Residential Electrical Energy Efficiency in Jamaica, W.I.: Resource Potential and Preliminary Program Implementation

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Jamaica is experiencing strong growth in electrical demand, and faces a near-term need for additional resources. As an alternative to meeting all the new demand from building power plants, a comprehensive demand-side resource acquisition program has been designed to increase efficiency in the residential, commercial and industrial sectors.

This paper addresses residential sector programs, including analysis of the potential for displacing new energy supplies through demand-side investments, a description of residential programs and the status of their pilot-phase implementation.

The residential DSM programs being undertaken target lighting, domestic hot water and refrigeration. The efficient lighting program requires significant efforts to identify products which are suitable to a 50 Hz system whose voltage varies more widely than US systems, including testing at the Jamaica Bureau of Standards (JBS) and a 100-home pilot program. The water heating program is designed to promote cost-effective substitution of solar water heating, including testing performed at the JBS, including a 30-home pilot program. Both lighting and hot water pilot programs will involve low-cost before-and-after load profile monitoring.

The residential refrigeration program is focussing on testing, labelling and incentives for efficient refrigerators, as well as investigating the feasibility of developing a very high efficiency small refrigerator, utilizing improved refrigeration cycles, to be produced by the Jamaican refrigeration industry. The air conditioning program focuses on testing, labeling and the introduction of standards.

Introduction

Economic and Environmental Context

Jamaica is a country of about 2.4 million population. The electricity system has an installed capacity of some 495 MW, with a peak demand of about 340 MW. Total energy generated is about 2000 GWh per year. There are about 270,000 residential customers, accounting for about 1/3 of the system load.

Due to unprecedented growth in demand, Jamaica is faced with a near-term need for additional resources. Demand is growing at about 6% per year -- with total demand expected to rise to 670 MW by the year 2010 (CLF 1990).

A comprehensive demand-side resource acquisition program has been designed to increase efficiency in the residential, commercial and industrial sectors as an alternative to building new diesel and soft-coal burning power plants. Current estimates are that demand-side management could reduce system growth requirements by 70 MW.

Project History

The Jamaica DSM project was started in January 1990, on the initiative of the Biomass Users Network of Washington, DC, who signed an agreement with JPS to provide assistance to transfer to a developing country mature North American experience in DSM planning. The Conservation Law Foundation of New England was designated project manager. The first product was a study entitled "Power by Efficiency", which made preliminary estimates of DSM potential under several program headings.

The project has so far been funded by a grant of US $920,000 from the Rockefeller Foundation, and a loan of $2 million from the Inter American Development Bank. An application for matching funds has been made to the World Bank's Global Environmental Fund, and is currently being processed.

At the invitation of officials at Jamaica's electric utility, Jamaica Public Service Company (JPS), a team was established with JPS staff and the staffs of the Conservation Law Foundation of New England (CLF) and the Biomass Users Network. This team has worked closely together to initiate demand-side planning and implementation. Vermont Energy Investment Corporation has been the lead consultant on behalf of CLF for analyzing, developing and implementing pilot programs for the residential sector.

Residential DSM Potential

Based on economic screening results, the cost-effective residential DSM resource potential is estimated in Table 1, based on aggressive, full-scale programs. The energy savings represent approximately 12% of total 1991 residential energy sales.

Background

End-Use Saturations and Energy Usage By End Use

Prior to initiation of the demand-side planning effort, there was little information about residential end-uses of electricity. A survey from some 10 years earlier was widely recognized as out of date, as appliance sales had increased dramatically since then. A survey was commissioned by the project, with the residential program design team developing the desired data, and a social science research group in Kingston, Jamaica, developing and administering the questionnaire. Approximately 1,500 customers were interviewed, with the sample stratified to ensure an adequate sample of the relatively small segment

