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Demand-Side Management Opportunity Report

Demand-Side Management
Resource Assessment
Hawaii Energy Strategy
Project #4

By:
NEOS Corporation

For:
State of Hawaii
Department of Business, Economic
Development, and Tourism
Energy Division

August 1995

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**HAWAII DEMAND-SIDE MANAGEMENT
RESOURCE ASSESSMENT**

FINAL REPORT

DSM Opportunity Report

Prepared for:

**State of Hawaii
Department of Business,
Economic Development, and Tourism
Energy Division**

August, 1995

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**HAWAII DEMAND-SIDE MANAGEMENT
RESOURCE ASSESSMENT**

FINAL REPORT

DSM Opportunity Report

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MEASURE IMPACTS DATABASE

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**HAWAII ENERGY STRATEGY PROGRAM
HAWAII DEMAND-SIDE MANAGEMENT ASSESSMENT
EXECUTIVE SUMMARY, RECOMMENDATIONS, AND CONCLUSIONS**

ES-1.0 PURPOSE AND OBJECTIVES

The primary purpose of Project 4 was to develop a comprehensive assessment of Hawaii's demand-side resources for use in energy policy development. In addition, Project 4 supported the Department of Business, Economic Development, and Tourism's (DBEDT) participation in the utilities' Integrated Resource Planning (IRP) process mandated by the Hawaii Public Utilities Commission.

Demand-side management (DSM) is defined as any utility activity aimed at modifying the customer's use of energy to produce desired changes in demand. It includes conservation, load management, and efficiency programs. DSM offers the potential for lower customer utility bills, deferral of major power plant investments, reduced environmental impacts, and potential diversification of resources.

The Project accomplished the following:

- 1) Assessed how energy is used in Hawaii's residential and commercial sectors.
- 2) Determined the potential for increasing the efficiency of energy use in each of these sectors, and identified the measures for reaching this potential.
- 3) Identified the data required to develop DSM programs, acquire data, and develop a plan to acquire additional data.
- 4) Institutionalized a DSM planning capability within the DBEDT Energy Division.

ES-2.0 HOW PROJECT 4 WAS ACCOMPLISHED

The project was divided into two phases. Barakat & Chamberlin, Inc. (BCI), performed the first phase that established a framework and data requirements for a DSM measure database, developed data collection workplans, collected data for a DSM measure database and commercial building prototypes, and characterized ten commercial building types. A *DSM Measures Compendium* was produced which identified and described the most appropriate DSM measures for consideration in Hawaii. On-site surveys of 50 commercial buildings yielded a set of building prototypes for engineering simulations.

NEOS Corporation performed Phase 2 and also collected building prototype data under a subcontract to BCI in Phase 1 of the project. NEOS used and expanded upon Phase 1 data to conduct building prototype simulations of DSM measures and technical, economic, market assessments of potential DSM, and recommended DSM programs.

The product of the two phases of the project was the DBEDT DSM Assessment Model. This model provides a comprehensive assessment of DSM potential by DSM measure, building type, and county over a 20-year forecast horizon.

ES-3.0 APPROACH AND METHODOLOGY

A database of DSM technologies was created for DSM measures applicable to Hawaii. Simultaneously, energy audits of 50 commercial buildings were conducted to support the description of 17 building prototypes. These energy audits, information contained in the DSM measure database, and supplemental information were used to develop DOE-2.1E input files for each of the different building types.

An engineering simulation model, DOE-2.1E¹, was used to test energy savings from the application of DSM measures on the building prototypes. The results were part of the input into the DBEDT DSM Assessment Model, along with the characteristics of future building and appliance stocks from the June and July 1994 ENERGY 2020² runs and various DSM programmatic assumptions based on current mainland DSM programs. The DSM Assessment Model provided estimates of the potential DSM resource for each year in the forecast period by measure and building type for each of the four counties (for Maui, Maui Island only) in Hawaii.

Each of the 17 building types was assessed using both DOE-2.1E and the DBEDT DSM Assessment Model. The DBEDT DSM Model provides both aggregate and detailed information on the size of the potential DSM resource throughout the forecast period. The detailed information is available down to the DSM measure level for each building type, by county. Four different scenarios were developed that included Technical, Economic, Market, and Hawaii Program Potential.³ Technical potential is the DSM potential if every existing piece of equipment or practice were changed to a technically feasible energy efficient option or practice. Economic potential is similar to Technical potential except that the Total Resource Cost (TRC) test was used as a cost screen. Only those DSM measures or practices that passed the TRC test are included in the estimate of Economic potential. The Market scenario also utilizes the TRC cost screening mechanism but has lower levels of market penetration than the Economic scenario. The market penetration rates for the Market scenario were based on a review of experiences from the most comprehensive DSM programs available on the mainland. The Hawaii Program potential scenario also utilizes the TRC cost screening mechanism, but utilizes still lower levels of market penetration. These market penetration rates were based on typical programmatic experience from DSM programs from the mainland rather than the experience from the most successful programs that were used in the Market scenario.

ES-4.0 THE PROJECT 4 REPORTS

The final report for Project 4 consists of a final report and five reference volumes. The final report includes:

- *Executive Summary, Recommendations and Conclusions.* This provides a short summary of the methodology, findings, and conclusions.

¹ The DOE2.1E program is an hourly building energy simulation program. Initially developed in 1976, the model has since undergone significant development through support from the US Department of Energy and others. It is the most widely used tool throughout the world for conducting building energy use studies.

² In developing the DBEDT DSM Assessment Model, preliminary versions (April 1994 - July 1994) of ENERGY 2020 were used. These versions were later significantly revised. The outputs from these early versions of ENERGY 2020 affect the results of the DBEDT DSM Assessment Model, particularly in the gas sector.

- *DSM Opportunities* report. This report provides detailed descriptions of the DBEDT DSM Assessment Model and its supporting methodology and results from different scenario runs of the model. Also included are descriptions of DSM programs and characteristics relevant to program design which affect the size and timing of potential DSM resources.

Supporting reference volumes include:

- *Building Prototype Analysis*. This reference volume provides detailed descriptions of, and the baseline assumptions and simulation results for, the building prototype simulations. The reference volume presents detailed information for each of the different building prototypes developed for use with the building simulation model.
- *Final Residential and Commercial Building Prototypes and Developed UECs and EUIs*. This reference volume is in three parts. Each part includes an introduction defining the nomenclature, code definitions, and methodology. Following the introduction are measure descriptions and detailed DOE-2.1E results for each DSM measure considered. The detailed DOE-2.1E results are presented for 17 different building types for the City and County of Honolulu (Honolulu) and an additional six climate zone applications for resorts and hotels for the counties of Maui (Maui Island only), Hawaii, and Kauai (a total of 23 different simulation results).
- *Residential and Commercial Sector DSM Analyses: Detailed Results From The DBEDT DSM Assessment Model*. Tables, graphs, and program summary reports detailing the results of four different scenario applications of the DBEDT DSM Assessment Model are included in this five-part reference volume. The first part is a statewide summary of each of the four scenario results. The remaining four parts include the results by each of the four scenarios.
- *The DBEDT DSM Assessment Model User's Manual*. The manual shows the user how to modify input files, update output files, and run the model that consists of a series of integrated Quattro Pro for Windows spreadsheets.
- *The DOETRAN User's Manual*. The DOETRAN Model is a DSM database manager developed to transfer data between the Model and the DBEDT DSM Assessment Model. DOETRAN accepts output from DOE-2.1E and translates it into the format required by the Assessment Model. The manual explains how to operate the model.

Two other major reports were produced by the project and were distributed independently of the final report. They provided data used in the DSM assessment. They include:

- *The DSM Measures Compendium* details 2,001 electric and gas DSM measures applicable to residential and nonresidential end uses in Hawaii. The compendium contains descriptions of each measure, information on how the measures work, documentation of calculations and assumptions used to develop data tables, and descriptions of qualitative information such as externalities and market acceptance. Measure data tables contain numerical information describing measure impacts, costs, lifetime, and load shape identification. Generic load shape data tables contain numerical information describing annual energy consumption profiles. The data from the *Compendium* formed a basis for assessing the energy savings potential in Hawaii's various end use sectors and was used to identify measures for incorporation into conceptual DSM programs for further evaluation.

- *Characterization of Building Prototypes* describes Hawaii's commercial building stock and provides the data required to simulate building performance in a computer-based engineering simulation model.

ES-5.0 RECOMMENDED DSM PROGRAMS

The program designs recommended for the State of Hawaii electric and gas utilities are a series of DSM measure rebate programs with moderate levels of promotion and advertising. The more successful DSM programs have the common theme of providing reasonably sized rebates with high levels of program advertising and promotion. The DSM measures considered within the DBEDT DSM Assessment Model were grouped together into the following programs:

- Residential Lighting;
- Residential Appliance Rebates (Refrigerators, Freezers, Clothes Dryers, Clothes Washers, Air Conditioners);
- Residential Water Heat (Including Solar Water Heat);
- Residential HVAC Measures;
- Residential Load Control; and
- Commercial/Industrial General Retrofit and Rebate.

The final DSM measure offerings within each program under the Market Potential and Hawaii Program Potential scenarios include only those DSM measures that pass the TRC test. A brief identification of all the DSM measures considered for each program including an identification of which measures failed to pass the TRC screening test follows.

The residential³ sector lighting program was designed to offer residential customers two alternatives to standard incandescent lamps and an alternative to standard fluorescent lighting. The alternatives to standard incandescent lamps include compact fluorescent lamps and halogen lamps. The alternative for standard fluorescent lighting is T8 lamps with electronic ballasts. The DSM measure of replacing standard fluorescent lighting with T8 lamps that have electronic ballasts did not pass the TRC test.

The residential appliance rebate program includes DSM measures designed to improve the efficiency of refrigerators, freezers, clothes dryers, and cooking ranges. Clothes drying measures are available for both electric and gas applications. The remaining measures are for electricity only. The DSM measures included in the refrigerator and freezer portion of the appliance rebate program include a second refrigerator buy-back measure and measures designed to exceed the 1993 federal refrigerator/freezer efficiency standard. The DSM measures designed to exceed the 1993 federal refrigerator/freezer efficiency standard did not pass the TRC test.

Three electric and one gas clothes dryer options are provided through the clothes drying portion of the appliance rebate program. The clothes drying moisture sensor is an appropriate measure for both gas and electric dryers. This device terminates the drying cycle rather than using a timer. In addition, two emerging technologies that could save significant amounts of electricity are included within the analysis. These are heat pump clothes dryers and microwave clothes dryers. The microwave clothes

³ Residential customers are single family and multi-family with separate meters. Master-metered apartments and condominiums are considered in the commercial sector.

drying technology did not pass the TRC test nor did the heat pump clothes drying technology in multi-family homes (it did pass when applied to single family homes).

Cooktop reflector pans were included as a DSM measure for consideration within the appliance rebate program. This measure is designed to realize energy savings by replacing existing standard pans with reflector pans made of chrome or aluminum. However, this measure did not pass the TRC test.

A large number of DSM measures are included within the Residential Water Heat Program for both electricity and gas. These include:

- Efficient Water Heaters (electricity and gas);
- Faucet Aerators (electricity and gas);
- Low Flow Showerheads (electricity and gas);
- Hot Water Pipe Insulation (electricity and gas);
- Horizontal Axis Clotheswasher (electricity and gas);
- Active Solar Water Heater (electricity and gas); and
- Heat Pump Water Heater (electricity only).

Only the heat pump water heater technology did not pass the TRC test in multi-family homes. The heat pump water heater technology did pass the TRC test in single family homes.

Residential space heating essentially does not exist in Hawaii and space cooling, especially central air conditioning, has a very low saturation. Despite the low saturation of air conditioning in Hawaii, DSM opportunities exist for the residential sector through the promotion of more efficient air conditioners and through the addition of wall and ceiling insulation. However, neither the addition of wall insulation nor the addition of ceiling insulation passed the TRC test.

In the Residential Load Control Program, participants would have external controls connected to their water heating and air conditioning units to allow the utilities to reduce their energy use at peak times of the day and during peak months of the year. The air conditioning load control units did not pass the TRC test; the water heating controls did.

The Commercial General Retrofit and Rebate program offers commercial customers the opportunity to install energy-efficient equipment during renovations/replacements or new construction projects. Energy efficiency measures that apply to lighting, HVAC, water heating, refrigeration, and cooking are eligible for rebates. Certain measures passed the TRC test when applied to particular building types and failed the TRC test when applied to other building types.

ES-6.0 PROJECT 4 CONCLUSIONS

The Hawaii Program scenario developed in this project most closely resembles the types of programs that may be offered in Hawaii in the future. This scenario assumes significant DSM program offerings from the electric and gas utilities with moderate levels of utility incentives and high levels of advertisement and promotion.

Figure ES-6-1 shows the potential for peak demand electricity reduction. Table ES-6-1 summarizes the size of the potential DSM resource by county for electric and gas energy and electric peak demand. The size of the resource varies over the forecast period based on annual program penetration rates and

effective measure life. The gas DSM resource potential includes potential savings from both utility gas and bottled gas.

The size of the potential resource grows through the year 2006, then levels off and begins declining throughout the rest of the forecast period. The primary reason for this decline is the impact of DSM measure life. Most of the implementation of DSM measures occurs over the first half of the forecast period with much lower levels of DSM measure implementation occurring in the last half of the forecast period. The effects of the DSM measures implemented over the first half of the forecast period begin to decay and disappear as each measure reaches its anticipated effective measure life. The DBEDT DSM Assessment Model incorporates the assumption that about 50 percent of the DSM measures that reach their effective measure lives are replaced by new measures that are at least as efficient as the original measures. This measure replacement assumption prevents an even more dramatic decline if no assumption of replacement were included. In contrast, if one were to assume 100 percent replacement of DSM measures with measures at least as effective as the original DSM measures, there would be no decline in the estimate of DSM potential over the last half of the forecast period. In fact, there would be continued growth. However, such an assumption was not deemed reasonable and the 50 percent replacement value was used.

ES-6.1 Residential Sector

Table ES-6-2 summarizes the size of the potential residential DSM resource by county and key forecast year under the "Hawaii Program" scenario. As one would expect, the size of the potential DSM resource from the residential sector follows the size of the population in each of the respective counties with the City and County of Honolulu providing most of the potential DSM resource. However, due to the higher saturation of gas water heaters in Hawaii County, the gas DSM potential resource there is nearly as great as Honolulu despite Hawaii County's much smaller population. This saturation of gas water heaters includes those using both utility gas and bottled gas. (Table ES-6-4)

Figure ES-6-1
Hawaii Program Potential - Peak Electricity Demand Reduction

Table ES-6-1
Hawaii Program Potential - Electricity And Gas DSM Potential

COUNTY	ELECTRICITY (MWh)			GAS (KTHERM)		
	1999	2006	2014	1999	2006	2014
Kauai	14,959	31,921	28,401	43	108	98
Hawaii	28,928	66,776	62,494	200	534	524
Honolulu	212,552	472,126	428,828	327	875	840
Maui	37,469	80,327	72,199	59	145	123
TOTAL	293,908	651,150	591,922	629	1,662	1,585
COUNTY	PEAK ELECTRICITY (KW)					
	1999	2006	2014			
Kauai	2,524	5,316	4,800			
Hawaii	4,499	10,188	9,196			
Honolulu	33,825	74,690	68,009			
Maui	6,302	13,478	12,282			
TOTAL	47,150	103,672	94,287			

Table ES-6-2
Residential DSM Potential - Hawaii Program

COUNTY	ELECTRICITY (MWh)			GAS (KTHERM)		
	1999	2006	2014	1999	2006	2014
Kauai	2,882	9,102	10,666	29	76	75
Hawaii	7,523	23,207	25,575	171	462	468
Honolulu	35,207	111,550	129,889	162	492	552
Maui	6,790	21,977	25,925	28	73	71
TOTAL	52,402	165,836	192,055	390	1,103	1,166

Figure ES-6-2 illustrates the share of the DSM potential provided by the top five residential electric DSM measures: solar water heaters, heat pump water heaters, compact fluorescent bulbs, efficient water heater tanks, and heat pump clothes dryers. The supporting data table for Figure ES-6-2 is Table ES-6-3.

Figure ES-6-3 illustrates the share of the DSM potential provided by the top five residential gas DSM measures. These are solar water heaters, efficient water heater tanks, horizontal axis clothes washers, water heat pipe insulation, and low flow showerheads. The supporting data table for Figure ES-6-3 is Table ES-6-4.

Figure ES-6-2
Residential Electric DSM Measures with the Most Potential
Hawaii Program - 2006

Table ES-6-3
Residential Electric DSM Measures with the Most Potential
Hawaii Program (by County) - 2006 (MWh)

	Oahu	Hawaii	Maui	Kauai	Total
Solar Water Heater	22,757	5,676	4,440	2,048	34,921
Heat Pump Water Heater	14,134	3,540	2,759	1,310	21,743
Heat Pump Clothes Dryer	8,729	2,149	1,912	847	13,637
Compact Fluorescent Bulbs	12,645	2,525	2,419	807	18,396
Efficient Water Heater Tank	11,839	1,856	2,096	685	16,476
Other	41,446	7,461	8,351	3,405	60,663
TOTAL	111,550	23,207	21,977	9,102	165,836

Figure ES-6-3
Residential Gas DSM Measures with the Most Potential
Hawaii Program - 2006

Table ES-6-4
Residential Gas DSM Measures with the Most Potential
Hawaii Program (by County) - 2006 (KTHERM)

	Honolulu	Hawaii	Maui	Kauai	Total
Solar Water Heater	179	222	30	34	465
Low Flow Showerhead	32	25	4	5	66
Water Pipe Insulation	46	35	6	6	93
Horizontal Axis Clotheswasher	37	44	5	6	92
Efficient Water Heater Tank	174	119	22	21	336
Other	24	17	6	4	51
TOTAL	492	462	73	76	1,103

ES-6.2 Commercial Sector

Table ES-6-5 summarizes the size of the potential commercial sector DSM resource by county and key forecast year for the "Hawaii Program" scenario. As with the residential sector, the City and County of Honolulu provides the largest potential DSM resource. The potential is larger than all of the other counties combined. The commercial gas DSM resource potential for Hawaii County is much smaller than for Honolulu County and does not mirror the residential sector.

Table ES-6-5
Commercial DSM Potential - Hawaii Program

COUNTY	ELECTRICITY (MWh)			GAS (KTHERM)		
	1999	2006	2014	1999	2006	2014
Kauai	12,077	22,819	17,735	14	32	23
Hawaii	21,405	43,569	36,919	29	72	56
Honolulu	177,345	360,576	298,939	165	383	288
Maui	30,679	58,350	46,274	31	72	52
TOTAL	241,506	485,314	399,867	239	559	419

Figures ES-6-4 and ES-6-5 identify the five commercial sector electricity and gas DSM measures, respectively, that provide the most potential and their share of that total potential. Tables ES-6-6 and ES-6-7 provide the numeric values for the DSM impacts for the top five commercial sector electricity and gas DSM measures by county and the state as a whole for electricity and gas, respectively.

For electricity, lighting measures dominate the listing of measures with high efficiency air conditioning providing the most potential for a non-lighting measure. The top five electric DSM measures provide only 57% of the total commercial sector electric DSM resource. They include optical reflectors, T-8 fluorescent bulbs with electronic ballasts, electronic ballast refits, occupancy sensors, and high efficiency air conditioning. Lighting measures, such as compact fluorescent exit signs, also provide a significant amount of the remaining 43%, but it also includes a diverse set of measures ranging from cooling measures to efficient refrigeration, depending on the commercial building type. For gas, point of use water heating is the single most effective measure, followed by water heater tank insulation, efficient water heater tanks, water heater tank insulation, solar water heaters, and timeclocks for the hot water pumps providing lower levels of DSM potential.

