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Jeffrey Johnson, Chairman
Guam Public Utilities Commission
Suite 207, GCIC Building
Hagatna, Guam 96932

Docket 13-14: Demand Side Management

Dear Chairman Johnson,

Lummus Consultants International, Inc. (Lummus Consultants) is pleased to submit this letter report to the Public Utilities Commission in response to Mr. Fred Horecky's request to evaluate and make recommendation for GPA's Demand Side Management (DSM) activities with a focus on what if any offerings should be considered by GPA and the Commission in moving forward.

We have provided some insight into the activities of other island utilities and offered insight relative to the cost effectiveness parameters for investment decisions. We suggest a number of potential DSM program measures for adoption that can provide significant savings to both GPA and its ratepayers and have performed preliminary screening for four of these. Finally, we would like to convey that there is a wide array of energy conservation options and that the adoption of other DSM measures by GPA should not be limited to the ones that we have offered for consideration.

Lummus Consultants appreciates the opportunity to assist the Commission in this matter. If you have any questions or need further assistance, please do not hesitate to call or write.

Sincerely,
Lummus Consultants International, Inc.

Kathleen A. Kelly

Kathleen A. Kelly

Vice President and Practice Leader

150 ROYALL STREET • CANTON, MA 02021-1030• 617.589.2000 • FAX 617.589.1372

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1 Docket 13-14: Demand Side Management

Adoption of Demand Side Management (DSM) initiatives_typically addresses the objective of reducing energy consumption and demand in order to defer or eliminate construction of additional power generation resources with the goal of conserving natural resources (fuel sources), reducing emissions, and managing the cost of energy to consumers. Most mainland and many island jurisdictions utilize the Total Resource Cost Test to assess DSM or energy efficiency program cost-effectiveness. This test takes into account not only the direct utility and customer costs of DSM adoption but the societal benefits and costs as well. According to the December 2013 report by the American Council for an Energy-Efficient Economy (ACEEE) titled "*Making the Business Case for Energy Efficiency: Case Studies for Supportive Utility Regulation*", budgets for electric energy efficiency in the US were set at $5.9 billion in 2012 alone; energy efficiency represents a major investment by electric utilities and is now being investigated for potential investment in Guam.

The Lummus Consultants review requested by the Guam Public Utility Commission, investigated DSM measures implemented by other vertically-integrated utilities without regard to whether they were public power or investor-owned, as both share common goals, which is reducing the cost of supply while providing savings to ratepayers. Many public power electricity providers have invested in DSM over the last 25 years due to their role in providing customers cleaner power, sustainability, and local business improvement. An excerpt from Burlington Electric Department's (BED) website on Energy Efficiency (EE) and its role in their vision and values is provided here – this perspective is similar to many other municipal entities approach to DSM or EE.

As Burlington steadily grew through the latter half of the twentieth century and the demand for electricity increased, the voters of Burlington made the wise decision to meet as much of the energy needs of the city as possible through energy efficiency efforts. Burlington voters took the lead in 1990, when they overwhelmingly approved an $11.3 million bond to fund demand side management (energy efficiency) programs. BED remains committed to offering its customers high quality and affordable energy services and a secure, environmentally sound supply of electricity into the future. Energy efficiency continues to play a major role in achieving this goal, and is increasingly the cornerstone of BED's resource acquisition strategy.
Energy efficiency has been clearly shown to be Vermont's least expensive future energy supply resource, and is every day a greater environmental imperative. About $30 million has been invested in BED's energy efficiency efforts over the last 19 years. This includes about $13 million spent by BED and another $17 million in matching expenditures by our customers. The willingness of our customers to invest is a strong testament to the value that they place on these services.
The overall effect has been dramatic. Annual electricity consumption in 2009 was about 2 percent greater than in 1989. Thus, we have met the energy needs of a growing local economy over the last 19 years through efficiency! Energy efficiency investments save Burlington consumers more than $10.1 million of retail electric costs annually.

Burlington Electric Department Website

1.1 Introduction

To begin its review and assessment of DSM activity and potential in Guam, Lummus Consultants reviewed GPA's DSM analysis that was included in its 2013 Integrated Resource Plan (IRP)[1]. The DSM analysis provided by GPA indicated that although a diversity of program measures was screened, only a few were selected for potential implementation. The DSM program measures that were selected as having economic potential are shown in Table 1.

[1] The DSM study in GPA's 2013 Integrated Resource Plan was performed by R.W. Beck.

Table 1: DSM Measures Evaluated for Economic Potential

Residential	Commercial
2.5 Ton Central A/C - New Unit	60 Ton Chiller, 8 x 5 Operation
CFL Lighting (25 watts)	Commercial CFL Lighting (25 watts)

The program measures in this table did not pass the Ratepayer Impact Measure Test (RIM), which GPA considers to be a threshold measure for which it would consider implementing a DSM program; this is in alignment with Commission's policies relative to program cost-effectiveness.

In its report to the Commission on GPA's IRP[2], Lummus Consultants provided a number of observations regarding the DSM analysis, including:

- The range of potential DSM options considered by GPA as showing promise appeared to be too narrow;
- Although the report indicated that a wider range of options was explored, there was no identification of those options evident in the study or supporting information provided to demonstrate the result of screening for those options;
- CFL lamps as a potential option for residential and commercial was rendered moot in light of Federal regulations that transition away from traditional incandescent lamps in favor of CFLs;
- There appeared to be a lack of technical detail for the particular equipment studied;
- There was no explicit discussion as to how avoided capacity and energy costs were developed;
- There was no detail as to program costs for the utility or the customer;
- The Participant Test was not included, which could have provided insight into whether any customer incentives to adopt the DSM options would be needed.

These observations, along with the fact that many mainland and island isolated utilities have and continue to offer such programs to customers and find them to be lower in overall cost when compared to traditional supply resources, led to the impetus for this report.

GPA currently does not offer any incentive or rebates for DSM programs. Its current efforts relative to encouraging energy conservation to residential and the majority of its general service customers appears limited to energy conservation information contained in its Home Appliance Guide. GPA does, however, have other initiatives, including:

- Energy efficiency and renewable projects for large government/commercial customers and Federal customers, although these appear to be driven by the customer;
- Street lighting retrofits which is designed to increase internal efficiency;

[2] Lummus Consultants report to the GPUC titled Docket 13-02: Review and Evaluation of GPA's 2013 Integrated Resource Plan, dated July 23, 2013, Section V – Demand Side Management, pages 9-10.

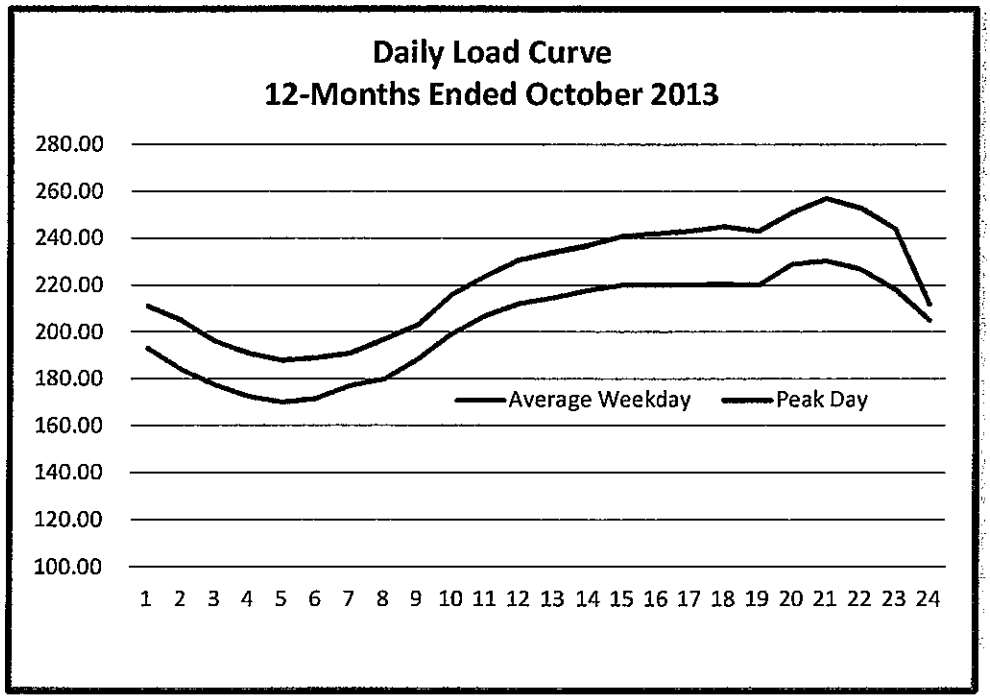
- Government (including ARRA funded) building retrofits; and
- A Solar Water Rebate Pilot Program.

