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SOLAR WATER HEATING IN THE TOURISM INDUSTRY

WITH A FOCUS ON THE CARIBBEAN REGION

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SUPERVISION AND COORDINATION

Amr Abdelhai, United Nations Environment Programme

LEAD AUTHOR

Gregor Hintler, Meister Consultants Group

CONTRIBUTING AUTHORS

Wayne Archibald, University of the Virgin Islands

Suveer Bahirwani, Meister Consultants Group

Christina Becker-Birck, Meister Consultants Group

Emily Chessin, Meister Consultants Group

Egan Waggoner, Meister Consultants Group

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Frank Comito, Caribbean Hotel and Tourism Association

Loreto Duffy-Mayers, Caribbean Hotel Energy Efficiency and Renewable Energy Action - Advanced Programme (CHENACT - AP), Caribbean Hotel and Tourism Association

James Husbands, Solar Dynamics

Waltrude Patrick, Bay Gardens Hotel, Saint Lucia

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INTRODUCTION

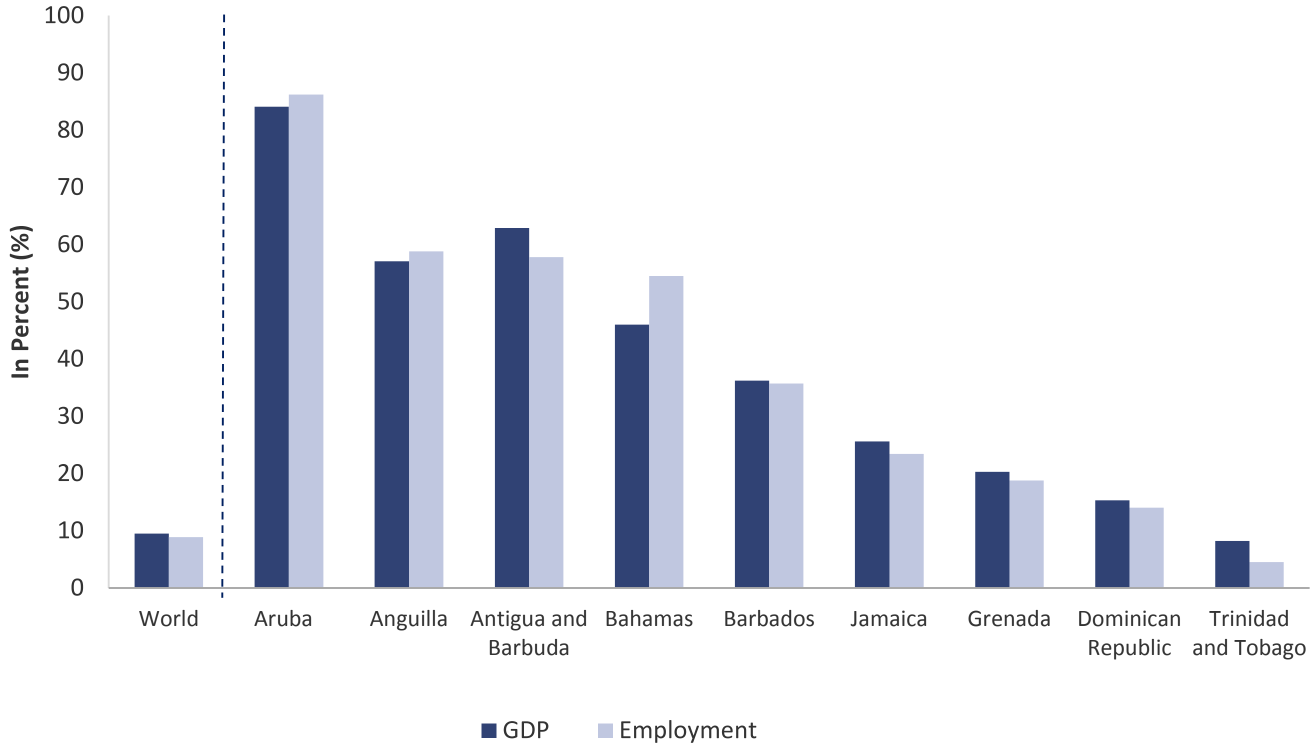
This report on solar water heating (SWH) in the Caribbean tourism industry was developed on behalf of the Global Solar Water Heating (GSWH) Market Transformation and Strengthening Initiative ("the GSWH project"). The GSWH project is a joint initiative of the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP) and is funded by the Global Environmental Facility (GEF) with co-financing from the International Copper Association (ICA). The objective of the GSWH project is to develop, strengthen and accelerate the growth of the solar water heating (SWH) sector.

This report provides a starting point for tourism businesses that are interested in exploring the opportunity of SWH. Specifically, this report focuses on SWH opportunities for small to medium sized hotels. UNEP has been involved in several projects that provide further guidance on renewable energy and energy efficiency programmes for the hotel sector, such as the Hotel Energy Solutions Programme. It is recommended that this report be read in tandem with other UNEP reports focused on energy management for the broader hotel sector (Hotel Energy Solutions, 2011; Hotel Energy Solutions, 2011).

Tourism is one of the main economic drivers in the Caribbean region. For many islands in the region, tourism is a major source of GDP and employment. According to the World Travel & Tourism Council (WTTC), the tourism industry accounted for 14.6% of the region's total GDP in 2014, amounting to USD 51.9 billion.[1] In some jurisdictions, tourism accounted for over 50% of GDP and employment (See Figure 1) (World Travel and Tourism Council, 2014). Therefore, maintaining a strong tourism sector is essential for the region's economy.

[1] The World Travel & Tourism Council (WTTC) defines the total contribution of the industry as "GDP generated by industries that deal directly with tourists, including hotels, travel agents, airlines and other passenger transport services, as well as the activities of restaurant and leisure industries that deal directly with tourists" plus "GDP and employment of spending by those who are directly or indirectly employed by Travel & Tourism."(World Travel and Tourism Council, 2015)

Figure 1: 2013 Total Contribution of Travel & Tourism to GDP and Employment (World Travel and Tourism Council, 2014)



Like all companies, tourism businesses seek to reduce operating costs and increase revenues. In the Caribbean region, tourism businesses face high and fluctuating energy prices because most islands rely almost entirely on imported liquid fossil fuels for energy generation. As a result, the region has some of the highest electricity rates in the world.[2] In an industry with high energy demand, electricity costs can represent a significant portion of operating costs. For instance, surveys in the Caribbean have shown that electricity cost can make up 4% to 26% of a hotels' operating budget (Didier, 2006).

In addition, Caribbean tourism businesses are facing increasing pressure to improve their environmental performance to meet the growing demand for greater sustainability in the travel and tourism industry (Matus, 2012). By implementing sustainability measures, the tourism industry can contribute to the region's ambitious targets to reduce fossil fuel consumption and increase the share of renewable energy to total electricity generation to 20% in 2017 and 47% in 2027 (Auth, Konold, Musolino, & Ochs, 2013;CARICOM, 2013).

[2] In 2012, the average cost of electricity in the Caribbean was US $.33/kWh, and prices were as high as US $.45/kWh[2] in Antigua and Barbuda in 2014 (IDB, 2012; APUA 2015).

There are a wide range of sustainability strategies tourism businesses can pursue to minimize their environmental impact including adopting renewable energy technologies (Daly et al., 2010). Text Box 1 outlines a few examples of renewable energy technologies suitable for small to medium sized hotels in the Caribbean region.