Figure ES-6-4
Commercial Electric DSM Measures with the Most Potential
Hawaii Program - 2006

Table ES-6-6
Commercial Electric DSM Measures with the Most Potential
Hawaii Program (by County) - 2006

Measure	Savings (MWh)				
	Honolulu	Hawaii	Maui	Kauai	TOTAL
Optical Reflectors-2X4 Recessed	91,356	11,417	13,666	5,415	121,853
Compact Fluorescent Lamps	25,099	3,631	5,180	1,718	35,627
Electronic Ballasts	34,768	3,260	4,615	1,656	44,299
4' T8 Lamps W/Electronic Ballasts	39,281	3,899	4,674	1,772	49,625
High Efficiency DX AC-COP 2.9	15,786	3,453	4,871	2,052	26,160
Other	154,287	17,922	25,344	10,207	207,760
Total	360,576	43,569	58,350	22,819	485,314

Figure ES-6-5
Commercial Gas DSM Measures with the Most Potential
Hawaii Program - 2006

Table ES-6-7
Commercial Gas DSM Measures with the Most Potential
Hawaii Program (by County) - 2006

Measure	Savings (KTHERM)				
	Honolulu	Hawaii	Maui	Kauai	TOTAL
Tank Insulation-Fiber Blanket	35	13	13	6	67
Point of Use Water Heating	272	41	44	20	376
Hot Water Circulation Pump Timeclock	19	0	0	0	19
High Efficiency Gas Water Heater	30	14	13	6	62
Active Solar Water Heating	28	4	2	0	34
Total	383	72	72	32	559

ES-7.0 RECOMMENDATIONS

The work to identify the size of Hawaii's DSM resource and identify the DSM measures with the most potential was based on the foundation of explicitly estimating the impacts of DSM measures on representative Hawaii buildings using Hawaii specific weather files. This methodology was based on the best information available. Future revisions to the DOE-2.1E and the DBEDT DSM Assessment Model assumptions and inputs, using Hawaii-specific data as it becomes available, should improve the accuracy of the DSM Assessment.

ES-7.1 Data Needs

DOE-2.1E modeling was based on building prototypes whose characteristics were developed from a small sample consisting of 50 on-site building inspections. This was a limited data set from which to develop building characteristics for the State. Future customer surveys should identify any need for revisions to the DOE-2.1E modeling efforts.

When more detailed customer surveys are completed in Hawaii, characteristics by building type should be developed and compared to the characteristics of the building prototypes in the original sample of 50 on-site building inspections. If significant differences are found in the building characteristics derived from the new survey data when compared to the original prototypes, then the impacts of DSM measures for those building types should be re-estimated using DOE-2.1E.

The current non-residential portion of the DSM database should be enhanced to include more DSM measures for the agricultural and industrial sectors. The measures considered should be specific to Hawaii conditions and include data for food processing, stone and clay, metal fabrication, water pumping, and irrigation. The DBEDT DSM Assessment Model should then be updated to include consideration of new agricultural and industrial measures.

ES-7.2 Program Evaluation

The uncertainty and variance surrounding the estimates of DSM measure impact and the extent of those impacts over time make on-going program evaluation efforts important. The DSM measure impacts used by the DBEDT DSM Assessment Model are for estimated average conditions. Evaluation of DSM program efforts will determine the actual levels of impacts and the stability of those impacts over time. Actual program design and adoption are dependent on many factors, so the fact that a measure has a high theoretical potential may not necessarily mean that it could, or would, be selected by a utility. As program evaluation develops sounder estimates of measure impacts, new values should be used to update the DBEDT DSM database.

ES-7.3 Policy Scenarios

Some of the findings of this project indicated that certain DSM policies should be evaluated in the ENERGY 2020 model as to their effectiveness in reducing demand and their impact on Hawaii's economy. The following findings were recommended to be evaluated:

Residential Sector

1. Mandate that all electric water heaters must have load control devices.
2. Mandate that all refrigerators and freezers sold in Hawaii be at least 10 percent more efficient than the current federal standards.
3. Mandate that 60 percent of all new residential construction have solar water heating.

Commercial Sector

1. Mandate the placement of load control devices on commercial building air-conditioning, and water heating systems.
2. Mandate the installation of energy management systems in all large office and large retail new construction.

**HAWAII ENERGY STRATEGY PROGRAM
HAWAII DEMAND-SIDE MANAGEMENT RESOURCE ASSESSMENT
FINAL REPORT
STATE OF HAWAII DSM OPPORTUNITY REPORT**

1.0 INTRODUCTION

The Hawaii Demand-Side Management Resource Assessment was the fourth of seven projects in the Hawaii Energy Strategy (HES) program. HES was designed by the Department of Business, Economic Development, and Tourism (DBEDT) to produce an integrated energy strategy for the State of Hawaii. The purpose of Project 4 was to develop a comprehensive assessment of Hawaii's demand-side management (DSM) resources. To meet this objective, the project was divided into two phases. The first phase included development of a DSM technology database and the identification of Hawaii commercial building characteristics through on-site audits. These Phase 1 products were then used in Phase 2 to identify expected energy impacts from DSM measures in typical residential and commercial buildings in Hawaii. The building energy simulation model DOE-2.1E was utilized to identify the DSM energy impacts. More detailed information on the typical buildings and the DOE-2.1E modeling effort is available in Reference Volume 1, "Building Prototype Analysis".

In addition to the DOE-2.1E analysis, estimates of residential and commercial sector gas and electric DSM potential for the four counties of Honolulu, Hawaii, Maui, and Kauai through 2014 were forecasted by the new DBEDT DSM Assessment Model. Results from DBEDT's energy forecasting model, ENERGY 2020⁴, were linked with results from DOE-2.1E building energy simulation runs and estimates of DSM measure impacts, costs, lifetime, and anticipated market penetration rates in the DBEDT DSM Model. Through its algorithms, estimates of DSM potential for each forecast year were developed. Using the load shape information from the DOE-2.1E simulation runs, estimates of electric peak demand impacts were developed.

Barakat & Chamberlin, Inc. (BCI) completed Phase 1 of Project 4. NEOS Corporation completed Phase 2 of Project 4 and also collected building prototype data under a subcontract to BCI in Phase 1 of the project. The NEOS project team included one sub-contractor, Paul Reeves, a consultant in the operating of the DOE-2.1E engineering model.

The following report was prepared under the technical direction of Gary Cullen (project manager) with assistance from Ednan Hamzawi, Paul Reeves, Rebecca Young, Mary McNally, Richard Oberg, Constance Newman, and Pauline Valenzuela. DBEDT project managers were Carilyn Shon and Elizabeth Raman.

⁴ ENERGY 2020 is a system dynamics model developed by Systematic Solutions (SSI), which was designed especially for comprehensive energy planning at a regional level. In October 1992, the demand module of ENERGY 2020 was selected by DBEDT to forecast Hawaii's energy needs. Subsequently, the entire model was adopted and calibrated for each county in Hawaii. ENERGY 2020 provides the basic structure, and each user customizes the model for individual use based on local conditions. (i.e., The Hawaii version of the model is different than the one used, for example, in Vermont.)

1.1 What Is A DSM Assessment?

A DSM assessment estimates the size, timing, and cost of potential DSM resources over a forecast period. This assessment incorporates anticipated changes in the number and characteristics of existing buildings and appliances, as provided by the ENERGY 2020 forecast, as well as assumptions on a large number of key variables. The most important of these variables include:

- measure life;
- measure cost;
- measure decay characteristics;
- remaining market potential;
- maximum market potential;
- market potential under different DSM program designs;
- annual program penetration rates;
- DSM program administrative costs;
- expected net DSM savings (net-to-gross ratio applied to DSM measure savings levels);
- electricity peak hour.

Changes in any of these underlying assumptions and forecasts change the size, cost and timing of the potential DSM resource. The DBEDT DSM Assessment Model allows the planner to modify any of these variables in order to test scenarios and run sensitivities.

1.2 Project 4 Objectives

The Project team accomplished the following:

- Developed a DSM measures compendium and set of DSM Assessment building prototypes which were used, along with other sources of DSM data and ENERGY 2020 assumptions, as basic data for the building simulations;
- Developed prototypical buildings and performed engineering model energy use simulations to identify DSM impacts by selected DSM measure in each building prototype. This was accomplished by the engineering simulation model DOE-2.1E;
- Provided estimates of the DSM resource potential for the State of Hawaii by county by using the DBEDT DSM Assessment Model;
- Identified additional resource data requirements and developed a plan of action for obtaining the needed data; and
- Provided working versions of the DBEDT DSM Assessment Model and the DOE-2.1E Engineering Simulation Model and necessary training to DBEDT staff on how to operate the models.

1.3 Assumptions And Data Inputs

The DBEDT DSM Assessment Model provides a comprehensive assessment of the DSM potential by DSM measure, building type and county within Hawaii over a 20-year forecast horizon. It relies on the following as assumptions and data inputs.

- Identification of the most appropriate DSM measures for consideration in Hawaii DSM planning, based on available data from a literature search. These data were the beginning step in an assessment of the magnitude of energy savings potential in Hawaii.
- On-site surveys of 50 commercial buildings which produced a set of building prototypes to support engineering simulation modeling efforts.
- Estimates of building and appliance saturations by fuel type and the amount of commercial floorspace and number of homes over a 20-year forecast horizon which were obtained from June and July 1994 ENERGY 2020 forecasting runs and used to develop a baseline for the model.
- Detailed energy use characteristics and the impacts of DSM measures on DSM Assessment typical residential and commercial building types in Hawaii, developed by utilizing the DOE-2.1E Building Energy Simulation Model.
- Data were supplemented as necessary from other sources. The primary secondary source was the California Energy Commission with its California Conservation Inventory database.

When reviewing the results from the DBEDT DSM Assessment Model and the DOE-2.1E modeling, it should be remembered that computer modeling is an imprecise art that utilizes as much real world information as possible. NEOS employed the BCI on-site audits as the primary data source for defining building characteristics. However, the 50 on-site energy surveys provide only minimal information which was supplemented by information in the document *Technology Energy Savings Volume II: Building Prototypes* prepared for the California Conservation Inventory Group by NEOS in March 1994. Feedback received from DBEDT staff after review of the initial prototype working paper was also utilized as a source for prototype modifications. In developing a DSM assessment, either the results of an engineering based end-use forecasting model (such as REEPS and COMMEND or the CEC forecasting models) or actual end-use metering results are generally available for calibrating DOE-2.1E results. However, end-use metering data do not as yet exist for Hawaii and preliminary versions (April 1994-July 1994) of the ENERGY 2020 model were used to produce end use information. (These versions were later significantly revised.) The outputs from these early versions of ENERGY 2020 affect the results of the DBEDT DSM Assessment Model, particularly in the gas sector. Finally, as DOE-2.1E runs were made and results analyzed, the NEOS DOE-2.1E modeler changed some building characteristics in order to obtain what NEOS considered reasonable results based on experience in the mainland United States.

1.4 Approach and Methodology

A database of 2,001 different DSM technology applications was developed for DSM measures applicable to Hawaii. Simultaneously, commercial building energy audits were conducted on 50 buildings in Hawaii to support the development of DSM Assessment building prototypes. These energy audits, along with the information contained in the DSM measure database and supplemental information obtained from the California Energy Commission, were used to develop input files for the different building types in the DBEDT DSM Assessment Model. These building types included:

- residential single- and multi-family home (single-metered);
- large and small office;
- large and small retail;
- fast food and sit-down restaurants;
- refrigerated and non-refrigerated warehouse;
- school and college;
- grocery;
- hospital;
- hotels;
- resorts;
- master metered residential building.

The building characteristics contained in these DSM Assessment building input files constituted baseline building characteristics. A highly regarded engineering simulation model, DOE-2.1E, was selected to develop baseline energy use impacts as well as test impacts of DSM measures on the building prototypes. The DOE-2.1E program is capable of simulating energy and peak demand profiles and DSM measure impacts. Initial DOE-2.1E output using the available building characteristics provided the baseline energy use values. These output baseline values were compared to predicted energy use values from ENERGY 2020, and utilities' end use model outputs. Once satisfactory baseline energy use values were obtained, parametric runs were performed adding a single DSM measure to the basecase input file assumptions. Each DSM measure was simulated individually. This approach allowed for the identification of the energy impacts of each specific DSM measure without the influence of other DSM measures that may also be applied to the same end-use. Intra-active affects, which is the influence of more than one DSM measure on the same end-use, is accounted for within the DBEDT DSM Assessment Model. The resultant parametric building simulation output provided the estimates of energy and peak demand impacts for each DSM measure considered.

The results of these DOE-2.1E building simulation runs form part of the input into the DBEDT DSM Assessment Model. Raw output from DOE-2.1E had to be converted into a form useable by the DSM Assessment Model. A translation computer program named DOETRAN was developed. The database software Paradox 5.0 for Windows was used to perform this data translation. The DOETRAN model performs three basic functions, with an optional fourth. The first function is to configure the user's computer for DOETRAN. The second function is to import files with energy and loadshape data for each building type. The third function is to process the data into the DBEDT DSM Assessment Model format. The optional fourth function provided by DOETRAN is to view graphs of total electric annual impacts by measure. This last option allows a comparative view of how one measure rates against another.

The DBEDT DSM Assessment Model provides estimates of the potential DSM resource for each year in the forecast period by measure and building type for each of the four counties in Hawaii. The Model was developed in Quattro Pro for Windows and is based on an integration of utility load forecast data (ENERGY 2020) with the results of the engineering energy simulation model DOE-2.1E applied to typical buildings and appliances. The Model is designed to be a user friendly, easy to use DSM assessment tool that offers several significant advantages.

- Linking with an energy forecasting model. The DSM Model utilizes several key variables from DBEDT's ENERGY 2020 forecasting model. This linkage assures the development of DSM resource estimates that are compatible with DBEDT's own forecast of energy use.
- Incorporating the effects of DSM measure life. Once a measure is implemented, it does not necessarily remain a resource over the entire forecast period. The DSM Model incorporates a measure life function that decays the effectiveness of measures over time. The DSM Model also allows a user defined percentage of fully decayed measures to be available again as a resource option at the end of its measure life.
- Developing estimates of the DSM resource for each year of the forecast. Many DSM models only estimate the DSM resource for one year and then spread out the incremental amounts over the forecast period. However, building and appliance decay may lead to over- or under-estimates of the resource for any given forecast year. For example, several existing commercial building types have significant building decay rates. In some forecasting models, 30 to 40 percent of the existing stock may no longer exist by the end of the forecast period. If the DSM resource is being estimated based on stock remaining at the end of the forecast period, the size of the resource is larger for most years of the forecast. Conversely, if the resource is estimated based on current estimates of building stock, a much smaller portion of the resource will actually be available during the forecast period.
- Identifying both energy and peak demand impacts of DSM programs. DSM measure load shapes for the peak day of each month are contained in the model. These load shapes are used to estimate the peak demand impact from the identified DSM potential.
- Providing the capability of using the DSM Model for scenario development. By modifying any of the many user controlled data input variables, the user can develop alternative scenarios quickly and easily. In the development of this report, four DSM scenarios were developed and modeled.

The DSM Model provides the user estimates of the DSM resource by program, sector, year, and levelized cost category for each county in Hawaii. Output is provided for electric energy (MWh), peak demand (MW), and gas energy (kTherm). The DSM Model utilizes monthly peak day load shape information to develop peak demand estimates. The user supplies the model with the month and hour for the system peak.

Figure 1-1 provides a generic overview of the variables utilized by the DBEDT DSM Assessment Model. The numbers in parenthesis refer to the report sections where the discussion of the variable exists. Algorithms within the DSM model utilize these variables to develop the estimates of DSM potential. There are five key steps taken by the DSM Model to develop the DSM potential estimates:

Figure 1-1
DBEDT DSM Assessment Model Components

1. Levelized cost calculation and screening;
2. Consideration of:
 - Building and appliance stocks
 - Fuel Saturation;
 - Maximum and remaining market potential;
 - Net-to-gross ratios;
3. Annual program participation rates;
4. Consideration of measure life; and
5. Consideration of measure continuance.

Four different DSM scenarios were developed for this project. These included estimates of Technical Potential, Economic Potential, Market Potential, and Hawaii Program Potential.

Technical Potential is defined as the DSM potential if every existing piece of equipment or practice were changed to a technically feasible energy efficient option or practice (regardless of cost) without any significant change in lifestyle or economic output. Within the DBEDT DSM Assessment model, Technical Potential is calculated by setting the maximum market penetration to 100% with no cost screens in effect. The only limitation is maximum annual penetration being limited to 1/(appliance life) for programs designed to replace devices upon burnout.

Economic Potential is defined as that portion of the Technical Potential that is economically feasible to implement. Within the DBEDT DSM Assessment Model, Economic Potential is calculated by setting the maximum market penetration to 100% and screening DSM measures with a cost screen. Both a Total Resource Cost test (TRC) and a Ratepayer Impact Measure (RIM) test are available as cost screening tools.⁵ The estimates of Economic Potential presented in this document utilized the TRC cost screen. As with Technical Potential, the only limitation is maximum annual penetration being limited to 1/(appliance life) for programs designed to replace devices upon burnout.

Market Potential, also referred to as achievable potential, incorporates the concepts of a maximum market penetration rate that is likely less than 100% and annual program penetration rates that reflect reasonable estimates of what can be expected with well designed DSM programs and incentives. The values used by the DBEDT DSM Assessment model were based on a review of experiences from the most comprehensive DSM programs available on the mainland. The TRC and RIM test cost screens are also employed to determine Market Potential.

Hawaii Program Potential is similar to Market Potential except that the maximum market penetration rates are modified. The modifications reflect maximum market penetrations based on the general programmatic experience from DSM programs on the mainland rather than the experience from only the most comprehensive and successful programs. The program designs include significant rebate

⁵ The Total Resource Cost Test (TRC) measures the net costs of a demand-side management program as a resource option based on the total costs of the program, including both the participant's and the utility's costs. The Ratepayer Impact Measure (RIM) test measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program. Rates will go down if the change in revenues from the program is greater than the change in utility costs. Conversely, rates or bills will go up if revenues collected after program implementation are less than the total costs incurred by the utility in implementing the program.

levels and program advertising, but not up to the very highest levels of the most comprehensive DSM programs available on the mainland.

1.5 The Project 4 Reports

The final report for Project 4 consists of the Executive Summary, the main report volume "DSM Opportunities", and five reference volumes. The report volumes include:

- **Executive Summary.** A brief summary of the Demand-Side Management Resource Assessment project. Summary results and recommended Hawaii DSM strategies are identified; and
- **DSM Opportunities.** The main report provides a description of building prototype simulations, detailed descriptions of the DSM Assessment Model and its supporting methodology along with detailed results from different scenario runs of the DSM Model. Also included are descriptions of DSM programs and characteristics relevant to program design that effects the size and timing of potential DSM resources. Of particular importance in terms of the size and timing of potential DSM resources are the availability of financial incentives and the intensity of program advertising and promotion.

The supporting reference volumes include:

- **Reference Volume 1 - Building Prototype Analysis.** This reference volume provides a detailed description of, and the baseline assumptions and simulation results for, the building prototype simulations. The reference volume presents detailed information for each of the DSM Assessment different building prototypes developed for use with the building simulation program;
- **Reference Volume 2 - Final Residential and Commercial Building Prototypes and DOE-2.1E Developed UECs and EUIs.** This reference volume is split into three parts. Within each part is an introduction defining the nomenclature, code definitions, and methodology. Following this introduction are measure descriptions and detailed DOE-2.1E results for each DSM measure considered. The detailed DOE-2.1E results are presented for 17 different building types and an additional 6 climate zone applications for resorts and hotels for the counties of Maui, Hawaii, and Kauai (a total of 23 different simulation results);
- **Reference Volume 3 - Residential and Commercial Sector DSM Analyses: Detailed Results From The DBEDT DSM Assessment Model.** Tables and graphs along with program summary tables detailing the results of the four DSM scenario applications of the DBEDT DSM Assessment Model compose this five part reference volume. The first part is a statewide summary of each of the four scenario results. The remaining four parts include the results of the Assessment Model by each of the four scenarios: 1) Technical Potential; 2) Economic Potential; 3) Market Potential; and 4) Hawaii Program Potential.
- **Reference Volume 4 - The DBEDT DSM Assessment Model User's Manual.** The DBEDT DSM Assessment Model consists of a series of integrated Quattro Pro spreadsheets. This manual illustrates how to access and modify input files, access and update output files, and run the model.

- **Reference Volume 5 - The DOETRAN User's Manual.** The DOETRAN Model is a DSM database manager developed to act as an intermediary between the DOE-2.1E model and the DBEDT DSM Assessment Model. DOETRAN accepts output from DOE-2.1E and translates that into the format required by the Assessment Model. This manual explains how to operate the model.

Two other major reports, DSM Measures Compendium and Building Prototypes, were produced by the project and have been distributed independently of the final report. These reports provided data used in the DSM assessment. The reports are summarized below.

