

EVALUATION OF RENEWABLE ENERGY INCENTIVES: THE BARBADOS SOLAR WATER HEATING EXPERIENCE

Bob Perlack¹ and William Hinds²

¹Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831

²Ministry of Energy and Public Utilities, Barbados

Email: perlackrd@ornl.gov

Abstract

This paper reports on an assessment of the fiscal incentives used by the Government of Barbados to promote solar water heating. Our results indicate that energy savings are substantially greater than the tax cost of fiscal incentives. We also estimate that solar water heaters save about 130,000 barrels of oil or nearly a third of domestic production. The associated carbon savings are more than 4% of total country-wide emissions. The success of the Barbadian solar water heating program is due to a combination of factors including high electricity rates and tax incentives which together make for very low homeowner payback periods.

Keywords: Solar water heaters, incentives, tax cost, benefits

Introduction

A multi-year energy project was recently initiated under the U.S. Agency for International Development's (USAID) Caribbean Regional Program. Start-up activities are focused on facilitating access to financing to implement cost-effective energy efficiency improvements and renewable energy technologies (RETs), expanding export markets for RETs, and capacity-building for sustainable energy system analysis, training, and implementation. To provide some perspective and context for future regional energy project activities, USAID sponsored an evaluation of the Barbados solar water heating program. The evaluation included the development of background information on technical and market barriers to RET use, the identification of how policies and incentives were selected and implemented to promote solar water heater (SWH) use; the diffusion and market penetration of SWHs in Barbados; an economic assessment of the incentives used to promote SWHs; and the identification of key lessons learned. In this paper, we present the results of the economic assessment of the fiscal incentives used by the Government of Barbados (GOB) to promote SWHs.

Net Economic Benefits of the Barbados SWH Experience

Numerous incentives and mechanisms have been used and/or suggested to promote the diffusion of RETs. These measures include a host of fiscal incentives (e.g., tax credits, tax deductions, rebates, subsidies, and green pricing); various regulatory measures including renewable portfolio standards, surcharges to fund renewable energy projects, net metering, and environmental standards; financing mechanisms such as low-interest loans; government purchase programs; government investment in research and development; and programs aimed at educating the public about potential benefits. In all cases, however, incentives are used to achieve specific policy objectives -- lower the installed costs of RETs; reduce the risk associated with the purchase of a new technology; help condition or create a market for producers; and capture societal benefits, such as reducing environmental emissions and oil imports.

The GOB used two fiscal incentives initially in 1974 to promote SWHs (Ince, 1999). The incentives included the elimination of import tariffs on raw materials used to manufacture

SWHs and the imposition of a 30% consumption tax on electric water heaters. In 1980, the GOB implemented a third fiscal incentive. This third incentive allowed homeowners to deduct the full-cost of a SWH installation up to a maximum of \$BD3500. This tax deduction was eliminated in 1993 and reintroduced in 1996 as part of a broader homeowners allowance deduction. This deduction allows homeowners an annual deduction up to BD\$3500 for mortgage interest, repairs, renovations, energy or water saving devices, solar water heaters, and water storage tanks. In addition to the fiscal incentives, the GOB purchased significant numbers of water heaters for housing development projects. The initial purchase was for about 80 units in the mid-1970s followed by four other purchases in the 1980s and 1990s.

Figure 1 provides a summary of SWH installations in Barbados. Sales of SWHs increased steadily from 1974 when 12 units were sold to 1989 when more than 2800 units were sold. In the early to mid-1980s growth in SWH sales slackened considerably despite the promulgation of the homeowner SWH tax deduction in 1980. The lessening in sales during this period was due in-part to the economic recession following the second oil price shock in the late 1970s. With the onset of the major economic recession in 1990 installations declined precipitously to under 1000 units in 1993. As the economic recovery began SWH sales increased and stabilized at current levels.¹ Currently, there are approximately 35,000 SWH units installed on the island. The current market is estimated at about 1500 systems per year split unevenly among three companies – Solar Dynamics, SunPower, and AquaSol. The size of this market is relatively stable consisting primarily of new construction and to a lesser extent installations in existing construction.