Text Box 1. Renewable Energy Technologies for the Small to Medium Hotel Sector

Although this report focuses exclusively on SWH, there are other renewable energy technologies and energy efficiency measures that tourism business can explore to meet their energy needs in a more sustainable manner. The project, Hotel Energy Solutions, an initiative by the UN World Tourism Organization (UNWTO) in collaboration with UNEP, International Hotel and Restaurant Association (IHRA), the French Environment and Energy Management Agency (ADEME), and the European Renewable Energy Council (EREC) seeks to help small to medium enterprises in the tourism and accommodation sector improve their energy efficiency and renewable energy solutions. Their toolkit, *Key Renewable Energy Solutions for SME hotels,* details renewable energy technologies and the benefits they can bring to hotel businesses. In addition to the SWH technology options discussed in Section 2, this Text Box outlines the most relevant alternative technologies for the tourism sector in the Caribbean region:

- Solar PV. Solar photovoltaic (PV) cells produce electricity from sunlight. Solar PV systems are usually made up of multiple solar panels, which contain a number of solar cells, and an inverter. The inverter converts the direct current (DC) produced by the cells to alternating current (AC). Solar PV is the fastest growing source of electricity generation globally and is widely applicable to the Caribbean region. On many islands, high electricity rates and favourable climatic conditions make solar PV cost-competitive or cheaper than electricity from the utility. Furthermore, there are often financing options that can help reduce the high upfront cost of solar PV systems. Solar PV systems should be installed on rooftops or the ground. Small system installation typically takes less than one day and require little lifetime maintenance.
- Small Wind Energy Systems. Generation of renewable energy from wind is a proven technology and widely applied. The basic components of small wind energy systems are the same as in large-scale applications: rotors that drive a generator, controllers, inverters, wiring and a tower. Horizontally mounted rotors have to be installed on a tower, ideally at least 9m above any obstacles within its vicinity of 150m. For hotels, vertical-axis motors could be a more viable option, as they can be installed on rooftops, operate at lower wind speeds, and can take advantage of wind from multiple directions. Small wind energy systems provide clean energy, but the typical payback periods is between 10-25 years.
- Combined Heat and Power (CHP). Micro CHP plants – defined as systems up to 50 kW – use an internal combustion engine to run a generator – producing heat and power. If not powered by biofuels, CHP is strictly speaking not a renewable energy technology. But unlike common diesel generators, the heat from the combustion process is captured and fed to the central heating system or used to heat water, which makes CHP systems extremely energy efficient. Hotels in the Caribbean are excellent candidates for CHP, as they have high electricity and hot water demand. A small CHP plant can mitigate or eliminate demand for hot water or steam, and reduce electricity demand. Additionally, CHP plants can reduce voltage and current imbalances, improving power quality for hotels in regions with unreliable or unstable grids. Installation of CHP is relatively easy, since they can operate similarly to conventional boilers and can be connected to existing heating systems.

The full report – Hotel Energy Solutions (2011), Key Renewable Energy (RE) Solutions for SME Hotels,– can be accessed at:
http://hotelenergysolutions.net/publication/key-renewable-energy-re-solutions-sme-hotels

Solar water heating (SWH) takes advantage of the region's abundant solar resource (5-6 kWh/m^2/day) to provide a simple, cost-effective, and sustainable means of heating water (Figure 2). SWH systems are a proven technology that can be an effective and economically viable alternative to traditional electric water heating—the most commonly used water heating technology in the region (Taibi & Journeay-Kaler, 2014).

Figure 2: Country level average daily solar radiation (kWh/m^2/day) (CESC, 2014)

This guide is intended for industry leaders, building managers, and business owners in the tourism industry, who are interested in learning about the opportunities, barriers, and design considerations of SWH systems. This guide is structured as followed:

- Section 1 provides an overview of the opportunities and barriers to solar water heating deployment in the tourism industry in the Caribbean region.
- Section 2 provides an overview of SWH technologies and applications and outlines design issues tourism businesses should consider when installing solar water heating systems.
- Section 3 outlines steps tourism businesses can take to invest in solar water heating systems.
- Section 4 provides a series of case studies profiling tourism businesses that have adopted solar water heating, and provides information on available resources that can help inform a business owner's decision to invest in solar water heating.

SECTION 1 SWH OPPORTUNITIES AND BARRIERS

1.1 OPPORTUNITIES FOR SWH DEPLOYMENT IN THE TOURISM INDUSTRY

SWH is a proven technology that has been widely applied across residential, commercial and industrial sectors around the world (REN21, 2015). China and northern Europe have led the global SWH market in terms of total installed capacity, although island jurisdictions such as Barbados and Cyprus have some of the highest penetrations of SWH on a per capita basis. SWH can be used on-site to meet the immediate thermal load of a building or can be stored locally in tanks to meet future water heating needs. Buildings with high, consistent demand for hot water tend to enjoy the best return on investment, as they can use more of the energy generated by the SWH system and benefit from economies of scale. Many tourism businesses have large, consistent hot water demand including hotels and motels, laundries, and restaurants, making them primary candidates for solar water heating (Hotel Energy Solutions, 2011; Veilleux & Rickerson, 2013).

In the Caribbean, SWH investment has the potential to reduce energy costs, stimulate local markets for clean energy technologies, and improve the environmental performance of the tourism sector. The following section outlines the major benefits of solar water heating in the Caribbean tourism sector:

- Energy cost reductions: Electricity expenditures make up a significant portion of operating expenses in the tourism industry, especially amongst businesses providing accommodation services for tourists[3]. For example, as shown in Figure 3, large hotels[4] in Barbados attribute 60% of electricity use to hot water, climate control, laundry, and pool heating. SWH systems can replace conventional thermal systems in a cost-effective manner, as described in more detail in Section 2. Taking advantage of the region's abundant solar resources of 5-6 kWh/m^2/day and low seasonal variation, the application of SWH systems can help businesses save money and hedge against the volatility of electricity prices. According to a recent study conducted by the International Renewable Energy Agency (IRENA), the estimated payback period for SWH systems for hotels on islands can be as quick as one year. Quicker payback rates occur when countries have high electricity costs and abundant solar resources and SWH technologies are suitably designed to meet a building's needs. Furthermore, energy audits carried out in 31 hotels in Barbados found that on average, investments in SWH would reduce electricity demand for water heating by 27%. The proposed projects would on average cost $203,485, but yield annual electricity cost savings of $202,545, paying back the upfront investments

[3] This includes hotels, resorts, bed and breakfasts, inns, guest houses, and vacation rentals.

[4] Defined as hotels with more than 200 rooms.

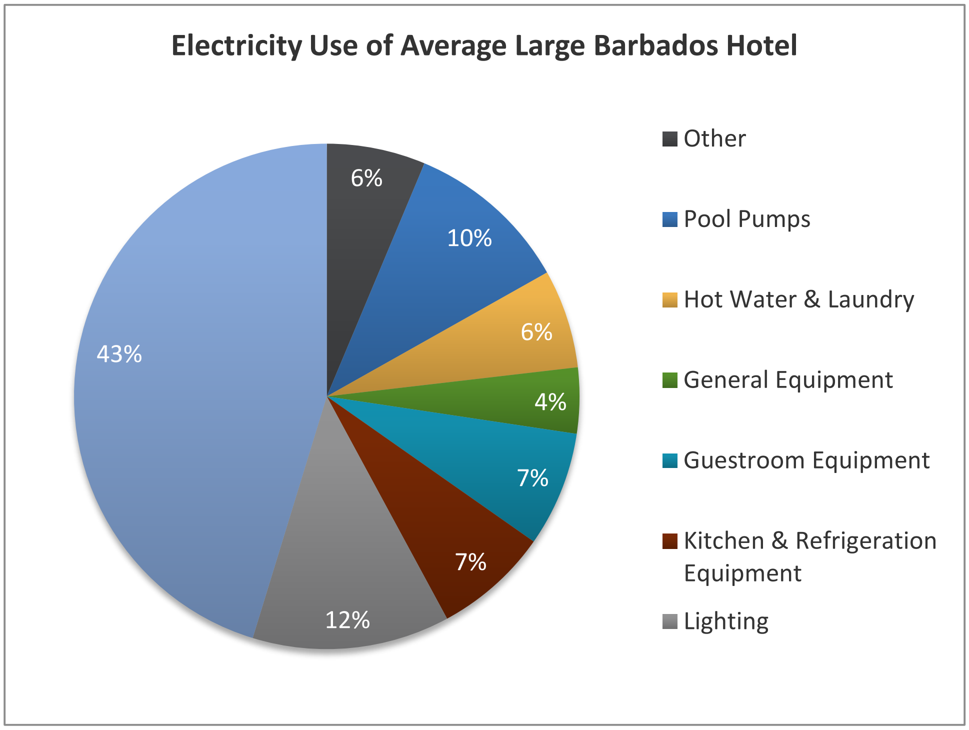
in just over one year (Gardner, 2011). The case studies in Section 4 further detail the potential energy cost reductions tourism businesses can experience. The hotels profiled are saving up to 40% on their electricity bills, meeting up to 100% of their hot water demand and have experienced payback periods of less than two years. As illustrated by these examples, investments in SWH, in particular for buildings with high energy demand for hot water and cooling can yield significant cost savings and reduce vulnerability to high and fluctuating energy prices.