- **The DSM Measures Compendium.** This report examines measures affecting two energy sources (e.g., electricity and gas) and three market sectors (e.g., residential, commercial, and industrial). The database contains detailed data by fuel, on 2,001 DSM measures in six residential end uses. The residential end uses included water heating, lighting, refrigeration, and cooking.

The database also contains six nonresidential end uses (e.g., cooling, refrigeration, lighting, process heat, water heating, and motors/ventilation). Because some measures (e.g., cooling and motor categories) have considerable overlap in the commercial and industrial sectors, the database presents measures in the two sectors in a single chapter on nonresidential measures. The non-residential measures were studied for seven building types (e.g., small office, large office, retail, college, school, industrial, and refrigerated buildings).

The two database chapters each have a framework consisting of five main components: database report and measure data tables (electric); database report and measure data tables (gas); generic load shape data (electric); generic load shape data (gas); and a water heating model.

The database report contains text descriptions of each measure, including information on how the measures work, documentation of calculations and assumptions used to develop data tables, and descriptions of qualitative information such as externalities and market acceptance. The measure data tables contain numerical information describing measure impacts, costs, lifetime, and load shape identification.

The generic load shape data tables contain numerical information describing annual energy consumption profiles. For gas measures, the database defines load shapes with simple peak factors that relate annual energy to peak-day demand requirements. For electric measures, the database defines generic load shapes that relate annual energy to hourly changes in demand level.

- **Characterization of Building Prototypes.** This report identifies specific types of buildings that together describe the commercial building stock in existence in Hawaii and characterizes each building type with the data required to simulate building performance in a computer-based engineering simulation model.

The development of these characteristics was based on a combination of primary and secondary data sources. Primary data were collected during 50 on-site surveys. The sample plan determined the number of site visits per building type based on a

combination of: (1) a weighted average based on energy use per building type within the commercial sector; and (2) a minimum of four site surveys completed for each. Table 1-1 in the Appendix summarizes these characteristics.

2.0 THE DSM OPPORTUNITY

A summary of results from the DBEDT DSM Assessment model runs is provided in this portion of the report. A separate reference volume containing extensive tables and graphs for each scenario is provided as *Reference Volume 3 - Residential and Commercial Sector DSM Analyses: Detailed Results From The DBEDT DSM Assessment Model*. This reference volume is divided into five parts that include: a statewide summary; Technical Potential; Economic Potential; Market Potential; and Hawaii Program Potential. DSM potential estimates are provided for both electricity and gas. The gas estimate includes potential from homes and buildings using either utility gas or bottled gas.

2.1 Statewide Potential

Figure 2-1 summarizes the size of the potential DSM resource by scenario for the year 2006 for electric energy, electric peak demand, and gas energy. The year 2006 was selected because it is approximately mid-way through the 20 year forecast period and because conventional, oil fired, baseload generating resources require 6-8 years from the start of seeking plant approval to the start-up of the generating facility itself. DSM potential ranges from about 650,000 MWh of electric energy, 100 MW of peak demand, and 1,650 kTherm of gas for the Hawaii Program scenario to about 1,600,000 MWh, 290 MW, and 3,600 kTherm of gas for the technical potential scenario.

Referring back to the scenario definitions provided in section 1.2, the only difference between the Technical and Economic potential scenarios is the use of the TRC test as a cost effectiveness screen for measures. Program design considerations are included in the Market Potential and Hawaii Program Potential scenarios. DSM programs are the means of developing the measures into resources. The differences between the Market Potential and Hawaii Program Potential lie with the estimates of maximum market penetration rates by program within each scenario. Program design influences the estimate of the maximum market penetration rates.

Nearly all measures considered in the DSM assessment passed the cost effectiveness test. Section 2.3 identifies the specific DSM measures that failed the TRC test. The number of DSM measures included in the Economic, Market, and Hawaii Program scenarios are the same. The relative share of savings per measure within these three scenarios are identical; only the amount of savings by measure differs between these three scenarios.

Figure 2-2 illustrates the size of the potential DSM resource (electric energy, electric peak demand, and gas energy) for the residential and commercial sectors by selected forecast year (1999, 2006, and 2014) for the Hawaii Program scenario. For the commercial sector, the DSM potential is largest for the year 2006. However, for the residential sector, the DSM potential grows throughout the forecast period. The reason for these two different patterns is primarily a result of two factors. First, the number of homes in the residential sector grows at a faster rate than the amount of commercial floorspace over the forecast period. This results in more DSM measures being applied to new construction in latter years of the forecast period in the residential sector. The second major factor is the higher incidence of measures with shorter measure lifetimes occurring in the commercial sector. Lighting measures are the dominant commercial sector DSM measures and many of these measures, especially bulbs, have short measure lives.

Figure 2-1

**DSM POTENTIAL BY SCENARIO
ALL ISLANDS - ELECTRIC ENERGY - 2006**

**DSM POTENTIAL BY SCENARIO
ALL ISLANDS - ELECTRIC PEAK - 2006**

**DSM POTENTIAL BY SCENARIO
ALL ISLANDS - GAS ENERGY - 2006**

Figure 2-2

HAWAII PROGRAM DSM POTENTIAL
ALL ISLANDS - ELECTRIC ENERGY

HAWAII PROGRAM DSM POTENTIAL
ALL ISLANDS - ELECTRIC PEAK

HAWAII PROGRAM DSM POTENTIAL
ALL ISLANDS - GAS ENERGY

Figure 2-3 displays each county's share of residential sector DSM potential in the year 2006 for the Hawaii Program scenario. The figure is divided into three parts with the top pie chart illustrating the county share for electric energy, the middle pie chart the share for electric peak, and the bottom pie chart the county share for gas energy.

As one would expect, the size of the potential DSM resource for the residential sector basically follows the size of the population in each of the respective counties with Honolulu providing most of the potential DSM resource. However, the gas DSM potential resource for Hawaii county is nearly as great as Honolulu's despite the much larger population in Honolulu.

The reason for the apparent anomaly of a large gas DSM resource potential in the county of Hawaii lies in the use of the June and July 1994 ENERGY 2020 runs. In these runs, the ENERGY 2020 model reported that all delivered gas is utility gas. In contrast, for Hawaii County the ENERGY 2020 model reported that about 48 percent of the delivered gas is utility gas and 52 percent is bottled gas.

Figure 2-3
Hawaii Program Electric DSM Potential
By County - Residential Energy - 2006

Hawaii Program Electric DSM Potential
By County - Residential Peak - 2006

Hawaii Program Gas DSM Potential
By County - Residential Gas - 2006

Figure 2-4 identifies the share of commercial sector DSM potential by each county in the year 2006 for the Hawaii Program scenario. As in Figure 2-3, the figure is divided into three parts with the top pie chart illustrating each county's share for electric energy, the middle pie chart the share for electric peak, and the bottom pie chart for gas energy.

Honolulu provides nearly three-fourths of the commercial sector DSM potential for the State of Hawaii. Unlike the residential sector where the gas DSM potential is nearly the same for the counties of Hawaii and Honolulu, the commercial sector gas DSM potential for Honolulu is nearly 70 percent of the state total.

Tables 2-1, 2-2, and 2-3 provide, for selected years, the estimates of DSM potential by county, sector, and scenario for electric energy, electric peak demand, and gas energy, respectively. These values were used in developing Figures 2-1 through 2-4.

2.2 DSM Measures Providing The Most Potential

Figures ES-6-2 and ES-6-3 identify the five DSM measures providing the most potential in the residential sector. Figures ES-6-4 and ES-6-5 identify the top five commercial sector DSM measures. These shares represent an average across all counties and are very similar for the Economic, Market, and Hawaii Potential scenarios. Shares within the Technical Potential scenario would be slightly smaller due to the fact that no cost screening of measures was performed within the Technical Potential scenario. Shares are very similar for the remaining three scenarios since the only difference between them is the value for the maximum market penetration rate. The maximum market penetration rates vary by DSM program and vary by DSM scenario. However, the number of measures included within the Economic, Market, and Hawaii Potential scenarios is the same and the relative share within a scenario changes only slightly with the changes in maximum market penetration by scenario.

Water heating measures provide most of residential sector DSM potential for both electricity and gas. The solar water heating measure contributes the single most potential by providing 21 percent of the residential electric DSM potential and 42 percent of the residential gas DSM potential. Tables 2-5 through 2-8 list the individual measures and their shares of energy savings by county for the residential sector.

The DSM potential within the commercial sector is not dominated by any one measure; 43 percent of the commercial sector electric DSM potential is provided by measures other than the top five. Lighting measures provide the bulk of electricity DSM potential; and, water heating measures provide all of the gas DSM potential. Occupancy sensors, four foot T-8 fluorescent lamps with electronic ballasts, and the electronic ballast measures provide nearly 50 percent of the commercial sector electric DSM potential while point of use water heat provides nearly 70 percent of the commercial sector gas DSM potential. Tables 2-10 through 2-35 list the individual measures and their shares of energy savings by building type for the commercial sector.

Figure 2-4
Hawaii Program Electric DSM Potential
By County - Commercial Energy - 2006

Hawaii Program Electric DSM Potential
By County - Commercial Peak - 2006

Hawaii Program Gas DSM Potential
By County - Commercial Gas - 2006

2.3 DSM Measure Screening By The TRC Test

Table 2-4 lists the commercial sector DSM measures screened out by the TRC test from the Technical Potential scenario. The measures screened cover all end-uses and vary by building type. Measure screening is discussed in Section 7.

The residential sector DSM measures screened out by the TRC test include:

- T-8 Lamps with Electronic Ballasts (all SF and MF);
- Heat Pump Clothes Dryers (all MF);
- Microwave Clothes Dryers (all SF and MF);
- Refrigerators Meeting SERP Standards (all SF and MF);
- Refrigerators Surpassing Federal Standards by More Than 10% (all SF and MF);
- Stovetop Reflector Pans (all SF and MF);
- Horizontal Axis Clothes Washer (all MF - gas and electric water heat);
- Heat Pump Water Heater (all MF);
- R0 - R19 Ceiling Insulation (existing SF and MF homes w/Room A/C);
- R0 - R11 Wall Insulation (existing SF and MF homes w/Room A/C);
- R11 - R19 Ceiling Insulation (new SF and MF homes w/Room A/C);
- Central A/C Unit to 12 EER (new SF and MF homes w/Central A/C);
- R0 - R11 Wall Insulation (all SF and MF homes w/Central A/C);
- R11 - R19 Ceiling Insulation (new SF and MF homes w/Central A/C); and
- A/C Cycling (all SF and MF homes w/electric water heat);

2.4 Residential Sector DSM Measures

Figures ES-6-2 and ES-6-3 identify the five top residential DSM measures in terms of their share of total residential sector DSM potential for electricity and gas, respectively. As discussed in Section 2.2, the amount of DSM potential varies by scenario, but the share of the savings is similar across the three scenarios that use the TRC screen: Economic; Market; and Hawaii Program scenarios. Variability does exist between counties in each DSM measure's share of county total DSM potential. This variability is due to end-use saturation differences and differences in the weather files between counties used by DOE-2.1E to simulate many of the DSM impacts.

Tables 2-5, 2-6, 2-7, and 2-8 in the Appendix list the residential electric and gas DSM measures, their cost, and their share of the county total residential DSM potential for Honolulu, Hawaii, Maui, and Kauai respectively. Electric DSM measures are listed at the top of each table and gas DSM measures at the bottom. Within each fuel type, single family DSM measures are listed first, then multi-family DSM measures.

For electric DSM measures, water heat measures provide the most potential and weatherization measures the least. Solar water heat and heat pump water heaters in single family homes provide the single most DSM potential in all counties. However, solar water heaters are only considered cost effective for single family homes with four or more occupants and the application of heat pump water heaters in multi-family units did not pass the TRC test. For multi-family units, the compact fluorescent DSM measure provides the most DSM potential followed closely by efficient water heater tanks.

The moisture sensors measure in gas clothes drying provide the least potential for gas residential DSM measures. Solar water heat is the single largest gas DSM measure, but is only applicable to single family homes with four or more occupants. Efficient gas water heater tanks provide the second largest gas DSM potential in single family homes and the largest in multi-family units.

The relative magnitude of savings varies somewhat by county. However, the dominant measures in one county are generally the dominant measures in all counties. However, heat pump clothes dryers is an example of a measure that varies in importance by county. In all counties except Kauai, the heat pump clothes dryer provides the third largest single electric DSM measure potential. In Kauai, because of its low saturation of electric clothes dryers, heat pump clothes dryers provide the ninth largest single measure of electric DSM potential.

The relative importance of measures designed for single family application versus measures designed for multi-family application varies significantly by county. In Honolulu, and to a lesser degree Maui, multi-family DSM measures provide meaningful levels of DSM potential. In Hawaii and Kauai counties, the levels of DSM potential are small. The number of multi-family units in Honolulu and Maui counties is significantly larger than in Hawaii and Kauai counties. Table 2-9 identifies the share of residential DSM potential by building type for the state and for each county. In Honolulu county, multi-family units provide over 20 percent of the electric and over 25 percent of the gas DSM potential. In contrast, multi-family units provide only about six percent of the electric and less than five percent of the gas DSM potential in Hawaii county.

In addition to the energy and peak demand savings resulting from the placement of residential DSM measures in homes, a load control program designed to cycle electric water heater loads during periods of peak demand offers significant peak demand reduction potential, but no energy savings. As identified in Table 2-2, the electric peak savings anticipated to accrue as the result of the placement of residential DSM measures in homes is 29,700 KW by the year 2006 for the Hawaii Program scenario. An electric water heater load control program would increase the potential electric peak demand reduction by another 53,199 KW for a total of 82,899 KW by the year 2006 for the Hawaii Program scenario.

2.5 Commercial Sector DSM Measures

Figures ES-6-4 and ES-6-5 identify the five top commercial sector DSM measures in terms of their share of total residential sector DSM potential. As with the residential sector, the amount of DSM potential varies by scenario, but the share of the savings is constant across the three scenarios that use the TRC screen: Economic; Market; and Hawaii Program. Variability does exist between counties in each DSM measure's share of county total DSM potential.

A disaggregation down to fifteen different building types was included for DSM assessment in the commercial sector. The actual number of buildings considered varied by county with all fifteen building types considered in Honolulu but only eight in Kauai. The number of commercial building types considered outside of Honolulu was limited by the county data available from ENERGY 2020..

Within each building type, an average of 50 to 60 DSM measures was considered in the DSM assessment. Tables 2-10 through 2-24 in the Appendix list the electric DSM measures and Tables 2-25 through 2-35 list the gas DSM measures that passed the TRC test for each building type. Within the measure name, the leading letter "X" indicates existing buildings and "N" new buildings. For each

measure, the levelized cost is provided and the share of total building type DSM potential being provided by each measure (both energy and peak for electricity and energy for gas) is identified. The building types identified by ENERGY 2020 with no gas usage include:

- Small Office;
- Large Retail;
- Small Retail; and
- Hospitals.

The DSM measures that provide the most potential vary by building type. Lighting measures are the most dominant for electric DSM, with the optical reflector DSM measure providing the largest share of DSM potential for nine of the fifteen building types. The metal halide lamp measure has the largest share in refrigerated and non-refrigerated warehouses. Several measures are nearly equally important in the hotel, resort, and master metered apartment building types. These include occupancy sensors, energy management systems, compact fluorescent bulbs, along with optical reflectors. Some measures, such as HVAC system time clocks, provide positive energy savings but negative peak demand savings. This is reflective of the load patterns developed by DOE-2.1E that coincidentally happened to have a negative impact for the peak hour. The time clocks reduce the number of times the HVAC unit is turned on, but the load requirements for the HVAC turn-ons with the time clocks requires more demand on the system. The moment of system turn-on was coincidentally modeled by DOE-2.1E to be in the same hour as the utility's peak hour. The thermal energy storage (ice on coil) measure has negative energy savings but positive peak demand impacts. This reflects the use of off-peak energy to develop the ice on coil.

Point-of-use water heating provides the largest share of gas DSM potential for all building types except three. Solar water heating provides the largest share in fast food restaurants and colleges and the high efficiency gas water heater provides the largest share in sit down restaurants.

Figure 2-5 identifies the share of DSM potential by building type for the State of Hawaii. The top portion of the figure represents shares for electric DSM measures and the bottom portion, the shares for gas DSM measures. For the state as a whole, office buildings provide the greatest potential for both electric and gas DSM potential. Other important building types include retail and hotel/resort. The least DSM potential comes from warehouses followed by schools/colleges. It should be noted that some of the gas DSM shares by building type reflect ENERGY 2020's identification of zero percent gas saturation for some building types such as hospitals, large offices, warehouses, and colleges.

Within Figure 2-5, as well as the figures with data at the county level, some building types were combined. Nine building categories are identified in each graph. Certain buildings are combinations of buildings and these include:

- Office - includes small and large office;
- Retail - includes small and large retail;
- Restaurant - includes fast food and sit-down;
- Warehouse - includes refrigerated and non-refrigerated;
- School/College - includes school and college; and
- Hotel/Resort - includes hotel and resort.

2.5.1 Commercial Sector - City and County of Honolulu (Honolulu)

Each of the fifteen different building types were included in the DSM assessment for Honolulu for electric DSM measures, while eleven were included for gas DSM measures. The building types not included for gas DSM measures are the buildings identified by ENERGY 2020 as having no gas saturation. These are:

- Small Office;
- Large Retail;
- Small Retail; and
- Hospital.

Figure 2-6 identifies the share of DSM potential by building type for Honolulu. Office buildings provide the greatest potential for electric DSM potential with a share of over 37 percent. Hotels and resorts provide the next largest potential for electric DSM while warehouses provide the least. For gas, hotels and resorts provide the greatest potential with a share of over 35 percent with office buildings providing the second largest share at about 30 percent. Of the buildings with gas saturation, warehouses provide the least DSM potential.

Figure 2-7 identifies the DSM measures with the most potential for savings for Honolulu. The Optical Reflector measure provides the most electric potential, and Point of Use Water Heat the most gas potential. The shares by measure are similar to those shown in Figures ES-6-4 and ES-6-5 for the state as a whole.

2.5.2 Commercial Sector - Hawaii County

ENERGY 2020 provided building specific information that allowed ten different commercial sector building types to be analyzed in the DSM assessment for Hawaii county. The ten buildings were:

- Small Office;
- Retail - Large and Small;
- Grocery;
- School;
- Restaurant - Fast Food and Sit Down;
- Hotel;
- Resort; and
- Master Metered Apartment.

Of these ten building types, ENERGY 2020 reports no gas saturation in large retail, hotels and resorts. Figure 2-8 identifies the share of DSM potential by building type for Hawaii county. Unlike Honolulu, retail buildings and hotels/resorts provide the greatest potential for electric DSM potential with each having a share of over 26 percent. Master metered apartment buildings provide the least. For gas, retail is the dominant building type with a share of over 60 percent with office buildings providing the second largest share at about 12 percent. Of the buildings with gas saturation, master-metered apartments and restaurants provide the least DSM potential. Figure 2-9 identifies the DSM measure with the most potential for savings for Hawaii County. The Optical Reflector measure provides the most electric potential and Point of Use Water Heat the most gas potential. The shares by measure are similar to those shown in Figures ES-6-4 and ES-6-5 for the state as a whole.

Figure 2-5
COMMERCIAL ELECTRIC DSM BY BUILDING
HAWAI PROGRAM - STATE TOTAL - 2006

GAS - HAWAII PROGRAM - 2006

Figure 2-6
COMMERCIAL ELECTRIC DSM BY BUILDING
HAWAII PROGRAM - HONOLULU COUNTY - 2006

GAS - HAWAII PROGRAM - 2006

Figure 2-7
COMMERCIAL DSM MEASURES WITH THE MOST POTENTIAL
HONOLULU COUNTY
ELECTRIC - HAWAII PROGRAM - 2006

GAS - HAWAII PROGRAM - 2006

Figure 2-8
COMMERCIAL ELECTRIC DSM BY BUILDING
HAWAII PROGRAM - HAWAII COUNTY - 2006

GAS - HAWAII PROGRAM - 2006

Figure 2-9
COMMERCIAL DSM MEASURES WITH THE MOST POTENTIAL
HAWAII COUNTY
ELECTRIC - HAWAII PROGRAM - 2006

GAS - HAWAII PROGRAM - 2006

A major departure from the statewide shares is the absence of the Hot Water Timeclock gas measure. This measure is found in large offices, colleges, and hotels. ENERGY 2020 provides no floorspace estimates in this county, for large offices, or colleges and identified only electric saturation for hotels.

