installers undergo comprehensive training and certification where applicable to participate in the utility's solar program.

The Caribbean has had its fair share of problems associated with bad installations. The Solar Water Heating Program for Hotels in Jamaica operated by the Demand Side Unit of the Jamaica Public Service Company (JPSco) is a prime example. Many of the systems inspected after the initial installation required repairs to complete the installation before they were commissioned. Systems were found to be on the roof but not attached to the structure; others had been attached to metal shingles with light gauge rivets. These systems would have blown away in high winds, with absolutely no chance of surviving a tropical storm or hurricane. Without adequate training and supervision, installation problems such as these will undermine consumer confidence in solar water heating and doom efforts to create successful solar energy programs on the part of utilities companies and other stakeholders in the region.

An alarming fact is most of the installers had been through a training program but found ways to shortcut the process that led to the bad installations. Fortunately, JPSco staff insisted the repairs be made prior to releasing payment to the vendors for the installation. This is a very good reason to include installation inspections and commissioning procedures in any utility program.

Development of properly trained and qualified installers can help to ensure a program's success. It is very feasible to recruit and train installers from the local areas. Apprentice training, supervision by qualified or certified installers (see installer certification below) and installation inspections will be critical to the program.

System design and sizing

Sizing of residential solar water heating systems is generally easy: the rule of thumb is 20-gallons per person for the first two people and 15-gallons for each additional person in the house.

Commercial systems require professional design and sizing. The hot water load of the facility must be determined. The application may be different from those for residential hot water. Manufacturing processes, commercial laundries, hotel kitchens and restaurants will require higher temperatures and appropriate sizing to ensure the best economics for the system and the utility program.

Software programs are available to assist the sizing a solar thermal systems and determining the output or energy it will generate.

The **RETScreen International Clean Energy Project Analysis Software**[15] is an innovative and unique energy awareness, decision support and capacity building tool. It consists of standardized and integrated project analysis software that can be used world-wide to evaluate the energy production, life-cycle costs and greenhouse gas emission reductions for various types of proposed energy efficient and renewable energy technologies compared to conventional energy systems. In addition to the software, the tool includes product, cost and international weather databases; an online manual; a case study based college/university-level training course and electronic textbook; and an Internet-based Marketplace. All of these are available free, in both English and French, online at http://www.retscreen.org/. For those with limited or no Internet access, all the materials are also available on CD-ROM.

Certification

There are three recognized options for certification of solar thermal collectors. Two are operated in the United States: SRCC and FSEC. The other, Solar Keymark, is in Europe.

SRCC

The Solar Rating and Certification Corporation SRCC is an independent third-part certification organization that administers national certification and rating programs for solar energy equipment.

The SRCC currently operates three major solar programs:

- Collector certification
- Water heating system certification
- Swimming pool heating system certification

Collector certification

The programs provide a means for evaluating the maintainability of solar collectors and thermal performance rating characteristic of all-day energy output of a solar collector under prescribed rating conditions. The scope of the program includes domestic hot water, swimming pool, and space heating.

The program is administered according to SRCC Document OG-100, "Operating Guidelines for Certifying Solar Collectors," and its companion technical document, SRCC Standard 100, "Test Methods and Minimum Standards for Certifying Solar Collectors."

[15] http://www.retscreen.net

Program participation is voluntary and all manufacturers of applicable products are eligible to participate in the SRCC solar collector certification program. SRCC's certification program operating guidelines, test methods and minimum standards, and rating methodologies require the performance of nationally accepted equipment tests on solar equipment by independent laboratories which are accredited by SRCC. The test results and product data are evaluated by SRCC to determine the product's compliance with the minimum standards for certification and to calculate the performance ratings.

Equipment that has been certified and rated by SRCC is required to bear the SRCC certification label, which shows the performance rating for that product. In addition, each certified product is published by SRCC in a directory. Each product's directory listing contains information on the product's material and specifications as well as the certified thermal performance rating.

System Certification

SRCC also developed a solar water heating system rating and certification program, short-titled OG-300. The purpose of this solar water heating system certification and rating program is to improve performance and reliability of solar products. It integrates results of collector tests and system and component tests with evaluations against minimum standards of system durability, reliability, safety and operation; as well as factors affecting total system design, installation, maintenance and service. The SRCC program also provides annual savings figures for the certified systems. These annuals are provided for specific locations.

See http://www.solar-rating.org/RATINGS/annuals/annuals.htm for more information.

FSEC

The Florida Solar Energy Center operates a Testing and Certification program for the State of Florida. All products (collectors and systems) sold or installed in the State must have FSEC Certification. System guidelines are outlined in the FSEC document "Florida Standard Practice for Design and Installation of Solar Domestic Water and Pool Heating Systems," FSEC-GP-7-80 and "Operation of the Florida Standards Program for Solar Domestic Water, FSEC-GP-8-80 January 1985."

Collector certifications and thermal performance ratings are a useful tool in comparing the efficiency and economics of various flat-plate solar collectors. Since collectors used in domestic hot water (DHW) systems typically operate in the intermediate temperature range (120°F-160°F), FSEC collector certifications list the tested collector ratings for comparison. It must be stressed that these comparisons are only a guide and should not be considered as a rank ordering of collectors. Bear in mind that comparisons based on these ratings address thermal efficiency and energy output per investment dollar only; they do not imply equivalent reliability or durability among collectors.

Solar Keymark

CEN (European Committee for Standardization) or SOLAR KEYMARK is a voluntary third-party European certification mark, demonstrating to the consumer or user of a product that it is in conformity with the relevant European Standard(s).

Products covered by the Solar Keymark Certification scheme are:

- Solar thermal collectors - as defined in EN12975-1 : Only "liquid heating solar collectors". Excluded are: Collectors "in which the thermal storage unit is an integral part of the collector", and "tracking concentrating solar collectors"
- Factory made solar thermal systems - as defined in EN12976-1: "Factory made solar heating systems are batch products with one trade name, sold as complete and ready to install kits, with fixed configuration."

Installer

A successful "Fee-for-Service" program is dependent on the proper design, installation and maintenance of the solar water heating system. The installation is one of the critical components of the program and must be done by a trained and qualified technician.

Properly installing a solar water heating system requires an installer with knowledge and experience in the plumbing, roofing, and electrical trades. Many failures of solar water heating systems are directly related to the improper installation. Failures occur for many reasons all, almost all of which can be avoided by the proper installation.

Some examples of failure include:

- Improper sizing and site selection resulting in low performance.
- Systems not staying on the roof during storms because the solar collector and/or storage tank is not structurally attached to the roof to withstand the high winds seen in the Caribbean and other areas subject to high winds and storms.
- Improper piping design resulting in low performance, failure or heat loss from un-insulated pipe.
- Improper wiring of the sensors, controller, pump or, photovoltaic module.
- Improper locations of vents and valves resulting in low performance or critical safety issues.
- Not structurally attaching the solar collector and/or storage tank to the building.

A "Fee-for-Service" program must include a comprehensive training program for the installation technician or contractor. It is recommended that the installer have the skills outlined by the North American Board of Certified Energy Professionals (NABCEP).
The tasks outlined below were a consensus agreement of the task analysis associated with the installation of a solar water heating system by solar thermal industry in the United States.

Primary Objective for Solar System Installation Contractor[16]

Given basic instructions, manufacturer installation manual, major components specifications, schematics and drawings, the installer is required to install a solar water heating system that meets the performance and reliability needs of the customer, incorporates quality craftsmanship, and complies with all applicable codes and standards by:

1. Working safely with solar water and pool heating systems
2. Identifying systems and their components
3. Adapting a system design
4. Conducting a site assessment
5. Installing solar collectors
6. Installing water heater and storage tanks
7. Installing piping, pipe insulation and connecting system piping
8. Installing system valves, pumps and monitoring components
9. Installing electrical control systems
10. Installing operation and identification tags and labels
11. Performing a system checkout
12. Maintaining and troubleshooting a solar thermal system

It is recommended that any installation-training program and contractor qualifications certification utilize the recommendations and course curriculum of the NABCEP Solar Thermal Certification.

SRCC OG-300 Solar Water Heating System Installation Guidelines

SRCC has listed on their website installation guidelines for solar water heating systems. These installation guidelines are presented as a tool to be used by solar installers and any other interested parties in assuring that systems are installed in a manner that meets SRCC requirements.

Many of these criteria are used in evaluating systems that have applied for SRCC system certification. Other guidelines can only be evaluated once a solar system has been installed. Therefore, the information provided in this site is suitable for both those installing and designing solar water heating systems.

The information provided will also be useful to building and code officials as well as utilities and state and local agencies implementing solar programs that require the SRCC certification and rating program. The information will be especially helpful for those local agencies wanting to conduct installation inspections.

The guidelines have been separated into subsystem categories. These categories represent the major subsystems of a solar water heating system.

[16] NABCEP Task analysis

These are:

- Collector
- Transport
- Control
- Storage

Within each subsystem, the guidelines have been ranked by order of importance as they relate to the installation process. These guidelines are available at: http://www.solar-rating.org/education/og300education.htm

Technical Procedures for Program Implementation

The development of program criteria and guidelines are essential before initiating a solar water heating program. These criteria include site selection, system types, sizing and performance requirements, and solar contractor qualification requirements. Solar site and system inspection tools and training are also required for program technical support personnel. Basic training in solar applications and systems should also be required for program decision makers and managers. Means to identify clients and sites that would benefit from the solar systems are also an important element in the success of such a program.

Following is a detailed description of proposed activities for program implementation, covering technical aspects related to solar water heating as well as competency training. It is recommended that utility companies seek external support, as needed, to prepare for solar water heating program operations. Such support, available from various sources, would include relevant presentations, hands-on laboratories and field training. Field training should strive to ensure that all parties participating in this program achieve confidence with site and solar system inspections. This training should also include an overview of the solar program, solar water heating principles, as well as detailed site and system inspection instructions and the use of system inspection forms. Each section will be discussed in detail below.

System Type Requirements

The introduction of solar water heating systems in utility company programs provides many challenges and special requirements. These challenges are compounded by the need to keep installed costs at a minimum in order to achieve overall system cost savings and effectiveness. It is important that the system design be kept simple and reliable. Both utility staff and potential clients must understand basic operation principles. A complete understanding of both the applications and system design types is critical to the successful implementation of a solar water heating program.

System Installation Requirements

Proper instillation methods should be presented to utility staff responsible for final post installation system inspection.

Along with standard solar industry installation practices of SRCC, NABCEP, and FSEC GP-7 Installation Standards described earlier, the program should also have general guidelines that have to be met. These included the following:

1. Installed collectors have to be oriented within 90° west or east of due south and mounted at an angle plus or minus 15° from local latitude.

2. Except when required by system design or constrained by safety considerations, water heaters are to have a minimum insulation rating of R-12. An exterior insulation blanket could also be used to satisfy this requirement.

3. Insulation rated at R-2.4 or greater is to be installed on all interconnecting hot and cold-water piping installed in attics, unconditioned garages other unconditioned indoor spaces, as well as all conditioned spaces.

Installation Contractor Qualifications

Requirements should also be established for participating solar installers. To this end, a workshop should be conducted for qualified installers to inform them of the program's requirements and expectations.

Prior to becoming a program-approved contractor, the following guidelines should have to be met.