A more detailed description of these programs and future GPA initiatives is contained in Appendix 1. Most of these "initiatives" have been funded by the American Recovery and Reinvestment Act (ARRA) Grant Funds that were sought and received by the Government of Guam.

1.2 Potential for Energy and Demand Savings on the GPA System

GPA's average weekday and peak day load shape for the 12-months ended October 2013 are depicted in Figure 1. The peak demand for the GPA system occurred on May 16, 2013 at 8 PM at a system load of 257 MW. In 2011 and 2012 the system also peaked at 8 PM on a weekday. As is the case for many other utilities, energy demand starts ramping up around 9 AM; however, no discrete peak occurs for GPA during the daytime hours. If a reduction in new capacity need was to be specifically targeted as part of an efficiency push by GPA, the most likely hours would be between 7 PM and 10 PM[3] There is potential for energy savings throughout the day and the evening hours with DSM initiatives and many of these initiatives result in attendant capacity savings at the time of the evening peak hour. This capacity savings will tend to flatten the load shape, thereby improving system load factor and reducing the need for either peaking facilities or, if sufficiently large, intermediate load facilities and generally will reduce cost and use of constrained resources.

Figure 1: GPA Average Weekday and Peak Day Load Curve



Evaluating the potential cost reductions for the Authority and its customers requires an understanding of the load shapes as shown above, the customer contribution to those load shapes, and the cost of power in base, intermediate and peaking periods. In order to understand how the marginal cost of generation varies

[3] This type of demand reduction could be accomplished by implementing critical peak pricing in rate design with the use of smart meters.

throughout a typical weekday, Lummus Consultants requested such information but GPA indicated that this information was currently not available for this analysis. Typically, as generation moves from base load to intermediate facilities into peaking facilities the cost of generation tends to rise.

In order to adequately assess the potential for DSM program measures to residential and commercial customers in Guam, Lummus Consultants asked GPA for additional data, including:

- Residential, commercial and industrial load profiles;
- Available appliance data;
- Lighting and air-conditioning usage.

GPA indicated that these data were also not currently available.

1.3 DSM Offerings of Other Island Utilities

A number of Pacific islands offer energy efficiency programs, including: Hawaii, Philippines, Cook Islands, Papua New Guinea (PNG), Samoa, Tonga, and Vanuatu. All are concerned with similar energy issues related to expensive generation, inefficient appliances and inefficient buildings operating in a tropical environment and each have energy efficiency and renewable goals and objectives. The common objective of these island programs is to reduce energy consumption sourced from high cost fuel or diesel oil. Most of the islands rely on increasingly expensive diesel or oil fueled generation so reductions in energy use directly benefits consumer bills relative to fuel cost savings. Renewable programs such as solar (PV) and small wind were also mentioned in some of these islands plans to reduce energy usage. Several of the island energy efficiency and renewal plans are described in Appendix 2.

Common energy efficiency programs utilized on these islands (Puerto Rico, Virgin Islands, N. Mariana Islands, American Samoa, Hawaii) include energy efficient split and central air conditioners (both residential and commercial), refrigeration (refrigerators & freezers), lighting (LEDs for residential, conversion from T12 to T8/T5 lighting for commercial - including sensors), appliance replacement (washers, dryers & dishwashers) and window repair/replacement. With respect to taking advantage of opportunities in new construction, in addition to energy efficient end uses (appliances and equipment) these island utilities offer savings from building designs with fewer windows, facing the structure away from direct sunlight, and taking advantage of sea breezes for cooling. Other opportunities offered include replacing outdoor and street lighting with LEDs or induction lamps.

Appendix 2 contains a listing of the DSM activities of other island utilities.

In terms of funding, some of the Pacific islands have energy efficiency and renewable projects funded and administered by outside parties. There are two specific projects in the Pacific islands: the Philippine Energy Efficiency Project (PEEP) and Promoting Energy Efficiency in the Pacific Phase 2 (PEEP2), which are funded by the Asian Developed Bank (ADB) with technical assistance and implementation by the International Institute for Energy Conservation (IIEC). United States territories have funding made available through the Department of Energy (DOE) and American Recovery and Reinvestment Act (ARRA). GPA may be able to avail itself of similar funding sources. Appendix 3 provides information and links to the PEEP and PEEP2 programs.

1.4 Discussion of Technologies and Energy Conservation Measures

Energy efficiency technologies are constantly evolving and new technologies are being introduced to the consumer. This section discusses some of the most current opportunities.

Lighting

Lighting is estimated to comprise a significant portion of GPA's annual energy requirements and since GPA's peak hour typically occurs at 8 P.M., there is potential for capacity savings on the system from lighting improvements in efficiency. Over the past decade, DSM efforts nationally to reduce residential lighting load have been focused on replacing traditional incandescent lamps with compact fluorescent lamps (CFLs). However, the U.S. Energy Independence and Security Act of 2007, as modified, mandated that beginning in late 2012, there would be a progressive increase in energy efficiency for 40-watt to 100-watt bulbs measured in terms of lumen brightness per watt of input power, or lumens per watt. By 2020 a second tier of restrictions would become effective, which requires that all general service bulbs produce at least 45 lumens per watt, similar to current CFLs. Additionally, new packaging requirements in the U.S. will be changed to refer principally to the lumen level of a bulb rather than its wattage. Table 2, compares the efficiency of the standard incandescent lamp with other currently available lamp technologies.

Table 2: Efficiencies of Current General Purpose Lamps

	Lumens	Watts	Lumens/Watt
Standard Incandescent	1,700	100	17.0
Compact Fluorescent (CFL)	1,700	26	65.4
Halogen Incandescent	1,490	72	20.7
Light Emitting Diode (LED)			
2012 Offerings	800	12.5	64.0
2013/2014 Offerings			64-90+

In light of current Federal regulations that require the transition from traditional incandescent to more efficient technologies, DSM program measures to encourage customers to transition to CFLs are now moot. Rather, an opportunity exists for GPA to encourage its ratepayers to transition to those LED lamps that are in the higher end of the efficiency range. LED bulbs have undergone a significant price drop in the past year along with increasing efficiencies. LED prices are expected to drop further, as there is currently intense competition among LED bulb manufacturers. Since the more efficient LEDs generate less heat than CFLs, there is an additional savings in generation requirement to serve air-conditioning load. This secondary consideration could be taken into account on the benefit side of the cost effectiveness tests. Lummus Consultants performed a preliminary screening of LED bulbs that included a rebate of $4 per LED bulb. The results are shown in Table 5.

On the commercial side, offices have relied on fluorescent lighting for many years. Type T-12 tube fluorescent lights, with efficiencies on the order of 60 lumens per watt are now being phased out in favor of thinner T-8 lamps with efficiencies of approximately 90 lumens per watt and still thinner, higher efficiency T-5 fluorescent tubes with efficiencies in excess of 100 lumens per watt. Attendant with the transition to more efficient bulbs, are more efficient electronic ballasts that replace the older magnetic ballasts that have losses on the order of 20%. Transitioning to T-8 or T-5 lamps requires additional costs from materials and installation of a new fixture or fixture conversion kit, but that cost is expected to be offset by the energy and potential capacity savings that can be realized. Commercial LED lighting strips are also available that are designed for retrofit into existing T-8 fixtures.