2.5.3 Commercial Sector - Maui County

The number of commercial sector buildings modeled for Maui county include nine of the ten buildings that were in the Hawaii county assessment. ENERGY 2020 provides no information for schools in Maui county. ENERGY 2020 reports gas saturation in the following building types:

- Small Office;
- Small Retail;
- Grocery;
- Restaurant - Fast Food and Sit Down; and
- Master Metered Apartment.

Figure 2-10 identifies the share of DSM potential by building type for Maui county. The share of DSM potential by building type is similar to that found in Hawaii county. For electric DSM potential, the share supplied by office buildings is somewhat smaller and the share provided by hotel/resort somewhat larger than found in Hawaii county. For gas measures, retail is somewhat smaller, while grocery and master-metered apartments somewhat larger than found in Hawaii county.

Figure 2-11 identifies the DSM measures with the most potential for savings for Maui. The Optical Reflector measure provides the most electric potential and Point of Use Water Heat the most gas potential. The shares by measure are similar to those shown in Figures ES-6-4 and ES-6-5 for the state as a whole.

A major departure from the statewide shares is the absence of the Hot Water Timeclock gas measure. This measure is found in large offices, colleges, and hotels. ENERGY 2020 provides no floorspace estimates in this county, for large offices, or colleges and identified only electric saturation for hotels.

2.5.4 Commercial Sector - Kauai County

The commercial sector buildings contained in the electric DSM assessment for Kauai county include the following seven building types:

- Small Office;
- Retail - Large and Small;
- Grocery;
- Restaurant - Fast Food and Sit Down;
- Hotel; and
- Resort.

ENERGY 2020 provides no information for the other possible building types in Kauai county. ENERGY 2020 reports gas saturation in the following building types:

- Small Office;

- Small Retail;
- Grocery; and
- Restaurant - Fast Food and Sit Down.

Figure 2-12 identifies the share of DSM potential by building type for Kauai county. Except for the disappearance of the master-metered apartment building, the share of DSM potential by building type is essentially the same as found on Maui.

Figure 2-13 identifies the DSM measure with the most potential for savings for Kauai County. The Optical Reflector measure provides the most electric potential and Point of Use Water Heat the most gas potential. The shares by measure are similar to those shown in Figures ES-6-4 and ES-6-5 for the state as a whole.

A major departure from the statewide shares is the absence of the Hot Water Timeclock gas measure. This measure is found in large offices, colleges, and hotels. ENERGY 2020 provides no floorspace estimates in this county, for large offices, or colleges and identified only electric saturation for hotels.

Figure 2-10
COMMERCIAL ELECTRIC DSM BY BUILDING
HAWAII PROGRAM - MAUI COUNTY - 2006

GAS - HAWAII PROGRAM - 2006

Figure 2-11
COMMERCIAL DSM MEASURES WITH THE MOST POTENTIAL
MAUI COUNTY
ELECTRIC - HAWAII PROGRAM - 2006

GAS - HAWAII PROGRAM - 2006

Figure 2-12
COMMERCIAL ELECTRIC DSM BY BUILDING
HAWAII PROGRAM - KAUAI COUNTY - 2006

GAS - HAWAII PROGRAM - 2006

Figure 2-13
COMMERCIAL DSM MEASURES WITH THE MOST POTENTIAL
KAUAI COUNTY
ELECTRIC - HAWAII PROGRAM - 2006

GAS - HAWAII PROGRAM - 2006

3.0 STATE OF HAWAII DSM PROGRAM CONCEPTS

The program designs recommended for the State of Hawaii electric and gas utilities are a series of DSM measure rebate programs. The more successful DSM programs have the common theme of providing reasonably sized rebates with high levels of program advertising and promotion.

The general characteristics and resulting success or failure of a large number of DSM programs offered by various electric and gas utilities in the mainland United States and Canada were reviewed. A synopsis of these programs is provided in Appendix A of this report. The purpose of the review of DSM programs was to identify successful program designs that could be adopted by programs offered by electric and gas utilities in Hawaii as well as to help establish values for many of the variables used by the DBEDT DSM Assessment Model.

Each of the DSM measures considered within the DBEDT DSM Assessment Model were grouped into program categories. However, the potential impacts of DSM programs infer specific program design considerations including budgets, amount of financial incentive being offered, and level of marketing activity. The Technical Potential and Economic Potential scenarios do not consider specific program design considerations. The Technical Potential scenario estimates the size of the potential DSM resource regardless of cost effectiveness with the DSM measure applied to each technically feasible application. The Economic Potential scenario also applies DSM measures to each technically feasible application, but only those measures that pass the TRC screening test.

Market and Hawaii Program Potential scenarios utilize the TRC screening of DSM measures and include impacts of specific program design considerations. Neither of these scenarios has budget constraints, but each is different in its level of financial incentives and level of marketing activity. The level of financial incentives and marketing activity affects the "Maximum Market Penetration Rate" parameter within the DBEDT DSM Assessment Model. As described in Section 1.4 of this report, the maximum market penetration rates for DSM programs were assumed to be 100 percent for the Technical and Economic Potential scenarios. For the Market scenario, the maximum market penetration rates are designed to reflect reasonable estimates of what can be expected with well-designed DSM programs with high rebate levels (70% - 100% of installed measure cost) and well designed advertising campaigns. For the Hawaii Program scenario, the maximum market penetration rates were designed to reflect the average rates experienced by DSM programs on the mainland with moderate rebate levels (25 - 50% of installed measure cost) and moderate advertising campaigns. These rates were based on the review of the DSM programs described in Appendix A.

Specifically, before TRC economic screening, the DBEDT DSM Assessment Model contained the following rebate programs:

- Residential Lighting;
- Residential Appliance Rebates (Refrigerators, Freezers, Clothes Dryers, and Cooking);
- Residential Water Heat (Solar Water Heat, Clothes Washers, and Water Heater Tank Measures);
- Residential HVAC Measures (Insulation, Air Conditioning);
- Residential Load Control; and
- Commercial General Retrofit and Rebate.

Descriptions of each program follow. Each program is described with the DSM measures identified before the TRC screening test. The measures that failed the TRC test are identified.

3.1 Residential Lighting

The recommended residential sector lighting program was designed to offer residential customers two alternatives to standard incandescent lamps and an alternative to standard fluorescent lighting. The alternatives to standard incandescent lamps included compact fluorescent lamps and halogen lamps. The alternative for standard fluorescent lighting is T8 lamps with electronic ballasts. Detailed descriptions of the measures are contained in "Reference Volume 2 - Final Residential and Commercial Building Prototypes and Developed UECs and EUIs". Replacing standard fluorescent lighting with T8 lamps with electronic ballasts failed to pass the TRC screening test.

The program design includes varying levels of financial incentives dependent on which DSM scenario was being considered. The financial incentives may take the form of mail-in rebates, instant rebates, or the distribution of free bulbs directly by the utility. The program is to be marketed through bill inserts, retailer promotions, newspaper ads, and radio and television commercials. The review of mainland DSM programs found the level of marketing and the targeting of potential customers to be critical components to a successful program. Since nearly everyone is a potential client for residential lighting applications, extensive advertisement through the mass media, the utilization of schools and civic groups to distribute bulbs at a reduced cost for fund raising, and the distribution of rebate coupons at retail locations are effective marketing techniques.

3.2 Residential Appliance Rebates

The residential appliance rebate program includes DSM measures designed to improve the efficiency of refrigerators, freezers, clothes dryers, and cooking ranges. Clothes drying measures were available for both electric and gas applications. The remaining measures were for electricity only. The DBEDT DSM Assessment Model provides separate results for refrigerators/freezers, clothes drying (separately for electricity and gas), and cooking.

The DSM measures contained in the refrigerator and freezer portion of the appliance rebate program included a second refrigerator buy-back measure and measures designed to exceed the 1993 federal refrigerator/freezer efficiency standard. The refrigerator buy-back measure involved the purchase of customers' existing refrigerators that were in working order. The purchase takes place at the time of the purchase of a new refrigerator and was designed to be offered simultaneously with the efficient refrigerator portion of this program. The amount paid for the second refrigerator by the utility is between 50 and 100 percent of the average market value for used refrigerators. The utility has the responsibility of properly disposing of the used refrigerators. Marketing is done through information provided to the consumer by the retailer at the time of purchase of a new, energy efficient refrigerator. Energy efficient refrigerators are generally more expensive than standard refrigerators that provides an opportunity of a larger sale to the retailer.

The efficient refrigerator and freezer portion of the program offered two levels of incentives for refrigerators and a single level for freezers. For both refrigerators and freezers, a rebate is to be offered for refrigerators and freezers that exceed the 1993 federal standard by at least 10 percent. An additional efficiency incentive is offered for the purchase of refrigerators that are as efficient as the one currently being manufactured for the Super Efficient Refrigerator Program (SERP). SERP is an effort

by a consortium of utilities to assist refrigerator manufacturers in the research and development of a marketable refrigerator that is approximately 25 to 50 percent more efficient than required by the 1993 Federal standard. Such a refrigerator has been developed through SERP and will be coming more available in the market place as demand increases. Initial availability will be within the service areas of the utilities that sponsored SERP. However, it is expected that availability will soon be widespread, especially in utility service areas that actively promote the purchase of such refrigerators. The size of the rebates is generally to the level to cover the incremental cost between the baseline, 1993 Federal standard refrigerators and freezers and the more efficient models. Retailer promotion is the primary marketing tool supported by bill inserts, newspaper ads, and radio and television commercials. The DSM measures designed to exceed the 1993 federal refrigerator/freezer efficiency standard did not pass the TRC test.

Three electric and one gas clothes dryer options were provided through the clothes drying portion of the appliance rebate program. The clothes drying moisture sensor was an appropriate measure for both gas and electric dryers. This device terminates the drying cycle rather than using a timer. In addition, two emerging technologies that could save significant amounts of electricity were included within the analysis. These are heat pump clothes dryers and microwave clothesdryers. Both technologies are in the prototype stage. Southern California Edison has a working prototype of a microwave clothes dryer at their technology center that has been operating successfully. Although neither technology is commercially available at this time, it is believed both will be commercially available in the near future and should be considered as viable resource options. The microwave clothes drying technology did not pass the TRC test nor did the heat pump clothes drying technology in multi-family homes (it did pass when applied to single family homes). The size of the rebates for these measures should generally be at a level to cover at least a major portion of the incremental cost between the efficient technology and the baseline technology. As with refrigerators and freezers, retailer promotion should be the primary marketing tool supported by bill inserts, newspaper ads, and radio and television commercials.

Cooktop reflector pans were included as a DSM measure for consideration within the appliance rebate program. This measure was designed to realize energy savings by replacing existing standard pans with reflector pans made of chrome or aluminum. However, the measure did not pass the TRC cost effectiveness test and therefore should not be included as a program offering.

3.3 Residential Water Heat

A large number of DSM measures were included within the Residential Water Heat Program for both electricity and gas. They were:

- Efficient Water Heaters (electricity and gas);
- Faucet Aerators (electricity and gas);
- Low Flow Showerheads (electricity and gas);
- Hot Water Pipe Insulation (electricity and gas);
- Horizontal Axis Clotheswasher (electricity and gas);
- Active Solar Water Heater (electricity and gas); and
- Heat Pump Water Heater (electricity only).

Detailed descriptions of these measures are contained in "Reference Volume 2 - Final Residential and Commercial Building Prototypes and Developed UECs and EUIs". Only the heat pump water heater

technology did not pass the TRC test in multi-family homes. The heat pump water heater technology did pass the TRC test in single family homes.

Promotion should vary among the various water heating measures. The efficient water heaters, the horizontal clothes washers and the heat pump water heaters should be promoted in the same manner as refrigerators and freezers with rebate levels designed to cover at least a major portion of the incremental cost between the efficient technology and the baseline technology. Faucet aerators, low flow showerheads, and hot water pipe insulation should be promoted in a manner similar to residential lighting with the financial incentives taking the form of mail-in rebates, instant rebates, or the distribution of free measures directly by the utility. Promotion of these measures should be through bill inserts, retailer promotions, newspaper ads, and radio and television commercials.

Active solar water heaters need to be offered and promoted differently than the other water heating DSM measures. Solar water heating systems can save significant levels of energy, but they are also expensive. The assessment of cost-effectiveness concluded that the measure should only be offered to single family homes that have at least four household members. The level of incentive should incorporate at least 50 percent of the incremental cost beyond conventional water heating systems. The existing state tax credit should be taken into account when determining rebate levels. Extensive marketing needs to exist that utilizes bill inserts, retailer promotions, newspaper ads, and radio and television commercials. The target market of households with four or more needs to be emphasized through the advertising.

3.4 Residential HVAC Measures

Residential space heating essentially does not exist in Hawaii and space cooling, especially central air conditioning, has a very low saturation. Despite the low saturation of residential air conditioning in Hawaii, DSM opportunities exist in the residential sector through the promotion of more efficient air conditioners and through the addition of wall and ceiling insulation. However, neither the addition of wall insulation nor the addition of ceiling insulation passed the TRC cost effectiveness test and therefore should not be included as a program offering. The DSM measures of efficient room and efficient central air conditioning systems did pass the TRC test and provide sufficient DSM resource potential to be included as a DSM program offering. The size of the rebates for the air conditioning measures should generally be at a level to cover a major portion of the incremental cost between the efficient technology and the baseline air conditioning technology. As with refrigerators and freezers, retailer promotion should be the primary marketing tool supported by bill inserts, newspaper ads, and radio and television commercials.

3.5 Residential Load Control

In this program, participants are asked to place external controls on their water heating and air conditioning units to reduce their energy use at peak times of the day and during peak months of the year. The air conditioning load control units did not pass the TRC test.

The controls often have been installed in such a way that the participant can remove or over-ride them temporarily, so that their participation is completely voluntary at all times. Financial incentives are usually offered and for the program considered by the DBEDT DSM Assessment Model, a financial incentive of \$75 per year is identified. Marketing methods used to inform customers about the program

include mailings, phone solicitation, mass media advertisements, bill inserts, door-to-door contacts, presentations in meetings, etc.

3.6 Commercial General Retrofit and Rebate

The Commercial General Retrofit and Rebate program offers commercial customers the opportunity to install energy-efficient equipment during renovations/replacements or new construction projects. Energy efficiency measures that apply to lighting, HVAC, water heating, refrigeration, and cooking were eligible for rebates. Certain measures passed the TRC test when applied to particular building types and failed the TRC test when applied to other building types. Table 2-4 identifies the measures that failed the TRC test by building type.

The size of the rebates for these measures should generally be at a level to cover a major portion of the incremental cost between the efficient technology and the baseline technology. The program is delivered either through rebates to customers or rebates to dealers. Also combinations of rebate and low- or no-interest loans could be offered to meet the customer's financing needs. Additionally, some projects could be referred to Energy Service Companies (ESCOs) who assist customers with project design, project financing and rebate applications, installation and construction. The program is promoted through advertisements on radio and television, in newspapers, in market specific trade publications, bill inserts, and special mailings. It is recommended that an energy audit of the participant facility be performed as part of the process of identifying feasible DSM measures.

4.0 THE BASE CASE

The DSM base case was derived by first establishing the current energy use and building and appliance stock characteristics by sector, end-use and county (excluding Molokai and Lanai) for the State of Hawaii. Development of the basecase also included identifying the DSM measures to be considered for DOE-2.1E analysis. Three steps were undertaken to develop base case characteristics. First, building characteristics for prototypical buildings needed to be identified. Second, energy use characteristics by end-use needed to be specified. Third, the amount of building stock and the fuel saturations within end-use categories needed to be determined. Due to lack of Hawaii specific data this process was difficult.

The fifty on-site building surveys and the Hawaii Model Energy Code were the prime sources of information for development of the building prototype characteristics. The on-site surveys were conducted⁶ to develop the commercial building prototypes. Development of these commercial building prototypes also utilized work previously performed by NEOS for the California Conservation Inventory Group⁷. The July 1993 version of the Hawaii Model Energy Code along with results from residential customer surveys performed by HELCO, MECO, and HECO, and the previously mentioned work for the California Conservation Inventory Group were used in the development of the residential building prototype characteristics. A separate reference volume details the development of the building prototypes, *Reference Volume 2 - Final Residential and Commercial Building Prototypes and Developed UECs and EUIs*.

Results from the ENERGY 2020 model provided many of the energy use characteristics for the base case. However, ENERGY 2020 does not provide end-use energy consumption values for all end-uses required by DOE-2.1E which necessitated use of other sources

The sources of data for estimating baseline energy use, the amount of building stock and the fuel saturations within end-use categories were the following:

- Input data from the April 1994 version of SST's ENERGY 2020 model for Hawaii. At that time, only the City and County of Honolulu module had been calibrated.
- The UECs⁸, EUIs⁹, and building and appliance saturations by fuel type that were used as inputs into the REEPS and COMMEND models used by the Hawaiian Electric Company (HECO) as of April 1994 were assessed. The UECs that were utilized by

⁶ Deliverable #7: Characterization of Building Prototypes, prepared for the Department of Business, Economic Development, and Tourism Energy Division, State of Hawaii by Barakat and Chamberlin, Inc, February 1994.

⁷ Technology Energy Savings, Volume II: Building Prototypes, prepared for the California Conservation Inventory Group by NEOS Corporation, March 1994.

⁸ Unit Energy Consumption (UEC) is the energy consumption at the end-use level for homes, in the residential sector, and per square foot, for the commercial sector.

⁹ Energy Use Index (EUI) refers to the relative amount of energy use (relative to a base year) at the end-use level for homes, in the residential sector, and per square foot, for the commercial sector. For instance, if the base year were 1994 and the UEC in 1994 were 100 kWh and in the year 2000, the UEC for the same end-use were 90 kWh, the EUI in the year 2000 would be 0.9 (90/100).

HECO and Regional Economic Research, Inc. (RER) ¹⁰ in the REEPS analysis were derivatives of a Conditional Demand Analysis (CDA) study performed by RER¹¹. Floor space and sales information for the commercial sector used in the COMMEND forecast performed by RER¹² were obtained from: (1) a commercial telephone survey performed by SSI; (2) the Commercial Building Energy Conservation Survey performed by HECO in 1989; and (3) the Non-Residential Building Energy Conservation Survey performed by HECO in 1986. The EUIs utilized in the COMMEND forecast were derived from floor space and sales data.

Comparison between REEPS and COMMEND and ENERGY 2020 values were developed for 1990. ENERGY 2020 results for 1992 were also reviewed since 1992 is the base year for the DBEDT DSM Assessment Model and the DOE-2.1E simulations.

4.1 Residential UEC Estimates

The average UECs used as inputs into the ENERGY 2020 model (April 1994 version) and into HECO's REEPS model are identified in Tables 4-1 and 4-3 (Electric) and Tables 4-2 and 4-4 (Gas). Two years are reported, 1990 (as a means to directly compare with the REEPS results) and 1992 (which is the base year specified for the DOE-2.1E simulations and the DBEDT DSM Assessment Model).

In 1993, HECO utilized the REEPS model to forecast energy consumption by end-use for its service territory. The UECs that were used in this model were derived from a Conditional Demand Analysis (see footnote 7). HECO's 1990 Residential Customer Survey and billing system data were used to estimate the share equations in the CDA. Adjustments were made to the results based upon comparisons with other utility metering data and HECO's staff engineers' professional assessments. In particular, multi-family water heating UECs and cooking UECs were modified from initial estimates. Initial UECs derived from the CDA were calibrated "to be consistent with overall customer class appliance shares and energy sales." (see footnote 8). In particular, UECs for the electric resistance water heating were increased to be consistent with a Florida end-use metering study and engineering estimates used by HECO staff.

The values identified as "RECOMMENDED VALUES" in Tables 4-1 through 4-4 were the recommended initial target values used by the DOE-2.1E engineering simulation model. However, these "RECOMMENDED VALUES" were starting points and were not necessarily the final UECs resulting from the DOE-2.1E model. The "RECOMMENDED VALUES" listed in the tables are average values for both new and existing vintages and the UECs calculated using DOE-2.1E were

¹⁰ Hawaiian Electric Company, Inc. REEPS Implementation, Regional Economic Research, Inc., August 16, 1993.

¹¹ Hawaiian Electric Company, Inc. Conditional Demand Study, Regional Economic Research, Inc., August 16, 1993.