1. License: Contractors must be licensed contractors, in accordance with local contracting and business licensing requirements to install residential or commercial solar water heating systems.

2. Experience: Installers have to demonstrate capabilities to install residential solar water heating systems. Past experience is critical in meeting this requirement.

3. Place of Business: Installers are required to provide continuous post-installation service to the areas in which they install program solar water heating systems.

4. National and Local Codes and Ordinances: Contractors have to comply with all applicable national and local codes and ordinances. Appropriate installation permits are to be obtained for each system installation.

System Warranty Requirements

Warranties for the installation and the installed equipment are also required. The requirements are as follows:

1. Collector:

The Contractor is required to provide a full ten (10) year written warranty on the collector. The warranty covers the full costs of field inspection, parts and labor required to remedy the defects, including, if necessary, replacement at the site.

The warranty does not cover defects of any kind resulting from exposure to harmful materials, fire, flood, lightning, hurricane, tornado, hailstorm, windstorm, earthquake or other acts of nature, vandalism, explosions, harmful chemicals, acidic or caustic water, other fluids, fumes or vapors, operation of the collector under excessive flow rates, misuse, abuse, negligence, accident, alteration, falling objects or any other causes beyond the control of the Contractor.

2. Systems:

The Contractor has to provide a full one (1) year warranty on the system. The warranty covered failure of the installed solar system, including any component or assembly where such failure is caused by a defect in materials, manufacture, or installation.

The warranty also covers damage resulting from over-heating. This includes the full cost of all parts, labor, shipping and handling necessary to remedy the defect, including, and if necessary, replacement at the site.

In those installations in which the SWH systems are retrofitted to the existing conventional electric water heater and the existing water heater fails due to normal circumstances during the one (1) year warranty period, the system warranty excludes the replacement of the water heater.

The system warranty does not cover defects of any kind resulting from exposure to harmful materials, fire, flood, lightning, hurricane, tornado, hailstorm, windstorm, earthquake or other acts of nature, vandalism, explosions, harmful chemicals, acidic or caustic water, other fluids, fumes or vapors, operation of the collector under excessive flow rates, misuse, abuse, negligence, accident, alteration, falling objects or any other causes beyond the control of the Contractor.

The system warranty is effective at the date of installation.

The fulfillment of the warranty is the responsibility of the installation contractor.

3. Contractor Identification:

The Contractor's name, address and phone number has to conspicuously appear on all warranties.

A formal application packet is to be provided to any solar installer interested in becoming a program authorized installer. The application documentation is completed by the vendor and returned for review and acceptance by the utility. The following list outlines the documents in the packet and those required from the applicants.

- Form 1 - Contractor Profile and License
- Form 2 - Solar System Application
- "Approved Solar Energy System" Form
- System and collector warranties
- Copy of the collector and system warranties that will be given to clients
- Solar system Homeowner's Manual

The utility should publish a listing of participating solar installers. During the initial phases of the program, external technical experts could assist the utility in developing their bid requirements for local installers.

Program Implementation - Training

External consultants can provide an in-depth solar program that emphasized both in-house lecture and hands-on field solar training. Training would include field activities that were repeated during numerous sessions in order to ensure that all parties participating with this program are familiar and confident with site and solar system inspections.

External consultants could also provide training guidance and program implementation assistance to all participating utilities. This training would include an overview of solar water heating principles and basic information, as well as detailed site and system inspection instructions and the use of system inspection forms.

Site Selection Criteria

1. The residence or business has to be located in the participating utility area and have electric service to the building.
2. At least two people have to be living in the residence.
3. Solar access have to be suitable to provide uninterrupted winter and summer season solar radiation at the potential collector mounting location between approximately 9 AM and 4 PM. There is to be no shading from trees, bushes, and fences (if the collector was ground mounted), etc., on the collector during this time period.

Site Selection - General

Utility officials will be responsible for the selection of residences that will participate in the program. The inspection procedures and their proper chronology are clearly outlined below. Inspection forms for use by field personnel also accompany the detailed procedures.

Residential site inspections are provided for each step of the inspection process. Each inspection step is listed in a chronological order that should be adhered to. The steps are as follows:

1. Solar access inspection
2. Roof inspection
3. Water heater inspection
4. Electrical inspection
5. Plumbing inspection
6. Site information questionnaire

Site Inspection Order Procedure

This procedure outlines the chronology of the site inspection process. It is important that this chronology be maintained since failure of one inspection step could very well signify that the residence is unsuitable for a solar system installation. For instance, if no solar access exists, it is futile to continue the inspection process.

Solar Access Inspection

This should be the easiest of the inspection procedures. At some sites, it may be obvious that the site is unsuitable for solar due to extreme shading at all possible solar collector locations. At others, inspection personnel will have to use a solar access tool to determine that sufficient solar radiation exists during a reasonable period of time during the day.

Ideally, the location at which the solar collector is to be mounted should face south, but facing the collector within 45° to 90° either east or west of due south is satisfactory. The use of a compass and solar site selection tool is invaluable in determining suitable solar access.

Roof Inspection

The primary purpose of the roof inspection is to determine whether the roof is both structurally and materially sound enough for the mounting of a solar collector. Collector weights range from approximately 80-150 pounds for flat plate collectors to 450 pounds and over for integral collector storage and thermosiphon systems. The final decision should be made by utility representatives based on findings developed after a thorough roof inspection and consultation with a licensed roofing contractor.

The primary determinant for acceptability of a roof for a solar collector installation should be the structural soundness of the roof. Other factors such as rusted nails, loose tiles, can be replaced or repaired, but will not adversely, in themselves, affect the adequate installation of the solar collector. These factors may nevertheless provide clues to more severe roofing problems that could affect the structural stability of the roof. If, after the inspections are complete and the local utility is still in doubt about a specific roof's condition, it is recommended that a reputable roofing firm be consulted.

Water Heater Inspection

The electric water heater inspection should be conducted to determine the condition of the electric water heating tank. Much of the information listed on the inspection form can be obtained from the water tank nameplate.

Electrical Inspection

The electrical inspection should be conducted to determine whether there are special electrical problems that could affect the installation of a solar water heating system. Minor problems may in some cases be corrected by the local utility, while a qualified electrical contractor should resolve more substantial electrical problems.

Plumbing Inspection

The plumbing inspection should be conducted to determine whether there are any special plumbing problems that could adversely affect the installation of a solar water heating system. Many problems can be remedied by the local utility prior to the installation of the solar system. More major problems may have to be repaired by a qualified plumbing contractor. A thorough inspection of the existing water heating tank, piping, valves, and faucets should be conducted.

Occupant Questionnaire

Once the residence and its occupants have been identified as qualified for participation in the program, the site information questionnaire should be completed. This questionnaire will provide information that will be used by the utility to size the appropriate system for the home or business. In addition, the local installation contractors in their bidding packet development may use the information.

Collector Solar Siting Aid

The Collector Site Selector is designed to determine the best location for a solar collector. It is also invaluable in determining if a specific location is not suitable for solar system installation. The Solar Pathfinder™ is used for shade analysis (solar or canopy/habitat studies). Any trees, buildings, or other objects that could cast shadows are reflected in the plastic dome, clearly showing shading patterns at the site. The underlying diagrams are latitude specific and are engineered with data for the entire year. A wax pencil can be used to trace around the reflected shadows on the sun path diagram, providing a permanent record of each reading.

Appendix I: Heat Meter Suppliers

Metrima AB Christophe Dupouy Area Sales Manager Metrima AB 46 8 4105 11 67 46 8 4105 11 67 Cell christophe.dupouy@svmnn.se http://www.metrima.com	Lenz Solar Stefan Brändle Lenz Solar- und Wärmetechnik Hirzenstrasse 2 Niederuwzil, 9244 Switzerland +41 (0) 71 955 70 20 +506 3802476 +506 2287163 sb@solpowercr.com
Clark 10 Brent Drive Hudson, MA 01749 Tel 978-568-3400 Fax 978-568-0060 sales@clarksol.com http://www.clarksol.com	Istec Corp Ed Bullis Istec Corporation 92 Main St. Sparta, NJ 07871 (973)726-7090 (973)726-8707 ed.bullis@istec-corp.com http://www.istec-corp.com
Contrex Jef Gaskill President Contrec - USA, LLC 916 Belcher Drive Pelham, AL 35124 (205)685-3000 (205)685-3001	Onicon Inc. 2161 Logan St. Clearwater, FL 33765 (727)447-6140 http://www.onicon.com
Steca Stefen Oswald Steca, Germany 011 49 8331-8558 57 01149 8331-8558 11 stefan.oswald@steca.de	

Appendix II: Inspection Procedures and Forms

The Pre-installation site inspection should be conducted in the following order:

1. SOLAR ACCESS INSPECTION
2. ROOF INSPECTION
3. WATER HEATER INSPECTION
4. ELECTRICAL INSPECTION
5. PLUMBING INSPECTION
6. OCCUPANT QUESTIONNAIRE

1. SOLAR ACCESS

   PASSED: Proceed to ROOF INSPECTION.

   FAILED: If roof mount unsuitable, investigate possible ground mount. If ground mount is feasible, proceed to WATER HEATER INSPECTION. If ground mount is unfeasible, discontinue inspections. Site ineligible.

2. ROOF INSPECTION

   PASSED: Proceed to WATER HEATER INSPECTION

   PASSED (MINOR REPAIRS REQUIRED): Determine costs of minor repairs and proceed to WATER HEATER INSPECTION if repair costs are within the repair budget.

   FAILED: Site ineligible.

3. WATER HEATER INSPECTION

   PASSED: Proceed to ELECTRICAL INSPECTION.

   PASSED (MINOR REPAIRS REQUIRED): Determine costs of minor repairs and proceed to ELECTRICAL INSPECTION if total repair costs are within the repair budget.

   FAILED: Replacement tank will be required.
   Proceed to ELECTRICAL INSPECTION.

4. ELECTRICAL INSPECTION

   PASSED: Proceed to PLUMBING INSPECTION.

PASSED (MINOR REPAIRS REQUIRED): Determine costs of minor repairs and proceed to PLUMBING INSPECTION if total repair costs are within the repair budget.

FAILED: If electrical problems are irreparable, site is ineligible.

5. PLUMBING INSPECTION

PASSED: Proceed to OCCUPANT QUESTIONNAIRE.

PASSED (MINOR REPAIRS REQUIRED): Determine costs of minor repairs and proceed to OCCUPANT QUESTIONNAIRE if total repair costs are within the repair budget.

FAILED: Site ineligible.

Solar Access Inspection Details

Solar access at the residence must be available for a solar system to be installed. Ideally, the location at which the solar collector is to be mounted should face south, but facing the collector within 30° to 45° either east or west of due south is satisfactory. The use of a compass and solar site selection tool is invaluable in determining suitable solar access.

Solar access determination should be completed by following the steps listed below:

Determine if the potential solar collector mounting position is facing south (or within 45° west or east of due south)

- □ Indicate collector mounting location

Using the solar site selection tool, determine that there is uninterrupted winter and summer season solar at the potential solar collector mounting location between the hours of 9 am to 4 pm. There should be no shading from trees, bushes, chimneys, fire walls, fences (if ground mounted) etc. on the collector during this time period. Potential vegetation growth leading to collector shading must also be considered.