Table 1. Jamaica Public Service Residential DSM Potential

End Use [1]	Savings (MWh/yr) [2]	Savings (Peak kW) [3]	JPS Cost ($000) [4]	Avoided Cost ($000) [5]
Hot Water	18,960	2,865	$6,004	$12,821
Refrigeration	16,970	2,075	$4,628	$9,255
Air Conditioning	20,500	19,500	$27,625	$55,250
Lighting	14,324	1,394	$5,921	$7,228
Total	70,754	25,834	$44,178	$84,553

[1] See discussion of individual pilots for descriptions of measures installed. Air conditioning includes small C&I. All other end-uses are for residential sector only.
[2] See notes under each pilot description for assumptions.
[3] Savings are diversified, and are coincident with the afternoon JPS system peak.
[4] Costs to JPS. Total installed measure costs are different, depending on program design. See discussion of pilot programs cost allocations. No O&M costs are included here. All costs and benefits are in US dollars throughout this paper.
[5] Based on current avoided generation, capacity and T&D costs. Environmental externalities are not included.

of customers with the highest usage. Results were adjusted for this stratification and compiled by the research group, including numerous cross-tabulations of data requested by the program design team and a disaggregation based on end use, by customer income class. See Table 2 (PSearch 1991).

The survey was critical in directing the residential DSM program design team to those areas where electricity use could be significantly impacted, as well as helping identify end uses where electricity use is already reasonably low.

The wide variation of energy use by income level brought into focus the need to be able to offer some programs directed at low users, in order to offset any increase in rates that financing of other programs is expected to cause. The survey results indicate that most of the low-use customers do not have hot water heaters, refrigerators in this group tend to be small, relatively efficient units, leaving efficient lighting retrofit as the only basis for a program with broad applicability.

A relatively large number of customers, 82%, have refrigerators, each using on average, approximately 1,029 kWh per year, representing 54% of all residential consumption. However, the survey also indicates that many of these refrigerators are small, relatively efficient units built for the 50 Hz system, while a small but significant percentage are large US-market refrigerators with high consumption.

Lighting usage and potential for retrofits was another important result from the survey. Table 3 shows the average number of incandescent lamps, and their usage.

Lack of Local End-Use Load Profile Data

One problem facing the design team is a lack of end-use load profiles specific to Jamaica on which to base demand savings estimates. For initial analysis United States load profiles, adjusted as seemed "reasonable," were used, but planning is underway to gather some profile data on significant residential loads during the pilot and demonstration phases of the programs, to be able to better characterize savings in the future. Whether this effort will use load profile recorders in selected locations and/or frequently-read elapsed time indicators in parallel with selected loads will depend, in part, on funding available for monitoring equipment, data gathering and analysis.

Table 2. Electricity Consumption by Major End Uses

	Annual Income ($ US/year)			
	≤$1,700	$1,700 to $6,000	$6,000 to $8,600	≥$8,600
Lighting				
Saturation [1]	97%	99%	100%	99%
Annual Usage [2]	312	372	456	456
Refrigeration				
Saturation	59%	88%	93%	92%
Annual Usage	860	891	1,007	1,305
Room A/C				
Saturation	0%	1%	1%	8%
Annual Usage [3]	--	--	--	519
Water Heating				
Saturation	0%	2%	6%	19%
Annual Usage [3]	--	--	--	1,745

[1] Percent of respondents with appliance.
[2] Annual energy usage, in kWH/yr, for those having appliance.
[3] Estimated for highest income group based on total sample, sample too small for further disaggregation.

Table 3. Average Incandescent Lamp Usage

	<60 Watts	>=60 Watts
Average Number of Lamps Over All Customers	5.17	1.3
% of Lamps in Use More Than 2 hrs/day	18.3%	41.7%
Number of Lamps in Use More Than 2 hrs/day	0.95	0.54

Avoided Costs and Externalities

JPS is in need of more capacity, experiencing shortages on a regular basis. One focus of the DSM planning effort in Jamaica is comparing the cost of DSM with new, soft-coal fired generation, the least-cost new generation alternative favored by JPS and international lenders. The avoided costs are essentially those of such new generation. To date, externalities, accounting for the costs for remedying pollution generated, have not been included in any of the cost-benefit analyses. Avoided costs are estimated at $91/(MWh saved per year), including generation, capacity and transmission and distribution savings. These compare to a range of $43 to $75 for several Mid-Atlantic and Northeast United States utilities, without externalities.