- Improving environmental performance: Due to the predominance of electricity generated from diesel and high levels of energy demand, Caribbean hotels are estimated to emit three million tons of CO_2 annually, contributing to local and global air pollution and climate change (Tetra Tech, 2012). Research shows that tourists are becoming increasingly eco-conscious and are willing to pay a premium to minimize their environmental impact. A survey conducted by Tripadvisor, the world's largest online travel community, revealed that "one-quarter [of respondents] are considering an ecotourism trip. Thirty-eight percent of respondents said that environmentally-friendly tourism is a consideration when traveling." Respondents also indicated that the number one criterion to define an eco-friendly hotel is whether it has taken measures to reduce energy consumption (TripAdvisor, 2012). Investments in renewable energy technology (RET) such as SWH can not only reduce operating costs and improve environmental performance, but can also enable businesses to participate in regional and global certification schemes (e.g. Green Globe Certification), raise awareness among staff and guests about sustainability issues, and attract a rapidly growing constituency of environmentally conscious tourists (Hotel Energy Solutions, 2011; Green Globe, 2015).

- Raising awareness and increasing familiarity with renewable energy: Tourism businesses have an opportunity to raise awareness of the benefits of RETs amongst their customers and staff. Customers may not be familiar with or may not have had direct experience with RETs. Businesses can offer this first experience by providing reliable heating or electricity services to their customers through renewable energy. Staff awareness can also be raised by training staff on how the technology works and offering tours of the system to guests or involving them in maintenance programs (Hotel Energy Solutions, 2011).

- Creation of local employment: Widespread adoption of renewable energy resources in the Caribbean will lead to increased demand for local professionals trained in installation, operation, and maintenance of SWH systems. Through increased investment in SWH, the tourism industry can be a good corporate citizen for the environment and stimulate the local economy.

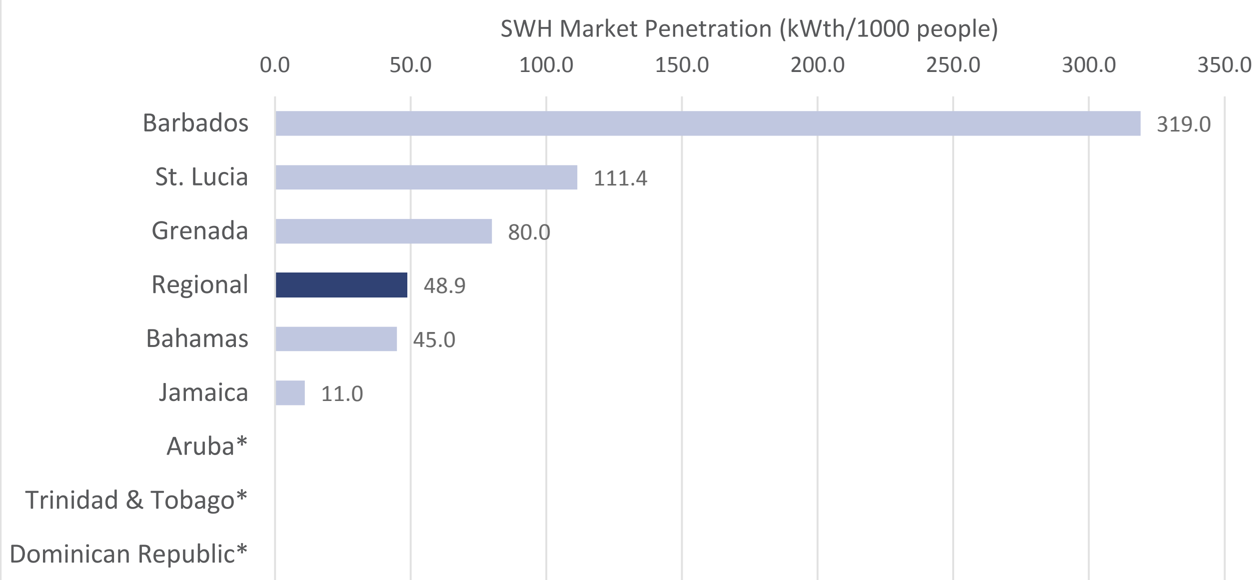
Figure 3: Breakdown of Electricity Use of Average Large Hotel in Barbados (Tetra Tech, 2012)



1.2 BARRIERS TO SWH DEPLOYMENT IN THE TOURISM INDUSTRY

Despite the favorable economic and climatic conditions, the SWH market in the Caribbean is still emerging. Average per capita deployment is relatively low, estimated at 48.9 kW_{th}/1000 people compared to the market leader of Austria at 430 kWth/1,000 people (CREDP, 2013; Gardner, 2012; Mauthner & Weiss, 2015). However, this regional average is skewed by the high levels of SWH deployment in Barbados (319 kW_{th}/1000 people), Saint Lucia (111.4 kW_{th}/1000 people), and Grenada (80.0 kW_{th}/1000 people) (Gray et al., 2015) (Figure 4).

Figure 4: SWH Market Penetration in Select Caribbean Countries (Gray et al., 2015)



*There is insufficient data in Aruba, Trinidad & Tobago, and Dominican Republic to estimate the SWH market penetration. Further explanation of country SWH market penetration described in individual country assessments.

As a global leader in SWH deployment, Barbados has a history of reducing investment barriers and providing financial incentives for SWH, and today ranks amongst the top four countries in the world for installed capacity per capita, along with Austria, Cyprus, and Israel (Mauthner and Weiss, 2015).

However, the majority of Caribbean countries face considerable barriers to SWH, which prevent wider adoption in the tourism industry. While Caribbean countries are in different stages of addressing barriers, common SWH barriers include:

- Financial barriers: SWH systems in the Caribbean generally have short payback periods and a high net present value (NPV). However, installer interviews revealed the upfront cost for a SWH system for hotels in the region is about US$ 1,000 per room (16.5 square feet of collector area with a 40 gallon tank), depending on materials used, solar resource availability, and import costs.[5] This cost can deter building owners or managers from making an investment. In addition, payback periods can be longer depending on incentives, local electricity rates, and system sizing, which may not match the short-term internal payback requirements of 1.5 to 3 years in the hotel sector (MCG Industry Interviews, 2015).

- Organizational decision-making: At the executive level, energy use in many industries (including hospitality) is viewed by management as a single, narrow set of technical issues and not a “core” or strategic issue. A variety of studies have documented how firms fail to prioritize energy management, treat energy as a fixed cost, and/or fail to recognize the potential for energy to contribute to the bottom line. Management attention to energy is often short-lived and arises only in response to external influences such as energy price shocks, regulation (or threat of regulation), or pressure from

[5] Source: MCG Industry Interviews, 2015

customers or consumers (Lutzenhiser et al., 2002). In hotels, management has to make decisions on how to best allocate finite resources between various projects from energy upgrades to design and interior improvements to restaurants upgrades to adding entertainment features (MCG Industry Interviews, 2015). As a result, hotel management may not prioritize energy investments, particularly when dealing with technologies that are less familiar, such as SWH. In addition, decision making regarding large investments often takes place at the executive level rather than the hotel manager level. Therefore, hotels that are franchises of a larger company may not have decision making authority over capital intensive projects such as renewable energy investments.

- **Incumbent technology:** Building owners or managers may have already invested in electric or gas water heating or cooling systems that still have a useful life or that have yet to be paid off. This can be a barrier to building owners or managers making additional investments in new technologies such as SWH. Furthermore, the incumbent heating and cooling systems might work well, and facility managers are more familiar with their operation and maintenance. Facility managers therefore tend to be hesitant to switching to an unfamiliar technology. Risk (real or perceived) can also deter investment. The field of building management is heavily oriented around occupant comfort, complaint avoidance, and avoidance of energy supply disruptions, and building managers are incentivized to be highly risk-averse.

- **Weak enabling policy environments for SWH:** While many Caribbean countries have adopted renewable energy targets and action plans over the past decade, few countries have implemented specific policies to support SWH development (i.e. national targets, building mandates, financial incentives, government supported loan programs). The case of Barbados, in contrast, shows that clear targets and strong incentives (see Table 1) and continued government support can stimulate growth of the SWH industry (Gray et al., 2015).

Table 1: SWH targets and incentives in Barbados (Gray et al., 2015); (Proverbs, 2015)

Target / Incentive	Amount
Number of household SWHs	50% increase before 2025
Domestic energy needs	29% from renewables by 2019
Green Business Tax Incentive	Tax deductions (e.g. 20% of capital expenditures incurred for retrofitting, including SWH)
SmartFund low interest financing and grant program	~1% interest rate loan for SWH to small and medium enterprises (SMEs), 25 year tenor

- **Reliability concerns:** There are few quality standards for SWH installation in the Caribbean region and limited monitoring of installed SWH systems. Little data is available to evaluate the long-term performance of systems and address reliability concerns of building managers. Additionally, poor maintenance has led to the deterioration of some SWH systems, negatively impacting the reputation of the technology in some areas of the Caribbean (MCG Industry Interviews, 2015*)*.