- □ Unshaded time period: ____am to ____ pm

Roof mounting is the standard and preferred location for mounting solar collectors. Nevertheless, ground mounting of specific solar systems may also be acceptable in certain circumstances. In general, ground mounts are more suitable for integral collector storage and thermosiphon type solar systems. If suitable solar access is unavailable for roof mounting, or if roof mounting is undesirable or impossible due to structural considerations, conduct Steps 1 and 2 for the ground mount location.

Collectors should ideally will be mounted at ±15° from the local latitude.

If the solar access criteria have been met and the potential solar collector mounting location is suitable, proceed to the roof criteria inspection. If suitable solar access does not exist at this site, it is recommended that the residence not be considered for participation in the program.

Roof Inspection

The primary purpose of the roof inspection is to determine whether the roof is both structurally and materially sound enough for the mounting of a solar collector. Collector weights range from approximately 80-150 pounds for flat plate collectors to 450 pounds and over for integral collector storage and thermosiphon systems. The final decision will be made by local WAP agencies based on findings developed after a thorough roof inspection. The primary determinant for acceptability of a roof for a solar collector installation should be the structural soundness of the roof. Other factors such as rusted nails, loose tiles, can be replaced or repaired, but will not adversely, in themselves, affect the adequate installation of the solar collector. These factors may nevertheless provide clues to more severe roofing problems that could affect the structural stability of the roof. If , after the inspections are complete and the local utility is still in doubt about a specific roof's condition, it is recommended that a reputable roofing firm be consulted.

The following roofing inspection procedure should be conducted for potential solar system installation sites.

□ Roof orientation: (At collector location)

- □ South or nearly South
- □ Southeast or Southwest
- □ East or West
- □ North

□ Roof materials

- □ Shingle
- □ Tile
- □ Built-up gravel
- □ Other (describe)

□ Roof pitch

- □ 0 (Tilt Angle 0° to 3°, roof tilt 0°)
- □ 1 in 12 (Tilt Angle 3° to 7°, roof tilt 4.8°)
- □ 2 in 12 (Tilt Angle 7° to 12°, roof tilt 9.5°)
- □ 3 in 12 (Tilt angle 12° to 16°, roof tilt 14°)
- □ 4 in 12 (Tilt angle 16° to 20°, roof tilt 18.4°)
- □ 5 in 12 (Tilt angle 20° to 25°, roof tilt 22.6°)
- □ 6 in 12 (Tilt angle 25° to 30°, roof tilt 26.6°)
- □ 8 in 12 (Tilt angle 30° to 37°, roof tilt 33.7°)
- □ 10 in 12 (Tilt angle 37° to 43°, roof tilt 39.8°)
- □ 12 in 12 (Tilt angle 43° to 50°, roof tilt 45.0°)

- □ Determine the age of the roof and whether any previous re-roofing or repair work has been conducted in the past. This may provide valuable information on the present condition of the roof.

- □ Determine if the roof is leaking.
  - □ Ask the homeowner if roof or ceiling leaks have ever occurred.
  - □ Inspect the inside of the residence for evidence of leaks.
  - □ Check the rafters and eaves to determine if water stains are evident on the rafters (Keep in mind that water damage inside the house is not always caused by roofing problems.)

- □ Examine the roof visually
  (Problems with any of the following could indicate serious roofing complications.)
  - □ Ridge deflection
  - □ Rafter deflection
  - □ Sheathing deterioration
  - □ Surface "springy" under load
  - □ Adequate internal support

  (Note: Sagging may be due to improper support or sagging of the rafters.)

- □ For specific types of roof material, check for the following:
  - □ Asphalt Singles
    - □ Missing or broken shingles
    - □ Loose surface granules
    - □ Nails loose, missing, rusted
    - □ Torn shingles
    - □ Split or curled shingles
    - □ Worn areas
    - □ Poorly applied
    - □ Other:

  - □ Built-up Roofing on flat or low sloped roofs
    - □ Bare spots in surfacing
    - □ Separations and breaks in the felt
    - □ Bubbles, blister, crack, or soft spots
    - □ Water accumulation
    - □ Gravel surface deteriorated

  - □ Tile roofs
    - □ Broken or missing tiles

  - □ Attic space

  Is there sufficient room in the attic for the laying of water pipe and also for access by solar system installation personnel?

Is the condition of the attic crawl space stable enough for workmen to walk on?

□ Distance from collector location to water tank
____' Horizontal run
____' Vertical run

□ Provide overhead sketch of site dimensions. (House and roof orientation, tank location, trees, height of trees, shading, etc.) This will provide vital information for inspection reviewers and solar installers. A photograph is ideal.

Problems Encountered:

FINAL JUDGEMENT:

□ Roof condition suitable for collector mounting.

□ Roof problems are minor and repairs can be made that will allow installation of solar collector.

□ Costs of required repair exceed utility repair budget.

Water Heater Inspection

The following electric water heater inspection should be conducted to determine the condition of the electric water heating tank. Much of the information listed below can be obtained from the water tank nameplate.

□ Is there an electric hot water heater at the residence?
- □ Yes
- □ No

□ Location of water tank:
- □ Garage
- □ Closet
- □ Utility room
- □ Under kitchen counter
- □ Outdoors (Porch)
- □ Outdoors (Carport)
- □ Outdoors (Exposed to elements)
- □ Outdoors (Covered by shed)
- □ Other (Please describe)______________________

□ Tank Manufacturer:

□ Model:

□ Age of tank: (Consult owner) □ 1-5 years □ 6-10 years □ 10-15 years □ 20+ years

(Note: If tank is leaking, exhibits major rust, etc. or is over 10 years old, tank will be replaced.)

□ Capacity (gals.):

□ Size of tank: ____Tall ____Squat

□ Number of heating elements (1 or 2):

□ Wattage of top heating element:

□ Wattage of lower heating element:

□ Check for heating element operation: (See suggested procedure below.)

□ Type of tank insulation:

□ R-value of tank insulation:

□ Tank insulation blanket (if previously installed):

Type:
Material:
Thickness:
R-Value:

□ Check for tank water leaks.

□ Check for tank piping and valve water leaks.

□ Check that tank pressure-temperature relief valve is installed.

□ Check around piping connections and valve connections for possible leaks. (Rust or white or greenish crusting of pipe, valves, or joints could indicate the presence of leaks.)

□ Check that tank drain valve is accessible.

□ Check that tank drain valve is operational.

□ Determine hot water outlet line piping type and size.

____Copper ____Plastic ____Galvanized ____Other (List)

____3/8" ____½" ____3/4" ____1"

□ Determine cold service line piping type and size.

____Copper ____Plastic ____Galvanized ____Other (List)

____3/8" ____½" ____3/4" ____1"

□ Determine that cold service line isolation line is installed and operational.

□ Determine distance from collector location to water tank.

____' Horizontal run

____' Vertical run

□ Provide rough sketch of tank, plumbing, and vicinity of walls. This will provide vital information for the inspection reviewers and solar installers. A photograph is ideal.

□ The following is a simple test to determine whether the water heater is operating properly. (This should be conducted after determining that no excessive hot water usage has taken place prior to the test.):

1. Find a hot water faucet that is closest to the hot water heater.

2. Turn the hot water on and place a thermometer under the flowing water.

3. Allow the temperature to stabilize.

4. Once the water temperature has stabilized, the approximate water temperature will be indicated.

5. Failure to reach acceptable temperatures (120o to 140o F) can be the result of improper thermostat settings, defective thermostats or heating elements, circuit or fuse problems, or severe hot water leaks.

NOTE:

If the existing tank is operational and appears to be in suitable condition for use with a solar water heating system, the tank should be kept in place.

If the inspected water tank is leaking, or in deteriorating condition, or is more than 10 years old, it should be replaced.

It is highly recommended that only 40 gallon and larger tanks be used in the program's solar system. The larger the tank, the greater the reserve of solar heated water. Tanks 30 gallons and smaller that need to be replaced should be replaced with larger tanks (40 and preferably 52 gallon).

PROBLEMS ENCOUNTERED:

COST OF REPAIRING THE WATER HEATER TO STANDARDS SUITABLE FOR THE INSTALLATION OF A SOLAR COLLECTOR:

FINAL JUDGEMENT: □ Tank condition is satisfactory.

□ Repairs are minor and can be made prior to installation of solar systems using existing tank..

□ Tank must be replaced.

Electrical Inspection

The following electrical inspection should be conducted to determine whether there are special electrical problems that could affect the installation of a solar water heating system. Minor problems may in some cases be corrected by the local WAP agencies, while more substantial problems should be resolved by qualified electrical contractors.

- □ Check to determine that the residence currently has an electrically operated hot water heater tank. (This should have already been determined during the Water Heater Inspection procedure.)

- □ Check the circuit panel circuit breaker or fuse.

- □ Check the water heater branch circuit wiring and conduit to the electric hot water heater.

  - □ Is the conduit rusty, split, etc?
  - □ Is exposed wiring insulation deteriorated, damaged, brittle, or crumbly?
  - □ Is there exposed electrical wiring?
  - □ Is there moisture in the conduit, on wires, or in the circuit panel?
  - □ Are all electrical connections secure?

- □ Check the hot water heater electrical junction box.

- □ Determine that an electrical receptacle (plug-in for pump, controller, timer, etc.) is within a reasonable distance of the water tank location.

- □ Check to see that 110V electric outlet is available in the vicinity of the water tank.

- □ Determine distance of 110V electric outlet from water tank (in feet).

- □ Determine if the 110V outlet has a three-pronged ground receptacle.

- □ If there is currently no electrically operated hot water heater, determine the following:

  - □ Does the circuit panel have a spare circuit breaker for a hot water heater?
  - □ If it does not, determine the amperage capacity available for the total residence. (A residence should have a minimum 100 amperage capacity.)

PROBLEMS ENCOUNTERED:

COST OF REPAIRING PROBLEMS :

FINAL JUDGEMENT:

□ Electrical conditions are acceptable.

□ Electrical repairs can be made that will allow installation of solar collector.

  □ Costs of required repairs exceed UTILITY repair budget.

Plumbing Inspection

The following plumbing inspection should be conducted to determine whether there are any special plumbing problems that could adversely affect the installation of a solar water heating system. Many discovered problems can be remedied by the local Utility prior to the installation of the solar system. More major problems may have to be repaired by a qualified plumbing contractor. A thorough inspection of the existing water heating tank, piping, valves, and faucets should be conducted.

□ Determine if the water system is a city water system or a well system.

□ Determine the water pressure by checking several faucets to make sure that water flow is adequate. (Low pressure may be the result of small service lines, calcification of water lines; poor pump operation on individual pressure tank water systems, etc.)

□ Check the shutoff valves at the service water entrance and at other points throughout the system for proper operation. (It is possible that these valves could have become frozen due to age or infrequent usage.)

□ Check for leaks at all water supply lines. (Rust or white or greenish crusting of pipe or joints could indicate leaks.)

□ Check the plumbing fixtures and faucets throughout the house for leaks and poor connections. (Rust or white or greenish crusting around the valves, pipes or joints could indicate leaks.)

PROBLEMS ENCOUNTERED:

COST OF REPAIRING PLUMBING PROBLEMS:

FINAL JUDGEMENT:

□ Plumbing condition adequate.