Air-conditioning

Air Conditioning is estimated to account for the greatest residential energy use on GPA's system. Between 1993 and before 2006 the U.S. Department of Energy mandated that air-conditioner energy conservation standards as specified in the Code of Federal Regulations[4] must have minimum Seasonal Energy Efficiency Ratios (SEER) of 10.0 for split systems and 9.7 for single package systems[5]. Beginning January 23, 2006 and before January 1, 2015, minimum SEER's for split system and single-package air-conditioners were increased to a SEER of 13[6]. There are currently split-system and single-package air-conditioners available with SEER ratings in the mid-20 range. An air-conditioner with a SEER of 25 is approximately 48 percent more efficient than a minimum air-conditioner with a SEER of 13, albeit, at a higher initial cost.

In addition to federally prescribed minimum energy efficiency standards, there are new and innovative approaches to delivering cold air through buildings. Conventional split system central air-conditioners have compressors that cycle either fully ON or OFF and have ductwork in the building that can have energy losses in the order of 30 percent. For these installations, the entire house is air-conditioned regardless of whether individual rooms are occupied. A variation of conventional split system central air-conditioners is a multi-split system with an evaporator in each living space. As this configuration routes refrigerant to each room, it requires a minimum of ductwork. Although it has the advantage of significantly limiting energy losses in comparison to a conventional system, the compressor is still either all ON or OFF. In conversation with an air conditioner contractor in Guam indicated that approximately 30 percent of residential households in Guam have ducted split units and 70 percent have ductless units. A technology that is increasingly gaining traction in the U.S. is the Variable Refrigerant Flow (VRF) ductless air-conditioning system. These systems also have evaporators in or near each room. However, through the use of an inverter that converts AC to DC for motor control in the outside central unit, flow of the refrigerant from the outside unit is able to be varied so as to meet the aggregate requirement of specific rooms in which air-conditioning is required. This technology can offer energy savings of 15-20 percent as compared with a multi-split system and much greater energy savings compared with ducted split systems.

Lummus Consultants recognizes that initial installed cost is a primary concern of most of GPA's, and most mainland customers, may require an incentive or rebate in order to purchase a higher efficiency or VRF system. Also whereas outside air-conditioning units in the mainland U.S. may have an average service life of 15 years, the life span of an equivalent unit in Guam may only be seven to 10 years due to the high humidity, salty environment and voltage fluctuations on GPA's system. Lummus Consultants did not perform preliminary screening for VRF air conditioners, as there are a myriad of variables specific to each customer, including current air conditioner technology, configuration, and country in which the new air conditioner is manufactured. Nonetheless, Lummus Consultants recommends that VRF air conditioners be screened and incorporated as a DSM measure with even a nominal rebate. Hawaii offers $200 rebates for VRF systems and this type of program could be a viable DSM program for GPA as well.

Refrigerators

Refrigerator efficiency has undergone progressive and very significant increases since the 1970s. 16.5 to 18.9 cubic-foot refrigerators sold prior to 1980 consumed over 2,000 kWh per year[7]. Around 2004 the average, same size refrigerator consumed approximately 500 kWh, or 75 percent less energy. These efficiency increases were

[4] 10 CFR 430.32(c)(1).

[5] EER, or Energy Efficiency Ratio is the (BTU/hour)/(Watt-hours) at a constant outside temperature of 95-degrees F. The Seasonal Energy Efficiency Ratio (SEER) provides a measure of the efficiency of the air-conditioner over the course of a season at varying temperatures. In warmer climates such as Guam, with relatively constant temperature, the SEER measure tends to approach the EER measure.

[6] 10 CFR 430.32(c)(2).

[7] Energystar.gov.

not so much due to new innovative technology, but rather, fallout of the 1973 Arab Oil Embargo that lead to progressively increasing oil prices. According to industry experts, efficient refrigerator design involves a trade-off that considers the additional cost of compressor motors, compressor placement, and increased insulation wall thickness, which may not be agreeable to consumers, versus cost, aesthetics and ease of everyday use. Although the rate of improvement in refrigerator efficiency may be declining[8], there remains significant potential to include energy efficient refrigerators as a DSM measure for Guam. Current Energy Star refrigerators are rated at approximately 385 kWh per year and are approximately 20 percent more efficient than non-Energy Star refrigerators. Recognizing the steep decline in refrigerator energy efficiency, if GPA could incent a consumer to completely replace an older refrigerator that is currently working by requiring a trade-in, significantly greater savings could be realized by both GPA and the customer. Lummus Consultants performed preliminary screening for refrigerators. The results are summarized in Table 5.

Solar Photovoltaic Panels

Over the past six years, the efficiency of mainstream photovoltaic (PV) modules have remained constant at around 20 percent efficiency, but the installed cost of the panels have dropped from approximately $8/watt to approximately $4.00 per watt. There is also a 30 percent Federal income tax credit available for new installations that helps to significantly defray initial installation costs. A typical residential PV installation in Guam could have a capacity of 5 kW. The solar panel installation provides an opportunity for the owner/customer to generate more kWh during the day that can be consumed, with the additional energy provided to GPA through a net metering arrangement[9]. Another approach could be through a value of solar tariff that requires the consumer with a PV system to take all of its requirements from GPA and to sell the output of its PV system to GPA based on the value of solar tariff. The more common approach in Hawaii, California and the Mainland U.S. is net metering; however, with an increasing pace of PV installations, utilities and regulators are shifting to alternative approaches to ensure the consumers' economic decision making is appropriate and that the utility remains whole for its distribution investment.

Lummus Consultants believes that the current lower capital cost of a photovoltaic panel installation merits review as an efficiency or DSM measure and has included it in its preliminary screening, which is discussed later in this document. In this regard, we recognize that since photovoltaic only generates power during the day it does not act to reduce GPA's evening peak. To do so would require battery storage, which today, would virtually double the initial cost of the installation.

Solar Hot Water Heaters

Solar hot water programs combine rebates, tax credits and bill savings to encourage consumers to participate. Savings are based upon the customer's annual hot water usage in conjunction with utility rates. Current federal tax credits along with local tax credits can make the program economical. The initial cost of the hot water heater runs as much as five times as much as a conventional hot water heater, therefore, a solar hot water heater may be more effectively targeted to those ratepayers that have additional appliances that require hot water, such as dishwashers and clothes dryers.

Smart Power Strips

Computers and electronic devices of all sorts have become ubiquitous in virtually every home. Many of these devices are either continuously on or in sleep mode and drawing power, if only a few watts. However, the

[8] Interestingly, a Monitor-Top refrigerator made by General Electric from 1925 to 1937 used only 244 kWh per year. (http://www.greenbuildingadvisor.com/blogs/dept/musings/choosing-energy-efficient-refrigerator).

[9] Lummus Consultants is of the understanding that present, GPA only allows up to 1,000 customers to provide energy to the utility under net metering.

aggregate of these devices in the household and among households adds up to a significant load on GPA's generation system. Smart Power Strips have outlets that perform specific functions. For example, when using a Smart Power Strip, if a computer or laptop is plugged into a master outlet, when that outlet is turned off, related equipment such as printers, scanners and the computer monitor will also be turned off. Other outlets on the power strip can keep power on continuously. Smart Power Strips are available in varying degrees of sophistication and can save GPA customers two percent or more kWh per month.