- Lack of awareness: While SWH is ubiquitous in Barbados (80-90% of homes, majority of hotels and businesses) and is generally included in all new home construction on the island, public awareness and acceptance of SWH is significantly lower in other Caribbean countries (Gardner, 2011). Reliability concerns and a lack of awareness highlight the importance of showcasing successful SWH projects in the region. The case studies in Section 4, Appendix A demonstrate three examples of hotels that have been successfully using SWH to meet their customers' and facility's needs for over a decade.

- Small and fragmented SWH industries: Since most Caribbean countries have low levels of SWH deployment, there are relatively few installers and only a limited number of renewable energy industry groups. There is also limited SWH manufacturing across the region outside of Barbados and Saint Lucia, although some islands have companies that manufacture replacement components. SWH systems in the region are sourced either from Barbados and Saint Lucia, or from international manufactures (e.g. USA, UK, Greece, Israel, Australia, and China, among others) (Gray et al., 2015).

Despite the significant potential for SWH in the Caribbean described in Section 1.1, the barriers outlined above have prevented more substantial investment in the technology. However, there are initiatives that aim to reduce barriers and provide businesses the resources needed to make informed decisions on how to reduce energy costs sustainably. For example, CARICOM works with member countries to sponsor an annual Energy Awareness Week to increase awareness about energy efficiency measures, including solar water heating (Global Sustainable Energy Islands Initiative & The Saint Lucia Co-operative League Limited, 2005). There are also a number of ways to reduce the burden of high upfront costs to businesses. Table 3 in the Appendix C provides an overview of selected financing options in the region.

SECTION 2 SWH TECHNOLOGY, DESIGN & INSTALLATION CONSIDERATIONS

The design and application of SWH technology varies widely. This first half of this section provides an overview of the most important technological features, applications, and design considerations of SWH systems. The second half provides details on issues to consider in the design and installation of SWH systems in the tourism sector.

2.1 SWH COMPONENTS

A typical solar water heating system consists of solar collectors, water storage tanks, a controller, piping, insulation, valves, and gauges. Heat is generated from incoming direct and diffuse solar energy radiation, which is converted into useable energy by the solar collector panel. Water or glycol (i.e. non-toxic antifreeze) is circulated through the panel, which transfers heat from the collector, through pipes, and to a storage tank—where hot water is stored directly or transferred to the storage water indirectly via a heat exchanger (Hotel Energy Solutions, 2011; Veilleux, 2013).

2.2 SWH PANEL TYPES

The most widely used types of solar thermal panels are flat plate collectors and evacuated tube collectors (Veilleux & Koo, 2015).

- Flat plate collectors (FPC). Flat plate collectors may be either **glazed** or **unglazed** collectors. The simplest FPC is an unglazed collector made of plastic. Unglazed FPCs operate at low temperatures (75-95 degrees Fahrenheit) and are mainly used to heat swimming pools. Glazed FPCs operate at low and medium temperatures (85-160 degrees Fahrenheit) and are most commonly used by Caribbean hotels (Figure 5).
- Evacuated tube collectors (ETC). Evacuated tube collectors (Figure 5) are appropriate for low to medium-high temperature applications (up to 300 degrees Fahrenheit), including process heating. They absorb solar heat via parallel rows of vacuum sealed glass tubes (Veilleux & Koo, 2015). Evacuated tubes provide a high level of insulation, so that these collectors have very low heat losses

to the outside environment. Worldwide, ETCs make up over 70% of the global SWH market, in large part due to their widespread adoption in China (Mauthner & Weiss, 2015).

Figure 5: Glazed Flat Plate Collector with Storage & Evacuated Tube Collector with Storage

Glazed Flat Plate Collector with Storage

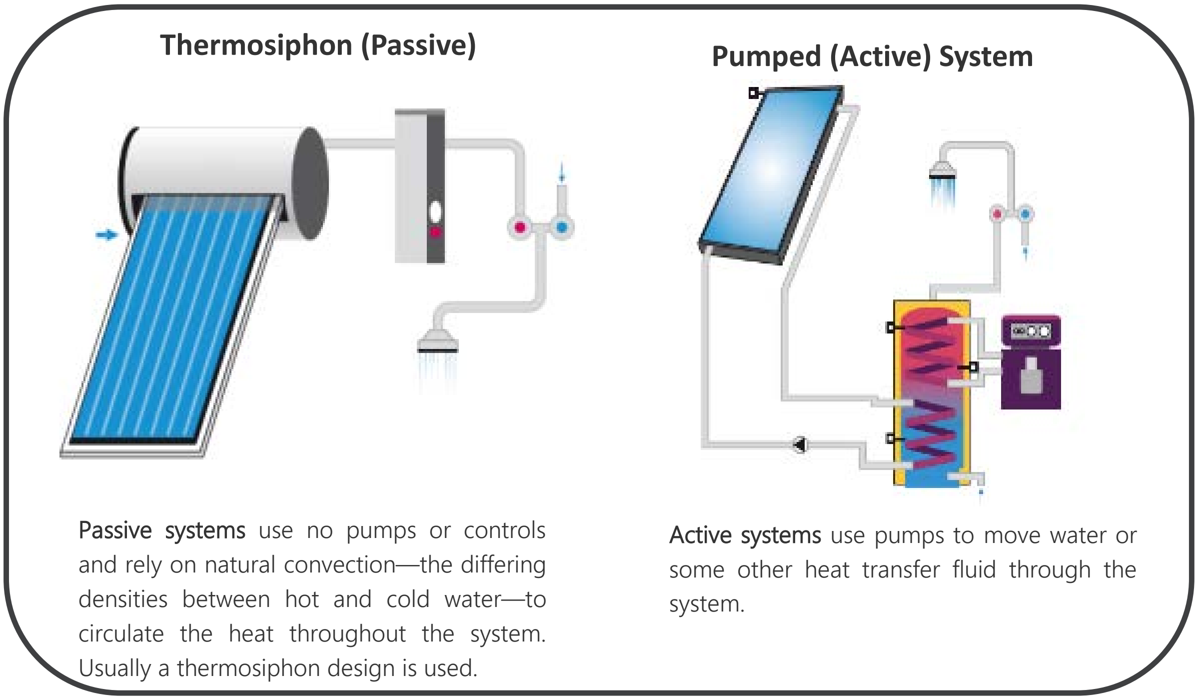
Evacuated Tube Collector with Storage

Solar thermal systems may be designed as either active or passive systems (Figure 6). Active systems use pumps to move water or some other heat transfer fluid through the system. Passive systems rely on a thermosiphon design that uses natural convection based on differing densities of hot and cold water to circulate heat throughout the system (Veilleux & Koo, 2015).

Most solar water heating systems installed in the Caribbean use glazed flat plate with a passive thermosiphon system, due to the simple and economical design (Taibi & Journeay-Kaler, 2014). Facilities with process heat requirements or smaller hotels could use this type of design by installing several individual systems in a series. However, larger facilities and hotels with higher demand for hot water usually opt for active flat plate systems with central storage and a backup heater (Gardner, 2011; Husbands, 2015).

Panels may be mounted on rooftops, on the ground, or integrated directly into a building. Most solar thermal panels are installed on racking mounted on rooftops or on the ground.

Figure 6: Example of Thermosiphon and a Pumped Circulation System (Beereport, 2012)



2.3 SWH APPLICATIONS

SWH systems can be applied in various areas. In the tourism sector, SWH systems are often used to provide water heating, process heat, and swimming pool heating. In addition, solar thermal systems can also be used for air or water cooling. The section below details the main solar thermal applications that are relevant to the tourism sector.

- Hot water. SWH for hot water demand is the most common application for SWH. Globally, estimates show that domestic hot water applications accounted for 94% of the energy provided by solar heating systems worldwide in 2013 (Mauthner & Weiss, 2015). In countries with high solar insolation and low seasonal variation (i.e. Caribbean countries), SWH can supply up to 100% of hot water demand as demonstrated by the case studies in Section 4 (MCG Industry Interviews, 2015).
- Swimming pools. SWH can also provide hot water for swimming pools for Caribbean tourism businesses. Usually water from the pool is circulated through unglazed collectors without the need to add a storage tank. These systems can be integrated relatively easily into existing pool infrastructure, but may require a larger pump (Hotel Energy Solutions, 2011). Globally, estimates show that SWH pool heating accounts for 4% of solar heating's contribution to the energy supply (Mauthner & Weiss, 2015).
- Process heat. Solar commercial and industrial process heating applications provide hot water for buildings and industries with low temperature (up to 150°C) process heating needs, such as hotels, restaurants, car washes, laundries, food processing, water treatment and desalination. SWH

technologies are increasingly seen as a cost-effective means to provide process heat for commercial buildings and industrial processes (Veilleux & Koo, 2015; UNEP Global Solar Water Heating Project & ESTIF, 2015).