□ Plumbing repairs can be made.

□ Costs of required repairs exceed repair budget.

Post-installation system inspection

The inspection checklists provide officials with a standardized method for inspecting installed solar water heating systems.

Separate comprehensive checklists have been prepared to cover each of the solar system types that utility officials are likely to encounter. These include:

- Integral collector storage (ICS) systems
- Thermosiphon systems
- Photovoltaic controlled pumped systems
- Differential controlled pumped systems (direct)
- Differential controlled pumped systems (indirect in the event of poor water conditions)

The checklists are organized initially by system types. Within each system type, the checklists are broken down into:

a. the collector area inspection which includes the collector, collector mounting, exterior piping and insulation, and valves

b. the storage tank inspection which includes the retrofitted conventional water heater, insulation jacket, heating elements, and service water pipe insulation

c. the balance of system components which includes insulation, check valves, isolation valves, tempering valves, pumps, controllers, system owner's manual, etc.

The breakdown in each checklist is organized in such a manner as to make the inspection as streamlined, simple, and expeditious as possible. Inspection time will be reduced considerably as program officials become familiar with both the systems and the inspection forms.

All systems that have been approved for installation in the program should have an approved installation design and schematic. The primary objective of the inspection is to assure that those components listed on the specific system approval form are installed in a proper manner. Thereby, the first step in conducting a system inspection should be to obtain the system approval sheet (which contains a listing of all components to be installed and a corresponding schematic of that system) and quickly verify that the listed components have indeed been installed. Second, the inspector should then review the schematic and insure that the components have been installed as indicated on the schematic. The final phase should be to conduct the detailed inspection as outlined in the inspection checklist. Any discrepancies should be noted and followed up with a call to the installer.

Integral Collector Storage System (ICS) Inspection Form

INSPECTOR: DATE OF INSPECTION:
RESIDENT NAME: ADDRESS:

ITEM TO INSPECT	YES	NO	N/A	REMARKS
Components listed on FSEC System Approval form and schematic are included in installation				
Collector certification label is affixed to collector				
Manufacturer and model of collector (See Remarks)				Manufacturer: Model:
Collector location (See remarks)				__ Roof __ Ground __ Other (Describe):
Collector is in an unshaded location				
Collector orientation (See Remarks) (Must be within 45^{o} west or east of south or on west facing roof.)				__ South or nearly south __ Southeast or southwest __ East or west
Collector Azimuth Angle (Include if compass reading is available-See Remarks)				_____^{o} East of south _____^{o} West of south
Collector Tilt (From Horizontal-See Remarks) (Must be flush mounted to roof or at an angle ± 15^{o} from local latitude. If on flat roof, ± 15^{o} from local latitude.)				_____^{o}
Collector tilted for proper drainage				
Distance from collector to tank (See Remarks)				_____ Horizontal (Feet) _____ Vertical (Feet)
Collector is firmly attached to roof structure				
Clearance under collector (See Remarks)				______"
Pipe roof penetrations are sealed				
Exterior piping is insulated				Type of insulation:
Thickness of exterior pipe insulation (See Remarks)				______"
Exterior piping is protected from UV degradation				
Protective coating for exterior pipe insulation (See Remarks)				Protective method:
Piping insulation joints well sealed				
Pressure relief valve is installed				
Tank Location (See Remarks)				__ Garage __ Carport __ Closet __ Outside __ Kitchen __ Other
Tank Manufacturer (See Remarks)				Mfg:

Tank Model (See Remarks)				Model:
Tank capacity (See Remarks)				Gallons _____
R-value of tank insulation (See Remarks)				R-value _____
Insulation blanket (If used)				
Type of insulation in blanket (See Remarks)				Type:
Thickness of insulation in blanket (See Remarks)				_____ "
Tank element/thermostat doors accessible				
Number of heating elements (See Remarks)				__ 1 __ 2
Upper heating element wattage (See Remarks)				_____Wattage
Lower heating element wattage (See Remarks)				_____Wattage
Upper thermostat set point				_____ ^{o} F
Lower thermostat set point				_____ ^{o} F
Pressure-Temperature Relief Valve installed				
Pressure-Temperature Relief Valve exhaust routed to proper location as per local codes				
Hot and cold water service piping insulated				
Conventional tank properly converted to solar				
Freeze prevention information label attached to tank or other conspicuous location				
Components indicated on FSEC System Approval form and schematic are installed in their proper locations				
Collector feed and return line piping material (See Remarks)				__ Copper __ Other _______________
Collector feed and return piping insulated				
Collector feed and return line piping is drainable				
Diverter valve (solar/auxiliary tank) turned to “solar” feed				
Isolation valves in collector feed and return lines				
Drain valves in collector feed and return lines				
Insulation (R-2.4 or greater) installed on all interconnecting hot and cold water piping installed in attics				
System warranty provided				

Photovoltaic System Inspection Form

INSPECTOR: DATE OF INSPECTION:
RESIDENT NAME: ADDRESS:

ITEM TO INSPECT	YES	NO	N/A	REMARKS
Components listed on FSEC/SRCC System Approval form and schematic are included in the installation				
Certification label is affixed to collector				
Manufacturer and model of collector (See Remarks)				Manufacturer: Model:
Collector location (See remarks)				__ Roof __ Ground __ Other (Describe):
Collector is in an unshaded location				
Collector orientation (See Remarks) (Must be within 45° west or east of south or on west facing roof)				__ South or nearly south __ Southeast or southwest __ East or west
Collector Azimuth Angle (Include if compass reading is available-See Remarks)				_____° East of south _____° West of south
Collector Tilt (From Horizontal-See Remarks) (Must be mounted flush to roof or ± 15 degrees from local latitude. If on flat roof, ± 15 degrees from local latitude.)				____°
Collector tilted for proper drainage				
Clearance under collector (See Remarks)				_____"
Distance from collector to tank (See Remarks)				_____ Horizontal (Feet) _____ Vertical (Feet)
Collector is firmly attached to roof structure				
Roof piping penetrations are sealed				
Roof wiring penetrations are sealed				
Exterior piping is insulated (See remarks)				Type of insulation:
Thickness of exterior pipe insulation (See Remarks)				______"
Exterior pipe insulation protected from UV degradation				
Protective coating for exterior pipe insulation (See remarks)				Protective method:
Piping insulation joints are well sealed				
Air vent is installed in vertical position at the highest				

point				
Pressure relief valve is installed				
Vacuum breaker installed (If required - see schematic)				
PV Module Manufacturer and model (See Remarks)				Manuf: Model:
PV module is in an unshaded location				
PV module does not shade solar collector				
PV module orientation				__ Same as solar collector __ Other
PV module tilt				__ Same as solar collector __ Other
PV module fastening method				__ Bolted to solar collector frame __ Roof mount __ Other
PV Module electrical connections are secure and protected from environment (See Remarks)				__ Type of connections.
PV Module wiring exposed to sun is UV protected				
PV Module wire free of crimps and free from chaffing obstructions				
Tank Location (See Remarks)				__ Garage __ Carport __ Closet __ Outside __ Kitchen __ Other
Tank Manufacturer (See Remarks)				Mfg:
Tank Model (See Remarks)				Model:
Tank capacity (See Remarks)				Gallons _____
R-value of tank insulation (See Remarks)				R-value____
Type of insulation in blanket (See Remarks)				Type:
Thickness of insulation in blanket (See Remarks)				_____ "
Tank element/thermostat doors accessible				
Number of heating elements (See Remarks)				__ 1 __ 2
Upper heating element wattage (See Remarks)				_____Wattage
Lower heating element wattage (See Remarks)				_____Wattage
Upper thermostat set point (See Remarks)				_____ ^{o} F
Lower thermostat set point (See Remarks)				_____ ^{o} F

Pressure-Temperature Relief Valve installed				
Pressure-Temperature Relief Valve exhaust routed to proper location as per local codes				
Hot and cold service lines insulated				
Conventional tank properly converted to solar				
Freeze prevention information label attached to tank or other conspicuous location				
Collector feed and return line piping material (See Remarks)				__ Copper __ Other
Collector feed and return insulation secure				
DC Pump installed				
Pump Manufacturer (See Remarks)				Manufacturer:
Pump Model (See Remarks)				Model:
Pump properly oriented				
PV module wiring properly connected to DC pump wiring				
PV/DC pump connection method				
Check valve installed				__ Spring __ Swing
Isolation valves in collector feed and return lines				
Drain valves in collector feed and return lines				
Anti-scald valve installed (See Remarks)				Mfg: Model:
Anti-scald valve set point (See Remark)				Set point _____
Insulation (Rated at R-2.4) or greater installed on all interconnecting hot and cold water piping installed in attics, unconditioned garages, other unconditioned indoor spaces, as well as all conditioned spaces.				
Owner's manual provided				
System warranty provided				

Thermosiphon System Inspection Form

INSPECTOR: DATE OF INSPECTION:
RESIDENT NAME: ADDRESS:

ITEM TO INSPECT	YES	NO	N/A	REMARKS
Components listed on FSEC System Approval form and schematic are included in installation				
Certification label is affixed to collector				
Manufacturer and model of collector (See Remarks)				Manufacturer: Model:
Collector location (See remarks)				- Roof - Ground - Other (Describe):
Collector is in an unshaded location				
Collector orientation (See Remarks) (Must be with 45^{o} west or east of south)				- South or nearly south - Southeast or southwest - East or west
Collector Azimuth Angle (Include if compass reading is available-See Remarks)				_____^{o} East of south _____^{o} West of south
Collector Tilt (From Horizontal-See Remarks)(Must be mounted at an angle plus or minus 15^{0} from latitude)				_____^{o}
Clearance under collector (See Remarks)				_____"
Distance from collector to tank (See Remarks)				_____ Horizontal (Feet) _____ Vertical (Feet)
Collector is firmly attached to roof structure				
Roof piping penetrations are sealed				
Roof wiring penetrations are sealed				
Exterior piping is insulated (See remarks)				Type of insulation:
Thickness of exterior pipe insulation. (See Remarks)				______"
Exterior pipe insulation protected from UV degradation				
Protective coating for exterior pipe insulation				Protective method:

(See remarks)				

Piping insulation joints well sealed				
Air vent is installed in vertical position at highest point				
Temperature and Pressure (TP) Relief Valve or Pressure (P) Relief valve is installed				
Vacuum breaker installed (if required – see system approval)				
Solar storage tank properly installed				
Storage tank valves installed as per schematic				
Tank Location (See Remarks)				- Garage - Carport - Closet - Outside - Kitchen - Other
Tank Manufacturer (See Remarks)				Mfg:
Tank Model (See Remarks)				Model:
Tank capacity (See Remarks)				Gallons _____
R-value of tank insulation (See Remarks)				R-value _____
Insulation blanket				
Type of insulation in blanket (See Remarks)				Type:
Thickness of insulation in blanket (See Remarks)				_____ inches
Number of heating elements (See Remarks)				__1 __2
Upper heating element wattage and set point (See Remarks)				______Wattage _____ ° F
Lower heating element wattage and set point (See Remarks)				______Wattage _____ ° F
Pressure-Temperature Relief Valve installed				
Hot and cold service piping insulated				
Conventional tank properly converted to solar				
Components indicated on FSEC System Approval schematic are installed in their proper locations				
Collector feed and return line piping material (See Remarks)				__ Copper __ Other ___________