The foregoing discussion is only intended to provide a sampling of potential DSM measures rather than to provide an all-inclusive review of potential DSM options for GPA. Technology and innovation is always evolving and DSM offerings can range from simple ceiling or whole house fans, occupancy sensors, residential photovoltaic, or to more sophisticated programs such as air-conditioning cycling around the evening peak hour, implemented in part using smart meter technology.

1.5 Discussion of Cost Effectiveness Tests

There are generally five standard tests used to assess the cost effectiveness of a DSM or EE measure as described below.

- The **Participant Cost Test (PCT)** assesses the benefits and costs from the perspective of the customer installing the measure. The PCT provides insight as to whether an incentive payment may be needed in order to convince the customer to adopt the program measure.
    - Answers key question: Will participants benefit over the measure life?
- The **Total Resource Cost Test (TRC)** assesses the benefits and costs from the perspective of the utility and its customers (participants and non-participants) in the utility's service territory. This test includes both utility costs and participant costs.
    - Answers key question: Will the total costs of energy in the utility's service area decrease?
- The **Societal Cost Test (SCT)** includes all benefits and costs of the TRC, but also benefits to society, including monetized benefits such as cleaner air or health impacts.
    - Answers key question: Is the utility, island, state, territory, or country better off as a whole?
- The **Program Administrator Cost Text (PACT)** measures costs and benefits from the perspective of the utility, government agency or third-party that is charged with implementing the program.
    - The PACT provides an indication of how the energy efficiency measure compares with supply-side investments.
    - Answers key question: Will utility bills increase?
- The **Ratepayer Impact Measure Test (RIM)** assesses the impact of the energy efficiency measure on non-participating ratepayers or customers. The RIM test includes the same costs and benefits as the PACT test, but in addition, recognizes lost utility revenues that result from energy and demand conservation. For this reason the RIM test is the most difficult in terms of achieving a positive net benefit.
    - The RIM test is used typically as a secondary consideration to provide a high-level understanding of the likely pressure on rates.
    - Answers key question: Will utility rates increase?

Currently the Guam PUC requires the use of the Ratepayer Impact Test to assess the cost effectiveness of DSM or EE programs. This test is the strictest in use today. Lummus Consultants observes that if supply side options were required to pass the RIM test, no new plants would be constructed as all such investment typically increases rates. The Commission should assess and compare the potential use of the TRC test in combination with the RIM test (and potentially other tests such as the PCT) for future decisions relative to DSM investment. The recommended multiple test approach provides a more level decision making approach between supply and demand options while considering the potential rate implications for non-participants. The new approach would require changes in GPA's approach to integrated resource planning.

Table 3 illustrates the costs and benefits that are included in each of these tests.

Table 3: Benefits and Costs Included in Program Measure Tests

	Participant Cost Test (PCT)	Total Resource Cost Test (TRC)	Societal Cost Test (SCT)	Program Administrator Cost Test (PACT)	Ratepayer Impact Measure Test (RIM)
Benefits					
Incentive Payments	✓				
Bill Savings	✓				
Avoided Energy Costs (utility)		✓	✓	✓	✓
Avoided Capacity Costs (utility)		✓	✓	✓	✓
Benefits incl. Health & Clean Air			✓		
Costs					
Program Overhead Costs (utility)		✓	✓	✓	✓
Program Installation Costs (utility)		✓	✓	✓	✓
Incremental Equipment & Installation Costs	✓	✓	✓		
Program Incentive Costs				✓	✓
Lost Revenues					✓

As each of these five standard tests evaluates program measures from a different perspective, an evaluation of all of the tests in conjunction with one another provides a more comprehensive picture than any one test alone. The aggregate of all of the information should be used to shape how the cost effectiveness of energy-related programs is treated in terms of the policy goals and circumstances of a given program, utility, and regulatory commission.

In the U.S. the most common primary measurement of energy efficiency cost-effectiveness is the TRC, followed by the SCT[10]. Table 4 shows the primary and secondary cost-effectiveness tests used by different states.

[10] Source: National Action Plan for Energy Efficiency (2008). Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers. Energy and Environmental Economics, Inc. and Regulatory Assistance Project.

Table 4: Cost-Effectiveness Tests in Use by Different States as Primary or Secondary Consideration[11]

TRC	SCT	PCT	PACT	RIM
AR, **CA**, CO, CT, DE, FL, GA, HI, IL, IN, KS, **MA**, MN, **MO**, MT, **NH**, **NM**, NY, UT, VA	**AZ**, CO, GA, HI, IA, IN, **ME**, **MN**, MT, NV, OR, VA, **VT**, **WI**	AR, FL, GA, HI, IA, IN, MN, VA	AT, CA, **CT**, HI, IA, IN, MN, MO, NV, OR, **TX**, **UT**, VA	AR, DC, **FL**, GA, HI, IA, IN, KS, MN, NH, VA
Note: Boldface indicates the primary cost-effectiveness test used by each state.				

Appendix 4 also shows the range of cost-effectiveness tests that are used by different states. Some states prescribe cost/benefit thresholds to be used as pass-fail, and some use each of the tests to inform the decision making or merging the results of the tests that are used. As one example, in the District of Columbia, the RIM is used for DSM programs. Those which have a cost-benefit ratio of between 0.8 and 1.0 may be evaluated for other benefits, including long-term savings, market transformation, peak savings, and societal benefits and approved for implementation even though the initial RIM was less than 1.0, the typical threshold below which programs are rejected.

1.5.1 DSM Screening

Lummus Consultants performed a very high-level screening for some of the energy saving initiatives identified in the Discussion of Technologies and Energy Conservation Measures section of this report. The measures screened were:

- LED Lamps;
- Energy Star Refrigerators;
- Photovoltaic Panels; and
- Solar Water Heating.

For purposes of this high-level screening, we only considered those costs associated with the first year of each program measure installation and compared those costs with benefits that could be realized over the life of the measure installation. Benefits were based on 2013 avoided energy and demand costs reported in GPA's 2013 IRP[12]. Installed equipment costs and operational characteristics of photovoltaic panels and, solar water heating were developed based on discussions with contractors in Guam that specialize in each type of installation. Customer participation incentives were in line with those offered by the Hawaiian utilities. The results of this high-level screening in terms of benefit to cost ratios by cost effectiveness test are shown in Table 5.

[11] *Ibid.*, p. 1-2.

[12] GPA 2013 Integrated Resource Plan, Appendix D, Section 3– Results, EPRI Demand and Energy Reduction Cost Benefit Model: Summary of Avoided Costs and Program/Project Costs, page 1 of 5.

Table 5: High-Level DSM Screening Benefit to Cost Ratios

	Total	LED Lamps	Energy Star Refrigerators	Photovoltaic Panels	Solar Water Heating
	Benefit to Cost Ratios				
Participant Test	-	4.14	7.72	8.89	2.78
Total Resource Cost Test	2.22	1.06	1.33	2.95	1.47
Program Administrator Test	5.48	1.43	1.74	6.88	4.69
Ratepayer Impact Measure Test	1.32	0.93	0.93	1.30	1.46

The preliminary results show that each of the four measures for which preliminary screening was completed resulted in benefit cost ratios greater than 1.0 for two out of the four tests. The Ratepayer Impact Measure Test, which is typically the most difficult to pass, shows benefit to cost ratios slightly less than one for LED lamps and refrigerators. However, we note that our initial screening is very high-level and a more thorough and focused testing needs to be done to confirm our preliminary results. The methodology and assumptions used for each of these program measures are detailed in Appendix 5.

1.6 Discussion and Recommendations

Lummus Consultants recognizes that an island isolated utility is in a unique situation compared to Mainland U.S. utilities but there is sufficient evidence among island utilities that it is in the best interests of both the customer and GPA for development of DSM program measures educational information options to save energy. Most of the other island utilities identified in this review have an array of DSM programs and similar programs should be explored further by GPA.