- Cooling: SWH collectors capture the suns' thermal energy and through a thermally driven cooling process (like adsorption or absorption chillers) cool and/or dehumidify buildings (Beerepoot, 2012). The supply of SWH applications for cooling usually closely follows the cooling demand of buildings, which is highest during peak sunshine hours (UNEP Global Solar Water Heating Project & ESTIF, 2015). The market for solar cooling is just emerging, though it is a promising application (Kempener, n.d.; REN21, 2015; Veilleux & Koo, 2015).
- Hot water and air heating and cooling: Both water and air heating and air cooling can be supplied by solar combi plus systems. The systems generate heat that can be used to drive an adsorption chiller as described above and provide the heat necessary for space and water heating. Solar combi plus systems are well suited for areas with heating demand in winter, high cooling demand in summer, as well as water heating demand year-round (Hotel Energy Solutions, 2011).

More information and fact sheets on each of the applications described above can be found online at:

UNEP's *Global Solar Water Heating Project:* http://solarthermalworld.org/content/application-factsheets-solar-water-heating-installations

The Hotel Energy Solutions (2011) guide *Key Renewable Energy (RE) Solutions for SME Hotels:* http://hotelenergysolutions.net/publication/key-renewable-energy-re-solutions-sme-hotels

2.4 SWH DESIGN & INSTALLATION CONSIDERATIONS

The design and installation of a solar water heating system depends on a number of factors. The section below outlines some of the key design issues tourism business should consider when installing SWH systems in the Caribbean.

System Size. Estimating the suitable SWH system size will depend on a given facility's hot water consumption and solar resource. However, energy demand for hot water or process heating is often difficult to predict. Hot water demand is influenced by a number of variables including user habits, the number and efficiency of appliances, and the required water temperature (Trenkner & Dias, 2014). Compounding this, buildings rarely meter hot water usage, thus, it is challenging to find historical data on hot water usage. There are, however, some commonly applied "rules of thumb" based on utility bill analysis for total heating and hot water usage that can be used to estimate hot water requirements for buildings and hot water applications. For example, in the hotel sector, 40 gallons of hot water per a two person room is a recommended volume (Husbands, 2015). Stakeholders may also utilize *RETscreen* (see Table 3 for more information) or analogous software to quickly estimate the demand for hot water and determine the appropriate sizing for SWH systems. Alternatively, stakeholders could temporarily meter hot water usage using a flow meter or similar device when considering SWH installation, especially for large, commercial systems (Veilleux & Koo, 2015).

Geographic Considerations. In limestone rich regions of the Caribbean (e.g. Jamaica and Bahamas), "hard water" (i.e. water with a high mineral content) may cause the build-up or scaling of salts within the piping of SWH systems (Gardner, 2011; US Deparment of Energy, 2015). For instance, in the case study of Bay Gardens Hotel in Saint Lucia the system vendor commented that the magnesium anode should to be monitored and eventually replaced since high calcium content of the water in Saint Lucia will cause it to erode (Section 4, Appendix A). This can ultimately reduce system performance. Users can install water softeners or circulate a mildly acidic solution periodically to reduce the precipitation and accumulation of salts. Regularly scheduled system maintenance will help to ensure longer life and improve system performance (Husbands, 2015). The use of an active (closed loop) systems can help to alleviate the burden of maintenance associated with hard water environments (Gardner, 2011).

Climatic Considerations. The Caribbean region is prone to annual tropical storms. SWH systems must integrate robust designs capable of withstanding hurricane force winds, rains, and corrosion due to the saline rich environments. The use of metals such as iron and steel for fixture and racking should be avoided due to their corrosive nature (See Section 4, Appendix A, Case Study: Bay Gardens Hotel). Ideal systems will incorporate non-corrosive materials (e.g. aluminum or stainless steel) and reinforced extrusions to withstand intense winds (Gardner, 2011; Husbands, 2006).

Building Considerations. Not every building is suitable for SWH and suitability is usually determined through a site survey. During the survey, an expert will assess (a) if the roof quality is sufficient to withstand the load of a SWH system and allow an installation crew to safely perform its work, (b) if sufficient sunlight will hit the collectors, (c) if there is an accessible and sufficiently sized room for storage, and (d) if the necessary plumbing could be installed without unreasonable expenditures (Clean Energy Solutions Center, 2015).

Aesthetic Considerations. Hotels and resorts have cited concerns regarding the aesthetics of SWH systems. In particular, hotels fear that guests will find SWH systems unattractive and will hurt the hotels reputation. Fortunately, businesses can work with their installers to discuss options for minimizing the visibility of systems. In the case of Turtle Beach in Barbados the resort found it challenging to maximize sun exposure while maintaining aesthetics (Section 4, Appendix A). However, as mentioned in Section 1, a rapidly growing constituency of tourists is considering eco-tourism and eco-friendly hotels where measures have been taken to reduce energy consumption, and SWH systems can be one of the most visible expressions of environmental commitment.

SECTION 3 STEPS FOR PROPERTY OWNERS

Tourism businesses interested in exploring SWH should use this as an opportunity to evaluate their entire energy system and develop a facility-wide energy strategy. Through a comprehensive planning approach and energy audit, business owners can determine which energy management measures to implement to achieve maximum financial and environmental impact (Hotel Energy Solutions, 2011). Box 2 provides more information on the steps tourism business owners can take to develop a comprehensive energy management strategy. SWH can be identified in the energy management strategy as one option. The remainder of this section focuses on the steps property owners can take to develop and install a SWH project.

Text Box 2. Hotel energy management guidelines and resources

The Hotel Energy Solutions project published *Hotel Energy Management Guidelines (2011)*, a report providing a six-step process to assist hotels in developing a comprehensive energy management strategy. The guide provides resources such as checklists and templates to facilitate the development of a successful strategy. The six-step process is outlined in greater detail below:

Figure 7: Overview of process for establishing an energy management strategy (Hotel Energy Solutions, 2011).

1. Successful energy management strategies begin with a strong commitment by hotel leadership to improve energy performance. Ideally, a team responsible for the process is formed and an energy policy with clear

goals and objectives is established.

2. In order to understand the facility's energy consumption and assess its savings potential, it is important to track and collect energy use data. The data will provide a baseline against which progress and ultimately success can be measured, and allows for benchmarking against similar hotels. This phase also includes an energy audit where the technical, financial and operating performance of the energy system is evaluated and potential renewable energy or energy efficiency solutions are identified. During this step, SWH can be identified as a potential energy option. The Hotel Energy Solutions project also provides a free e-toolkit to assess a hotel's energy consumption and carbon footprint, as well as an ROI calculator to determine which proposed solution is financially most viable.
3. Based on the solutions identified in the previous step, clear goals and timelines for energy upgrades should be established.
4. To achieve those goals, a detailed action plan should be developed that includes a schedule for each measure, resource planning, and staffing, ensuring an efficient process.
5. The implementation of the action plan will require the collaboration and cooperation of all stakeholders involved. It includes raising awareness of the energy goals, training staff to execute new procedures and understand new technologies, and tracking progress.
6. At the end of each process period, the action plan should be reviewed to evaluate progress and identify success factors and failures. Based on the assessment, new goals should be set and the action plan adjusted accordingly.

The guide also provides an *Energy Planning Template* to facilitate step 2, and a *Walk Through Assessment Checklist* to help identify measures that reduce energy consumption and technologies that generate clean energy.

Hotel and tourism business owners are highly encouraged to use this step-by-step guide to develop an energy management strategy, of which installing SWH could be an important element.