Collector feed and return piping insulated				
Collector feed and return line piping is drainable				
Check valve installed				__ Spring __ Swing
Isolation valves in collector feed and return lines				
Drain valves in collector feed and return lines				
Insulation (Rated at R-2.4) or greater installed on all interconnecting hot and cold water piping installed in attics, unconditioned garages, other unconditioned indoor spaces, as well as all conditioned spaces.				
Owner's manual provided				
System warranty provided				

Direct Differential Control System Inspection Form

INSPECTOR: DATE OF INSPECTION:
RESIDENT NAME: ADDRESS:

ITEM TO INSPECT	YES	NO	N/A	REMARKS
Components listed on FSEC System Approval form and schematic are included in installation				
Collector certification label is affixed to collector				
Manufacturer and model of collector (See Remarks)				Manufacturer: Model:
Collector location (See remarks)				__ Roof __ Ground __ Other (Describe):
Collector is in an unshaded location				
Collector orientation (See Remarks) (Must be within 45° west or east of south.)				__ South or nearly south __ Southeast or southwest __ East or west
Collector Azimuth Angle (Include if compass reading is available-See Remarks)				_____° East of south _____° West of south
Collector Tilt (From Horizontal-See Remarks) (Must be mounted at an angle plus or minus 15° from latitude.)				_____°
Clearance under collector (See Remarks)				_____"
Collector tilted for proper drainage				
Distance from collector to tank (See Remarks)				_____ Horizontal (Feet) _____ Vertical (Feet)
Collector is firmly attached to roof structure				
Roof piping penetrations are sealed				
Roof wiring penetrations are sealed				
Exterior piping is insulated (See remarks)				Type of insulation:

Thickness of exterior pipe insulation (See Remarks)				______"
Exterior pipe insulation protected from UV degradation				
Protective coating for exterior pipe insulation (See remarks)(Ex: paint, foil tape, etc.)				Protective method:
Piping insulation joints well sealed				
Air vent is installed in vertical position at highest point				
Temperature and Pressure (TP) Relief Valve or Pressure (P) Relief valve is installed				
Vacuum breaker installed (if required - see schematic)				
Collector sensor securely attached to collector/piping				
Sensor wires uncrimped and free from chaffing obstructions				
Sensor wires protected from environmental degradation				
Tank Location (See Remarks)				Carport __ Closet __ Outside__ Kitchen __ Other________
Tank Manufacturer (See Remarks)				Mfg:
Tank Model (See Remarks)				Model:
Tank capacity (See Remarks)				Gallons _____
R-value of tank insulation (See Remarks)				_____R-value
Insulation blanket included				
Type of insulation in blanket (See Remarks)(Ex: fiberglass, etc.)				Type:
Thickness of insulation in blanket (See Remarks)				_____"
Number of tank heating elements (See Remarks)				__ 1 __ 2
Upper heating element wattage (See Remarks)				_____Wattage
Upper thermostat set point				_____ ^{o}F
Lower heating element connected				
Lower heating element set point				_____ ^{o}F
Lower heating element wattage (See Remarks)				_____Wattage

Pressure-Temperature Relief Valve installed				
Hot and cold service piping insulated				
Conventional tank properly converted to solar				
Components indicated on System form and schematic are installed in their proper locations				
Controller is installed				
Controller Manufacturer (See Remarks)				Manufacturer:
Controller Model (See Remarks)				Model:
Sensor securely attached to storage tank				
Sensor wires away from 120V/240V wiring				
Sensors wired to proper terminals on controller				
Pump installed				
Pump Manufacturer (See Remarks)				Manufacturer:
Pump Model (See Remarks)				Model:
Pump properly oriented				
Collector feed and return line piping material (See Remarks)				__ Copper __ Other ____________
Collector feed and return piping insulated				
Collector feed and return lines drainable				
Check valve installed				__ Motorized __ Spring __ Swing
Isolation valves in collector feed and return lines				
Drain valves in collector feed and return lines				
Anti-scald valve installed				Mfg: Model:
Anti-scald valve set point (See remarks)				Set point: ____
Insulation (R-2.4 or greater) installed on all interconnecting hot and cold water piping installed in attics,				
Owner's manual provided				
System warranty provided				

Appendix III: Financial and Cash Flow Analysis

Solar Thermal Business Planning
Workbook for International Markets

Companion Software for Guide to Creating Financial Proformas for a Utility Solar Thermal Service for Residential Customers

Sponsored By:

Solar Energy Industries Association

Developed By:

Energy Alliance Group

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Energy Alliance Group is an international consulting firm specializing in new business and product development related to energy services, strategic marketing, and commercialization of advanced energy-related technologies.
Clients include energy utilities; national, state and local governments; and large energy users.

Note: Adaptations were made by Green Markets International, Inc. to incorporate carbon reduction sales revenue for projections generated in this Guidebook and Appendix.

SOLAR BUSINESS MODEL GENERAL INPUTS
Caribbean Utility Solar Program

GENERAL INFORMATION

Organization	Caribbean Utility Solar Program
Discount Rate (Financial)	14.0%
Finance Mechanism	Debt
Discount Rate (Environmental)	14.0%

MONTHLY CUSTOMER CHARGE

Country	Other Location
F-chart Site	Kingston Jamaica
System Size	Medium
Electric Rate, Cost per kWh	0.330
Customer Fee/Savings Ratio	90%
Annual Hot Water Load, kWh	2,177
Water Heater Efficiency	70%
Annual Solar Fraction	90%
Monthly Customer Savings	76.95
Monthly Customer Charge	69.26
Sales Tax	-
Net Service Fee Revenue	69.26

FINANCING

Interest Expense - Rate	5.0%
Interest Income - Rate	6.0%

TAXES

Gross receipts tax	0.00%
Property Tax ○ Book ◉ Market	0.00%
Net Worth Tax	0.00%
Other Tax	0.00%
Sales Tax	0.00%
Import Duty Tax	5.00%
Income Tax	0.00%

SOLAR EQUIPMENT DEPRECIATION

For Book Purposes	
If Straight Line, # Years	Straight Line / Custom Schedule
5	
For Tax Purposes	
If Straight Line, # Years	MACRS -- 5 Year / MACRS -- 7 Year

TAX CREDITS

Investment Tax Credit	0.0%
Other Tax Credit	0.0%
Loss Carryforward (Y/N)	n

CUSTOMER CONTRACT TERM

Contract Term, Years	20

ANNUAL MAINTENANCE COST

Annual Unit Maintenance Cost	10.00

BUSINESS EXPENSES (000's)

	Annual Business Expenses				
Year	Office Rental	Phone/Elec Utilities	Travel/Ent. Conf.	Prof. Services	Other Marketing
0	-	-	-	50	20
1	20	5	-	75	4
2	20	6	-	50	3
3	20	8	-	50	2
4	20	8	-	50	1
5	20	8	-	50	1
6	20	8	-	50	1
7	20	8	-	50	1
8	20	8	-	50	1
9	20	8	-	50	1
10	20	8	-	50	1
11	10	2	-	25	1
12	10	2	-	25	1
13	10	2	-	25	1
14	10	2	-	25	1
15	10	2	-	25	1
16	10	2	-	25	1
17	10	2	-	25	1
18	10	2	-	25	1
19	10	2	-	25	1
20	10	2	-	25	1
21			-		
22	-	-	-	-	-
23	-	-	-	-	-
24	-	-	-	-	-
25	-	-	-	-	-
26	-	-	-	-	-
27	-	-	-	-	-
28	-	-	-	-	-
29	-	-	-	-	-
30	-	-	-	-	-

SYSTEMS INSTALLED, INCENTIVES AND COSTS

Year	Systems Installed	Incentives Per System	Costs Per Installation: Equipment	Installation	Freight	Import Duty	Total
1	300	-	1,350	390	42	68	1,850
2	600	-	1,350	390	42	68	1,850
3	1,500	-	1,350	390	42	68	1,850
4	2,600	-	1,350	390	42	68	1,850
5		-	1,283	370	55	64	1,772
6		-	1,218	350	55	61	1,684
7		-	1,157	350	55	58	1,620
8		-	1,100	350	55	55	1,560
9		-	1,100	350	55	55	1,560
10		-	1,100	350	55	55	1,560
Total	5,000	-	6,750,000	1,950,000	210,000	337,500	9,247,500

SYSTEM INFORMATION FOR SOLAR HOT WATER HEATING SYSTEMS
Caribbean Utility Solar Program

			SYSTEM SIZE					
			SMALL		MEDIUM		LARGE	
	Country	F-chart Site	Annual Hot Water Load (kWh)	Annual Solar Fraction	Annual Hot Water Load (kWh)	Annual Solar Fraction	Annual Hot Water Load (kWh)	Annual Solar Fraction
1	Brazil	Buenos Aires, Argentina	2,520	72%	4,336	61%	6,153	65%
2	India	Madras, India	1,670	84%	2,901	88%	4,161	93%
3	China	Shimizu, Japan	2,666	57%	4,512	47%	6,299	51%
4	Indonesia	Kuala Lumpur, Malaysia	1,787	72%	3,135	76%	4,483	83%
5	South Africa	Pretoria, South Africa	2,520	85%	4,366	72%	6,182	77%
6	Mexico	Ciudad University, Mexico	2,637	76%	4,541	63%	6,475	68%
7	Guatemala	San Juan, Puerto Rico	1,846	75%	3,223	78%	4,600	86%
8	Nicaragua	San Juan, Puerto Rico	1,846	75%	3,223	78%	4,600	86%
9	Dominican Republic	San Juan, Puerto Rico	1,846	75%	3,223	78%	4,600	86%
10	Phillippines	Quezon City, Phillipines	1,758	67%	3,076	70%	4,395	77%
11	USA	Green Bay, Wisconsin	0	0%	0	0%	6,387	52%
12	Other Location	Kingston Jamaica	0	90%	2,177	90%	0	0%

SALES BUILD-UP
Caribbean Utility Solar Program

	TOTAL	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Annual Systems Sales	**5,000**	300	600	1,500	2,600	-	-	-	-	-	-
Cumulative Systems Sales	**5,000**	300	900	2,400	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Cost Per System	**1,850**	1,850	1,850	1,850	1,850	1,772	1,684	1,620	1,560	1,560	1,560
Annual System Costs **(000's)**	**9,248**	555	1,110	2,774	4,809	-	-	-	-	-	-
Installations in Place		300	900	2,400	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Service Revenues **(000's)**	**83,112**	249	748	1,995	4,156	4,156	4,156	4,156	4,156	4,156	4,156
Solar Eqip Depr. For Book **(000's)**	**9,248**	111	333	888	1,850	1,850	1,739	1,517	962	-	-
Solar Eqip Depr. For Tax **(000's)**	**9,248**	111	399	1,015	2,127	2,260	1,402	949	695	289	-

SYSTEMS IN PLACE	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Year 1	300	300	300	300	300	300	300	300	300	300
Year 2	0	600	600	600	600	600	600	600	600	600
Year 3	0	0	1500	1500	1500	1500	1500	1500	1500	1500
Year 4	0	0	0	2600	2600	2600	2600	2600	2600	2600
Year 5	0	0	0	0		0	0	0	0	0
Year 6	0	0	0	0	0		0	0	0	0
Year 7	0	0	0	0	0	0		0	0	0
Year 8	0	0	0	0	0	0	0	0	0	0
Year 9	0	0	0	0	0	0	0	0	0	0
Year 10	0	0	0	0	0	0	0	0	0	0
TOTAL	**300**	**900**	**2400**	**5000**	**5000**	**5000**	**5000**	**5000**	**5000**	**5000**