A common question regarding the use of fiscal incentives and other government programs to stimulate the diffusion of RETs is whether these

¹ Data on sales of SWHs were collected by the Barbados Statistical Service from 1974 through 1992. Sales data from 1993 to 2002 are based on inferences gained in meetings with the manufacturers.

incentives are a prudent and justifiable use of taxpayer’s money. An initial attempt to answer this question was made by Husbands (1994). Husbands estimated that the SWH systems installed between 1974 and 1992 produced a total energy savings of \$US50 million and cost the GOB \$US6.6 million in revenue. Figure 2 summarizes our estimate of the tax cost of the fiscal incentives. In estimating the tax cost of the incentives, we made a number of assumptions regarding income distribution, the impact of the duty-free raw material exemption on the installed system cost, and the fraction of systems installed in dwellings as opposed to hotels. For the period 1980 to 1992, we used the same income distribution as Husbands (1994) – 20% of the population with no taxable income, 40% with taxable incomes up to \$15,000 and a tax rate of 20%, 20% of the population with taxable incomes up to \$25,000 with a tax rate of 30%, and 20% with taxable incomes greater than \$25,000 with a tax rate of 40%. For the period after 1992, assumptions were changed to reflect income tax reform and the reduced number of tax brackets (0%, 25%, and 40%). In addition, we assumed that the effect of the duty-free importation of raw materials lowered installed costs by about \$BD200. We further assumed that 80% of the SWHs were installed in dwellings as opposed to hotels and other tourist accommodations.

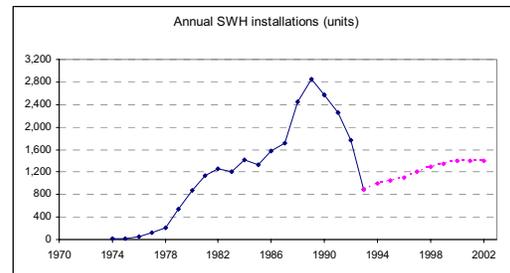


Figure 1. Annual SWH installations in Barbados (Source: 1974 – 2002).

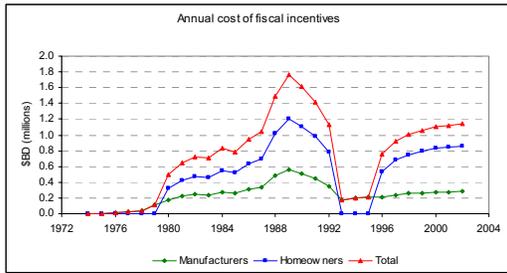


Figure 2. Estimated annual tax cost of SWH fiscal incentives (1974 – 2002).

As expected, the estimated tax cost of the incentives generally follows that of the installation data presented in Figure 1. Historically, about two-thirds of the tax cost of the incentives is due to the homeowner deduction and one-third due to the manufacturer tariff exemption on raw materials. The tax cost of the incentive reached a maximum of nearly \$BD1.8 million in 1989. The consumer deduction cost about \$BD1.2 million and the duty-free importation of raw materials about \$BD0.6 million. In the most recent year, the cost of the tax incentives was about \$BD1.1 million. This tax cost is a very small fraction of GOB revenues. In 2002, the GOB collected \$BD1740 million of which \$300 million was from personal income taxes. Cumulatively, the tax cost of the SWH incentives is estimated at about \$BD21.5 million through 2002.

Three types of benefits are usually attributable to RETs. These include the direct energy savings, the local and global environmental benefits, and energy security benefits. The estimation of energy savings is based on the assumption that SWHs displace some fraction of electric water heaters. The Barbados Statistical Service in 1990 and 2000 provides data on the extent of installed SWHs and other water heaters and how these water heaters are distributed by dwelling type. For 2000, these data show about 24,140 (30%) dwellings with SWHs installed and about 13,460 (16%) with some other type of water heater. By comparison, these estimates are substantially higher than 1990 – 12,390 and 8640 for SWHs and other water heaters, respectively. These data also indicate that other types of water heaters continue to be installed

despite the presence of the tax incentives, and the penetration of SWHs is markedly different among dwelling types.