The report and e-toolkit discussed in this section can be found online at:

The *Hotel Energy Management Guidelines*:
http://www.hes-unwto.org/HES_root_asp/resources.asp?LangID=1

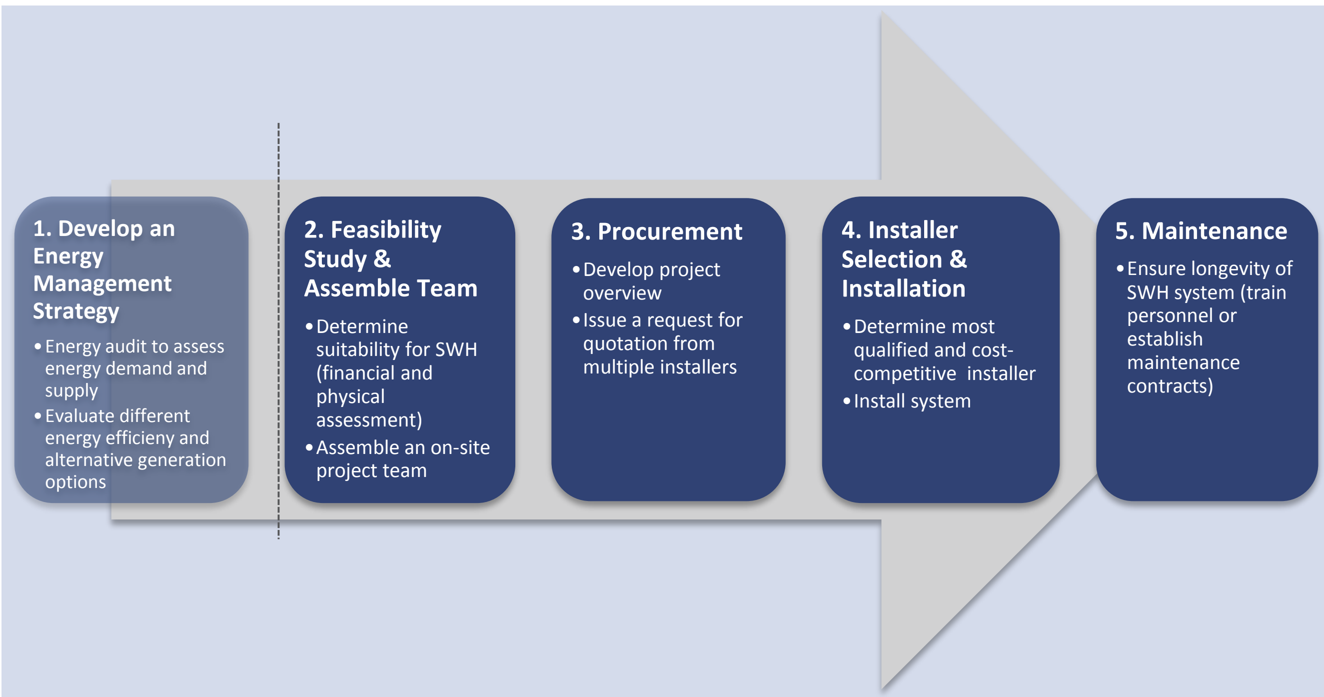
The Hotel Energy Solutions free e-toolkit: http://hotelenergysolutions.net/node/33251

3.1 DEVELOPING AND INSTALLING A SWH SYSTEM

As discussed above, the first step a tourism business owner should take is to develop an energy management strategy by following the procedures outlined in Box 2 and Figure 7. If SWH is identified as a viable energy option, tourism business owners should follow the process outlined in Figure 8.[6]

The complexity and scale of the project will determine which of the following steps to take. For larger installations, a property manager may wish to solicit multiple quotations or oversee a formal Request for Quotation (RFQ) process. The steps in this Section also provide guidance for working directly with an installer. Large projects should consider working with a professional engineer who can conduct a feasibility study, provide the design specifications of the SWH system for the procurement process, and support business owners with the selection of the contractor and contract negotiation.

Figure 8: SWH process overview (Hotel Energy Solutions, 2011)



3.1.1 CONDUCT A FEASIBILITY STUDY

The property owner should first determine whether their facility is suitable for solar water heating. Owners will want to hire an engineer or SWH installer to conduct a preliminary analysis to screen whether a property and its owner are potential candidates for a SWH system. If the property meets basic conditions for SWH, an appointment for an on-site assessment should be scheduled. The goal of the assessment is to confirm if the property is suitable for SWH and which complementary or alternative

[6] Developing an energy management strategy is included as step 1 in the process to ensure tourism business owners evaluate their entire energy system and develop a facility-wide energy strategy before investing in SWH. If a business owner has already taken step 1, they can proceed directly to step 2, the feasibility study.

energy efficiency measures could be installed. The suitability of a property for SWH depends on a number of factors, including hot water demand, existing water heating system, piping, building layout, roof quality, and shading of potential collector area. The on-site data collected during the assessment will provide the basis for the feasibility analysis and quote.

Comprehensive feasibility studies will include measuring hot water demand with flow meters, evaluation of different design options, a detailed financial analysis, and conclude with recommendations for a specific system. The recommended design specifications from the feasibility study are then included in the RFQ.

3.1.2 ASSEMBLE AN ON-SITE PROJECT TEAM

Once it has been decided to move forward with a SWH project, it is recommended to assemble an on-site project team to ensure successful execution. Depending on the size of the project, a team could include a project manager, a local energy and facility manager, a sustainability and safety officer, a budgeting officer, as well as the company's attorney or general counsel (Stoltenberg & Partyka, 2010). This section is intended to give property owners and the project team an overview of important steps to consider when planning a SWH project. To begin, business owners can familiarize themselves with the opportunities (Section 1) as well as different applications of SWH (Section 2), and use different tools and resources (Appendix B) to carry out preliminary analysis of system sizing and financials.

3.1.3 DEVELOPING A PROJECT OVERVIEW & SEEKING PROPOSALS FROM INSTALLERS

Once the feasibility study is completed, the project team will want to develop a project overview including a description of the property and project site. This will be included in the project RFQ. It is recommended to solicit multiple quotations to ensure the business is receiving the best available pricing and options from installers. A formal RFQ process will allow businesses to better compare bids and evaluate the best and most cost competitive installer. For the development of smaller projects an RFQ process may not be necessary, but business managers can use the same proposal elements listed below to evaluate quotes from installers (US DOE, 2003). RFQs should contain an overview of the project including a description of the property and the project site, minimum requirements for the installer company (insurance levels, number of years of experience, references etc.), general legal terms (indemnification, subcontracting, legal compliance, pre-contractual expenses, decommissioning etc.), RFQ process information (submission deadline, project timeline, evaluation process and criteria), and provide the information required for submission. The level of detail of the proposal will depend on the size of the project, but important elements to request from the installer could include (Cook et al. 2015, Forthcoming):

1. Company description (experience, number of employees, company financials, ongoing or previous litigation)
2. Project team (resumes of key personnel, engineering and electrical licenses, organizational chart)

3. Qualifications and project references (examples of similar project experience)
4. Proposed system and design (equipment type, panel area and storage tank, location of panels, piping)
5. Warranties (equipment and labor)
6. Construction plan and timeline
7. Financing options (direct ownership, lease, lease-to-own, loan options)
8. Measurement and system performance verification (temperature or production guarantee)
9. Operation and maintenance (O&M) plan
10. Pricing (detailed description for each financing option)

The solicitation period should be at least 4-6 weeks to give installers enough time to prepare a detailed and accurate proposal.

3.1.4 SELECTING AN INSTALLER & THE INSTALLATION PROCESS

Depending on the number of submissions, business owners should evaluate and score the various proposal elements to identify the most promising candidates. The best proposals should then be reviewed in more detail. It is important to verify business licenses, minimum insurance requirements and for large projects, company financials. The proposal itself should be evaluated based on clear criteria outlined in the RFQ. Potential evaluation criteria could include (Cook et al. 2015, Forthcoming):

1. Developer experience and project team, including previous work, staff qualifications, and references.
2. Project approach, including system design, proposed schedule, construction, financing, measurement and verification, operations and maintenance, and decommissioning plans.
3. Price proposal, based on offered PPA and lease rates over the life of the system.
4. Financial resources, referring to the developer's demonstrated ability to finance the construction of the solar installation.
5. Optional adders, such as educational tie-ins, the use of local materials, or similar criteria, if desired.

It is recommended to verify references and meet with 2-3 companies to discuss their proposals in-person.

Once an installer is selected, a final contract is negotiated and signed. Before installation begins, the project team should plan construction activity and potential short-term interruptions of water supply with the installer to minimize interruptions to day-to-day operations and inconvenience to guests. Upon completion of construction, it is recommended to review whether the system was installed according to the specifications selected, jointly perform measurements to verify system performance and correct for potential outstanding issues.

3.1.5 MONITORING AND MAINTENACE OF SYSTEMS

Most SWH systems require minimal maintenance. For example, SWH systems of the Bucuti & Tara Beach Resort in Aruba have been operating since 1987 and have only required the replacement of a few valves thus far (Section 4, Appendix A). However, to ensure that SWH systems, especially large systems, are operating at optimal performance, it is recommended to establish O&M contracts. In general, installers should be able to be on site within 48 hours to respond to immediate issues, and systems should be serviced at least twice a year to prevent calcium carbonate accumulation (mainly for regions with hard water). Active systems should be checked for proper operation of sensors and controllers (USDOE, 1996).