GPA currently uses the RIM test as its threshold test before proceeding with a DSM program measure. This test estimates the impact of an energy efficiency program measure on non-participants. In this regard, Lummus Consultants notes that for a RIM test result less than 1.0, in the short term, there is no effect on non-participants until rates are adjusted in a rate case proceeding, at which point there will likely be an increase to non-participants[13]. However, depending on the cost of fuel avoided at the margin resulting from the DSM measure savings, there may be a lower average cost of fuel, which is a benefit to all customers. In the longer term, the energy efficiency measure may also reduce the capacity requirements of the system. Depending on the type of avoided costs used in the cost effectiveness tests, i.e., based on current system configuration and market prices versus an expansion plant where capital investment changes, the RIM test can be above 1.0. If a new generating unit is a part of an expansion plan, the cost to all customers will likely increase. In light of the above, Lummus Consultants believes that the RIM test should be not be the exclusive threshold test, but rather, should be used as an adjunct to other cost-effectiveness tests. Many other jurisdictions utilize the Total Resource Cost Test as the decision making test and use the other tests to define incentives and to inform the decision. As mentioned earlier in this report, Lummus Consultants observes that if supply side options were required to pass the RIM test as DSM does in Guam, no new plants would be constructed as all investment typically increases rates. Treating the supply and demand options on an equivalent basis may serve to reduce rates over time for consumers.

We presented four program measures that, at least initially on a high level, appear to pass all of the thresholds by way of having a net benefit. These five program measures are very similar to those offered by Hawaiian utilities. However, we are not suggesting that GPA's consideration of DSM measures be limited to these four.

[13] For utilities that have a lost margin recovery mechanism, rates can increase between rate cases.

Rate design can be an important adjunct to DSM, especially with the ability to incorporate the functionality of GPA's Smart Meters. Effective DSM program measures that work in conjunction with usage during peak hours include: critical peak pricing and air-conditioning cycling. Plug-in electric vehicles can use as much energy as an entire house and it is likely that charging these vehicles will occur at the time of GPA's evening peak hour resulting in a lowering of GPA's system load factor. As these vehicles become more common in Guam, special rates can be developed for this end-use. In developing its reliability report to the PUC in Docket No. 13-13, Lummus Consultants noted that over the 12-months ended November 2013, there was a large spike in the number of outages at 10 PM. To the extent that this was due to system load, efforts to reduce evening load may result in better reliability.

Based on our review of the DSM activities of other island utilities and of the current initiatives that appear to be viable, Lummus Consultants offers the following recommendations:

- Guam public law currently provides for target levels of renewables to be integrated into GPA generation. The Guam PUC should consider supporting and instituting regulatory policy changes to support the adoption of DSM.
- A pilot DSM project should be started as soon as possible. This should be based on a discussion between the GPUC and the GPA with a focus on the findings of this report and next steps, including a timetable for a more transparent and detailed screening that includes a wide array of promising DSM program and energy conservation measures. For those measures that pass GPA's next screening, GPA should develop and provide to the PUC a detailed guide and timetable for implementation, including metrics for tracking program success. Lummus Consultants could act as an overseer and provide guidance in this endeavor.
- The GPUC and GPA should consider not using the Ratepayer Impact Measure test as the sole pass/fail criterion for a DSM measure.

Appendix 1: GPA Response to Lummus Consultants Requests for Information

GPA response to Lummus Consultants' request to provide a detailed description of current demand and energy conservation initiatives that GPA has in place.

GPA Response:

GPA does not have an incentive or rebate DSM program. GPA presently has Energy Services program that utilizes contracted Energy Service Partners Johnson Controls, Inc. (JCI) and Science Applications International Corporation (SAIC) to implement energy efficiency and renewable projects for large government/commercial customers and Federal customers at their request and through their funds.

To date GPA and its Energy Service Partners have implemented energy efficiency projects throughout several local government facilities funded by the American Recovery and Reinvestment Act (ARRA) Grant Funds received by the Government of Guam. They are summarized below:

- ARRA Streetlight Retrofits – $2.5 Million ARRA Block grant. Retrofitted 1073 streetlights with LED and Induction streetlights along the main roads – Route 1, 4, 8, 10, 10A, 14, 16, 30, 30A, San Vitores Rd., and in the villages. Estimated savings is about $175,000 per year.
- ARRA GovGuam Buildings Retrofits (phase 1)– $8.1 Million ARRA SEP grant. Energy upgrades for 44 facilities under 12 line agencies (DOA, DOAg, DOC, DMHSA, DPR, DPHSS, DPW, DYA, GEO, GFD, GPD, and GPLS). Upgrades include lighting retrofits, HVAC (A/C units and VAVs retrofits), plumbing retrofits, appliances replacement, roof coating improvement, window coating. Estimated savings is about $1M per year.
- ARRA GovGuam Buildings Retrofits (phase 2)– $3,136,099 ARRA BLOCK grant. Energy upgrades for 5 facilities – Government House, Ricardo J. Bordallo Governor's Complex, Chamorro Village, KGTF, Finegayan Elementary School. Upgrades include lighting retrofits, HVAC (A/C units and VAVs retrofits), plumbing retrofits, appliances replacement, roof coating improvement, window coating. Estimated savings is about $295,000 per year.
- ARRA Solar Water Heating Rebate Pilot Program - $270,300 ARRA BLOCK grant. Residential rebate pilot program for solar water heating unit installation including home audit. Funding was limited to 52 customers. Estimated savings is about $31,000 per year.

Other projects include the Guam International Airport using JCI to implement their energy efficiency projects and development of an island wide street light retrofit program. Although we've done several preliminary audits to civilian and federal agencies none have requested to proceed to investment grade audits towards implementation mainly due to project costs. GPA continues to pursue grants to fund energy efficiency project implementation for all its customers including revolving loan programs for commercial and residential customers with recovery via their power bill.

GPA will launch a Prepay Account service by first quarter 2014. Industry reports indicate that residential customers on a Prepay service basis reduce their energy consumption by over 11%. (See "defg-press-release-2013-03-20-prepay.pdf" attachment)

Future initiatives include:

- Utility Energy Service Contract (UESC) with the U.S. Army Core of Engineers (ACOE) (refer to "US Army Reserve Center Audit (Army Corps of Engineers).pdf" attachment for recent correspondence and task order)
- Solar PV Program with GCC (refer to Marianas Variety article attached as "32773-solar-rooftop-program-eyed-for-guam-community-college.pdf")

UESC Program with the United States Navy. In Preliminary discussions, Navy has a 15 MW target for renewable energy.

Appendix 2: Island DSM Programs

Location	Description of Program	Incentives/Rebates	Link
Virgin Islands	Energy Efficiency Residential State Rebate Program is a Residential program for those who have energy efficient improvements made with the following: Dishwasher, Refrigerators, Water Heaters, Heat pumps, Custom, and Tankless Gas.	The program offers up to $599 or 30% of the purchase price. The appliances must be Energy Star rated.	http://www.energy-grants.net/vi-u-s-virgin-islands-energy-efficiency-residential-state-rebate-program/
	Weatherization – CFLs, Energy Star refrigerator, hot water heater timer, low flow showerhead, aerator, power strips and education	$0, targeting low income, elderly	www.vienergy.org
	Energy Efficiency & Renewable Energy State Rebate Program is a Nonprofit, Residential, Nonprofit, Multi-Family Residential, and Commercial program for those who have energy efficient improvements made with the following: Wind, Solar Water Heat, and Photovoltaic.	The program offers up to $13,300 for solar systems to $7k for wind turbines.	http://www.energy-grants.net/vi-u-s-virgin-islands-energy-efficiency-renewable-energy-rebate-program/
Puerto Rico	All customers, small solar or wind installations (less than 100 kW)	Up to 40% of installed costs	http://www.prgef.com/TierOneInfo.aspx
	Building Energy Efficiency Retrofit State Rebate Program is an Industrial, Commercial, and Nonprofit program for those who have energy efficient improvements made with the following: Energy Mgmt. Systems/Building Controls, Windows, Motors, Motor VFDs, Condensing Units, Ventilation Upgrades, Combustion Air Control Systems for Boilers, Demand Outside Air Ventilation Systems, Lighting, Lighting Controls/Sensors, and Chillers.	The program offers up to $300k. All equipment must be UL or ETL listed.	http://www.energy-grants.net/pr-puerto-rico-building-energy-efficiency-retrofit-state-rebate-program/
	Solar Water Heater State Rebate Program is a Residential program for those who have energy efficient improvements made with the following: Solar Water Heat.	The program offers up to $1k. All equipment must be SRCC certified.	http://www.energy-grants.net/pr-puerto-rico-solar-water-heater-state-rebate-program/
	Agricultural Renewable Energy	The program offers	http://www.energy-