SALES BUILD-UP
Caribbean Utility Sola

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Annual Systems Sales										
Cumulative Systems Sales	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Cost Per System										
Annual System Costs **(000's)**	-	-	-	-	-	-	-	-	-	-
Installations in Place	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Service Revenues **(000's)**	4,156	4,156	4,156	4,156	4,156	4,156	4,156	4,156	4,156	4,156
Solar Eqip Depr. For Book **(000's)**	-	-	-	-	-	-	-	-	-	-
Solar Eqip Depr. For Tax **(000's)**	-	-	-	-	-	-	-	-	-	-

SYSTEMS IN PLACE	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Year 1	300	300	300	300	300	300	300	300	300	300
Year 2	600	600	600	600	600	600	600	600	600	600
Year 3	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Year 4	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600
Year 5	0	0	0	0	0	0	0	0	0	0
Year 6	0	0	0	0	0	0	0	0	0	0
Year 7	0	0	0	0	0	0	0	0	0	0
Year 8	0	0	0	0	0	0	0	0	0	0
Year 9	0	0	0	0	0	0	0	0	0	0
Year 10	0	0	0	0	0	0	0	0	0	0
TOTAL	**5000**	**5000**	**5000**	**5000**	**5000**	**5000**	**5000**	**5000**	**5000**	**5000**

SALES BUILD-UP
Caribbean Utility Sola

	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Annual Systems Sales										
Cumulative Systems Sales	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Cost Per System										
Annual System Costs **(000's)**	-	-	-	-	-	-	-	-	-	-
Installations in Place	4,700	4,100	2,600	-	-	-	-	-	-	-
Service Revenues **(000's)**	3,906	3,408	2,161	-	-	-	-	-	-	-
Solar Eqip Depr. For Book **(000's)**	-	-	-	-	-	-	-	-	-	-
Solar Eqip Depr. For Tax **(000's)**	-	-	-	-	-	-	-	-	-	-

SYSTEMS IN PLACE	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Year 1	0	0	0	0	0	0	0	0	0	0
Year 2	600	0	0	0	0	0	0	0	0	0
Year 3	1500	1500	0	0	0	0	0	0	0	0
Year 4	2600	2600	2600	0	0	0	0	0	0	0
Year 5	0	0	0	0	0	0	0	0	0	0
Year 6	0	0	0	0	0	0	0	0	0	0
Year 7	0	0	0	0	0	0	0	0	0	0
Year 8	0	0	0	0	0	0	0	0	0	0
Year 9	0	0	0	0	0	0	0	0	0	0
Year 10	0	0	0	0	0	0	0	0	0	0
TOTAL	**4700**	**4100**	**2600**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

SALES BUILD-UP
Caribbean Utility Solar Program

SOLAR EQUIPMENT DEPRECIATION FOR BOOK PURPOSES (000's)	Total	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Year 1	**555**	111	111	111	111	111	-	-	-	-	-
Year 2	**1,110**	-	222	222	222	222	222	-	-	-	-
Year 3	**2,774**	-	-	555	555	555	555	555	-	-	-
Year 4	**4,809**	-	-	-	962	962	962	962	962	-	-
Year 5	**-**	-	-	-	-	-	-	-	-	-	-
Year 6	**-**	-	-	-	-	-	-	-	-	-	-
Year 7	**-**	-	-	-	-	-	-	-	-	-	-
Year 8	**-**	-	-	-	-	-	-	-	-	-	-
Year 9	**-**	-	-	-	-	-	-	-	-	-	-
Year 10	**-**	-	-	-	-	-	-	-	-	-	-
Total Depreciable Amount	**9,248**	**111**	**333**	**888**	**1,850**	**1,850**	**1,739**	**1,517**	**962**	**-**	**-**
Total Sales Price	**9,248**										
Percent of Sales Price	100.0%										

SOLAR EQUIPMENT DEPRECIATION FOR TAX PURPOSES (000's)	Total	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Year 1	**555**	111	178	105	67	61	33	-	-	-	-
Year 2	**1,110**	-	222	355	211	133	122	67	-	-	-
Year 3	**2,774**	-	-	555	888	527	333	305	166	-	-
Year 4	**4,809**	-	-	-	962	1,539	914	577	529	289	-
Year 5	**-**	-	-	-	-	-	-	-	-	-	-
Year 6	**-**	-	-	-	-	-	-	-	-	-	-
Year 7	**-**	-	-	-	-	-	-	-	-	-	-
Year 8	**-**	-	-	-	-	-	-	-	-	-	-
Year 9	**-**	-	-	-	-	-	-	-	-	-	-
Year 10	**-**	-	-	-	-	-	-	-	-	-	-
Total Depreciable Amount	**9,248**	**111**	**399**	**1,015**	**2,127**	**2,260**	**1,402**	**949**	**695**	**289**	**-**
Total Sales Price	**9,248**										
Percent of Sales Price	100.0%										

SALES BUILD-UP
Caribbean Utility Sola

SOLAR EQUIPMENT DEPRECIATI FOR BOOK PURPOSES (000's)	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Year 1	-	-	-	-	-	-	-	-	-	-
Year 2	-	-	-	-	-	-	-	-	-	-
Year 3	-	-	-	-	-	-	-	-	-	-
Year 4	-	-	-	-	-	-	-	-	-	-
Year 5	-	-	-	-	-	-	-	-	-	-
Year 6	-	-	-	-	-	-	-	-	-	-
Year 7	-	-	-	-	-	-	-	-	-	-
Year 8	-	-	-	-	-	-	-	-	-	-
Year 9	-	-	-	-	-	-	-	-	-	-
Year 10	-	-	-	-	-	-	-	-	-	-
Total Depreciable Amount	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total Sales Price										
Percent of Sales Price										

SOLAR EQUIPMENT DEPRECIATI FOR TAX PURPOSES (000's)	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Year 1	-	-	-	-	-	-	-	-	-	-
Year 2	-	-	-	-	-	-	-	-	-	-
Year 3	-	-	-	-	-	-	-	-	-	-
Year 4	-	-	-	-	-	-	-	-	-	-
Year 5	-	-	-	-	-	-	-	-	-	-
Year 6	-	-	-	-	-	-	-	-	-	-
Year 7	-	-	-	-	-	-	-	-	-	-
Year 8	-	-	-	-	-	-	-	-	-	-
Year 9	-	-	-	-	-	-	-	-	-	-
Year 10	-	-	-	-	-	-	-	-	-	-
Total Depreciable Amount	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total Sales Price										
Percent of Sales Price										

SALES BUILD-UP
Caribbean Utility Sola

SOLAR EQUIPMENT DEPRECIATI FOR BOOK PURPOSES (000's)	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Year 1	-	-	-	-	-	-	-	-	-	-
Year 2	-	-	-	-	-	-	-	-	-	-
Year 3	-	-	-	-	-	-	-	-	-	-
Year 4	-	-	-	-	-	-	-	-	-	-
Year 5	-	-	-	-	-	-	-	-	-	-
Year 6	-	-	-	-	-	-	-	-	-	-
Year 7	-	-	-	-	-	-	-	-	-	-
Year 8	-	-	-	-	-	-	-	-	-	-
Year 9	-	-	-	-	-	-	-	-	-	-
Year 10	-	-	-	-	-	-	-	-	-	-
Total Depreciable Amount	-	-	-	-	-	-	-	-	-	-
Total Sales Price										
Percent of Sales Price										

SOLAR EQUIPMENT DEPRECIATI FOR TAX PURPOSES (000's)	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Year 1	-	-	-	-	-	-	-	-	-	-
Year 2	-	-	-	-	-	-	-	-	-	-
Year 3	-	-	-	-	-	-	-	-	-	-
Year 4	-	-	-	-	-	-	-	-	-	-
Year 5	-	-	-	-	-	-	-	-	-	-
Year 6	-	-	-	-	-	-	-	-	-	-
Year 7	-	-	-	-	-	-	-	-	-	-
Year 8	-	-	-	-	-	-	-	-	-	-
Year 9	-	-	-	-	-	-	-	-	-	-
Year 10	-	-	-	-	-	-	-	-	-	-
Total Depreciable Amount	-	-	-	-	-	-	-	-	-	-
Total Sales Price										
Percent of Sales Price										

STAFF BUILD-UP

Fringe and Overhead Factor	38.00%
Merit Increase Factor	2.50%
Holding Company Executive Salary Charge (% of Payroll)	3.50%

Selling Payroll	**Base Salary** (000's)	Year 1 Number of Employees	**Year 1 Salaries**	Year 2 Number of Employees	**Year 2 Salaries**	Year 3 Number of Employees	**Year 3 Salaries**	Year 4 Number of Employees	**Year 4 Salaries**
Sales Manager	30.00	0.00	-	0.00	-	0.00	-	0.00	-
Field Sales Manager	20.00	1.00	28	1.00	29	1.00	30	1.00	30
Sales Representative	15.00	2.00	42	2.00	43	2.00	45	2.00	46
Telemarketing	10.00	1.00	14	1.00	14	1.00	15	1.00	15
TBD			-		-		-		-
TBD			-		-		-		-
Total Selling Payroll		4.0	85	4.0	87	4.0	89	4.0	91
G&A Payroll									
General Manager	45.00	1.00	64	1.00	65	1.00	67	1.00	69
Engineering & Operations Manager	30.00	0.50	21	0.50	22	0.50	22	0.50	23
Administrative Assistant	25.00	1.00	35	1.00	36	1.00	37	1.00	38
Customer Coordinator	15.00	1.00	21	1.00	22	1.00	22	1.00	23
Category TBD			-		-		-		-
Category TBD			-		-		-		-
Category TBD			-		-		-		-
Category TBD			-		-		-		-
		3.5		3.5		3.5		3.5	
Total G&A Payroll			141		145		149		152
Total Payroll		7.5	226	7.5	232	7.5	238	7.5	244

STAFF BUILD-UP

Fringe and Overhead Factor	38.00%
Merit Increase Factor	2.50%
Holding Company Executive Salary Charge (% of Payroll)	3.50%

Selling Payroll	**Base Salary** (000's)	Year 5 Number of Employees	**Year 5 Salaries**	Year 6 Number of Employees	**Year 6 Salaries**	Year 7 Number of Employees	**Year 7 Salaries**	Year 8 Number of Employees	**Year 8 Salaries**
Sales Manager	30.00	0.00	-	0.00	-	0.00	-	0.00	-
Field Sales Manager	20.00	0.00	-	0.00	-	0.00	-	0.00	-
Sales Representative	15.00	0.00	-	0.00	-	0.00	-	0.00	-
Telemarketing	10.00	0.00	-	0.00	-	0.00	-	0.00	-
TBD			-		-		-		-
TBD			-		-		-		-
Total Selling Payroll		0.0	0	0.0	0	0.0	0	0.0	0
G&A Payroll									
General Manager	45.00	1.00	70	0.00	-	0.00	-	0.00	-
Engineering & Operations Manager	30.00	0.00	-	0.00	-	0.00	-	0.00	-
Administrative Assistant	25.00	0.00	-	0.00	-	0.00	-	0.00	-
Customer Coordinator	15.00	1.00	23	1.00	24	1.00	25	1.00	25
Category TBD			-		-		-		-
Category TBD			-		-		-		-
Category TBD			-		-		-		-
Category TBD			-		-		-		-
		2.0		1.0		1.0		1.0	
Total G&A Payroll			94		24		25		25
Total Payroll		2.0	94	1.0	24	1.0	25	1.0	25