The 50 Hz System

Jamaica is equipped with a 50 cycle system, with residential equipment running on 110 VAC, 50 Hz. This system is used by only 2 or 3 other countries in the world, making it very difficult to purchase appliances designed to operate under these conditions. Further, use of 60 Hz equipment is widespread, as US equipment is imported either wholesale or by individuals who purchase appliances when traveling, with little regard for manufacturers' admonitions about running the equipment on 50 Hz. Running 60 Hz inductive loads (including motors and fluorescent ballasts) on 50 Hz at the same voltage increases current flow through windings on the order of 20%, increasing waste heat, and significantly decreasing efficiency and life. Voltage, in general, tends to be low on the JPS system, which tends to compensate somewhat for the change in frequency for 60 Hz. equipment, but voltage tends to vary significantly, particularly in areas with stressed distribution. Distribution system improvements are under way which will remedy some of the low voltage problems, but may, at the same time, increase problems with 60 Hz equipment. All of this tends to contribute to early demise of electrical appliances, and makes forecasting of the persistence of energy savings from supposedly long-life equipment, such as compact fluorescents, problematic.

Problems and Progress with Tax and Duty Structure

At the same time that this project has been getting underway, the Jamaican government has been revising the tax code, in part to simplify the existing complicated, arcane structure. The tax and duty structure in Jamaica, until recently, has been a major obstacle to investment in conservation. Total taxes and duties doubled the cost of many imported items, but all imports by JPS (equipment and fuel) were without duty. This artificially inflated the cost of conservation relative to supply, and disregarded the fact that all money spent for electricity essentially went out as foreign exchange, while dollars spent for increased efficiency generated savings that (1) were spent at least in part on items containing local labor and (2) generated further sales tax revenue in the country. The shift toward conservation purchases will free up foreign exchange for purposes other than energy. Analysis of this issue generated through this project was helpful in the successful effort to have the consumption tax structure changed, so that a specified list of energy efficiency items, including compact fluorescents and solar heating equipment, are no longer subject to this tax. There are still custom duties on items imported from countries outside the Caribbean Common Market nations (CARICOM.) Efforts are under way to work with the CARICOM countries to remove these duties.

Economic Constraints

The Jamaica dollar has seen dramatic devaluation in the past two years: Since the inception of this project the exchange rate has gone from 7:1 to 25:1 Jamaican dollars to the US dollar. This devaluation raises significantly the cost of doing business for companies likely to participate in DSM programs, such as installers and importers. Borrowing capital to finance the importation of equipment becomes very costly. Virtually all materials are imported. Interest rates and inflation have also risen dramatically. Devaluation also increases the cost to customers for any co-payments for DSM measures, decreasing customer participation rates where co-payment is required. However, the ratio of avoided cost to benefits is not effected nearly as much as this change might indicate, since virtually all electricity generation costs--hardware as well as fuel--are for imports, as are most of the costs for efficiency hardware.

Locally Available DSM Technologies

Despite all the difficulties, the high cost of electricity keeps a variety of energy-efficient products on the market in Jamaica. Residential rates are in the $0.12 to $0.15/kWh range.

Imported Equipment

There are a variety of imported compact fluorescent lamps and fixtures available on the market in Jamaica. All of the 110 volt compacts, however, were designed for 60 Hz operation, and there is no data on how long they are lasting in actual use. (220 volt, 50 Hz European products are available for commercial installations wired for 220 volts.) US solar water heating systems are available through a number of installers. These are mostly active systems, although some are configured as gravity circulating (thermosiphon) systems. Small, relatively efficient, 50 Hz. refrigerators are imported from Trinidad. Small, high efficiency, split system air conditioners--"mini-splits"--most of these Japanese, have made major inroads into a market previously dominated by window units. (Split systems have the condenser unit outdoors and the evaporator and fan assembly indoors.) The market shift has been at least partly due to the old (recently changed) tariff structure, which lowered duty for components relative to completed units. The high price of window units has also increased the mini-split market share.