¹² Hawaiian Electric Company, Inc. COMMEND Implementation, Regional Economic Research, Inc., August 16, 1993.

specific to the old and new vintages. Also, professional review of DOE-2.1E results to insure reasonable UEC estimates from the DOE-2.1E model led to some changes between the recommended UECs and the final UECs.

For the most part, the values recommended for use by DOE-2.1E were the values obtained from ENERGY 2020. Divergence from the ENERGY 2020 values occurred when either the ENERGY 2020 values were at an aggregate level or when the UEC was deemed to be either too high or too low. The air conditioning and refrigerator end-uses were instances where ENERGY 2020 values were at an aggregate level. In ENERGY 2020 the saturation of refrigerators is greater than 1.0 reflecting the fact that some households have more than 1 refrigerator. However, DOE-2.1E requires UEC values for the first and second refrigerators separately. The HECO REEPS model provided such disaggregation. The values from the REEPS model were deemed to be similar to the ENERGY 2020 refrigerator value when the UEC for the first refrigerator was added to the UEC for the second refrigerator multiplied by the saturation for the second refrigerator. For single family units this value was 1,772 kWh (compared to ENERGY 2020 value of 1,700) and for multi-family this value was 1,292 kWh (compared to ENERGY 2020 value of 1,103). For air conditioning, UECs were needed for both central and room air conditioning systems. ENERGY 2020 only provided a single air conditioning UEC that is a combination of both central and room systems. REEPS provided UEC values for both room and central air conditioning systems, but the value for room air conditioning seemed low. Therefore, a recommended value was only given for central air conditioning and the DOE-2.1E model would be relied upon for a room air conditioning UEC.

The electric water heating UEC value reported by ENERGY 2020 model was considerably higher than the electric water heating UEC from the REEPS model. Based upon comments provided to DBEDT regarding the potentially incorrect inlet water temperature (a water inlet temperature lower than that experienced in Hawaii) used to calculate the water heating UECs (both gas and electric) used as inputs into the ENERGY 2020 model, NEOS recommended using the REEPS water heating UEC for DOE-2.1E.

The electric cooking and electric lighting UECs were significantly different for ENERGY 2020 and REEPS. However, NEOS could find little data to support either UEC and therefore recommended staying with the ENERGY 2020 value. As stated earlier, these recommended UEC values were not necessarily the same as the final UECs resulting from DOE-2.1E modeling.

4.2 Residential Appliance Saturations And Number of Households

Tables 4-5 and 4-6 identify the average appliance saturation levels as represented by ENERGY 2020 and REEPS. The appliance saturations for the REEPS model were taken directly from HECO's 1990 Residential Survey. The recommended baseline average appliance saturation rates for all but a few appliances were those from the ENERGY 2020 model. The exception to this rule was for the end-uses that were not disaggregated by ENERGY 2020 to the level needed for use by the DBEDT DSM Assessment Model. For air conditioning, the value for central air conditioning came from REEPS and the value for room air conditioning was the air conditioning value from ENERGY 2020 minus the REEPS value for central air conditioning. The appliance saturation values for refrigerator #1, refrigerator #2, freezer, dishwasher, and clothes washer come from REEPS.

ENERGY 2020 and REEPS each had the same estimates regarding the number of single family households in 1990 (111,587) and multi-family households in 1990 (105,884). Therefore, household estimates were taken from the ENERGY 2020 model.

4.3 Commercial Sector EUI, End-Use Saturation, And Floorspace Estimates

The DBEDT DSM Model was dependent on the ENERGY 2020 model for estimates of commercial sector growth or contraction over the forecast period. These estimates of change over the forecast period must be in the form of floorspace by building type and fuel saturation by end-use for each forecast year. However, ENERGY 2020 does not provide floorspace estimates and its estimates of fuel saturation by end-use were not directly useable by DOE-2.1E. In addition, ENERGY 2020 does not provide estimates of end-use EUIs. However, using information from the HECO COMMEND forecast and HECO surveys of their commercial sector customers, estimates of baseline EUI, end-use saturation, and floorspace were developed. ENERGY 2020 provided estimates of relative floorspace and fuel saturation change over the forecast period.

Estimates of baseline end-use EUIs were needed for Honolulu county before DOE-2.1E commercial sector energy simulation efforts could begin. DOE-2.1E building simulation efforts were performed for Honolulu commercial building prototypes, except for hotels and resorts. DOE-2.1E building simulations for hotels and resorts were performed for all four counties. Only minor building modifications and different weather files distinguish the county prototypes from the Honolulu prototype. At the time of DOE-2.1E building prototype development, the only ENERGY 2020 forecast available was for the county of Honolulu. Therefore, baseline estimates of total floorspace, end-use saturation and EUIs were developed using county of Honolulu data only. Estimates of total floorspace for the remaining three counties were developed later in the project after the ENERGY 2020 forecasts for these remaining counties were available. Baseline floorspace estimates for the counties other than Honolulu were based on the relationships between total sales by building type and total floorspace by building type as developed for Honolulu county.

The recommended values of floorspace for buildings with electricity are shown in Table 4-7 in millions of square feet (MSF). These values were based on floorspace estimates developed for HECO by RER for use in their COMMEND forecasting model. RER used information from the HECO 1989 Commercial Building Energy Consumption Survey, a phone survey of HECO commercial customers performed by Synergic Resources Corporation, and the "Locations Business Database" for the island of Oahu. More complete information on how RER estimated baseline floorspace is available in their COMMEND report to HECO (see footnote 9).

Recommended electric EUIs by end-use and building type are also shown in Table 4-7. The ENERGY 2020 data on baseline electricity sales was used to weight the average EUI data from COMMEND. The recommended values for average EUI and marginal EUI were developed using the following formulas:

$$(1) \quad \text{Recommended Average EUI} = (A / B) * \text{Average EUI from COMMEND}$$

Where:

Recommended Average EUI = NEOS recommended value.

A = the total baseline electricity sales across end-uses by building type from ENERGY 2020.

B = the total baseline electricity sales across end-uses by building type from COMMEND.

Average EUI from COMMEND = Average EUI from HECO's COMMEND.

(2) Recommended Marginal EUI = $(A / B) * \text{Marginal EUI from COMMEND}$

Where:

Recommended Marginal EUI = NEOS recommended value.

A = The total baseline electricity sales across end-uses by building type from ENERGY 2020.

B = The total baseline electricity sales across end-uses by building type from COMMEND.

Marginal EUI from COMMEND = Marginal EUI from HECO's COMMEND.

For some building types, EUI values were not recommended due to large differences in the estimated electricity sales predicted by the COMMEND and ENERGY 2020 models. When a large discrepancy existed, unadjusted DOE-2.1E.1 simulation results were used for baseline EUI values.

The same analysis was performed for gas usage in Table 4-8. However, due to wide differences in predicted baseline sales from ENERGY 2020 and COMMEND, there were no recommended values for average or marginal EUIs based on these models. Rather, unadjusted DOE-2.1E.1 simulation results were used for baseline EUI values.

End-use saturation estimates are also presented in Tables 4-7 and 4-8. These values were obtained from HECO's COMMEND model. ENERGY 2020 reports values for fuel shares. This represents the proportion of energy used for a particular end use, by various fuels. For example, suppose that 30 percent of buildings within a particular building type have gas water heating; 20 percent of the buildings have electric water heating; and the remaining 50 percent of the buildings have no water heating. COMMEND would identify end-use saturation as 30 percent for gas, 20 percent for electricity; and, 50 percent none. ENERGY 2020 would report that 60 percent of water heating for that building type is fueled by gas and 40 percent by electricity.

Data for small and large offices and for schools and colleges were aggregated in Tables 4-7 and 4-8 due to the aggregation of these building types in HECO's COMMEND model. Table 4-9 shows the estimates of average and marginal EUIs by end-use for office and school characteristics in a more disaggregate level than found in Tables 4-7 and 4-8. In order to obtain these estimates for the disaggregated office and school building types, baseline sales data from ENERGY 2020 were used along with weights obtained from disaggregated baseline electricity sales data from an electricity

forecast for San Diego Gas and Electric¹³. San Diego Gas and Electric data was used since its climate closely approximates that of Hawaii among data available for mainland U.S. regions.

4.4 DSM Measures To Be Considered For DOE-2.1E Analysis

Baseline energy use and building characteristics were developed with the intent of using the DOE-2.1E building simulation model to identify the impacts of DSM measures. Once these values had been established, it was necessary to identify the DSM measures to be considered for the DOE-2.1E analysis. It was intended that the "Hawaii Demand-Side Management Measures Handbook and Database"¹⁴ prepared by Barakat & Chamberlin, Inc. (BCI) would serve as the primary source of DSM data. Other sources of data would be utilized whenever measures or values were missing in the BCI database. This intent was generally followed for the residential sector.

For the commercial sector, however, the BCI database contained generic information that was at the measure level and not at the building level. The number of measures per building was determined through an examination of prototype building characteristics. DSM measure impacts are building type specific and highly dependent on the prototype characteristics and the operational schedule of the building. The DOE-2.1E model was used as the primary tool for estimating commercial sector DSM measure impacts. The BCI database was useful in helping identify particular individual measures and the costs per measure. The DSM database prepared by NEOS for the California Conservation Inventory Group (see footnote 4) served as an additional primary data source for commercial sector DSM measures.

Detailed information on the DSM measures included in the database in the DBEDT DSM Assessment Model is available in *Reference Volume 2 - Final Residential and Commercial Building Prototypes and Developed UECs and EUIs*.

4.4.1 Residential Sector

The residential sector was segmented into two building types; single family and multi-family, and two vintages; existing and new. The BCI DSM Database contained 24 measures that could be applied to the residential sector. The BCI database did not distinguish between single family and multi-family homes but did distinguish between electricity and gas and among new, replacement, or retrofit applications. Table 4-10 lists the measures included in the BCI database and whether or not they were included in the NEOS developed DBEDT DSM Assessment Model's DSM database. Table 4-11 lists the measures included in the NEOS DSM database. The NEOS database contains 25 different measures of which 14 are similar to those in the BCI database. The NEOS database contains all measures considered by the DBEDT DSM Assessment Model before the TRC screening test was applied.

¹³ California Energy Demand: 1993 - 2013, Volume VII: The San Diego Gas and Electric Service Area Forms, prepared by the California Energy Commission, June 1993.

¹⁴ Hawaii Demand -Side Management Measures Handbook and Database, Version 1.0, prepared for the Department of Business, Economic Development, and Tourism Energy Division, State of Hawaii by Barakat and Chamberlin, Inc., December 1993.

Differences in the number of measures included in the BCI and NEOS DSM databases were the result of a NEOS review of the comments received from reviewers on the BCI database, and review of alternative sources of information. These alternate sources include: the California Conservation Inventory; the Northwest Power Planning Council; Southern California Edison; Hawaiian Electric Company, Inc.; The Gas Company; and Kauai Electric.

In the water heating program, the NEOS DSM database does not include the Heat Trap, the Tank Wrap, or the Low-Water Dishwasher measures that were identified in the BCI database. The first two measures were excluded because both measures are essentially incorporated in efficient water heaters. The Low-Water Dishwasher measure was not included because of its high cost relative to the energy savings expected.

In the lighting program, the NEOS DSM database does not include Reduced Wattage Incandescents from the BCI database but does include T-8 Lamp w/Electric Ballast and Halogen Lamp measures that were not in the BCI database. The Reduced Wattage Incandescent measure was excluded because of its short measure life and the likelihood of reversion to previous wattage levels upon replacement. The T-8 Lamp w/Electric Ballast was included because this is a fixture replacement measure with long measure life. The Halogen Lamp measure was included because it provides an improved quality of light with a relatively long measure life and a perceived likelihood of long-term retention.

Only the Reflector Pan cooking measure was retained for inclusion in the NEOS DSM database from the group of five cooking measures in the BCI database. The measures not retained for analysis by NEOS provided low levels of potential energy savings at a high cost.

For clothes drying, the NEOS DSM database included the Moisture Sensor measure identified in the BCI database and also included two additional measures; Microwave Clothes Drying and Heat Pump Clothes Drying. Neither of these two new measures are commercially available at this time. However, it appears that they should be in the next few years, and the level of energy savings available from each could be significant. Therefore, they were added as a reminder of technologies with significant DSM potential that are near commercialization.

For the cooling measures, the BCI database identified High Efficiency Room and Central Air Conditioners. The NEOS DSM database does not include Servicing Central Air Conditioners because of its low measure life and low likelihood of persistent, long term savings. The NEOS DSM database does include both High Efficiency Room and Central Air Conditioners. In addition, the NEOS DSM database includes the impacts of additional ceiling and wall insulation to homes with air conditioning.

No load control measures were identified in the BCI database. The NEOS DSM database contains control measures for water heaters and air conditioners. Both of these measures have been highly effective for many utilities on the mainland, depending when their system peak occurred.

4.4.2 Commercial Sector

Direct comparison between the DSM measures within the BCI database and the DSM measures contained in the DSM database developed by NEOS was difficult since the BCI DSM measures are generic without identification or relation to particular configurations of different commercial prototypical buildings while the NEOS DSM measures are specifically correlated to particular

applications of DSM measures within the different prototypical buildings. The BCI database lists 48 different electric and gas commercial sector DSM measures while the NEOS database identifies 63 different measures. Table 4-12 provides a matrix of the DSM measures included within the NEOS DSM database by application to particular building types. Insufficient information exists in the BCI database to make a similar table. As with the residential sector, the NEOS DSM database contains all measures considered by the DBEDT DSM Assessment Model before the TRC screening test was applied.

The primary source for information in the NEOS DSM database was the previously mentioned DSM database of the California Conservation Inventory (CCI) group. The number of measures contained in the Inventory is extensive and the measures being considered for analysis in Hawaii represent a subset of these measures. Many of the measures included in the California Inventory were not appropriate for implementation in Hawaii and were thus excluded. The BCI database was used as a source of information for particular DSM measure characteristics and cost, but was not relied upon as the primary source of information for commercial sector DSM data. The CCI database contained more measures, more detail about the measures, and more building specific information across more building types than the BCI database.

Abbreviations are used to identify particular commercial building types. Building types are referred to using keywords shown below:

<u>Keyword</u>	<u>Building Type</u>
SOFF	Small Office
LOFF	Large Office
SRET	Small Retail
LRET	Large Retail
SDRE	Sit-Down Restaurant
FFRE	Fast Food Restaurant
GROC	Grocery
REFW	Refrigerated Warehouse
STOR	Non-Refrigerated Warehouse
HOSP	Hospital
SCHL	School
COLL	College
HOTR	Hotel & Resort
APRT	Master Metered Apartment Buildings

5.0 BUILDING PROTOTYPE SIMULATIONS

A building prototype technique was employed to estimate the DSM resource potential in Hawaii. Using building prototypes is a common technique for assessing energy use characteristics in buildings. The technique is also used by a number of organizations, including the Northwest Power Council and the California Energy Commission, to estimate DSM measure impacts. The DOE-2.1E.1 hourly energy simulation program was used as the computer modeling program to simulate base case and DSM measure energy and peak demand characteristics in prototypical buildings for both the residential and commercial sectors. The DOE-2.1E.1 model has also been used to estimate DSM measure impacts for the Northwest Power Council and the California Energy Commission.

Employment of this technique required following a six step process. These six steps were:

- Step 1 - Develop matrix of appropriate building types and vintages for each island, excluding Molokai and Lanai, and sector;
- Step 2 - Collect and develop building characteristics information (e.g., floor area, construction materials, operating schedules, and connected lighting and equipment loads) for the building type matrix;
- Step 3 - Develop corresponding matrix of average "target" UEC and EUI values for the different building types;
- Step 4 - Conduct building prototype simulations and calibrate, when possible, to baseline average targets (the final product of this step was the establishment of the base case for DSM evaluation);
- Step 5 - Select DSM measures and technologies appropriate for application in each building type; and
- Step 6 - Conduct parametric simulations and develop estimates of energy and peak load impacts for individual DSM measures and technologies selected for each building type.

Selection of the particular buildings and vintages for each island and sector for which prototypes were developed was dependent on ENERGY 2020 requirements for the particular buildings that were part of the 50-building on-site surveys. NEOS conducted the building surveys as a sub-contractor to BCI, but the number of sites and particular buildings selected were made by BCI and the DBEDT contract manager.

An existing and a new vintage building prototype were developed for each of the following commercial building types:

- Oahu Hotel/Resort;
- Oahu Small Office (generally defined as having < 30,000 square feet of floor area);
- Oahu Large Office (30,000 square feet);
- Oahu Retail;
- Oahu Restaurant (separate simulations for sit-down and fast food);
- Oahu Grocery Store;
- Oahu School;
- Oahu College;
- Oahu Hospital;
- Oahu Warehouse (may include separate simulations for refrigerated and non-refrigerated);

- Oahu Apartments;
- Oahu Miscellaneous;
- Maui Hotel/Resort;
- Hawaii Hotel/Resort;
- Kauai Hotel/Resort;
- Maui Miscellaneous;
- Hawaii Miscellaneous; and
- Kauai Miscellaneous.

In addition to these commercial building types, an existing building and a new vintage building prototypes were developed for single family and multi-family homes for the residential sector.

The on-site commercial building surveys conducted by NEOS for BCI, as well as the Hawaii Model Energy Code, were the prime sources for development of the building prototypes. The July 1993 version of the Code is the version that was referred to when delimiting New and Existing buildings. The Model Energy Code impact analysis, which utilized a version of the DOE-2.1E building simulation model, was an important source of information for the new vintage prototype analysis. Detailed information on the characteristics of the prototype buildings is contained in *Reference Volume 1 - Building Prototype Analysis*.

Step 3 of the building prototype technique required identifying "target" UEC and EUI values for the different building types. Results from the ENERGY 2020 model as well as information from HECO's REEPS and COMMEND models were used in this step. Discussion of how these sources were employed is contained in Section 4.1 of this report for the residential sector and Section 4.3 for the commercial sector. Discussion of how step 4, the development of the base case for each building prototype, was accomplished is contained in *Reference Volume 1 - Building Prototype Analysis*.

The selection of the appropriate DSM measures and technologies for application in each building type, step 5, relied on a number of different sources. Section 4.4 outlined how these measures were identified. The results of the parametric DOE-2.1E.1 model simulations used to estimate the energy and peak load impacts for the individual DSM measures, step 6, are contained in *Reference Volume 2 - Final Residential and Commercial Building Prototypes and Developed UECs and EUIs*.

6.0 ANNUAL DSM MEASURE IMPACTS

Developing the estimates of DSM measure impacts over time is a multi-step process that first adjusts the initial estimates of DSM measure impacts before the elements of program participation and time are applied. This section of the report deals with this first step of adjusting the initial estimates of DSM measure impacts. Section 9 treats the methodology for accommodating program participation and the effects of time. Adjusting the initial estimates of DSM measure impacts included consideration of the following variables:

- Unadjusted DSM measure impacts (6.1);
- Intra-active effects (6.2);
- Mutual Exclusivity (6.3);
- Transmission & distribution (or pipeline) adjustment (6.4);
- Net-to-gross factor (6.5);
- Number of dwellings or commercial building floor-area (6.6); and
- Appliance and end-use fuel saturations (6.6).

6.1 Unadjusted DSM Measure Impacts

Results from the DOE-2.1E.1 building simulations provided the estimates of unadjusted DSM measure impacts. These estimates of DSM measure impact are what would be expected by the building occupant if the measure were implemented. They are specific to individual applications of DSM measures without regard to whether other measures were also implemented. These values are found in the DSM measure input files (DSMRES for residential and DSMCOM1 and DSMCOM2 for Commercial). They were the starting point for the development of total DSM measure potential that takes into account all of the elements listed in Section 6.0.

6.2 Intra-active Effect Adjustment

The first step in adjusting the initial estimates of DSM measure impacts is to account for intra-active effects. The size of a DSM measure impact on a particular end-use may or may not change depending on whether more than one measure is applied to that end-use. For example, adding ceiling insulation to a home with air conditioning will reduce the cooling energy requirements as will replacing an existing air conditioning unit with a more efficient one. Implementing each individually will save a certain amount of electricity. However, the savings from implementing both measures will not be additive since implementing one will reduce the cooling load that the second measure will also impact. This effect is the intra-active measure effect and unadjusted DSM measure impacts must be modified to take this affect into account. In contrast, replacing certain bulbs in your home with compact fluorescent bulbs and others with energy efficient four foot fluorescent tubes will not result in an intra-active effect. Both measures are cumulative and no intra-active effect adjustment would be needed.