To estimate energy savings we assumed that SWHs displace 50% of electric water heaters with each SWH saving an estimated 3710 kWh annually. This savings estimate is based on an historical average tank size of 62 gallons, an efficiency of 90%, and a water temperature change of 60°F. Husbands (1994) assumed an average energy savings per SWH unit of 4000 kWh. The product of cumulative installations, per unit energy savings, and an electric water heater displacement of 50% results in our estimate of SWH energy savings. The estimated energy savings and kWhs saved are summarized in Figure 3. Valuation of the kWh savings is based on average historical domestic electric rates. Assuming that the preceding assumptions are reasonable, the Barbadian SWHs are saving about 65 million kWh annually with a ratepayer value of \$BD23 million. By comparison, Husbands estimated energy savings in 1992 at 75 million kWh with a valuation of \$BD19 million. The energy savings have a cumulative value through year 2002 of \$BD267 million.

A comparison of the cumulative costs of tax incentives and the benefits measured in energy savings is shown in Figure 4. The cumulative energy savings substantially exceed the tax cost of the incentives. The installation data presented earlier (Figure 1) show that the SWH industry was already starting to grow at a relatively fast pace prior to the passage of the homeowner tax deduction. It should not necessarily be construed that the tax incentives were entirely responsible for the relatively high penetration of SWHs in Barbados. Clearly, there is some measure of free-ridership – tax deductions taken by homeowners who would have installed a SWH without the incentives. However, without conducting extensive surveys it would be impossible to tell how much effect the tax incentives had in a homeowner's decision to install a water heater. Regardless of the factors responsible, energy savings significantly exceed the tax costs.

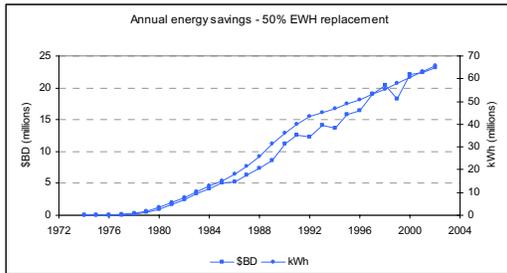


Figure 3. Annual SWH energy savings (50% electric water heater replacement).

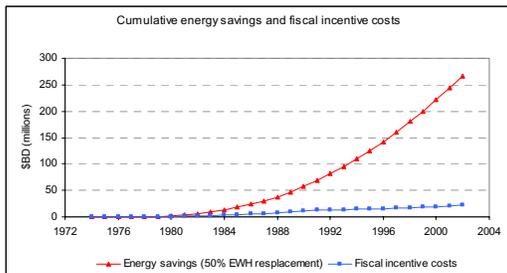


Figure 4. Estimated cumulative energy savings and tax cost of incentives (1974 – 2002).

A second category of benefits provided by SWHs are the primary oil savings. These estimated benefits are summarized in Figure 5. In 2002, we estimate that the 35,000 installed SWHs saved about 130 thousand barrels of oil with a value of \$BD6.0 million. These savings amount to about one-third of current domestic oil production, assuming 1200 bbl/day production.

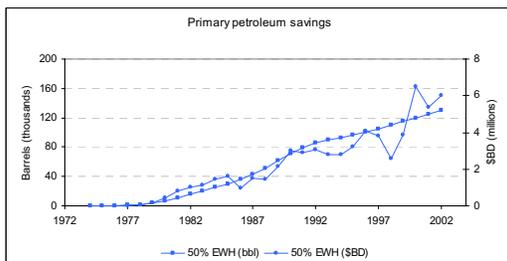


Figure 5. Estimated primary oil savings (1974 – 2002).

Environmental emissions are the final category of benefits evaluated. These include the local benefits (i.e., SO₂, NO_x, particulates, VOCs, etc) and global benefits, defined as reduced emissions of carbon. We did not attempt to

estimate the local environmental benefits. Figure 6 summarizes the carbon savings due to the installation of SWHs. The carbon savings are based on a composite carbon emission coefficient of 20 metric tons/Billion Btu. This composite emission factor reflects the percentage of fuel oil, diesel, and gas used by Barbados Light and Power to generate electricity. Carbon emissions for the entire country (CDIAC, 2003) and the percentage of carbon savings due to the SWH energy savings are also displayed to provide some perspective. These results show carbon savings in 2002 of 15,000 metric tons or 4.3% of emissions from all Barbadian carbon sources (principally power and to a lesser extent cement manufacturing).