Locally Produced Equipment

Three manufacturers of lighting equipment have, for some time, produced a screw-in ballast for 22 watt Circline lamps. Ballasts, lamps and other components are imported, with housings fabricated and the units assembled locally. Low-cost imports have recently begun to hurt this market, particularly as economic conditions have increased the cost of doing business locally. Efforts are being made to include local products in all programs.

Several solar collector manufacturers are also in business (mostly building other types of equipment given the slow market for solar) with capability to produce high quality equipment. Systems range from an all-plastic German engineered and franchised system that uses an unglazed collector with gravity circulation to copper-absorber, double-wall polycarbonate-glazed collectors with glass-lined tanks. Considerable expertise and experience with solar was gained over the 1960's and 1970's with foreign funded programs encouraging a number of installations.

There is also considerable local expertise in fluorescent ballast production. During better economic times, inductor/transformers for commercial fluorescent ballasts were wound locally, using imported wire and cores and other parts, and local labor. Cores were wound to specification for a particular job, recognizing the typical variations in voltage at that location, and designing the ballast accordingly. It is hoped that this expertise can also be tapped to maximize the life of residential lighting retrofits.

Small (9 cubic foot) refrigerators are also produced in Jamaica. These are relatively efficient manual defrost units, with Brazilian compressors designed to operate on 50 Hz, 110 volts. Some larger units using 50/60 Hz compressors are also produced.

DSM Measures and Pilot Programs

To further the planning process, and to begin to develop local expertise in program implementation, four residential pilot programs are being initiated. Lighting and water heating pilots will involve installations in a number of homes, while the refrigeration and air conditioning pilots involve testing and setting efficiency standards. Lighting and water heating pilots are expected to begin this summer, while setting of standards for refrigeration and air conditioning is not expected this calendar year.

Lighting Pilot

The first phase of the pilot has begun with testing of a number of compact fluorescent products at the Jamaica Bureau of Standards (JBS). Since the cost-effectiveness of lighting is critically sensitive to lamp life, it is felt that this testing is important. JBS is equipped for testing of incandescent lamps as part of their work with the Jamaican incandescent lamp manufacturer, including lumen output measurement with an integrating spherical chamber, power draw and power factor, and variable voltage for testing the lamps at various voltages expected on the Jamaica electric system. Lifespan testing is also being done, but results of this will not be available before the pilot installations. However, early testing of temperature rise and lumen output are expected to reveal any gross problems with operation under Jamaica conditions.

The second phase of the pilot will utilize a direct-installation approach. 100 homes will receive screw-in compact fluorescents and hard-wired fixtures, based on a protocol developed from the results of economic screening of the specific products that pass the JBS testing. While the full-scale lighting program may be a point-of-sale program, the direct installation pilot will give better control of lighting placement for characterizing the maximum number of installations that could be achieved in homes. Persistence of savings will be monitored over a period of time long enough to at least begin to see how long lamps last in actual service in Jamaica.

Avoided Cost Screening. Based on the survey, in the average customer's home there are an average of about 1-1/2 lamps in use over 2 hours per day; in homes of customers having at least one 60 watt (or higher wattage) lamp, there are about 2-1/2 lamps in use over 2 hours. This implies that there are potential opportunities for about 396,000 fluorescent lamp retrofits. (264,000 JPS residential customers at 1-1/2 lamps per home.) See Table 4. While no actual program can reach all customers and not all customers reached would accept fluorescent retrofit lamps (even assuming an installation at no cost to the customer), the present analysis focuses on available DSM potential. The results of the pilot programs are expected to improve prediction of both the technical potential and the portion of it which may actually be achieved through DSM program delivery.