Business owners and property managers can use this section in conjunction with the resources from the Appendices to develop RFQs and processes for selecting qualified installers. Ultimately, finding a financially reputable and high-quality installer is a prerequisite for the success and sustainability of a SWH project.

CONCLUSION

This guide provides a starting point for tourism businesses that are interested in exploring the opportunity of SWH. The travel and tourism industry is a major part of the economy of many Caribbean countries. Expenditures for energy in the industry are high, and in some cases make up more than one quarter of operating costs. SWH is a proven technology with a wide range of applications, which can be used to address high energy costs. Additionally, investments in SWH can stimulate the local economy and improve the environmental performance of tourism businesses.

However, a weak policy environment, lack of awareness, reliability concerns, a small and fragmented SWH industry, and financial barriers prevent more widespread adoption of SWH technology. To confront these barriers and take advantage of the region's SWH potential, this guide provides resources on financing options as well as information about different SWH technologies, and describes practical steps to a successful planning process for SWH projects. Finally, case studies in the Appendix show how businesses in the Caribbean have overcome different obstacles to SWH and developed projects that have reduced operating costs while mitigating their environmental footprint.

SECTION 4 APPENDIX

APPENDIX A. CASE STUDIES

- Bay Gardens Hotel & Inn, Saint Lucia: Saving Energy Costs with SWH
- Bucuti & Tara Beach Resort, Aruba: An Eco-Pioneer
- Elegant Hotels - Turtle Beach Resort, Barbados: Making the Right Move With SWH

BAY GARDENS HOTEL & INN, SAINT LUCIA: SAVING ENERGY COSTS WITH SWH

Business Information					
Co. name	*Bay Gardens Hotel & Inn*		**Type of establishment**		*Large Hotel*
Building size	*Hotel: 78 rooms & suites* *Inn: 33 rooms* *Capacity: 150 - 325 guests*		**Annual hot water demand**		*Not measured*
Fuel source	*Electricity*	**System type**	*Electric boilers*	**System capacity**	*Not measured*
Solar water heating at Bay Gardens Hotel, Saint Lucia					
System Type	*Flat Plate*	**System Capacity (in gallons)**	*Per room: 40* *Total: 4440*	**% of demand offset by SWH**	*100%*
Savings			Estimated payback		
40% monthly on property's electricity costs			*1.5 years*		

CASE BACKGROUND

Located in Rodney Bay, Gros Islet, in the north of Saint Lucia, Bay Gardens Hotel & Inn is a 3-star boutique property with 78 rooms and suites in the hotel and 33 rooms in the Inn. The hotel and inn together can house between 150-325 guests. All the rooms and the kitchen are served by the solar water heating system, which was installed soon after the hotel was built in 1995. Each 80-gallon system serves two rooms (40 gallons each). The collector size is 33 sq.ft. (~3 sq.m.), delivering water at a temperature of up to 140°F (60°C). Every system has three main parts. The flat panel collector (heats the water), a pump powered by a small PV panel, and an insulated underground tank (stores the water). The hotel uses a pump to keep the tanks away from the roof, so as to maintain the aesthetics of the property.

The estimated cost of the system is US$900-950 per room. A room with 100% occupancy through the year will use about 5.86[7] kWh of electrical energy to heat water every day. With electricity prices around US$.36-38/kWh, this would translate to an annual expense of about $790 per room.

[7] Average daily hot water consumption per room assumed at 40 gallons. Average rise in temperature of water needed is 60°F (from 80°F to 140°F). Specific heat of water is 1BTU/lb°F. Since 1 gallon = 8.34 lbs, BTUs needed for 40 gallons to rise by 60°F, = [40 X 60 X 8.34] = 20,016 BTUs, which is equivalent to 5.86 kWh.

MOTIVATIONS: WHY SOLAR WATER HEATING?

Bay Gardens installed solar water heating systems to reduce operating costs. The hotel's general manager, Ms. Waltrude Patrick points out that, "While overall costs on electricity have gone down by 40% with the help of SWH, actual savings depends on the occupancy rates at the hotel." The system, however, is integral to the finances of the hotel.

Saint Lucia has high electricity and liquefied petroleum gas (LPG) rates averaging around USD 0.38/kWh (2013-2014) and USD 0.69/lb respectively, for the hotel sector (LUCELEC 2015). Like most Caribbean islands, hot water produced with LPG or electricity drawn from the grid results in relatively high water heating bills.[8]

Since opening in 1995, Bay Gardens began exploring options to reduce their operating costs and soon after installed SWH system across the property with the help of Solar Dynamics, the only SWH supplier and installer in the region at the time. When asked what would happen if Bay Gardens were to move back to conventional electric heating, the maintenance manager, Kenneth Augustin shared, "Our operating costs would double!"

Project finances and details for Bay Gardens Hotel, Saint Lucia			
Initial cost	*US$100,000*	**Project developer**	*Solar Dynamics*
Incentives	*None*	**Capital source**	*Self-funded*
Net installed cost	*US$100,000*	**Financing, if any**	*None*

EXPERIENCE AND LESSONS LEARNED

Although the project was commissioned and executed without any major problems and the hotel would reinvest in SWH, the management believes it would be a better idea to use aluminum tanks. The hotel maintenance staff clarified that over time, iron-based tanks tend to rust and crack within the insulated chamber and so aluminum tanks would circumvent that problem. Discussions with the system vendor revealed that there are alternate solutions to this problem. One would be to replace the tank with a glass-lined steel tank. The rust could also be avoided by replacing the magnesium anode. The anode is expected to erode due to high calcium content in the water in Saint Lucia. Further, at a nominal cost, the useful life of the tank (and faucets) could be increased by adding a pressure valve to reduce the pressure of the (cold) water going into the system. Lastly, while not a frequent practice in the Caribbean region, a maintenance contract could be explored with the installer to prevent system operation and maintenance issues.

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[8] At US$0.38/kWh for electricity and US$0.69/lb for LPG, this translates to US$113 and US$43 per MMBTU respectively. EIA's Heating Fuel Comparison Calculator (www.eia.gov/tools/faqs/heatcalc.xls) used for reference.

BUCUTI & TARA BEACH RESORT, ARUBA: AN ECO-PIONEER

Business Information					
Co. name	*Bucuti & Tara Beach Resort, Aruba*		**Type of establishment**		*Beach resort*
Building size	*104 rooms* *Capacity: 200 – 250 guests*		**Annual hot water demand**		*Not available*
Fuel source	*LP Gas*	**System type**	*Boiler*	**System capacity**	*Not measured*
Solar water heating at Bucuti & Tara Beach Resort, Aruba					
System Type	*Flat plate*	**System Capacity (in gallons)**	*Per room: 50* *Total: 5200*	**% of demand offset by SWH**	*90%*
Savings			Estimated payback		
40% Monthly Reduction on Energy Bill			*Not available*		

CASE BACKGROUND

Bucuti & Tara Beach Resort in Aruba is a 104-room resort and an eco-pioneer in the hospitality industry. They initiated the first Green Globe 21 certification of hotels in Aruba in 2000, and were the first resort in the Americas to be certified for ISO 14001. Their activities around sustainability go beyond the simplistic guest-facing conservation programs. Solar water heating is one of the many measures they have adopted. For instance, the facility was featured in a study for having the lowest per-occupied-room electricity usage among all the hotels in Aruba; and they have installed systems to reduce water usage by 60%.

The SWH system services hot water for guest rooms and the guest laundry. In 1987, Mr. Biemans, the owner of the resort, decided to install SWH to replace the hotels LPG fired water boiler. At the time, Mr. Biemans had 12 SWH units of 50 gallon capacity installed. In 2004, Bucuti & Tara installed an additional 9 similar SWH units. Total costs, including labor and installation were US$100,000.

Project finances and details for Bucuti & Tara, Aruba			
Initial cost	*US$ 100,000*	**Financing, if any**	*None*
Incentives	*None*	**Project developer**	*Solar TC., Jacksonville, Florida*
Net installed cost	*US$ 100,000*	**Capital source**	*Self-funded*

MOTIVATIONS: WHY SOLAR WATER HEATING?

The primary motivations for installing SWH at Bucuti & Tara were to save energy and use alternative energy technologies. This is in line with the conservation policies of Bucuti & Tara. The technology was recommended to Mr. Biemans by the Florida Solar Institute.

PROJECT BARRIERS AND CHALLENGES

The project was commissioned and executed without any major problems.