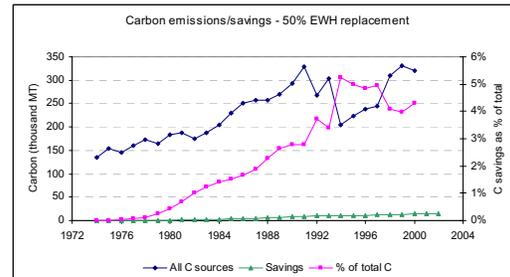


Figure 6. Estimated carbon savings from installation of SWH (1974 – 2002).

Evaluation of SWHs from the Homeowner Perspective

SWHs generally yield relatively significant energy costs savings over conventional electric and gas water heaters. Even in the U.S., where the cost of conventional fuels and solar insolation are less, a SWH can pay for itself in 4 to 8 years (DOE, 1996). In Barbados and other Caribbean islands, simple payback periods are considerably less owing to higher electricity rates and higher year-round solar insolation levels. Payback periods are calculated for the range of SWHs available to homeowners (40 to 80 gallons). Data for the approximate installed cost, energy savings, average electric rate, and annual savings assuming the SWH would replace an electric water heater are summarized in Table 1.

Table 1 also contains our estimate of payback periods calculated without the effect of the homeowner tax deduction and with the homeowner deduction for the two current tax brackets – 25% and 40%. For a 40 gallon system, the payback period would be about 2.7 years without the tax deduction and two or less years depending on tax bracket. Because of the greater energy savings relative to the installed cost, payback periods for the larger system are less. For the system size most commonly installed today, the payback period is about 2.1 years without the tax deduction. The payback period falls to 1.6 years if the homeowner is in the 25% tax bracket and 1.2 years if in the 40% tax bracket.

Table 1. Estimated payback periods for domestic SWHs.

Parameters	System size (gallons)			
	40	52	66	80
Cost (\$BD)	2250	2400	2850	3500
Energy (kWh)	2380	3090	3930	4760
Price (\$BD/kWh)	0.35	0.35	0.35	0.35
Savings (\$BD)	840	1092	1386	1680
Payback period (years)				
- w/o incentives	2.7	2.2	2.1	2.1
- 25% tax bracket	2.0	1.6	1.5	1.6
- 40% tax bracket	1.6	1.3	1.2	1.2

References

Barbados Statistical Service, *Population and Housing Statistics*, 1990 and 2000.

Carbon Dioxide Information Analysis Center (CDIAC) -- <http://cdiac.ornl.gov/>

Husbands, James, “A Review of the Costs of the Tax Incentives to the Solar Water Heating Industry in Barbados,” *Caribbean High Level Workshop on Renewable Energy technologies, Proceedings of the World Solar Summit*, St. Lucia, December 1994.

Ince, David, “Development of Solar Water Heating and Other Renewable Energy Technologies in Barbados,” Proceedings from the Global Conference on Renewable Energy Islands, Forum for Energy and Development (FED), November 1999 (<http://wire0.ises.org/wire/doclibs/GCREI.nsf!OpenDatabase>).

U.S. Department of Energy (DOE), *Solar Water Heating*, DOE/GO-10096-050, FS 119, Washington, March 1996. <http://www.eere.energy.gov/consumerinfo/factsheets/solrwatr.html#benefits>

Summary

Our results clearly show that there are some significant benefits from SWHs. Although the effect of the tax incentives on decisions to install SWHs cannot be determined precisely, it can be said that the tax cost of the incentives is only a fraction of the estimated benefits – user energy savings, reduced oil imports, and reduced carbon emissions.

The Barbadian SWH program has been and continues to be very successful. Although the market for SWHs is relatively stable based primarily on sales to new housing units, there are many homeowners that still do not have SWHs. Most of these are low-income households that cannot afford to purchase a SWH because they do not qualify for the tax deduction or do not have available financing. It would appear that additional sales of SWHs would be possible, if low-cost financing is made available to homeowners that do not have sufficient income to qualify for the tax deduction.