The economic screening results indicate a threshold of about 2 hours per day usage for societal (or total resource) cost effectiveness for screw-in retrofits, assuming US load profiles, and only a very slightly higher threshold for the utility test, assuming full installed cost paid by the utility. (Note that the utility test offers slightly lower net benefits than the societal test, since the utility test does not include the benefit of savings to the customer of not purchasing incandescent lamps.) Two hours per day average use for screw-ins very comfortably passes societal and utility screening, while fixture installations are cost effective at 4 hours per day using these tests. Final selection of lamps for the pilot will be based on the tests currently being conducted at the Jamaica Bureau of Standards (JBS), using criteria of estimated longevity, lowest purchase cost, ability to replace lamps separately from ballasts, and, to the extent possible, local production.

Solar Hot Water Pilot

The first phase of the solar hot water pilot has begun with testing of equipment at the JBS. A sophisticated test facility, built in the 1970's, has been refurbished for testing collectors and systems to United Sates ASHRAE standards. Equipment must be submitted by manufacturers for testing, and installations must meet minimum standards in order to be included in the program. The pilot will include installations on thirty homes that presently use electric water heating.

The pilot is planned to test the incentive structure as well as the technology for the full program. The customer must pay in cash a cost equivalent to that of a new electric water heater, the utility will pay a portion of the remaining cost, and the customer will finance the rest. The requirement for the initial customer share of the cost is designed to encourage installation of solar at the time of tank replacement or at the time of installation of a new water heater, but to discourage customers who had no intention of installing any type of hot water without the program. The utility share will be set so that the remaining amount that the customer finances will be small enough that monthly payments will be no greater than half the savings in electricity, guaranteeing positive cash flow to the customer. For a system cost of $1,500, the customer would pay $450, the utility would pay $750, and the remaining $300 would be financed, in this case over a short period of time, considering the small amount.

Avoided Cost Screening. The screening results indicate positive net benefit under both societal and utility tests for customers with annual domestic hot water (DHW) energy usage above 2,000 kWh. The survey results indicate 6% of customers have electric water heating, with an average annual usage of about 1,745 kWh. While no Jamaican frequency distribution of DHW energy usage is available, we do have some data on US frequency distributions of electric DHW usage, which we have applied to average annual DHW energy use from the JPS survey, as shown in Table 5.

Such a distribution indicates that about half the electric DHW customers have usage levels above the threshold for cost-effective solar hot water installations, and that the average usage of those customers is about 2,500 kWh per year. On the other hand, this leaves a substantial number of electric DHW customers for whom it would not be cost-effective to install solar hot water. Design for the full scale program will take this into account, by offering energy conservation devices (such as low-flow devices) to

Table 4. Residential Lighting Summary

DSM Measure	Number Installed [1]	Savings (MWh/yr) [2]	Savings (kW) [3]	Cost ($000) [4]
13 Watt CFL	250,800	7,524	752	$3,298
20 Watt Circline	128,304	5,517	513	$1,925
32 Watt Fixture	14,256	1,283	128	$699
Total	393,360	14,324	1,394	$5,921
Total Avoided Cost [5]				$7,228

[1] 264 residential customers, with 0.95 lamps under 60 watts and 0.54 lamps 60 watts and over. Lamps under 60 watts are replaced with screw-in 13 watt CFL (compact fluorescent) retrofits. Of the lamps 60 watts and over, it is estimated that 10% are in use over 3-1/2 hours per day, the threshold of usage for cost effective replacement with a circline fixture. Therefore, 90% are assumed replaced with 20-watt screw-in circline retrofits, and 10% with 32 watt fixtures.

[2] Savings per unit are based on 2-1/2 hours per day average usage, since the threshold for participation is 2 hours per day.

[3] kW savings are coincident with system peak, based on US end use load profiles and JPS afternoon system peak.

[4] JPS Costs are considered here to be full installed measure costs, but do not include customer O&M savings.

[5] Avoided costs are utility avoided costs, not including externalities.

Table 5. Estimated Frequency Distribution of Annual Electric Hot Water Energy Usage

% of Population	Annual DHW Usage (kWh/yr)
50%	1,030
30%	1,954
13%	2,722
7%	4,537

electric hot water customers with lower usage. The average usage of these customers is expected to be about 1,000 kWh per year.