EXPERIENCE AND LESSONS LEARNED

The system has been running with minimal maintenance since 1987. "The low maintenance may be on account of the durable copper tubes, although, every once in a while, a safety valve needs to be replaced," said Mr. Biemans. "Overall, I would do it again; in fact I would install the same system, if available," said Mr. Biemans.

Actual photos of Bucuti & Tara's SWH installation in Aruba. *Photo Credit:* Biemans, 2015

ELEGANT HOTELS - TURTLE BEACH RESORT, BARBADOS: MAKING THE RIGHT MOVE WITH SWH

Business Information			
Co. name	*Elegant Hotels—Turtle Beach Resort*	**Type of establishment**	*Large all-suite resort*
Building size	*161 junior & one-bedroom suites* *Capacity: 400 guests*	**Annual hot water demand**	*1.54 million gallons*

Prior to Solar Water Heating					
Fuel source	*Gas & Electricity*	**System type**	*Gas & Electric boiler*	**System capacity**	*20 gallons/room*
System Type	*Convection flow*	**System Capacity (in gallons)**	*Per room: 40* *Total: 6440*	**% of demand offset by SWH**	*100%*

Return on investment	Estimated payback
35.6%	*1.3 years*

CASE BACKGROUND

Located on the south coast of Barbados, Turtle Beach is a Green Globe certified resort with 161 junior and one-bedroom suites. The hotel can house about 400 guests at full capacity.

The solar water heating system for Turtle Beach was installed in 1997 by Solar Dynamics. In all, the systems measure 251 sq.m., and are designed to serve 100% of the resort's hot water load. Even with the occasional use of electrical boosters, the resort has reduced its energy bill for heating water by 95%. The resort put out a request for proposal in 1997 and three potential suppliers provided individual solutions to meet the specifications established by Turtle Beach. Specifications included: system capacity, recovery time, availability and the costs of maintenance of the installed system among other criteria.

MOTIVATIONS: WHY SOLAR WATER HEATING?

For Turtle Beach, installing a solar water heating system was not only for cost savings. With this measure, the resort has made a deliberate choice to reduce their carbon footprint and invest in renewable energy.

Project finances and details for Elegant Hotels – Turtle Beach Resort, Barbados			
Initial cost	*US$ 161,000*	**Project developer**	*Solar Dynamics*
Incentives	*None*	**Capital source**	*Self-funded*
Net installed cost	*US$161,000*	**Financing, if any**	*None*

EXPERIENCE, CHALLENGES AND LESSONS LEARNED

One of the major challenges Turtle Beach faced was installing the SWH systems was maintaining the aesthetics of the resort. Turtle Beach struggled to find enough roof space for SWH panels and to locate the tanks in a way, so that pumps could be avoided.

When asked what Turtle Beach would avoid if the SWH system were to be installed over again, property manager Michael Barrow said, "Sun exposure: we would ensure that panels and pumps are not installed where there is limited sun exposure." He also shared that if Turtle Beach were to install SWH again, they would keep the tanks on the roofs, ensure thermostats and pressure release valves were included on all the hot water tanks, and use CPVC piping.

Overall, Turtle Beach has had a positive experience with their solar water heating systems. Interestingly, Turtle Beach has had to replace two electric boilers over the past 4.5 years where as the resort has only refurbished their SWH systems once in 17 years.

Actual photos of Turtle Beach Resort SWH installation in Barbados. Photo Credit: Barrow, 2015

APPENDIX B. ADDITIONAL ONLINE TOOLS AND RESOURCES

In addition to the resources discussed in this report, the following online tools and resources can be used to help tourism business owners make informed investment decisions about solar water heating.

Table 2: Selected SWH online tools and resources

Tool	Description	Link
RET Screen Solar Water Heater Model	RET Screen is an excel-based modeling software to evaluate the energy production, financials, and environmental performance of solar water heating projects. The model is available for small-scale and commercial hot water applications, for swimming pools, as well as for large-scale industrial processes. It also contains a database with typical daily hot water demands for different building types.	http://www.retscreen.net/ang/g_solarw.php
GHG SWH Techscope Calculator	The UNEP Greenhouse Gas Calculator for Residential Solar Water Heating ("GHG Calculator") was developed to help policymakers quantify GHG emissions reductions associated with increased Solar Water Heating (SWH) deployment. The GHG Calculator is integrated into the UNEP TechScope Market Readiness Assessment Tool and can be used as a companion tool to help policymakers or other interested users plan SWH market development initiatives.	http://solarthermalworld.org/content/solar-water-heating-swh-techscope-ghg-calculator-tool
NREL System Advisor Model (SAM)	The SAM of the US National Renewable Energy Laboratory is a freely available software tool that allows users to predict SWH system performance based on operating and system costs. While originally designed for the United States, it has a function to import weather data from other geographic locations (which is available for free), making the model suitable for use in the Caribbean.	https://sam.nrel.gov/
Integrating Solar Thermal in Buildings – A	Integrating Solar Thermal in Buildings – A quick guide for Architects and Builders" aims at promoting solar water heating (SWH) systems	http://solarthermalworld.org/content/integrating-solar-thermal-buildings-quick-guide-architects-and-builders-2014

quick guide for Architects and Builders	to architects and builders from developing countries and help them consider integrating SWH applications in their designs. Intending to be a useful handbook, this "Quick Guide" provides a compact overview of the technology and its main characteristics; as well as the main requirements to be considered for its application in different types of projects and in different geographical locations.	
Application Factsheets for Solar Water Heating Installations	• Solar thermal collectors for the production of domestic hot water in the residential sector (Domestic Water Heaters Multi-family Houses) • Solar thermal collectors for the production of domestic hot water in the residential sector (Domestic Water Heaters Single family Houses) • Solar thermal collectors for the production of hot water used inlow temperature industrial processes (Solar Heat for Industrial Processes- SHIP). • Solar thermal collectors for the production of hot water in non-residential buildings (Domestic Water Heaters Social Amenities). • Solar thermal collectors for the production of hot water used in district heating networks (Solar District Heating). • Thermally driven cooling using solar thermal collectors- small-scale and large-scale (Solar Thermal Cooling).	http://solarthermalworld.org/content/application-factsheets-solar-water-heating-installations

APPENDIX C. FINANCING OPTIONS

There are several lending programs in the Caribbean region that seek to reduce financial investment barriers. These include loans for RETs, some specifically for SWH and for small to medium enterprises. Example programs and terms are listed in Table 3 below:

Table 3: Selected Financing Programs[9]

Financial Institution	Loan Programs/Terms
Jamaica National Housing Trust (Jamaica)	Solar Hot Water Loan Program • 3% interest rate, 5-year term • Apply towards system purchase and installation
Jamaica Scotia Bank (Jamaica)	125th Anniversary Loan Program • Alternative energy and equipment upgrades for SMEs • 9.5%-11.5% up to 5 years
Dominica Agricultural Industrial & Development (AID) Bank (Dominica)	Special line of credit for RE and EE equipment • AID lends directly to companies and households • 5% interest rate over a maximum tenor of 12 years • Eligible projects include solar, hydropower, biomass, wind, geothermal & energy saving/efficiency ventures • Rates are variable
National Bank of Dominica (Dominica)	Standard commercial loan for RE/EE investments • Interest rate based on risk over a maximum tenor of 15 years • Collateral: real estate or cash, cannot be solar system itself
Sustainable Energy Investment Program (SmartFund) (Barbados)	Commercial loan for SMEs • Low interest loan (~1%) • 25 year tenor • Five year grace period
Banco Hipotecario Dominicano (BHD) León (Dominican Republic)	Low interest loans for small to medium-sized projects • ~5.5% medium-term loan to finance up to 80% of installed cost • SWH is included in the eligible products list

9 The Caribbean Policy Research Institute's (CaPRI's) Renewable Energy Finance Database provides an extensive list of financing schemes for a range of RETs, including SWH, at: http://www.capricaribbean.com/re-finance?field_target_group_value=All&field_country_value=All&field_financing_type_value=All&field_technologies_value=All&combine=

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Energy Branch
Division of Technology, Industry and Economics
United Nations Environment Programme
15, rue de Milan
F-75441 • Paris CEDEX 09
France
Tel.: +33 1 44 37 14 50
Fax: +33 1 44 37 14 74
Email: unep.tie@unep.org
www.unep.org/energy

www.unep.org

United Nations Environment Programme
P.O. Box 30552 Nairobi, Kenya
Tel.: ++254-(0)20-62 1234
Fax: ++254-(0)20-62 3927
E-mail: cpiinfo@unep.org

UNEP

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