	State Rebate Program is an Agricultural program for those who have energy efficient improvements made with the following: Wind and Photovoltaic.	up to $200k.	grants.net/pr-puerto-rico-agricultural-renewable-energy-state-rebate-program/
Cook Islands	One of the projects approved is the Fridge Freezer Replacement Program (FFRP) in the Cook Islands. The objective of the FFRP is to replace old inefficient fridge/freezers with high efficient fridge/freezers and reduce electricity consumption by approximately 20-30% per participating household.	Retailers offer rebates between NZ$150 and NZ$500 to customers purchasing selected high efficient fridge/freezer models.	http://www.iiec.org/index.php/iiec-news/524-fridge-and-freezer-replacement-program-launched-in-the-cook-islands.html
Cook Islands, Papua New Guinea (PNG), Samoa, Tonga, and Vanuatu	Energy Audits	$0	http://www.iiec.org/index.php/iiec-news/510-walk-through-energy-audit-training-in-samoa-and-papua-new-guinea.html
Philippines	Philippine Energy Efficiency Project - retrofit about 40 government-owned office buildings with efficient lighting; procure 13 million compact fluorescent lamps (CFLs) for distribution to residential and other customers to reduce peak power demand; introduce energy-efficient lamps for public lighting; set up a laboratory for testing energy-efficient appliances and a lamp waste management facility; promote an efficient-building initiative; and develop and implement a communication and social mobilization program.	No costs	http://www.adb.org/projects/42001-013/details
Hawaii	Demand response program – Residential water heating and AC, CI load control and residential AC Cycling	Varies from $100 to $300 based upon technology	http://www.solari.net/documents/portfolio/Solari-HECO-2013-IRP-App-F-DR-&-DSM-Program-Data.pdf
	Solar hot water heater	Up to $1,000	http://www.hawaiienergy.com/rebates
	Lighting – CFL rebates	$1 per lamp	http://www.hawaiienergy.com/rebates
	Lighting – LED rebates	$6 -$8 per lamp	http://www.hawaiienergy.c

		om/rebates
Energy Star new refrigerator	$50	http://www.hawaiienergy.com/rebates
Energy Star refrigerator replacement	$125	http://www.hawaiienergy.com/rebates
Energy Star freezer	$50 to $65	http://www.hawaiienergy.com/rebates
Energy Star Washer	$50	http://www.hawaiienergy.com/rebates
HVAC replacement	$200	http://www.hawaiienergy.com/rebates
Solar attic fan	$50	http://www.hawaiienergy.com/rebates
Ceiling fan	$35	http://www.hawaiienergy.com/rebates
Whole house fan	$75	http://www.hawaiienergy.com/rebates
VFD pool pump	$150	http://www.hawaiienergy.com/rebates

Appendix 3: Funding Sources

Sources: IIEC website - http://www.ee-pacific.net/index.php/news1
http://www.iiec.org/index.php/iiec-news/509-philippine-energy-efficiency-project-surpasses-energy-savings-goal.html

The Philippine Energy Efficiency Project (PEEP) was established by the Philippine Government and is being implemented by the Philippine Department of Energy (DOE) with support from Asian Development Bank and IIEC.

The project, with a total approved budget of 46.5 million US dollars, covers a series of activities with the aim of reducing electricity consumption in the residential and public sectors, reducing the peak load power demand, reducing health risk associated with residual mercury and kerosene (in off-grid areas) and establishing a certification process for energy efficient and green commercial buildings. As of August 2012, the PEEP project team has successfully completed the implementation of the following activities:

Nationwide distribution of 5 million Compact Fluorescent Lamps (CFLs) which translate to an estimated energy savings of 44.7 kWh per incandescent bulb (IB) replaced[1] and annual energy savings of 223.56 GWh.

Retrofitting of 35 government buildings in Metro Manila: Installation of T5 14W lighting systems in 2,718 luminaires with 5,994 lamps and T5 28W lighting systems in 39,148 luminaires with 57,533 lamps. Measurement and verifications conducted indicate power demand reduction of 635 kW resulting in an annual energy saving of 1.37 GWh.

The Promoting Energy Efficiency in the Pacific – Phase 2 (PEEP2) Project is a regional technical assistance project funded by the Asian Development Bank (ADB) and the International Institute for Energy Conservation (IIEC) is the technical assistance consultant selected for project implementation.

The main objective of the PEEP2 is to identify, design and implement energy efficiency measures that deliver significant energy savings, lower greenhouse gas (GHG) emissions and reduce dependency on fossil fuels for electricity generation in the Cook Islands, Papua New Guinea, Samoa, Tonga and Vanuatu. As of December 2013, a total of 31 energy efficiency projects were designed and approved by the ADB for funding or co-financing by the ADB, Global Environment Facility, the Government of Australia and the Government of Japan. An additional three projects have also been approved for Papua New Guinea (see April 2014 article). The projects cover energy efficiency measures in the residential, commercial and public sectors (including street lighting).

Overall, the energy efficiency projects were developed under five main categories set under PEEP2:

- Energy Efficient Street Lighting Program
- Energy Efficient Lighting in Residential, Commercial and Government Sectors
- Energy Efficiency Measures in Hotels and Commercial Buildings
- Implementation of Energy Efficiency Measures in the Public Sector
- Fridge Freezer Replacement Program (Cook Islands)

The total projected annual energy savings are **3.49 GWh per year**, and annual energy cost savings of **1.75 million USD per year** and total annual CO_2 savings of **2,818 tons of CO_2 equivalent per year.** This does not include the estimated savings from the three additional projects in Papua New Guinea. Tables 1 and 2 provide a summary of the estimated annual savings per country and project category. The projects covering energy efficient lighting in the residential, commercial and government sectors represent about 70% of the total estimated annual energy savings. The full list of the projects approved to date is available on **www.ee-pacific.net/index.php/projects .**

The IIEC has commenced delivery and installation of energy efficient equipment in each of the five countries, which will continue during 2014. The estimated savings mentioned above will be monitored and verified for each project during 2014 and project case studies will be published during the second half of 2014.