STAFF BUILD-UP

Fringe and Overhead Factor	38.00%
Merit Increase Factor	2.50%
Holding Company Executive Salary Charge (% of Payroll)	3.50%

Selling Payroll	**Base Salary** (000's)	Year 9 Number of Employees	**Year 9 Salaries**	Year 10 Number of Employees	**Year 10 Salaries**	Year 11 Number of Employees	**Year 11 to 20**	Year 21 Number of Employees	**Year 21 to 30**
Sales Manager	30.00	0.00	-	0.00	-	0.00	-	0.00	-
Field Sales Manager	20.00	0.00	-	0.00	-	0.00	-	0.00	-
Sales Representative	15.00	0.00	-	0.00	-	0.00	-	0.00	-
Telemarketing	10.00	0.00	-	0.00	-	0.00	-	0.00	-
TBD			-		-		-		-
TBD			-		-		-		-
Total Selling Payroll		0.0	0	0.0	0	0.0	0	0.0	0
G&A Payroll									
General Manager	45.00	0.00	-	0.00	-	0.00	-	0.00	-
Engineering & Operations Manager	30.00	0.00	-	0.00	-	0.00	-	0.00	-
Administrative Assistant	25.00	0.00	-	0.00	-	0.00	-	0.00	-
Customer Coordinator	15.00	1.00	26	1.00	26		-		-
Category TBD			-		-		-		-
Category TBD			-		-		-		-
Category TBD			-		-		-		-
Category TBD			-		-		-		-
		1.0		1.0		0.0		0.0	
Total G&A Payroll			26		26		0		0
Total Payroll		1.0	26	1.0	26	0.0	0	0.0	0

INCOME STATEMENT

INCOME STATEMENT (000's) Caribbean Utility Solar Program	Startup Period	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Incremental Units/Service Agreements Sold		300	600	1,500	2,600	-	-	-	-	-	-
REVENUES											
Service Fee Revenue		249.3	748.0	1,994.7	4,155.6	4,155.6	4,155.6	4,155.6	4,155.6	4,155.6	4,155.6
Solar Installation Incentives		-	-	-	-	-	-	-	-	-	-
Carbon reduction sales revenue		8.4	25.2	67.2	139.9	139.9	139.9	139.9	139.9	139.9	139.9
Interest Income		-	-	-	-	-	233.6	41.1	250.9	263.5	264.2
Total Revenues		257.7	773.2	2,061.8	4,295.5	4,295.5	4,529.1	4,336.6	4,546.4	4,559.0	4,559.7
EXPENSES											
Labor and Overhead											
Marketing & Sales		84.9	87.0	89.2	91.4	-	-	-	-	-	-
Admin/Staff/Operations		141.5	145.0	148.6	152.3	93.7	24.0	24.6	25.2	25.9	26.5
Executive Payroll		7.9	8.1	8.3	8.5	3.3	0.8	0.9	0.9	0.9	0.9
Business Expenses											
Office Rental	-	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Phone, Electric and Other Utilities	-	5.0	6.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Travel/Entertainment/Conferences	-	-	-	-	-	-	-	-	-	-	-
Professional Services	50.0	75.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Other Marketing Expenses	20.0	4.0	3.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Maintenance on Systems			3.0	9.0	24.0	50.0	50.0	50.0	50.0	50.0	50.0
Taxes (Other than Income Tax)											
Gross Receipts Tax		-	-	-	-	-	-	-	-	-	-
Property tax based on market value	-	-	-	-	-	-	-	-	-	-	-
Net Worth Tax		-	-	-	-	-	-	-	-	-	-
Other Tax		-	-	-	-	-	-	-	-	-	-
Interest and Depreciation Expense											
Interest Expense		3.5	35.4	70.1	126.0	175.8	175.8	-	-	-	-
Depr expense - solar equip.		111.0	332.9	887.8	1,849.5	1,849.5	1,738.5	1,516.6	961.7	-	-
Total Expenses	70.0	452.7	690.5	1,293.0	2,330.8	2,251.2	2,068.1	1,671.1	1,116.8	155.8	156.4
NET INCOME BEFORE TAXES	(70.0)	(195.0)	82.7	768.8	1,964.7	2,044.3	2,461.0	2,665.5	3,429.6	4,403.2	4,403.3
Adjustments											
Energy investment tax benefit		-	-	-	-	-	-	-	-	-	-
Other Tax Credit											
Tax											
Income Tax Benefit (Expense)	-	-	-	-	-	-	-	-	-	-	-
NET INCOME AFTER TAXES	(70.0)	(195.0)	82.7	768.8	1,964.7	2,044.3	2,461.0	2,665.5	3,429.6	4,403.2	4,403.3
Present Value	(70.0)	(171.0)	63.7	518.9	1,163.3	1,061.7	1,121.2	1,065.2	1,202.3	1,354.0	1,187.8

INCOME STATEMENT

INCOME STATEMENT (000's) Caribbean Utility Solar Program	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Incremental Units/Service Agreements Sold	-	-	-	-	-	-	-	-	-	-
REVENUES										
Service Fee Revenue	4,155.6	4,155.6	4,155.6	4,155.6	4,155.6	4,155.6	4,155.6	4,155.6	4,155.6	4,155.6
Solar Installation Incentives	-	-	-	-	-	-	-	-	-	-
Carbon reduction sales revenue	139.9	139.9	139.9	139.9	139.9	139.9	139.9	139.9	139.9	139.9
Interest Income	264.2	268.3	268.5	268.6	268.6	268.6	268.6	268.6	268.6	268.6
Total Revenues	4,559.7	4,563.8	4,564.1	4,564.1	4,564.1	4,564.1	4,564.1	4,564.1	4,564.1	4,564.1
EXPENSES										
Labor and Overhead										
Marketing & Sales	-	-	-	-	-	-	-	-	-	-
Admin/Staff/Operations	-	-	-	-	-	-	-	-	-	-
Executive Payroll	-	-	-	-	-	-	-	-	-	-
Business Expenses										
Office Rental	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Phone, Electric and Other Utilities	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Travel/Entertainment/Conferences	-	-	-	-	-	-	-	-	-	-
Professional Services	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Other Marketing Expenses	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Maintenance on Systems	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Taxes (Other than Income Tax)										
Gross Receipts Tax	-	-	-	-	-	-	-	-	-	-
Property tax based on market value	-	-	-	-	-	-	-	-	-	-
Net Worth Tax	-	-	-	-	-	-	-	-	-	-
Other Tax	-	-	-	-	-	-	-	-	-	-
Interest and Depreciation Expense										
Interest Expense	-	-	-	-	-	-	-	-	-	-
Depr expense - solar equip.	-	-	-	-	-	-	-	-	-	-
Total Expenses	88.0	88.0	88.0	88.0	88.0	88.0	88.0	88.0	88.0	88.0
NET INCOME BEFORE TAXES	4,471.7	4,475.8	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1
Adjustments										
Energy investment tax benefit	-	-	-	-	-	-	-	-	-	-
Other Tax Credit										
Tax										
Income Tax Benefit (Expense)	-	-	-	-	-	-	-	-	-	-
NET INCOME AFTER TAXES	4,471.7	4,475.8	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1
Present Value	1,058.1	929.0	815.0	714.9	627.1	550.1	482.5	423.3	371.3	325.7

INCOME STATEMENT

INCOME STATEMENT (000's) Caribbean Utility Solar Program	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Total
Incremental Units/Service Agreements Sold	-	-	-	-	-	-	-	-	-	-	5,000
REVENUES											
Service Fee Revenue	3,906.3	3,407.6	2,160.9	-	-	-	-	-	-	-	83,112.0
Solar Installation Incentives	-	-	-	-	-	-	-	-	-	-	-
Carbon reduction sales revenue	131.5	114.7	72.8	-	-	-	-	-	-	-	2,479.3
Interest Income	268.6	255.4	223.8	145.0	7.1	0.4	0.0	0.0	0.0	0.0	4,634.7
Total Revenues	4,306.4	3,777.7	2,457.5	145.0	7.1	0.4	0.0	0.0	0.0	0.0	90,545.0
EXPENSES											
Labor and Overhead											
Marketing & Sales	-	-	-	-	-	-	-	-	-	-	352.4
Admin/Staff/Operations	-	-	-	-	-	-	-	-	-	-	807.2
Executive Payroll	-	-	-	-	-	-	-	-	-	-	40.6
Business Expenses											
Office Rental	-	-	-	-	-	-	-	-	-	-	300.0
Phone, Electric and Other Utilities	-	-	-	-	-	-	-	-	-	-	95.0
Travel/Entertainment/Conferences	-	-	-	-	-	-	-	-	-	-	-
Professional Services	-	-	-	-	-	-	-	-	-	-	825.0
Other Marketing Expenses	-	-	-	-	-	-	-	-	-	-	46.0
Maintenance on Systems	50.0	47.0	41.0	26.0	-	-	-	-	-	-	1,000.0
Taxes (Other than Income Tax)											
Gross Receipts Tax	-	-	-	-	-	-	-	-	-	-	-
Property tax based on market value	-	-	-	-	-	-	-	-	-	-	-
Net Worth Tax	-	-	-	-	-	-	-	-	-	-	-
Other Tax	-	-	-	-	-	-	-	-	-	-	-
Interest and Depreciation Expense											
Interest Expense	-	-	-	-	-	-	-	-	-	-	
Depr expense - solar equip.	-	-	-	-	-	-	-	-	-	-	9,247.5
Total Expenses	50.0	47.0	41.0	26.0	-	-	-	-	-	-	13,300.4
NET INCOME BEFORE TAXES	4,256.4	3,730.7	2,416.5	119.0	7.1	0.4	0.0	0.0	0.0	0.0	77,244.7
Adjustments											
Energy investment tax benefit	-	-	-	-	-	-	-	-	-	-	-
Other Tax Credit											
Tax											
Income Tax Benefit (Expense)	-	-	-	-	-	-	-	-	-	-	-
NET INCOME AFTER TAXES	4,256.4	3,730.7	2,416.5	119.0	7.1	0.4	0.0	0.0	0.0	0.0	77,244.7
Present Value	271.7	208.9	118.7	5.1	0.3	0.0	0.0	0.0	0.0	0.0	15,398.6