In summary, screening indicates that solar water heating remains cost-effective for a significant number of customers--approximately 3% of all residential customers, or 7,900 customers. The pilot will be important in helping to refine the threshold usage level for which solar DHW is cost-effective. See Table 6.

Refrigeration Pilot

From the recent survey results [1], 82% of customers have refrigerators, and these refrigerators consume, on average 1,029 kWh per year, representing 54% of all residential consumption. This is by far the largest single residential energy use. Most of the refrigerators (69%) are the small, manual defrost models produced in Jamaica or Trinidad, which are already relatively efficient. Accordingly, there is no quick and easy "big fix" regarding residential refrigeration. Two strategies are being pursued:

Table 6. Domestic Hot Water Measures Summary

DSM Measure	Possible Number Installed [1]	Savings (MWh/yr) [2]	Savings (Peak kW) [3]	Total Cost ($000) [4]	JPS Cost ($000) [5]
Solar Hot Water	7,900	17,775	2,686	$10,270	$5,925
Conservation	7,900	1,185	179	$79	$79
Total		18,960	2,865	$10,349	$6,004
Total Avoided Cost [6]					$12,821

[1] 6% of 264,000 residential customers have electric hot water, with half of these using above the threshold of 2,000 kWh per year, and half below. Total number does not include any increase in percentage of customers with electric DHW.
[2] Solar DHW saves 95% of average 2,500 kWh per year load, per installation; conservation measures save 150 kWh per year per installation.
[3] Based on US end-use load profile used in screening. kW savings are coincident with JPS afternoon system peak.
[4] Cost based on average of costs for systems designed for 2,000 and 3,000 kWh per year of $1,300. Costs are total installed costs, not including O&M or program operation. All costs in this report in $US.
[5] JPS share of cost, equal to $750 per solar DHW system, half the avoided cost. JPS assumed here to pay full cost of DHW conservation measures.
[6] Avoided costs are utility avoided costs, not including externalities.

Energy Standards. Equipment Testing is currently under way, in order to be able to implement energy standards for refrigerators, with efficiency gradually increasing, similar to the US standards, to achieve a 10% reduction in energy usage. The Energy Sector Management Assistance Program, a joint project of the United Nations Development Program and the World Bank, has funded a significant test facility and program at the JBS and testing of refrigerators is currently under way. 78 models will be tested in this first round of tests. Local testing is important due to climatic and electrical system differences. This testing will significantly reduce uncertainty in the current projections of possible savings with DSM.

Re-Tooling for Production of Very-High Efficiency Models. An investigation is planned to study the feasibility of engineering and re-tooling Jamaican refrigerator production to produce small, state of the art high-efficiency models, which would use about 30% less energy than the current small models. There are approximately 20,000 refrigerators sold per year in Jamaica, 80% of which are the small, manual defrost models. A 30% improvement in energy consumption and demand for one year's sales of these models would save 3,360 MWh per year and 0.4 MW. Producing these models would require some incremental improvements in compressors (higher efficiency motor and different refrigerant) and the redesign and re-tooling of at least the interior of the refrigerator, to accommodate the different technology (Shapiro 1991). For the 16,000 small refrigerators sold per year, the total avoided costs are $2.4 million. This would support a substantial effort at redeign and re-tooling.

Air Conditioning

The pilot program will implement efficiency standards that track current trends in technology improvement, projecting these trends out over the next 5 years. While most of the air conditioning savings projected for these programs is for commercial and industrial applications, all air

Table 7. Refrigeration Summary

DSM Measure	Number of Refrigerators Sold [1]	Savings (MWh/yr) [2]	Savings (kW) [3]	Cost ($000) [4]
Standards	35,000	3,255	385	$858
New Technology	65,000	13,715	1,690	$3,770
Total		16,970	2,075	$4,628
Total Avoided Cost [5]				$9,255

[1] Number of refrigerators sold over a 5-year period, divided into two groups: manual defrost under 10 cu.ft., and all others. New technology would apply to the first group; standards to the other group. According to the survey, 65% of existing refrigerators are of the first type. It is assumed this distribution applies to future purchases. Approximately 20,000 refrigerator are sold per year.