Within the DBEDT DSM Assessment Model, adjustments for intra-active effects occur in the DSM measure input files (DSMRES for residential and DSMCOM1 and DSMCOM2 for Commercial). In the residential file, the calculations were performed exogenously and then added to the database. However, because of the large number of commercial DSM measures, the commercial sector calculations were performed endogenously.

The more intra-active measures, the more complex the calculation to adjust the DSM measure impact estimate. Using a simple example of two intra-active measures, one saving five percent and the other saving ten percent, the following example is provided:

$$\begin{aligned}\text{TSF} &= \text{Mea\#1 Savings} + \text{Mea\#2 Savings} * (1 - \text{Mea\#1 Savings}) \\ &= 0.05 + .1 * (1 - 0.05) \\ &= 0.145\end{aligned}$$

Where:

$$\begin{aligned}\text{TSF} &= \text{Total Savings Fraction} \\ \text{Mea\#1 Savings} &= 0.05 \\ \text{Mea\#2 Savings} &= 0.10\end{aligned}$$

Adjusted Savings:

$$\begin{aligned}\text{Mea\#1 Adjusted Savings} &= 0.05 / 0.145 \\ &= 4.8\% \\ \text{MEa\#2 Adjusted Savings} &= 0.10 / 0.145 \\ &= 9.7\%\end{aligned}$$

6.3 Mutual Exclusivity Adjustment

Similar to the problem of intra-active effects is the problem of mutual exclusivity. Mutual exclusivity refers to the fact that the implementation of one measure precludes the implementation of another measure. An example would be that a heat pump water heater would not be installed if a solar water heating system had already been installed. The mutual exclusivity adjustment performed by the DBEDT DSM Assessment model modifies the size of the remaining market share so that each competing measure has its proper proportional share.

As with intra-active effects, adjustments for mutual exclusivity occur in the DSM measure input files (DSMRES for residential and DSMCOM1 and DSMCOM2 for Commercial). In the residential file, the calculations were performed exogenously and then added to the database. However, because of the large number of commercial DSM measures, the commercial sector calculations were performed endogenously.

As an example, assume that mutually exclusive measure #1 has a potential market share of 90%, mutually exclusive measure #2 has a potential market share of 60%, and mutually exclusive measure #3 has a potential market share of 75%. The sum of these three market shares is 225% with the largest being 90%. The basic formula follows:

$$\begin{aligned}\text{Modified Market Share} &= (\text{Current Market Share} * \text{Largest Market Share}) / (\text{Sum of Current Market Shares}) \\ \text{Mea\#1 Modified Market} &= (.9 * .9) / 2.25 = 36\%\end{aligned}$$

Mea#2 Modified Market	=	$(.6 * .9) / 2.25$	=	24%
Mea#3 Modified Market	=	$(.75 * .9) / 2.25$	=	30%

6.4 Transmission And Distribution (Or Pipeline) Adjustment

The unadjusted DSM measure impacts are estimations of DSM measure savings at the point of measure installation. Additional savings also accrue from the fact that the energy saved means energy not delivered and a corresponding savings from the lack of energy losses within the distribution system. For electricity, there are additional savings from the lack of transmission line losses. For gas, there are added savings from the lack of any losses that occur in the gas distribution system. For both gas and electricity, the DBEDT DSM Assessment Model used a five percent adjustment factor to increase realized energy savings from the DSM measures.

6.5 Net-To-Gross Factor

The function of the net-to-gross factor is to discount DSM measure impacts in order to eliminate what consumers would do in the absence of the DSM programs. In other words, its purpose is to isolate those impacts that are strictly program induced. Naturally occurring DSM impacts are taken into account in any energy forecasting model, including ENERGY 2020. Estimates of net-to-gross ratios were obtained from both the IRT Results Center's 1992 Series¹⁵ reviewing demand-side management programs and the California Conservation Inventory Control Group's Database of Utilities' Measurement and Evaluation Studies (1994)¹⁶. Table 6.1 identifies the residential sector and Table 6-2 the commercial sector net-to-gross factors used in the DBEDT DSM Assessment Model.

6.6 Utilization Of Building Stock And Fuel Saturation Estimates

The forecast of building stock and fuel saturation estimates was provided exogenously through a combination of the ENERGY 2020 forecast and supplemental algorithms based on HECO's REEPS and COMMEND models). Utilization of these values was the next intermediary step in the calculations of the annual DSM measure impacts. These calculations occurred within the main forecasting modules of the DBEDT DSM Assessment Model (HAW-RES and HAW-COM). Only those DSM measures that passed the economic screen (if there was one) move on to this step of the DSM assessment.

The result of this step is the total DSM potential for a measure without regard to annual program participation or measure life. These considerations are accommodated in the next step of the

¹⁵ IRT Environment, Inc., *The Results Center*, selected publications from the 1992 Series. Aspen, Colorado. 1992.

¹⁶ California Energy Commission, California Conservation Inventory Group. "Summaries of California Utilities' Measurement and Evaluation Studies as Presented in the Database of Energy Efficient Resources." January 1994.

assessment process: the estimation of measure savings over time. Section eight of this report illustrates the accommodation of annual program participation and measure life in the DSM assessment process.

The formula utilized in this step of the process is as follows:

$$\begin{aligned} \text{Total DSM Measure Potential} &= \text{Unadjusted Measure Impact} * \# \text{ of Units} * \text{Unit Fuel} \\ &\quad \text{Saturation} * \text{T \& D Adjustment} \\ &\quad * \text{Net-To-Gross Ratio} \end{aligned}$$

Using as an example the DSM measure Gas Solar Water Heating in Maui county, the following conditions exist:

•	Unadjusted Measure Impact	260 Therms
•	# of Single Family Homes	
	With 4 or More Occupants	3,552
•	Gas Water Heat Saturation	6.6 %
•	Pipeline Adjustment Factor	1.05
•	Net-to-Gross Ratio	98 %

$$\begin{aligned} \text{Total DSM Measure Potential} &= 260 * 3,552 * 0.066 * 1.05 * 0.98 \\ &= 62,720 \text{ Therms} \end{aligned}$$

This calculation was performed for the years 1995, 1999, 2006, and 2014. The values for the intervening years were interpolated. The resulting values for each forecast year were used in the next step of the DSM assessment; the estimation of measure savings over time (see Section 9).

7.0 TECHNICAL POTENTIAL AND ECONOMIC SCREENING

The DBEDT DSM Assessment Model allows for the development of four different DSM scenarios: Technical, Economic, Market, and Hawaii Program. Definitions of these scenarios was provided in Section 1.4. The Technical potential scenario includes estimates of DSM resource potential for all of the DSM measures included in the DSM database, regardless of cost. An economic screen, the Total Resource Cost Test (TRC), was used to identify the subset of measures deemed to be cost effective for inclusion in the three remaining scenarios.

The TRC test is expressed as a benefit-cost ratio with benefits divided by costs. The TRC measures the net costs of a DSM program as a resource option based on the total costs of the program, including both the participants' and the utility's costs. The costs are levelized over the lifetime of the DSM measure. The electricity benefits are calculated as the avoided costs of generation in \$/MWh, while the avoided costs of gas delivery are calculated in \$/THERM. To pass the TRC test, the benefit/cost ratio must be greater than or equal to 1.0.

7.1 Avoided Costs

The DBEDT DSM Assessment Model allows for the identification of unique avoided costs by county. However, for the scenarios developed under this project, the avoided costs were the same for each county. The avoided cost for electricity was identified as \$90.90/MWh and \$1.75/THERM for gas. The electricity avoided cost was based on the cost of a combined cycle generating facility as identified in the GASCO IRP filing of May 1993¹⁷. The gas avoided cost was based on the average cost of delivered gas, as identified in the HECO REEPS¹⁸ documentation plus 10 percent.

7.2 Levelized Cost Calculation

The process of calculating the levelized cost is the same as finding the size of a loan payment that would amortize the discounted costs at the chosen interest rate for the given life. The interest rate used for the levelized cost calculation is the input variable **Discount Rate**. Other variables used in the DBEDT DSM Assessment Model's levelized cost calculation include:

- One time measure cost;
- Annual measure cost;
- Administrative cost;
- Tax credit;
- Measure life;
- Measure savings;
- Net to Gross Ratio; and
- Transmission & distribution adjustment.

¹⁷ The Gas Company (GASCO) Integrated Resource Plan, Prepared by TELLUS Institute. May 1993.

¹⁸ Hawaiian Electric Company, Inc. REEPS IMPLEMENTATION, Prepared by Regional Economic Research, Inc.. August 1993.

Using the @PMT function of Quattro-Pro for Windows, the DBEDT DSM Assessment Model uses the following form to calculate levelized cost:

$$\begin{aligned}\text{Levelized Cost} &= \frac{(\text{Annual Measure Cost} + @PMT(\text{Principal, Rate, Term}))}{\text{Adjusted Measure Savings}} \\ &= \frac{(\text{Annual Measure Cost} + @PMT((\text{One Time Measure Cost} * (1 + \text{Administrative Cost Factor}) - \text{Tax Credit}), \text{Discount Rate, Measure Life}))}{(\text{Measure Savings} * \text{Transmission \& Distribution Adjustment} * \text{Net to Gross Ratio})}\end{aligned}$$

An example calculation:

$$\begin{aligned}\text{Levelized Cost} &= \frac{(\$10 + @PMT((\$180 * (1 + 15\%) - \$72), 6\%, 15))}{(500 * 1.075 * 0.8)} \\ &= \$0.056 / \text{kWh}\end{aligned}$$

Where:

- Annual Measure Cost = \$10
- One Time Measure Cost = \$180
- Administrative Cost = 15%
- Tax Credit = \$72
- Discount Rate = 6%
- Measure Life = 15 years
- Measure Savings = 500 kWh
- Transmission & Distribution Adj. = 1.075
- Net to Gross Ratio = 0.80

The discount rate values the cost of money over time and is expressed as a real discount rate. The DBEDT DSM Assessment Model used a discount rate of six percent that is the same real discount rate used in the GASCO IRP filings (see footnote 14).

Annual measure costs are net, annually recurring costs such as maintenance, costs that are beyond the annual costs incurred by the base technology. One time measure costs are the incremental capital costs for purchasing the DSM measure. These costs represent the additional cost required beyond the base case technology. The BCI database (see footnote 11) was the primary source for information on annual and one time measure costs. For the measures not included in the BCI database, the DSM cost data contained in the California Conservation Inventory¹⁹ were used.

The administrative cost ratio is the additional administrative cost of providing DSM programs expressed as a percentage of the total cost of the DSM measure. The total DSM measure cost is the sum of the costs to the utility and to the participant to purchase and install a DSM measure. (Note.

¹⁹ Measure Cost Study, California Conservation Inventory Group, prepared by XENERGY Inc.. May 1992.

this sum does not consider the cost (benefit) to the consumer or the non-participant, as may be reflected through rate increases (decreases) that are a consequence of a DSM program.)

The administrative cost ratio was based on the review of the mainland programs found in Appendix A as well as additional supporting studies. Linda Berry²⁰ surveyed the literature to reveal that an administrative cost ratio of 20 percent is commonly found for residential weatherization (e.g., insulation, caulking, weather-stripping) programs, between 25 percent and 35 percent is found as an estimate for commercial audit and incentive programs, and between ten percent and 15 percent is found for commercial lighting programs. Berry's review involved the use of two databases: the Office of Applied Energy Studies (OAES) database of Washington State University compiled in 1988; and the Northeast Region Demand-Side Management Data Exchange (NORDAX) database comprised of information regarding 90 programs implemented by more than 17 utilities. The Northwest Power Planning Council (NPPC)²¹ has also been known to use 20 percent as an estimate of the administrative cost ratio. However, most of the administrative cost ratios were based on the utility paid portion of the measure cost which on average for these programs appeared to be about two thirds of the total measure cost. Therefore, for the residential sector, the DBEDT DSM Assessment Model used an administrative cost ratio of 15 percent for all programs except lighting which used an administrative cost ratio of eight percent. For the commercial sector, the administrative cost ratio was also 15 percent for all programs except for indoor and exterior lights that had an administrative cost ratio of nine percent.

The value of State of Hawaii tax credits for the installation of certain DSM measures is accounted within the levelized cost of the appropriate measures. The credit was used to reduce the cost of the measure and was taken into account before the TRC economic screen.

Measure life is defined as the point where 50% of the installed DSM measures have failed. The methodology for incorporating the effects of measure life into the DSM resource estimates is addressed in Section 9. As with annual and first time measure costs, the BCI database (see footnote 11) was the primary source for measure life estimates, with the CCI database²² the secondary source for the estimates.

In the residential sector, the "Measure Savings" value was modified to account for interaction between space cooling energy use and reductions in energy use caused by the DSM measure. For instance, efficient lighting not only directly saves energy for the lighting end-use, it also reduces the cooling load in homes with air conditioning. The interaction variable was developed from the output of the residential DOE-2.1E.1 simulations. Parametric runs of DOE-2.1E.1 were performed with the DSM measures installed in homes with A/C and without A/C. Differences between the energy savings estimates for these two runs were the basis for the interaction variable. The interaction affect is only

²⁰ The Administrative Costs of Energy Programs., Prepared by Linda Berry for the Oak Ridge National Laboratory for the Department of Energy. November 1989.

²¹ 1991 Northwest Conservation and Electric Power Plan, Volume II - Part I, Northwest Power Planning Council, 1991.

²² California Conservation Inventory Group, "Database For Energy Efficient Resources." Maintained by the California Energy Commission, June 1994.

applied to homes with air conditioning. In the residential sector, measure savings value is adjusted in the following manner:

$$\text{Adjusted Measure Savings} = \text{Measure Savings} + \text{Interaction Variable} * (\text{Room A/C Saturation} + \text{Central A/C Saturation})$$

In the commercial sector, the base case buildings included air conditioning and therefore the interactive affects between the end uses were captured in the DSM measure energy impact estimates used by the DBEDT DSM Assessment Model.

As discussed in Section 6.4, the transmission and distribution adjustment (for electricity) and the pipeline adjustment (for gas) factors were used to increase the savings of DSM measures. This increase is designed to reflect the electricity and gas "**not lost**" in the distribution system before delivery to the customer.

The function of the net-to-gross factor is to isolate and discount those impacts that are strictly program induced. The levelized cost calculation adjusts savings but not costs by the net-to-gross factor. Because of free riders, the total cost of the measure would need to be paid. However, because some of that savings would have occurred in the absence of the DSM program, the savings achieved is discounted. (Additional discussion of the net-to-gross factor can be found in Section 6.5.)

8.0 ANNUAL PROGRAM PARTICIPATION RATES

Estimates of annual program participation must be made before accommodating the effects of program participation and measure life on the DSM impact estimates (see Section 9), estimates of annual program participation must be made. The question of annual program participation incorporates the issues of: 1) defining the target population for the program; 2) the discrete year-by-year estimates of the percentage of the target population that will likely participate; and, 3) the maximum market penetration that can be expected. The concepts of Technical, Economic, Market, and Hawaii Program potential also affect the estimates of maximum market penetration.

To highlight each of the factors that determine annual program participation, the example of the DSM measure Gas Solar Water Heating in Maui county from Section 6.6 is continued here. From the conditions presented in Section 6.6, the target population was defined as single family homes with gas water heat that have four or more occupants. This target population is:

•	# of Single Family Homes With 4 or More Occupants	3,552
•	Gas Water Heat Saturation	6.6 %
•	Total Target Population	$= 3,552 * 6.6\%$ $= 234$

This target population of 234 homes is further reduced by applying the discrete estimates of annual program participation and the maximum market penetration. Under the Hawaii Program scenario for 1999, the number of single family households in Maui county with gas water heat expected to install a gas solar water heating system is:

•	Total Target Population	234
•	Maximum Market Penetration	50%
•	Year 1999 Program Participation	15 %
•	Year 1999 Participation	$= 234 * 50\% * 15\%$ $= 18$

The annual program participation rates used by the DBEDT DSM Assessment Model correspond to the 15 percent program participation rate in 1999 used in the example above. Each year of the forecast has its own unique program participation rate.

The current sentiment in the DSM literature (Jaffe and Stavins²³ among others) suggests that the evolution over time of the adoption of Energy Conservation Measures (ECMs) follows a sigmoid or logistic curve. Figure 8-1 illustrates this function. Utilizing the function, there appears to be slow adoption at first, more rapid adoption (at an increasing rate) in the later but still early stages of the program, less rapid (but still increasing) adoption in the later stages of the program, a plateau period, and then a gradual tailing off participation as the market becomes fully saturated. The logistic curve is a description of adoption that is generally supported by the annual participation rates experienced in DSM programs on the mainland.

²³ The Energy Paradox And The Diffusion Of Conservation Technology, Adam B. Jaffe and Robert N. Savins, Resources For The Future, September 1993.

FIGURE 8-1

8.1 Target Population Assumptions

Target population assumptions identify the particular characteristics of the population being targeted by a DSM program. The way target populations are defined will affect the way that annual penetration rates are provided to the DBEDT DSM Assessment Model. Programs targeted for existing devices will identify the devices in existence during the base year as their target with annual program penetration rates expressed as a percentage of this target population. If the program is designed to replace a device at the time of normal burnout, the maximum annual program penetration rate is limited to the estimated number of burnouts occurring during that year. This maximum percentage is one divided by the measure life. Programs targeted for new construction will only be targeted toward the new buildings being built in a particular year. Annual program penetration rates are therefore expressed as a percentage of the new construction occurring that year and may be as high as 100%. Programs targeted for both new and existing structures utilize the total device population in each forecast year. Penetration rates are expressed as a percentage of this total population with the maximum annual program penetration rate being limited to the estimated number of burnouts occurring during that year when appropriate. An additional limitation to all target populations is the saturation and fuel type of the targeted device.

8.2 Maximum Market Penetration

The development of the Technical Potential and the Economic Potential DSM estimates utilize a maximum market penetration estimate of 100%. The development of the Market Specific Potential and the Hawaii Program Potential utilize maximum market penetration estimates that are less than 100%. Both Market Specific and Hawaii Program Potential estimates of maximum market penetration are based on an analysis of utility data on current and past programs and attitudinal surveys. Appendix A

contains a description of the DSM programs reviewed. Section 8.3 provides a discussion of the attitudinal surveys reviewed.

Maximum market penetration rates are expressed for a program as a whole. Table 8-1 identifies Market Specific and Hawaii Program Potential rates for the residential sector and Table 8-2 for the commercial sector.

8.3 Attitudinal Survey Results

Farhar²⁴ presents the results of several nationwide surveys that asked general questions about individual's perceptions and attitudes toward energy conservation, the energy crisis, and energy consumption. However, most of the questions in these surveys, however, were general, not program specific. Farhar found that Gallup²⁵ posed the following question to a sample of individuals, "Do you happen to be doing anything to reduce your use of energy--that is, your use of gasoline, electricity, or natural gas?" More than one-third of those surveyed responded that they "were not doing anything at all" to conserve energy. Farhar continued her survey by noting that an NBC News/Wall Street Journal²⁶ poll found that when asked whether they took steps to reduce the use of electricity and gas in their homes, 5 percent of the survey respondents claimed that they "never" did. A Gordon S. Black/USA Today²⁷ poll asked, "How much does your household cut back on heat in the winter or air conditioning in the summer to conserve energy?" Again, in this poll, five percent of those responding said "none at all."

Regional Economic Research²⁸ conducted an attitudinal survey of San Diego Gas and Electric's customer base to determine an estimate of refusal rates for demand-side management programs--the percentage of consumers refusing to participate in these programs. Of the customers participating in the survey, 16.3 percent said they would not participate in the program.

In an earlier review during the mid-1970's, nationwide polls taken by the Gallup Organization, Louis Harris and Associates, The New York Times, and the Columbia Broadcasting System were

²⁴ Farhar, Barbara C. "Public Perceptions and Preferences on Energy Policy." ACEEE 1992 Summer Study on Energy Efficiency in Buildings Proceedings--Human Dimensions 10:47-63.

²⁵ Gallup Organization. "Gallup/Newsweek Pool." American Institute of Public Opinion. Princeton, New Jersey. August 1990.

²⁶ Hart & Teeter Research Companies, "NBC News/Wall Street Journal Survey." April 1990.

²⁷ Gordon S. Black Corporation. "Public Opinion Survey." Sponsored By U.S.A. Today. March 1990.