CASH FLOW STATEMENT

CASH FLOW STATEMENT (000's) Caribbean Utility Solar Program	Startup Period	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
OPERATING ACTIVITIES											
Net Income before taxes	(70.0)	(195.0)	82.7	768.8	1,964.7	2,044.3	2,461.0	2,665.5	3,429.6	4,403.2	4,403.3
Add back book depreciation expense		111.0	332.9	887.8	1,849.5	1,849.5	1,738.5	1,516.6	961.7	-	-
Net Income pre Tax Depreciation	(70.0)	(84.0)	415.7	1,656.6	3,814.2	3,893.8	4,199.5	4,182.1	4,391.3	4,403.2	4,403.3
Less tax depreciation expense		111.0	399.5	1,015.4	2,126.9	2,260.1	1,401.9	948.8	695.4	288.5	-
Net income (loss) for tax	(70.0)	(195.0)	16.2	641.2	1,687.3	1,633.7	2,797.6	3,233.3	3,695.9	4,114.7	4,403.3
Energy Investment Tax Credit		-	-	-	-	-	-	-	-	-	-
Other tax credit	-	-	-	-	-	-	-	-	-	-	-
Income Tax Benefit (Expense)	-	-	-	-	-	-	-	-	-	-	-
After tax cash net income	(70.0)	(195.0)	16.2	641.2	1,687.3	1,633.7	2,797.6	3,233.3	3,695.9	4,114.7	4,403.3
Principal repayment on loan		-	-	-	-	-	(3,515.0)	-	-	-	-
Add back tax depreciation		111.0	399.5	1,015.4	2,126.9	2,260.1	1,401.9	948.8	695.4	288.5	-
Net cash from operations	(70.0)	(84.0)	415.7	1,656.6	3,814.2	3,893.8	684.5	4,182.1	4,391.3	4,403.2	4,403.3
INVESTING ACTIVITIES											
Solar equipment		(554.9)	(1,109.7)	(2,774.3)	(4,808.7)	-	-	-	-	-	-
Net cash used for investing		(554.9)	(1,109.7)	(2,774.3)	(4,808.7)	-	-	-	-	-	-
Net Cash Inflow (Outflow)	(70.0)	(638.9)	(694.0)	(1,117.6)	(994.5)	3,893.8	684.5	4,182.1	4,391.3	4,403.2	4,403.3
Present Value	(70.0)	(560.4)	(534.0)	(754.4)	(588.8)	2,022.3	311.9	1,671.3	1,539.4	1,354.0	1,187.8
Cumulative Present Value	(70.0)	(630.4)	(1,164.5)	(1,918.8)	(2,507.6)	(485.3)	(173.4)	1,497.9	3,037.3	4,391.3	5,579.1
Net Present Value	12,480.6										

CASH FLOW STATEMENT

CASH FLOW STATEMENT (000's) Caribbean Utility Solar Program	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
OPERATING ACTIVITIES										
Net Income before taxes	4,471.7	4,475.8	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1
Add back book depreciation expense	-	-	-	-	-	-	-	-	-	-
Net Income pre Tax Depreciation	4,471.7	4,475.8	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1
Less tax depreciation expense	-	-	-	-	-	-	-	-	-	-
Net income (loss) for tax	4,471.7	4,475.8	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1
Energy Investment Tax Credit	-	-	-	-	-	-	-	-	-	-
Other tax credit	-	-	-	-	-	-	-	-	-	-
Income Tax Benefit (Expense)	-	-	-	-	-	-	-	-	-	-
After tax cash net income	4,471.7	4,475.8	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1
Principal repayment on loan	-	-	-	-	-	-	-	-	-	-
Add back tax depreciation	-	-	-	-	-	-	-	-	-	-
Net cash from operations	4,471.7	4,475.8	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1
INVESTING ACTIVITIES										
Solar equipment	-	-	-	-	-	-	-	-	-	-
Net cash used for investing	-	-	-	-	-	-	-	-	-	-
Net Cash Inflow (Outflow)	4,471.7	4,475.8	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1	4,476.1
Present Value	1,058.1	929.0	815.0	714.9	627.1	550.1	482.5	423.3	371.3	325.7
Cumulative Present Value	6,637.2	7,566.2	8,381.1	9,096.0	9,723.1	10,273.2	10,755.7	11,179.0	11,550.2	11,875.9
Net Present Value										

CASH FLOW STATEMENT

CASH FLOW STATEMENT (000's) **Caribbean Utility Solar Program**	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**	**Year 26**	**Year 27**	**Year 28**	**Year 29**	**Year 30**
OPERATING ACTIVITIES										
Net Income before taxes	4,256.4	3,730.7	2,416.5	119.0	7.1	0.4	0.0	0.0	0.0	0.0
Add back book depreciation expense	-	-	-	-	-	-	-	-	-	-
Net Income pre Tax Depreciation	4,256.4	3,730.7	2,416.5	119.0	7.1	0.4	0.0	0.0	0.0	0.0
Less tax depreciation expense	-	-	-	-	-	-	-	-	-	-
Net income (loss) for tax	4,256.4	3,730.7	2,416.5	119.0	7.1	0.4	0.0	0.0	0.0	0.0
Energy Investment Tax Credit	-	-	-	-	-	-	-	-	-	-
Other tax credit	-	-	-	-	-	-	-	-	-	-
Income Tax Benefit (Expense)	-	-	-	-	-	-	-	-	-	-
After tax cash net income	4,256.4	3,730.7	2,416.5	119.0	7.1	0.4	0.0	0.0	0.0	0.0
Principal repayment on loan	-	-	-	-	-	-	-	-	-	-
Add back tax depreciation	-	-	-	-	-	-	-	-	-	-
Net cash from operations	4,256.4	3,730.7	2,416.5	119.0	7.1	0.4	0.0	0.0	0.0	0.0
INVESTING ACTIVITIES										
Solar equipment	-	-	-	-	-	-	-	-	-	-
Net cash used for investing	-	-	-	-	-	-	-	-	-	-
Net Cash Inflow (Outflow)	4,256.4	3,730.7	2,416.5	119.0	7.1	0.4	0.0	0.0	0.0	0.0
Present Value	271.7	208.9	118.7	5.1	0.3	0.0	0.0	0.0	0.0	0.0
Cumulative Present Value	12,147.6	12,356.5	12,475.1	12,480.3	12,480.5	12,480.6	12,480.6	12,480.6	12,480.6	12,480.6
Net Present Value										

BALANCE SHEET

BALANCE SHEET (000's) Caribbean Utility Solar Progran	Startup Period	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
ASSETS											
Current Assets											
Cash	0	0	0	0	0	3,894	4,578	8,760	13,152	17,555	21,958
Noncurrent Assets											
Solar equipment	0	555	1,665	4,439	9,248	9,248	9,248	9,248	9,248	9,248	9,248
less accum depr	0	(111)	(444)	(1,332)	(3,181)	(5,031)	(6,769)	(8,286)	(9,248)	(9,248)	(9,248)
Total Assets	0	444	1,221	3,107	6,066	8,111	7,057	9,722	13,152	17,555	21,958
LIABILITIES AND EQUITY											
Liabilities											
Deferred taxes	0	0	0	0	0	0	0	0	0	0	0
Loan payable	70	709	1,403	2,521	3,515	3,515	0	0	0	0	0
Total Liabilities	70	709	1,403	2,521	3,515	3,515	0	0	0	0	0
Equity											
Capital Contribution	0	0	0	0	0	0	0	0	0	0	0
Retained Earnings (Deficit)	(70)	(265)	(182)	587	2,551	4,596	7,057	9,722	13,152	17,555	21,958
Total Equity	(70)	(265)	(182)	587	2,551	4,596	7,057	9,722	13,152	17,555	21,958
Total Liabilities and Equity	0	444	1,221	3,107	6,066	8,111	7,057	9,722	13,152	17,555	21,958
CHECK	0	0	0	0	0	0	0	0	0	0	0
PROFITABILITY RATIOS											
Internal Rate of Return		NA	NA	NA	NA	4.4%	10.9%	30.6%	39.1%	43.5%	46.0%
Return on Assets	0.0%	-43.9%	6.8%	24.7%	32.4%	25.2%	34.9%	27.4%	26.1%	25.1%	20.1%
Return on Equity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Return on Investment	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Return on Sales	0.0%	-75.7%	10.7%	37.3%	45.7%	47.6%	54.3%	61.5%	75.4%	96.6%	96.6%

BALANCE SHEET

BALANCE SHEET (000's) **Caribbean Utility Solar Progran**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
ASSETS										
Current Assets										
Cash	26,430	30,906	35,382	39,858	44,334	48,810	53,286	57,762	62,238	66,715
Noncurrent Assets										
Solar equipment	9,248	9,248	9,248	9,248	9,248	9,248	9,248	9,248	9,248	9,248
less accum depr	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)
Total Assets	26,430	30,906	35,382	39,858	44,334	48,810	53,286	57,762	62,238	66,715
LIABILITIES AND EQUITY										
Liabilities										
Deferred taxes	0	0	0	0	0	0	0	0	0	0
Loan payable	0	0	0	0	0	0	0	0	0	0
Total Liabilities	0	0	0	0	0	0	0	0	0	0
Equity										
Capital Contribution	0	0	0	0	0	0	0	0	0	0
Retained Earnings (Deficit)	26,430	30,906	35,382	39,858	44,334	48,810	53,286	57,762	62,238	66,715
Total Equity	26,430	30,906	35,382	39,858	44,334	48,810	53,286	57,762	62,238	66,715
Total Liabilities and Equity	26,430	30,906	35,382	39,858	44,334	48,810	53,286	57,762	62,238	66,715
CHECK	0	0	0	0	0	0	0	0	0	0
PROFITABILITY RATIOS										
Internal Rate of Return	47.5%	48.4%	49.0%	49.4%	49.6%	49.8%	49.9%	49.9%	50.0%	50.0%
Return on Assets	16.9%	14.5%	12.7%	11.2%	10.1%	9.2%	8.4%	7.7%	7.2%	6.7%
Return on Equity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Return on Investment	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Return on Sales	98.1%	98.1%	98.1%	98.1%	98.1%	98.1%	98.1%	98.1%	98.1%	98.1%

BALANCE SHEET

BALANCE SHEET (000's) Caribbean Utility Solar Progran	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
ASSETS										
Current Assets										
Cash	70,971	74,702	77,118	77,237	77,244	77,245	77,245	77,245	77,245	77,245
Noncurrent Assets										
Solar equipment	9,248	9,248	9,248	9,248	9,248	9,248	9,248	9,248	9,248	9,248
less accum depr	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)	(9,248)
Total Assets	70,971	74,702	77,118	77,237	77,244	77,245	77,245	77,245	77,245	77,245
LIABILITIES AND EQUITY										
Liabilities										
Deferred taxes	0	0	0	0	0	0	0	0	0	0
Loan payable	0	0	0	0	0	0	0	0	0	0
Total Liabilities	0	0	0	0	0	0	0	0	0	0
Equity										
Capital Contribution	0	0	0	0	0	0	0	0	0	0
Retained Earnings (Deficit)	70,971	74,702	77,118	77,237	77,244	77,245	77,245	77,245	77,245	77,245
Total Equity	70,971	74,702	77,118	77,237	77,244	77,245	77,245	77,245	77,245	77,245
Total Liabilities and Equity	70,971	74,702	77,118	77,237	77,244	77,245	77,245	77,245	77,245	77,245
CHECK	0	0	0	0	0	0	0	0	0	0
PROFITABILITY RATIOS										
Internal Rate of Return	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Return on Assets	6.0%	5.0%	3.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Return on Equity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Return on Investment	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Return on Sales	98.8%	98.8%	98.3%	82.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%