[2] Savings of 211 kWh/yr and 0.026 kW for new technology and 93 kWh per year and 0.011 kW for standards. Total savings estimates include annual savings from refrigerators effected in five years of program activity. Note that standards could be implemented quickly, while implementation of new technology will require significant time.

[3] kW savings are coincident with system peak, based on US end use load profiles.

[4] JPS Costs are assumed here to be 50% of avoided costs.

[5] Avoided costs are utility avoided costs, not including externalities.

conditioning is being handled under the residential programs, because a single supply infrastructure serves both markets.

Installation standards and training for air conditioning, are also expected to be implemented, in part because the split systems require refrigeration expertise in order to realize the efficiency that these systems can achieve. Standards and accompanying labelling will be based on test results from JBS. It is estimated that standards could represent a 9% decrease in energy use by air conditioners sold in year 1 over current models, with savings improving to a 16% decrease in energy use over current models in year 5. Looking at the average savings achieved over the 5 years of a 12.5% decrease in energy use compared to current models, the screening results indicate a total avoided cost of $552. While the relationship of cost to efficiency is sometimes inconsistent, with some smaller higher efficiency units actually costing less than similar sized lower efficiency units, the general trend is toward higher cost for higher efficiency units. Incremental cost is on the order of $400 for the 12.5% energy savings, indicating good potential for an air conditioner efficiency standards program. Efficiency testing currently being commissioned will shed some light on savings estimates and may change results somewhat.

Monitoring and Evaluation for the Pilots

A significant monitoring and evaluation effort is being implemented as part of the pilot programs. A team from the University of the West Indies in Jamaica and private engineers has been brought together for this purpose, headed by Dr. Michael Witter, from the Consortium Graduate School of Social Research, University of the West Indies. Both process and impact evaluations will be conducted. Impact evaluations of the solar water heating pilot will include monitoring of the energy used by the existing electric water heater before the solar is installed, and for installations where the customer chooses to include a backup electric element, this usage will also be monitored. While some installations may receive load

Table 8. Air Conditioning Summary

DSM Measure	Number of Air Conditioners Sold [1]	Savings (MWh/yr) [2]	Savings (kW) [3]	Cost ($000) [4]
Standards	100,000	20,500	19,500	$27,625
Total Avoided Cost [5]				$55,250

[1] 20,000 units sold per year. Five-year total shown. Includes small commercial and industrial. Note that most of the savings shown are in the C&I sector.
[2] Savings of per unit are 205 kWh/yr and 0.194 kW.
[3] kW savings are coincident with system peak, based on US end use load profiles and JPS afternoon system peak.
[4] Measure costs. JPS investment assumed here to be 50% of avoided costs.
[5] Avoided costs are utility avoided costs, not including externalities.

profile recorders, it is planned that all the pilot installations will use elapsed time indicators to indicate electric element on-time and thus energy use.

Impact evaluation of the lighting pilot will rely on data from the installers with regard to wattage replaced and on customer interviews to estimate on-time of lights and hours of day when they are used. Some elapsed time indicators may be used.

Conclusions

Significant DSM potential exists in the residential sector in Jamaica. If all the DSM resource were captured, the 25 MW and 71,000 MWh per year saved would avoid significant new coal-fired power generation. The pilot programs will help answer the questions of how much of this available resource can actually be captured. The present equipment testing efforts, completed residential survey, the sample selection for participation in the pilots, and program and evaluation planning are important as much for building DSM program delivery capability in Jamaica as for the results achieved in implementing the pilots.

Acknowledgments

The demand-side management effort in Jamaica has been funded by the Jamaica Public Service Corporation, the Rockefeller Foundation, and the Conservation Law Foundation. Thanks to Joe Chaisson of CLF for review of this paper, and to Eric Espenhorst of Resource Insight, Inc., (RII) for the avoided cost information.

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