²⁸ Direct Assistance Market Saturation Study, Prepared by Regional Economic Research. for San Diego Gas & Electric, December 1991.

summarized by Milstein²⁹ to reveal that "over 80 percent of the public supported the idea of tax rebates for home insulation and retrofitting; energy efficiency standards for buildings, cars, and appliances; strict enforcement of the 55 mph speed limit; and the necessity of federal government controlling the distribution of scarce fuels."

From these reported values, it was concluded that when energy users are asked to self-report whether or not they were willing to participate actively in general energy conservation programs and, in particular, types of demand-side management programs, between roughly 5 to 20 percent were unwilling to participate. Note that the survey results cited above were for residential programs. Given these types of surveys, it was concluded that for particular types of demand-side management programs in which there were not sufficient data from which to derive a specific empirical estimate, a number between 5 and 20 was justified as an estimate of the percentage unwilling to participate.

8.4 Annual Program Participation

As mentioned at the beginning of this section, the DSM literature as well as a review of the annual participation rates from the DSM programs listed in Appendix B, suggest that annual participation rates follow a sigmoid or logistic curve. The participation rate input file for the DBEDT DSM Assessment Model utilized estimates of annual participation rates developed using a logistic curve formula. The Quattro Pro for Windows spreadsheet used to develop these estimates of annual participation was supplied to DBEDT (LOGOPTIM.WB1).

For the residential sector, annual participation rates were developed for each DSM measure. For the commercial sector, the annual participation rates were by end use. The reason for developing participation rates for each measure in the residential sector is that they may vary depending on the definition of the target population; and, for measures designed to replace devices at the time of burnout, by measure life. In the commercial sector, these concerns were not as great since the measures were considered separately for existing buildings and new construction and the target population was always the appropriate end use within each building type.

Three methods for estimating annual program participation were used depending on the target population and the need to accommodate measure life considerations. The first method was appropriate for measures targeted at all new and existing buildings/devices or all existing buildings/devices, each with no need to accommodate measure life considerations. In the spreadsheet "LOGOPTIM.WB1," the row entitled "Annual Participation" contains the results of the calculations. The values calculated for "Annual Participation" are merely the difference between the values for the current year "Cumulative Participation" and the previous year's value for "Cumulative Participation." The calculation contained in the spreadsheet row entitled "Cumulative Participation" is where the logistic formula exists. The formula structure is as follows:

²⁹ Milstein, J.S. "How Consumers Feel About Energy: Attitudes and Behavior During the Winter and Spring of 1976-77." In S. Warkov (Ed.) *Energy Policy in the United States: Social and Behavioral Dimensions*. Praeger Publishers. New York 1978.

$$\text{CumPart} = \text{Maximum Participation} / (1 + \text{Constant} * @\text{EXP}(-\text{Year} * \text{Inflection Point}))$$

Where:

Maximum Participation = the percent of the population that could potentially participate during that year. (100% in this method)

Constant = value that influences the beginning and ending points of the logistic curve. The value was set at 50 based on professional judgment and review of alternate constant values. The value can be modified.

Year = the year being considered after program startup.

Inflection Point = value that influences the shape of the logistic curve. The closer the value is to one, the shape of the curve appears more like a step function. The closer the value is to 0, the closer the shape of the curve is to an upwardly sloping straight line. The value has been set at 0.75 based on professional judgment and review of alternate values. The value can be modified.

The second method was appropriate for measures targeted at new construction only. In this situation, the target population was the amount of new construction occurring each year. Therefore, the participation rate for any given year could be as high as 100%. In the spreadsheet "LOGOPTIM.WB1," the row entitled "Cumulative Participation" contains the participation values appropriate for this second method. The logistic formula is identical to that outlined above for the "Cumulative Participation."

The third method was appropriate for measures targeted at all new and existing buildings/devices or all existing buildings/devices each with a need to accommodate measure life considerations. The spreadsheet row entitled "Lifetime Controlled Cumulative Participation" (in "LOGOPTIM.WB1") contains the participation values appropriate for this third method. In this third method, the basic logistic formula outlined above was utilized with two modifications. The first was to modify the value for maximum participation. In the first two methods, the value for maximum participation could in theory be as high as 100% in any one year. In this third method, the value was limited by the measure life. If the program were designed to replace a device on burnout that has a lifetime of, for example, 10 years, the theoretical maximum number of devices available from the target population would be 10%. Therefore, maximum participation was set as one divided by the measure life. The second modification was designed to prevent double counting. In the example of a program with a measure life of ten years, it was possible that participants in the eleventh year and so on could be previous participants from the first year and so on. To avoid this double counting potential, participation rates for each year after a measure's life were reduced by the corresponding participation rates from the years before the measure life was achieved. Using the example of the program with a measure life of 10 years, in year 11, participation would be as calculated by the normal formula minus the participation calculated for the first year of the program.

Annual program participation rates were developed by measure and fuel type for each of the four counties in Hawaii. Tables 8-3 and 8-4 identify the participation rates utilized to develop the DSM

assessment results reported in Section 2 of this report for the residential and commercial sectors, respectively.

9.0 MEASURE SAVINGS OVER TIME

The first step toward developing estimates of DSM resource potential was the modification of unadjusted DSM measure impacts as described in Section 6. The next step, as described in this section, accommodates the effects of annual program participation and measure life.

By the end of Section 6, the methodology detailing how the total DSM measure potential had been calculated had been presented. This value was a modification of the unadjusted DSM measure impacts taking into account:

- Intra-active effects;
- Mutual exclusivity;
- Transmission & distribution (or pipeline) adjustment;
- Net-to-gross factor;
- Number of dwellings or commercial building floor-area; and
- Appliance and end-use fuel saturations.

In this section, the distribution of the total DSM measure potential over the forecast period through the use of the annual program participation rates (see Section 8) will be described as well as the methodology for accommodating DSM measure life. The results from this step are the incremental and cumulative estimates of each DSM measure's impact.

There are four parts to this step of the DSM assessment. These include:

- Estimate incremental savings by forecast year;
- Estimate the effects of DSM measure decay on cumulative DSM impacts;
- Identify decayed savings available for re-participation; and
- Estimate cumulative impacts for each year.

The first part estimates the incremental savings occurring each year of the forecast period. This is developed by multiplying the total DSM measure potential (see Section 6) by the annual program participation rate and the maximum market penetration rate (see Section 8). Continuing the example from Section 6 of estimating the DSM potential for Gas Solar Water Heating in Maui county for 1999 under the Hawaii Program scenario:

•	Total DSM Measure Potential	62,720 Therms
•	1999 Program Participation Rate	15 %
•	Hawaii Program Maximum Market Penetration Rate	50%
Incremental 1999 DSM Impact		$= 62,720 * 0.15 * 0.5$ $= 4,704 \text{ Therms}$

After development of each year's incremental impact, the next part is to estimate the effects of DSM measure decay on the cumulative DSM impacts to date (DSM from 1995 through 1998). Because of the long measure life for solar water heaters (14 years) no decay has yet occurred to the cumulative energy savings in our example. However, the calculations to determine the effect are as follows:

$$\text{Adjusted Cumulative Savings} = \text{Cumulative Savings}_{n-1} * \text{Measure Life Decay}$$

The formula to estimate measure life decay is as follows:

$$\text{Measure Life Decay} = 1 - (1 / (1 + e^{-\text{Decay Factor} * (\text{Average Age of Installed Measures} - \text{Measure Life})}))$$

Where e = the base of natural logarithms.

In Quattro Pro for Windows, this measure life decay function takes the following form:

$$\text{Measure Life Decay} = 1 - 1 / (1 + @EXP ((- \text{Decay Factor}) * (\text{Average Age of Installed Measures} - \text{Measure Life})))$$

The decay factor is an input value into a natural log function for distributing the impacts of DSM measures over their measure life. Measure life is defined as the point where 50% of the installed DSM measures have failed. Many methods exist for decaying savings over time including no decay of savings during the measure life with total decay at the end of the measure life, and straight line decay with the DSM measure life being the midpoint in the decay line. The DBEDT DSM Assessment Model uses a natural log function with the measure life decay factor determining the shape of the decay curve. The closer the decay factor is to 1.0, the closer the curve looks like a step function with no decay of savings during the measure life but with total decay at the end of the measure life. The closer the value is to 0.0, the more the curve looks like a straight line with the DSM measure life being the midpoint in the decay line. To properly calculate the impacts of measure life and decay, the DSM Model would need to re-calculate each vintage of DSM measure for each year of the forecast period. However, this would entail an enormous amount of computing and therefore the DBEDT DSM Assessment Model uses a short-cut approach. The measure life decay function is calculated for each year of the forecast period but uses the weighted average age of the DSM measure instead of the age for each vintage of the measure. There are minor differences between the two methods, however, the differences were not deemed significant enough to warrant the additional computing time.

Continuing our example:

$$\begin{aligned} \text{Measure Life Decay} &= 1 - 1 / (1 + @EXP ((- .75) * (1.8 - 14))) \\ &= 1.0 \end{aligned}$$

Where:

- Decay Factor = .75
- Average Age of Installed Measures (weighted average of previous years) = 1.8 years
- Measure Life For Solar Water Heater = 14 years

$$\begin{aligned} \text{Adjusted Cumulative Savings} &= \text{Cumulative Savings}_{n-1} * \text{Measure Life Decay} \\ &= 11,204 * 1.0 \\ &= 11,204 \text{ Therms} \end{aligned}$$

Identifying the amount of decayed savings available for re-participation is the third calculation in this step of the DSM assessment. For the solar water heat example being used, there has yet to have been any decay to the cumulative DSM impacts. However, the calculation still occurs.

The amount of decayed savings available for re-participation in the DSM program is a function of measure life decay applied to the cumulative total of savings up through the previous year. The formula calculating the amount of decayed savings available for re-participation is as follows:

$$\text{Available Decayed Savings} = (1 - \text{Measure Life Decay}) * (\text{Cumulative Savings Up Through the Previous Year})$$

Continuing our example:

$$\begin{aligned}\text{Available Decayed Savings} &= (1 - 1.0) * 11,204 \text{ Therms} \\ &= 0 \text{ Therms}\end{aligned}$$

Where:

- Measure Life Decay = 1.0
- Cumulative Savings Up Through The Year 1998 = 11,204 Therms

The fourth part to this step of the DSM assessment is the development of the cumulative DSM impacts for each year of the forecast

Continuing with the gas solar water heat example:

$$\begin{aligned}\text{Cumulative Savings} &= \text{Adjusted Cumulative Savings} + \text{Incremental Savings} \\ &= 11,204 + 4,704 \\ &= 15,908 \text{ Therms}\end{aligned}$$

10.0 ESTIMATES OF MEASURE RE-PARTICIPATION

DSM measure re-participation is the percentage of program participants who choose to continue to implement or purchase an energy conservation measure (ECM) after the DSM program has ended. Measures of re-participation in DSM programs are rarely calculated as part of a program's overall evaluation. For some DSM programs, re-participation is not a significant consideration because the program consists of the permanent installation of ECMs such as in retrofitting and new construction programs, or the measures have long lifetimes (i.e., refrigerators). ECMs for which it would be helpful to know the measure of re-participation include efficient lighting, low flow showerheads and faucets, appliances, and insulation that needs to be replaced periodically, such as water heater wraps. Some lighting program data exist that approach measures of re-participation, but no data exist of this type for other ECMs. Measures of durability and removal rates are reported for showerheads, faucets, insulation, and other ECMs, but these are not the same as a measure of re-participation that implies a one-time decision made by a former program participant to purchase an ECM at full market price.

10.1 Replacement of Efficient Lamps

Velcenbach and Parker³⁰ provide data that most closely resemble measures of re-participation: rates of efficient bulb replacement by lighting program participants. The data were from a study of the persistence of lighting programs installed and recommended by Long Island Lighting Company for commercial customers between 1988 and 1990. The study summarized the results of on-site inspections of program participants' facilities made several years after the end of the rebate and audit programs. Data on the replacement of various types of efficient bulbs with new efficient bulbs of the same types were presented in the paper in terms of the number of kilowatts and kilowatt hours and as a percentage of total inspected kilowatts and kilowatt hours. The percentages across five years are shown in Table 10-1 (for kW only). There were no data presented concerning the number of participants who replaced bulbs, so the data do not reflect a measure of re-participation per se, but do give an indication of the percentage of bulbs that were replaced.

Table 10-1 illustrates the calculated measure renewal for high intensity discharge lamps, compact fluorescent lamps, 34-watt and 60-watt bulbs. Measure renewal was calculated as the number of kW that were replaced with efficient lighting measures without the inducement of rebates out of the total number of kW that were replaced (based on an on-site inspection). Note, the average aggregate percentage of kW that were replaced with efficient lighting measures over the five year period was 50%.

The study also counted the additional equipment that was purchased without a rebate. This figure was broken down into the additional equipment that was of the same technology and additional equipment that was of some other high efficiency technology. Many customers installed additional lighting measures without rebates after installing the original rebated equipment. The authors note, "Although this behavior pattern was relatively small as a percent of the total lighting units inspected (ranging from 2% to 7%), the actions accounted for a significant amount of energy in the sample (2.3 GWH from

³⁰ Velcenbach, Paul and Lee Parker. "Can DSM Survive Persistence?" *Energy Program Evaluation: Uses, Methods, and Results, Proceedings of the August 25-27, 1993 Conference*. Chicago, IL: Energy Program Evaluation Conference, 1993. Pp. 506-519.

1988-90), which doubles when extrapolated to the entire population." (Velcenbach and Parker, 1993, p.515)

In a different lighting program evaluation, Goett, Van Liere, and Quigley³¹ wrote that among surveyed participants of a Pacific Gas & Electric (PG&E) lighting program, 25 percent bought additional compact bulbs from a source other than PG&E, that is, not as part of the PG&E program. Of all program participants, not just those surveyed in the evaluation of the program, 6.7 percent said that the PG&E program "probably had some impact on their decision to buy bulbs outside the program". Although the authors do not report whether this stated impact is positive or negative, it was probably intended to mean positive. Among the 6.7%, the average number of bulbs bought outside the program was 4.3.

10.2 Plans to Purchase Efficient Lamps in Future

There were several studies of lighting programs that report on the stated intentions of program participants to purchase efficient lamps after the program ends. This kind of statistic was given in a study by Goett and Dillon³² of the commercial lighting programs conducted by Niagara Mohawk Power Company. The percentage of participants in various parts of the program who said that they plan to purchase high efficiency lamps in the future are given in Table 10-2, grouped by the different promotional strategies of the program. The first strategy was to send three mailings of information about efficient lamps only. The second strategy was to send the same three informational mailings plus an offer of a 50% rebate (\$0.40) for each efficient lamp purchased during the promotional period up to a maximum of 300 lamps. The third strategy included the mailings and a full rebate (\$0.80) for each lamp purchased. The fourth strategy consisted of a full rebate offered through an in-person visit plus a personalized follow-up letter. The weighted average across all strategies, excluding the control group, of the percentage of participants intending to purchase CFLs in the future in Table 10-2 is 52 percent.

Mills, Persson, and Strahl³³ presented similar data from a program in Denmark that installed compact fluorescent lamps (CFL). They wrote, "44% of the 17,000 participants were certain they would buy a replacement CFL in the future, while 7% did not expect to buy a replacement lamp." For those undecided, lamp prices were a key factor. At \$20, only 28 percent said that they would buy more lamps, while at \$15.00, 81 percent would buy more, and at \$10.00, 92 percent said they would buy more. Regarding an efficient lamp program in the Netherlands, half of the participants said that they would buy CFLs in the future.

³¹ Goett, Andrew, Kent Van Liere, and Dan Quigley. "Customer Acceptance and Use of Compact Fluorescents: Results from a Comprehensive Evaluation of PG&E's Program." *ACEEE 1992 Summer Study on Energy Efficiency in Buildings, Proceedings: Program Evaluation*. Volume 7:7.61-70.

³² Goett, Andrew and James Dillon. "Niagara Mohawk Commercial Lighting Conservation Program." *ACEEE 1990 Summer Study on Energy Efficiency in Buildings, Proceedings: Utility Programs*. Volume 8:8.43-51.

³³ Mills, Evan, Agneta Persson, and Joseph Strahl. "The Inception and Proliferation of European Residential Lighting Efficiency Programs." *ACEEE 1990 Summer Study on Energy Efficiency in Buildings, Proceedings: Utility Programs*. Volume 8:8.155-167

Regarding a Wisconsin Electric Power Company program where participants bought two lamps for the price of one, \$5.00, McDowell³⁴ wrote, "Over three-fourths of all current lamp users reported that they are very or somewhat likely to replace their CFL with a similar lamp." Problems with lamps that were reported were: 1) too dim (40% of the problems reported); 2) price too high; 3) take too long to come on; 4) not easily available; and 5) do not fit in fixtures.

Discussing the impacts of efficient lamp programs carried out by Southern California Edison and Wisconsin Electric, Ho, Schick, and Burnbaum³⁵ wrote, "It is important to recognize that although these programs successfully introduced compact fluorescents, evaluations showed that few customers were willing to purchase the bulbs at retail prices."

10.3 Recommendations

In summary, the data that most closely related to measuring re-participation rates from each study by section are highlighted below.

Replacement rates:

- From a study of commercial lighting programs by Long Island Lighting Company, on average (from 1987 through 1991) 50 percent of the inspected kW that were replaced were replaced with high efficient lighting technology without the inducement of rebates.
- In a PG&E study, 25 percent of surveyed participants bought efficient bulbs from a source outside the program in addition to bulbs bought through the program.

Intentions to purchase in the future:

- The weighted average of the percentage of participants in Niagara Mohawk Power Company lighting programs intending to purchase CFLs in the future is 50%.
- In Denmark, 44 percent of program participants were certain they would buy a replacement CFL in the future. In the Netherlands, half of lighting program participants said that they would buy CFLs in the future.
- In a Wisconsin Electric program, over 75 percent of lamp users reported that they were likely to replace their CFL with a similar lamp.

In conclusion, actual market studies of re-participation of program participants are not available making it difficult to estimate this figure even for the one ECM for which there is some information, efficient lighting. The ability to measure real re-participation rates is highly dependent on market conditions, making any estimates even more suspect. Given the replacement rates of bulbs in the Long Island Lighting Company case that hover around 40 to 50 percent, and the stated intentions to buy

³⁴ McDowell, Argene "The Long Term Persistence of CFL Usage in the Residential Market." *Energy Program Evaluation: Uses, Methods, and Results, Proceedings of the August 21-23, 1991 Conference*. Chicago, IL: Energy Program Evaluation Conference, 1991. Pp. 518-522.

³⁵ Ho, Kathleen, Harold Schick, and Ira Burnbaum. "Assessment of North American Utility Experience With Residential Energy Efficiency Programs." *ACEEE 1990 Summer Study on Energy Efficiency in Buildings, Proceedings: Utility Programs*. Volume 8:8.103-112

efficient lamps in the future also hovering around 50 percent, a liberal estimate would be 50 percent participation in lighting programs. Given the problems of measurement, and the low stated willingness to buy lamps at current prices, a conservative estimate would be 10 percent. If prices of efficient lamps decline as demand is stimulated by DSM programs and general consumer education regarding the overall energy savings from efficient lamps, the liberal estimate will become more reliable. Given that there were not data available for other types of DSM programs, the liberal estimate of 50 percent for measure renewal across programs was recommended until more program specific data becomes available.

11.0 PEAK IMPACTS

The DBEDT DSM Assessment Model contains estimates of the daily load shape for the peak day of each month for each measure. These load shapes were developed by the DOE-2.1E building energy simulation model. To develop estimates of DSM program peak impacts, the model user inputs the month and the hour of peak demand. The DSM Model selects the appropriate hourly share of energy savings for the selected peak hour. For example, suppose the month and hour of peak demand is December at 4:00 PM. From the peak demand database, the monthly share of the annual energy savings for the example program was identified as 20 percent and the peak hour share of the monthly energy savings was identified as six percent. For a program with 100 MWh of annual savings, the peak impact would be as follows:

$$\begin{aligned}\text{Peak Demand} &= (\text{Annual Energy Savings}) * (\text{Monthly Share of Energy Savings}) * \\ &\quad (\text{Peak Hour Share Of Monthly Energy Savings}) \\ &= (100 \text{ MWh}) * (20\%) * (6\%) \\ &= 1.2 \text{ MW}\end{aligned}$$

APPENDIX A
DSM PROGRAM DESCRIPTIONS

APPENDIX A

DSM PROGRAM DESCRIPTIONS

A great number of DSM programs has been offered by various electric and gas utilities on the mainland United States and Canada. Within this section of the report, a synopsis of many of these programs is provided. The purpose of this review of DSM programs is to identify successful program designs that could be adopted by the electric and gas utilities in Hawaii. They also helped establish values for many of the variables used by the DBEDT DSM Assessment Model.