Table 1 - Summary of Projected Annual Savings for PEEP2 Energy Efficiency Projects according to Country (December 2013)

[redacted]			
Papua New Guinea	262,405	133,144	165.9
[redacted]			
Tonga	638,924	250,977	581.7
[redacted]			
TOTAL	**3,485,217**	**1,753,403**	**2,818.3**

Table 2 - Summary of Projected Annual Savings for PEEP2 Energy Efficiency Projects by Project Category (December 2013)

[redacted]			
Energy Efficient Lighting in Residential, Commercial and Government Sectors	2,435,240	1,163,122	1,994.7
[redacted]			
Implementation of Energy Efficiency Measures in the Public Sector	451,194	272,157	405.0
[redacted]			

Appendix 4: Program Cost Effectiveness Tests

Cost Efficiency Tests in the US[20]

State	Primary Test	Total Resource Cost Test	Societal Cost Test	Participant Cost Test	Utility Cost Test	Ratepayer Impact Measure Test	Other	No Specific Test Required
Arizona	Societal (proposed)		X					
Arkansas		X		X	X	X		
California	TRC	X			X			
Colorado		X	X					
Connecticut	Utility	X			X			
District of Columbia						X	X	
Delaware		X						
Florida	RIM	X		X		X		
Georgia		X	X	X		X		
Hawaii		X	X	X	X	X		
Iowa			X	X	X	X		
Idaho								X
Illinois		X						
Indiana		X	X	X	X	X		
Kansas		X				X		
Kentucky								X
Massachusetts	TRC	X						
Maryland								X
Maine	Societal		X					
Minnesota	Societal	X	X	X	X	X		
Missouri	TRC	X			X			
Montana		X	X					
North Carolina								X
North Dakota								X
New Hampshire	TRC	X				X		
New Jersey							X	
New Mexico	TRC	X						
Nevada			X		X		X	
New York	TRC	X						
Oklahoma								X
Oregon			X		X			
Pennsylvania								X
Rhode Island							X	
South Carolina								X
Utah	Utility	X			X			
Virginia		X	X	X	X	X		
Vermont	Societal		X					
Texas	Utility				X			
Washington		X			X		X	
Wisconsin	Societal		X					
Wyoming								X

[20] *An Efficient Balance? Applying the Total Resource Cost Test to Conservation and Demand Management Initiatives of Local Distribution Companies in Ontario.* Winfield, Mark S; Koveshnikova, Tatiana. York University. June 2009. pp. 57

Appendix 5: Screening Analysis

SUMMARY OF TEST RESULTS

	Total	LED Lamps	Energy Star Refrigerators	Photovoltaic Panels	Solar Water Heating
	Benefit to Cost Ratios				
Participant Test	-	4.14	7.72	8.89	2.78
Total Resource Cost Test	2.22	1.06	1.33	2.95	1.47
Program Administrator Test	5.48	1.43	1.74	6.88	4.69
Ratepayer Impact Measure Test	1.32	0.93	0.93	1.30	1.46

PARTICIPANT TEST

	Total	LED Lamps	Energy Star Refrigerators	Photovoltaic Panels	Solar HW Heating
Initial Cost					
Initial Incremental Hardware Cost per Participant		$ 18.71	$ 100.00	$ 20,000.00	$ 7,500.00
Less Federal Income Tax Credit				(6,000.00)	(2,250.00)
Rebate		(8.00)	(50.00)	(5,000.00)	(1,000.00)
Net Initial Incremental Cost per Participant		$ 10.71	$ 50.00	$ 9,000.00	$ 4,250.00
Bill Savings					
Avoided kWh per Year		15.52	90.00	11,200.27	2,065.00
Participant Savings per Year		$ 4.43	$ 25.72	$ 3,200.52	$ 590.08
Life of Measure (years)		10	15	25	20
Avoided kWh over Life of Measure		155	1,350	280,007	41,300
Participant Savings over Life of Measure		$ 44	$ 386	$ 80,013	$ 11,802
Simple payback period (years)		2.42	1.94	2.81	7.20
Benefit / Cost Ratio		4.14	7.72	8.89	2.78

TOTAL RESOURCE COST TEST

	Total	LED Lamps	Energy Star Refrigerators	Photovoltaic Panels	Solar Water Heating
Implementation Costs					
Hardware Costs - Year 1 Only (Participant & GPA)	$ 1,881,454	$ 22,329	$ 34,750	$ 938,250	$ 886,125
Program Costs	500,000	45,778	77,841	182,173	194,208
Customer Incentives	781,180	16,680	34,750	521,250	208,500
Total Implementation Costs	$ 3,162,634	$ 84,787	$ 147,341	$ 1,641,673	$ 1,288,833
Avoided Energy & Demand Costs (over project life)					
Energy	$ 6,478,692	$ 53,660	$ 155,609	$ 4,841,280	$ 1,428,143
Demand	536,240	35,963	40,111	-	460,165
Total Avoided Costs	$ 7,014,932	$ 89,623	$ 195,720	$ 4,841,280	$ 1,888,308
Benefit / Cost Ratio	2.22	1.06	1.33	2.95	1.47

PROGRAM ADMINISTRATOR TEST

	Total	LED Lamps	Energy Star Refrigerators	Photovoltaic Panels	Solar Water Heating
Total Avoided Costs	$ 7,014,932	$ 89,623	$ 195,720	$ 4,841,280	$ 1,888,308
Implementation Costs					
Program Overhead Costs	500,000	45,778	77,841	182,173	194,208
Incentive Costs	781,180	16,680	34,750	521,250	208,500
Utility/Administrator Installation Costs	-	-	-	-	-
Total Costs	$ 1,281,180	$ 62,458	$ 112,591	$ 703,423	$ 402,708
Benefit / Cost Ratio	5.48	1.43	1.74	6.88	4.69

RATEPAYER IMPACT MEASURE TEST

	Total	LED Lamps	Energy Star Refrigerators	Photovoltaic Panels	Solar Water Heating
Total Avoided Costs	$ 7,014,932	$ 89,623	$ 195,720	$ 4,841,280	$ 1,888,308
Implementation Costs					
Program Overhead Costs	$ 500,000	$ 45,778	$ 77,841	$ 182,173	$ 194,208
Incentive Costs	781,180	16,680	34,750	521,250	208,500
Installation Costs		-	-	-	-
Lost Revenue	$ 4,050,891	33,552	97,297	3,027,077	892,966
Total Costs	$ 5,332,071	$ 96,010	$ 209,888	$ 3,730,500	$ 1,295,674
Benefit / Cost Ratio	1.32	0.93	0.93	1.30	1.46

COMMON ASSUMPTIONS (GPA)

Line	Description			Basis
1	Number of Residential Customers		41,700	
2	Incremental Residential Rate ($/kWh)			
3	Base Rate	$	0.093350	
	Insurance Charge	$	0.002900	
4	Emergency Water Well & Wastewater Charge (>500 kWh/mo.)	$	0.002790	
5	Working Capital Fund Surcharge	$	0.004660	

6	Sub-Total (Margin)	$	0.103700	
7	LEAC	$	0.182054	

8	Total	$	0.285754	
9	2013 Avoided Costs			
10	Energy ($/MWh)	$	155.00	GPA 2013 IRP
11	Demand ($/kW-year)	$	350.00	GPA 2013 IRP
12	Demand ($/kW-month)	$	29.17	
13	GPA System T&D Cumulative Loss Factor		1.07	Estimate meter to generation

SUMMARY OF KEY ASSUMPTIONS FOR MEASURE

	Total	LED Lamps	Energy Star Refrigerators	Photovoltaic Panels	Solar Heating
Initial Incremental Hardware Cost per Participant		$ 18.71	$ 100.00	$ 20,000	$ 7,500
Number of Participants (year one only)	3,093	2,085	695	104	209
kWh Savings per Participant (year one only)		15.5	90	11,200	2,065
Life of Measure (years)		10	15	25	20
kWh Savings over Life of Measure (participants)		323,547	938,250	29,190,716	8,611,050
kWh Savings over Life of Measure (GPA)		346,195	1,003,928	31,234,066	9,213,824
kW Demand Reduction - year one (GPA)		10.28	7.64	-	65.74
Rebate		$ 4.00	$ 50.00	$ 5,000	$ 1,000

ALLOCATION OF PROGRAM OVERHEAD COSTS

	Total	LED Lamps	Energy Star Refrigerators	Photovoltaic Panels	Solar Water Heating
Allocation of Total First Year Program Overhead Costs	$ 500,000				
Allocation Basis					
GPA Avoided Costs	25.00%				
Weighted No. of Participants					
No. of Participants	3,093	2,085	695	104	209
Relative Weighting Factor		1.0	10.0	100.0	100.0
Weighted No. of Participants	40,310	2,085	6,950	10,425	20,850
Percent	100.00%	5.17%	17.24%	25.86%	51.72%
Weighting in Program Costs	50.00%	2.59%	8.62%	12.93%	25.86%
Number of Program Measures	25.00%				
Total	100.00%				
Allocate Program Costs					
GPA Avoided Costs	$ 125,000	$ 1,597	$ 3,488	$ 86,267	$ 33,648
Weighted No. of Participants	250,000	12,931	43,103	64,655	129,310
Number of Program Measures	125,000	31,250	31,250	31,250	31,250
Total	$ 500,000	$ 45,778	$ 77,841	$ 182,173	$ 194,208

MEASURE: PROMOTE HIGHER EFFICIENCY LED LAMPS

ASSUMPTIONS FOR LED BULBS

	CFLs						
	Efficiency			Cost			
	lumens	watts	lumens/watt	Price	Quantity	$/bulb	Watts/1,000 lumens
	900.00	13.00	69.23	$ 8.78	4.00	$ 2.20	14.44
	900.00	13.00	69.23	9.98	6.00	1.66	14.44
	800.00	13.00	61.54	2.48	3.00	0.83	16.25
	1,600.00	23.00	69.57	12.98	4.00	3.25	14.38
	1,170.00	20.00	58.50	13.98	6.00	2.33	17.09
	1,640.00	23.00	71.30	9.98	2.00	4.99	14.02
Average	1,168.33		66.56			$ 2.54	15.11
$/1,000 lumens						**$ 2.18**	

	LEDs						
	lumens	watts	lumens/watt	Price	Quantity	$/bulb	Watts/1,000 lumens
CREE 60W (2700K)	800.00	9.50	84.21	56.82	6.00	9.47	
CREE 60W (5000K)	800.00	9.00	88.89	62.82	6.00	10.47	
Average	800.00	9.25	86.55			$ 9.97	11.56
Increase in efficiency			30.0%				
$/1,000 lumens						**$ 12.46**	11.25
$/watt/lumen							

ASSUMPTIONS FOR LED BULBS (Continued)

Avoided Costs	2013		
Avoided Costs (from GPA 2013 IRP)			
Demand $/kW-year	350.00		
Energy $/MWh	155.00		
Incremental Residential Rate ($/kWh)		$	0.2783
Est. buring hours per year	6.00		2,190
Avoided kWh			
No. of Residential Customers			41,700
Percent participation in program			5.0%
No. of Residential Customers in Program			2,085
Times LED lamps per customer			2.00
Number of LED lamps			4,170
Avoided kWh @ meter			323,547
T&D Loss Multiplier			1.07
Avoided kWh @ generation			346,195
Avoided kW			
Number of LED lamps			4,170
Avoided Watts per lamp			3.54
Avoided kW			15
Est. Coincidence Factor (CP/NCP)			0.65
Avoided On-Peak kW @ meter			9.60
T&D Loss Multiplier			1.07
Avoided kW @ generation			10.28

ASSUMPTIONS FOR LED BULBS (Continued)

	CFL	LED
Initial Outlay	$ 2.18	$ 12.46
Est. Life (years)	7	10
Adj. for 10-yr life	$ 3.11	$ 12.46
Increase in initial outlay		$ 9.35
Avoided kWh (1 lamp)		
burning hours over 10 years	21,900	21,900
watts/1,000 lumens	15.11	11.56
10-year kWh consumed	330.81	253.22
Avoided kWh over 10-years		77.59

MEASURE: PROMOTE ENERGY STAR REFRIGERATORS

ASSUMPTIONS FOR ENERGY STAR REFRIGERATORS

Equipment Assumptions

	Model No.	Cu-Ft Capacity	Energy Star	kWh	Price	Store		
Frigidaire 18.3-cu ft Top-Freezer Refrigerator (	LFTR1814LW	18.30	No	479	$ 477.00	Lowes	Type 3 16.5-18	51.00
Frigidaire 11.5-cu ft Top-Freezer Refrigerator (	FFPT12F3NW	11.50	No	409	539.00	Lowes	Type 3 10.5-12.4 cu-ft	
Whirlpool 17.6-cu ft Top-Freezer Refrigerator	W8TXNGZBQ	17.60	No	470	549.00	Lowes	Type 3 16.5-18.4 cu-ft	
Average		15.80		452.67	521.67			
Frigidaire 14.8-cu ft Top-Freezer Refrigerator (	FFHT1515LW	14.80	Yes	355	609.00	Lowes	Type 3 14.5-16.4 cu-ft	
Frigidaire 16.5-cu ft Top-Freezer Refrigerator (	FFHT1715L	16.50	Yes	368	589.00	Lowes	Type 3 16.5-18.4 cu-ft	
GE 18.1-cu ft Top-Freezer Refrigerator with Sir	GTH18GCDWW	18.10	Yes	385	649.00	Lowes	$	41.00
Average		16.47		369.36	615.67			
Energy Efficiency Delta				(83)	$ 94.00			
				-18.40%	18.02%			

Energy Star refrigerators are required to use approx. 20% less than non-certified models. https://www.energystar.gov/certified-products/detail/refrigerators

Avoided Costs	2013
Avoided Costs (from GPA 2013 IRP)	
Demand $/kW-year	350.00
Energy $/MWh	155.00

ENERGY STAR REFRIGERATORS (Continued)

	Refrigerators	
	Standard	Energy Star
Initial Outlay		
Est. Cost	$ 520.00	$ 620.00
Energy Star Incremental Cost		$ 100.00
kWh per Year	450	360
Avoided kWh / year		90
Average Service Life (years)		15
Avoided kWh over Service Life		1,350
Std. Refrigerator Annual Use (kWh)	450	
Annual Savings per Appliance (%)	20%	
Annual Savings per appliance (kWh)	90	
Annual Program Energy Savings		
No. of Residential Customers	41,700	
% Customers with Appliance	100.0%	
Customers with Appliance	41,700	
Avg. Appliance Life (years)	15	
Percent Replacements per Year	6.67%	
Percent Energy Star	50.0%	
Percent Apply for Rebate	50.0%	
Participants per year (Amount)	695	
Participants per year (Percent)	1.67%	
Percent Efficiency Gain	20.0%	
Appliance per Household with Appliance	1.00	
T&D Loss Multiplier	1.07	
Program Annual Savings (kWh)	66,929	
Avg. Hourly kWh Savings (Capacity)	7.64	
kWh Savings Over Appliance Life	1,003,928	
kW Capacity Savings Over Appliance Life	114.60	

MEASURE: PHOTOVOLTAIC PANELS

ASSUMPTIONS FOR PHOTOVOLTAIC PANELS

Installed Unit Cost ($/watt)	$	4.00
Installed Capacity (kW)		5.00
Average Capacity (kW) @ 1% degradation/yr		4.44
Installed Cost	$	20,000
Federal Income Tax Credit		30.0%
Sunlight hours per day		5.1
Monthly Energy / Installed Capacity Factor		0.210
Average Monthly Energy Production (kWh)		933
Life of Installation		25
No. of residential customers		41,700
Year 1 participation rate		0.25%
Year 1 No. of customers participating		104

MEASURE: SOLAR HOT WATER

ASSUMPTIONS FOR SOLAR HOT WATER

Installed Cost: $4,200-$5,800	$	5,000	1 story versus 2 story (use average)
Federal Income Tax Credit		30.0%	
Annual Maintenance over Life @ $125/yr	$	2,500	
Gallons Use per Person per Day		20	
kWh Savings per Month		172	Hawaii study
Avg. Hourly kWh Savings		0.236	
Factor to restate to GPA Peak Hour (8 PM)		1.25	
Approx. Peak Hour Avoided kW at Meter		0.295	
Life of Installation (years)		20	
No. of residential customers		41,700	
Year 1 participation rate		0.50%	
Year 1 No. of customers participating		209	