A.1 Residential Programs- General Retrofit and Rebate Programs

A.1.1 Hood River Conservation Project

The Hood River Conservation Project (completed in 1985) was a comprehensive weatherization program directed at implementing various energy-efficiency measures in the residential sector. The project was composed of several phases: the performance of an energy audit to identify appropriate measures for installation; installation of these measures; and follow-up monitoring and evaluation. Measures included insulation improvement, window and door enhancements, infiltration reduction, clock thermostat installations, water heater improvements, and air quality measures. Measures were installed between 1983 and 1985, and data were collected through 1989.

The mechanism by which the program was implemented included energy audits and direct installation. In addition, the techniques used to market the Hood River Project included intensive advertising, community activities, and personal contact.

A remarkable feature of the Hood River Project was the high participation in the program. Ninety one percent of the eligible population participated in the energy audits, whereas 85% of the eligible population participated in retrofitting their homes. The Hood River Project is often viewed as a prototype of an effective residential DSM program.

A.1.2 Ontario Hydro's Espanola Project

The Espanola Power Savers Project (completed in 1992) was designed to extract as high as possible reduction in electricity consumption from a geographically-concentrated area and to research the potential for this type of DSM approach in Ontario. The program was conducted in several steps. In the first step, customers were notified of the program and given the opportunity to sign-up. By the time the project formally began, approximately half of the homes and businesses in town were signed up to receive an audit. Audits were conducted to determine which measures would result in the greatest electricity energy and demand savings. Measures included: insulation; window and door retrofits; residential and commercial lighting; block heater timers; heating and ventilation; water heater tune-up and air sealing. In step 2, the customers were presented with a list of

recommendations of applicable energy savings measures and given a quotation with both Ontario Hydro and customer contributions. In step 3, after the customer had signed an agreement, measures were installed. The final step included the inspection of the retrofits and customer payment of his/her portion of the retrofits. Measures were installed in 1991 and 1992, and evaluations were to continue through 1995.

Similar to the Hood River Project, Ontario Hydro's Espanola project had high participation rates. Successful marketing techniques included intensive advertising, community activities involving the utility, and direct personal contact.

A.1.3 New England Electric System's (NEES) Residential Electric Space Heat Program

The Residential Space Heat Program is a direct installation program that provides energy efficiency improvement measures and information at no cost or low cost to residential customers with electric space heat. Measures eligible for rebate include: lighting; water heating; and other home energy-efficiency improvements. The pilot program began in 1988 and the full program began in the Fall of 1990. The program is planned to run through the year 2000.

The mechanism by which the measures were promoted was through direct installation by the utility at no cost or low cost to residential customers with electric space heat. The utility also employed contractors to market its program through direct mail. The contractor followed-up on all non-respondents with a second letter or phone call.

A.1.4 Osage Municipality Utility's Comprehensive Residential DSM Program

The Osage Municipality Utility (OMU) is located in a small, rural environment in Iowa. The OMU DSM program had two primary goals: to reduce customer bills; and to reduce the rate of peak demand growth to delay construction of new capacity. A goal of limiting the growth rate of peak demand was set at 3 percent per year in 1974 and has been met ever since. The program was general and comprehensive in the sense that it: allowed for rebates for common residential Energy Conservation Measures (ECMs); offered education and direct assistance with installation; offered infrared residential scans; and offered voluntary load management programs. The key to success of this program appears to be the positive relationship established between the community and the utility.

A.1.5 Western Massachusetts Electric's Spectrum Neighborhood Program

The Spectrum Neighborhood Program was a residential direct installation program that began in June 1991. Lighting, water, and appliance efficiency measures were eligible for rebates under this program. The program has funding through 1998 and was managed for the first two years by an energy management services company.

The program was offered to residential customers in WMECO's urban service area. The program was designed to deliver several electric efficiency measures in a single visit including efficient lighting, water heater tank wraps, pipe insulation, faucet aerators, and high efficiency shower heads. Also provided during the visit were the services of cleaning refrigerator coils, replacing air conditioner filters, and lowering hot water tank thermostat settings.

A.1.6 Pacific Gas And Electric's (PG&E) Delta Project

The Delta Project was an intensively marketed one year DSM project instituted in 1991 by PG&E. The targeted region for this project was PG&E's Delta District, a suburban area about 45 miles northeast of San Francisco. Both residential and commercial sectors were targeted. Primary marketing techniques and financial incentives included free installation and service (when applicable), direct mailing (including a personal letter describing the program), and rebates (when retrofits occur).

A unique feature about the Delta Project was that the targeted region is quite homogeneous in terms of demographic characteristics.

A.2 Home Energy Rating System Programs

Home energy rating programs have become prevalent in recent years and their success appears to be linked to the type of marketing strategy. Many of these types of programs include the objectives of intensive program marketing (publicizing energy conservation programs) and market enhancement (expanding and intensifying the market for energy efficient products). These objectives are commonly fulfilled by increasing the target audience's (consumers, builders, and developers) acceptance of energy conservation programs through various means. Marketing methods (such as education through bill inserts, brochures, information packets, displays, and direct mailings), direct personal contact (through trade shows and seminars), trade ally cooperation (through mass media), and point-of-purchase advertising are some of the various effective means to promote energy conservation in new residential construction.

A.2.1 Austin Electric Utility's Energy Star Rating Program

The Energy Star program promoted the construction and purchase of energy-efficient homes through a rating system. Homes were rated on an open point scale that was representative of energy cost savings that would be realized by the home as compared to a standard home built to the city's already strict energy code. Factors such as insulation type, glazing, solar screens, HVAC efficiencies, heat pump types, and fuel types were all considered in the generation of a rating for each new home. Many prospective buyers requested an Energy Star rating, and builders advertised the ratings as an attractive and marketable aspect of their product. The Austin municipal utility also advertised the rating program in local newspapers and real estate publications.

A.3 Residential Water Heating Programs

Water heating DSM measures are often included within DSM programs whose primary focus may be space heating. The NEES Residential Electric Space Heat Program (see Section A.1.3) and the Western Massachusetts Electric's Spectrum Neighborhood Program (see Section A.1.5) both offered rebates for efficient water heating measures.

A.4 Solar Domestic Water Heating Programs

A.4.1 Sacramento Municipal Utility District's (SMUD's) Solar Water Heat

The SMUD program has been through three permutations during its operation. Initially, the average rebate was \$1200. Those involved with the program at SMUD suspected that the high rebate prompted suppliers to increase the price of the systems by roughly \$700 (Murley, Personal Communication)¹. The price of the system rose from \$2,920 to \$3,640 during this initial phase of the program. SMUD assessed that this price increase was due to the suppliers' perceptions that the consumers' willingness to pay was higher than \$1,700 (roughly \$2,920-\$1,200) and captured part of the subsidy (actually the bulk of it) by raising price. As a result, SMUD took the program in-house since those responsible for the program felt that the costs of the system were too high.

SMUD initiated the second phase of the program by buying solar water heaters in bulk and selling them directly to consumers. The average price in this phase of the program was estimated as \$2580. The utility provided rebates of an average of \$850 and offered financing at 7.6% over 10 years for the remainder of the costs. This was, however, unsustainable since SMUD did not have the staff to support the endeavor nor was there an adequate marketing campaign in place to promote the solar water heaters.

The third and current phase of the SMUD program is again dependent on contractors to promote, sell, and install the solar systems. The rebates are now directly related to the Solar Savings Ratio (an efficiency measure of the system that measures the percentage of total water heater energy supplied by the solar system). In this way, the maximum rebate is \$863 and the financing cap is \$2,087 for a total maximum incentive of \$2,950. Rebates were structured with a base incentive of \$550 plus \$12.50 per SSR point above 40% up to a maximum SSR of 65%. The financing cap ranges from \$1,669 for a system with a 40% SSR to a maximum of \$2,087 for a 60% SSR system. Utility representatives claim that this approach appears to have surmounted the problem of escalating system prices.

¹ Murley, Cliff. SMUD. June 1994. Tel. (916) 732-5118.

The annual kWh savings estimates for the SMUD program for a family of four, assuming a 60% Solar Savings Ratio are 2,928. In contrast, for a family of three and a Solar Savings Ratio of 65%, the annual kWh savings are 2,587 since the baseline UEC is lower for a family of three.

A.4.2 Florida Power and Light Company's (FP&L's) Solar Water Heat

Florida Power and Light recently ended their Solar Water Heat Program. This program was based upon subsidizing the consumer through a payment in the household energy bill which was related to the number of persons in the household. The maximum rebate was \$400 for households with more than 7 persons. Note, this was a significantly lower rebate amount than SMUD's. FP&L determined that the solar water heating program was marginally cost-effective for many consumers due to the fact that the payback period was as high as 30 years. The maintenance cost of the program was estimated at \$60/year. FP&L noticed a drop in participation in recent years to approximately 2,000 new customers per year (from between 13,000 and 14,000 at the beginning of the program) due perhaps to this lack of consumer cost-effectiveness (consumers were incorrectly promised \$50-\$60 per month in savings when they were spending only \$10-\$15 per month on water heating anyway). Another identified reason for the decline in participation was that consumers were dissatisfied with the financing available.

A.4.3 Eugene Water and Electric Board's (EWEB's) Solar Water Heat

EWEB's solar program was a multi-stage program wherein eligible customers were provided literature on the program and those interested were provided a solar site visit to assess the residence and provide more detailed information about the program. If the customer was further interested, the utility provided the customer with a list of contractors and from this point forward the customer negotiates with the contractor to arrange implementation of a solar system. The average cost of a solar system under this program was roughly \$3,000 where the range of costs was from \$2,500 to \$4,000. Sixty five percent of the systems that were implemented under the EWEB program were small involving 30-35 square feet of panels. The range of square footage of the systems was from 30 to 60 square feet. Utility representatives claim the reason the most popular model was the smaller model was due to the intensive marketing strategy taken by one of the dealers in Eugene that marketed only small systems.

All of the solar water heating systems in the EWEB program were preheating systems in the sense that the solar component of the water heater raises the temperature of the water to perhaps 60 to 70 degrees depending upon the water inlet temperature. A back-up system was then employed that allows another fuel (electricity or gas) to heat the water to the desired temperature. The average water inlet temperature for the Eugene area is 52 degrees, with a range from 47 to 62 degrees.

EWEB rebated customers who implemented solar water heaters based upon the efficiency of the system. If the system was designed (based upon engineering estimates) to save 1,900 kWh/year the participant received \$200, if the system saved between 1,900 and 2,300 kWh/year the participant was rebated \$300, if the system saved in excess of 2,300 kWh/year the participant was rebated \$400 by EWEB. The typical system on average was expected to save 2000 kWh/year for an average

family size of three in Eugene. This value was an average based upon monitoring studies of solar water heating systems used in the early stages in the program. An additional feature of the Eugene program was that tax credits were also still available if a solar water heating system was implemented. A maximum tax credit of \$1,500 was available. If the maximum rebate and tax credit were taken together, the consumer paid up front (or finances through a bank or the contractor) \$1,100 for a \$4,000 system. Given that the average cost of electricity was \$.04/kWh, the simple payback period for the most efficient type of system would be 14 years ($\$1,100 / 2,000 \text{ kWh/year} \times \$0.04/\text{kWh}$). EWEB does not advertise the solar water heating program from the perspective of a quick payback, but rather pushes the idea that conservation was beneficial for the environment. Utility representatives at this stage have found that this has been effective due to the environmentally aware nature of its customer base. Although they find that there was roughly a 7.3% return on the participant's investment and that the cash flow analysis was positive, they remain committed to the idea that tapping into the consumer's environmental conscience is the best strategy.

A.5 Appliance Rebate Programs

A.5.1 Sacramento Municipal Utility District's (SMUD) Energy Efficient Refrigerator Program

SMUD's Energy Efficient Refrigerator Program involved two phases. The first phase involved a rebate program for the consumer if he or she purchased an energy efficient refrigerator that exceeded the 1994 Department of Energy (DOE) standards. If the purchased refrigerator exceeded the DOE standards by between 15 to 19.9 percent, a \$25 rebate was given; if the refrigerator exceeded the standards by between 20 to 24.9 percent, a \$50 rebate was given; and finally if the refrigerator exceeded the standards by 25 percent or more, a \$100 rebate was given. The program originated in 1991 and is continuing today.

The second phase of the program involved a refrigerator buy-back program and is discussed below in Section A.6.

A.6 Appliance Buy-Back Programs

A.6.1 SMUD'S Energy Efficient Refrigerator Program

The second phase of SMUD's Energy Efficient Refrigerator Program involved a refrigerator buy-back program where secondary refrigeration units were repurchased. \$100 was paid to the consumer if the refrigerators were in working order. As with the refrigerator rebate phase of this program, the buy-back program originated in 1991.

A.6.2 Wisconsin Electric's Appliance Turn-In Program

Begun in 1987 and still operating, Wisconsin Electric's Appliance Turn-In Program was the nation's first large scale residential appliance buy-back program. Old, inefficient, but operable refrigerators, freezers, and air conditioners were removed from residential customers' homes. In exchange for an air conditioner, the customer received either a \$25 check or a \$50 U.S. savings bond, and for a refrigerator or freezer, the customer received either a \$50 check or a \$100 U.S. savings bond. The program was marketed in the mass media, with bill inserts, and by stickers that were placed on new appliances at appliance dealers.

A.6.3 British Columbia Hydro's Power Smart Refrigerator Buy-Back Program

In 1990, British Columbia Hydro (BC Hydro) began a pilot buy-back program where they offered \$50 to customers who would let the utility come and take away their old, inefficient refrigerators. The program was marketed in advertisements and articles in community newspapers, bill inserts, presentations to the community, discussions with environmental groups, and distribution of promotional materials to new and used appliance dealers. The pilot program lasted for two years, picking up more than 16,000 refrigerators, and saving an estimated 119 GWh over the calculated remaining life of the old refrigerators. The program is being expanded province-wide. A state-of-the-art dismantling facility for the old refrigerators was also built.

A.7 Residential Lighting

A.7.1 Burlington Electric Department's Smartlight Program

The Burlington Electric Department's Smartlight program offered compact fluorescent lamps to residential customers through a light bulb leasing program. The light bulb leasing program involved positive cash flow for customers, where bill savings were greater than lease payments of \$0.20 per month. After 60 months, or \$12.00 worth of payments, the lease fee stopped. The program originated in October 1989 and is currently operating. Marketing techniques included: ad campaigns; brochures; displays at highly visible buildings within the city; newsletters; and bill inserts.

A.7.2 Central Maine Power's Operation Lightswitch Program

Operation Lightswitch provided residential customers with the opportunity to purchase efficient lightbulbs at reduced prices. The program was conducted in three phases. The first phase was conducted over a 5 month period during which time Lions Club members distributed halogen lamps for \$5 for six bulbs. The second phase involved Lions Club members distributing 15 watt compact fluorescent bulbs at \$3 per bulb. In the third phase coupons were distributed to all residential customers through their monthly bills. The coupons were redeemable at three participating grocery

store chains and were worth \$9 toward the purchase of a 15, 18, or 20 watt compact fluorescent bulb. The program's three discrete phases originated in October 1988 and ended in December 1991.

Effective marketing techniques included: television, radio, newspapers advertisements; newsletters; and displays at utility offices.

A.7.3 Boston Edison Company's Residential Efficient Lighting Program

Boston Edison encouraged residential customers to purchase and install energy efficient lighting technologies through mail-in rebates, instant rebates, installation of hardware fixtures, and special promotions. Boston Edison began the program in 1987 and offered mail-in rebates of \$1.50 to \$5.00 to customers who purchased any four types of efficient lamps. In 1989, additional products became available and instant rebates were offered at Boston Edison's storefront billing centers. In 1990, the rebates were changed to a percentage of the purchase price. In 1991, instant rebates became available at selected retail stores. In 1992, Boston Edison offered a three-bulb and harp adapter starter kit and worked with manufacturers to offer instant rebates at grocery stores. Several special promotions were also offered to provide light bulbs for free or for a small fee to raise money for various fund raising groups. The program is still operating currently. The program was marketed through bill inserts, retailer promotions, newspaper ads, bill inserts, and radio and television commercials.

A.7.4 Long Island Lighting Company's Dollars and Sense and Commercial Audit Programs

Between 1988 and 1990, the Long Island Lighting Company (LILCO) provided rebates and audits to commercial customers for recommended installation of energy efficient measures. Most of the equipment installed by the program were lighting measures, but some HVAC and efficient motor measures were also installed.

A.7.5 Niagara Mohawk Power Corporation's High Efficiency Lighting Program

In order to evaluate alternative marketing techniques, Niagara Mohawk promoted the commercial use of high efficiency lighting using three different promotional strategies. The three strategies were carried out in separate geographical regions and consisted of a personal phone call, direct mail solicitation, and a promotion through lighting suppliers. The direct mail customers were offered one of three different incentive packages: information only, a rebate of \$.40 per 4-foot or 8-foot fluorescent lamp, or a rebate of \$.80 per lamp. The program lasted six months and ended in March 1989.

A.7.6 PG&E'S Various Lighting Programs

Since 1990 and recently ending, Pacific Gas & Electric (PG&E) has offered various programs to promote the use of compact fluorescent bulbs. These include direct mail sales through a mail-order contractor, direct installations under PG&E's low income and Energy Savings Plan programs, and direct rebates to customers and lighting retailers. In the mail order portion of the program, PG&E offered two kinds of bulbs. The first was an 18-watt bulb with an electronic ballast that was intended to replace a 75-watt incandescent bulb, and the second is a 27-watt bulb that was designed to replace a 100-watt incandescent.

A.7.7 European Utility Compact Fluorescent Lamp Programs (Denmark and the Netherlands)

In 1986, Stockholm Energi of Sweden started the first European program to promote compact fluorescent lamps (CFLs) in the residential sector through financial incentives. By late 1988, 40 similar lighting programs were launched in Sweden, Denmark, the Netherlands, and West Germany. A broad range of strategies were used to promote CFLs including: mail and door-to-door giveaways, direct installation, rebates and other forms of retail discounts, wholesale discounts, government subsidies to lamp buyers and utilities, government removal of special lamp taxes, bulk lamp purchase with savings split between utilities and retailers, pay-on-the-bill approaches, and retail outlets independently offering special discounts after completion of a utility program.

A.7.8 Wisconsin Electric Power Company's Two-For-One Compact Fluorescent Lamp Program

In early 1987, as part of a pilot program, Wisconsin Electric Power Company provided 3000 residential customers with free compact fluorescent lamps to determine customer acceptance and usage patterns. Four types of lamps were used including a globe-shaped lamp, a circular-shaped lamp, and two different kinds of U-shaped lamps. In the fall of 1987, based on the favorable results of the pilot program, the Two-for-One Compact Fluorescent Lighting Program was offered to all 77,000 Wisconsin Electric residential customers. One type of U-shaped lamp was not included due to problems of fixture fit in the pilot. Using a bill insert, customers were offered two bulbs of their choice for \$5.00 with a purchase limit of \$10.00. Since program inception, over 136,000 CFLs have been provided to approximately 45,000 customers.

A.7.9 NEES' Residential Lighting Program and the Energy Fitness Program

In May 1991, the New England Electric System Companies published a lighting catalog and began a rebate program designed to encourage long-term demand for compact fluorescent lamps and to stimulate availability in the market. There were two components, mail order and retail. In the mail order part, customers were offered a bulb of any style for \$3.00. In the retail part, rebates were offered depending on the price of the bulb. In the second year of the program, some aspects changed, but overall it was highly successful.

The Energy Fitness Program, started in 1992, replaced the Lighting program that was initiated in 1991. The new program is a direct installation program offered to residential customers at the time they receive a state-sponsored audit. Water conservation measures, AC and refrigerator coil cleaning, space heating measures for electric space-heat customers, and CFLs were all included, but the CFLs contribute to roughly 90% of the displaced lifetime wattage savings for the program.

A.8 Residential Low Income Programs

A.8.1 United Illuminating's Homeworks Program

Homeworks was a direct installation program for low-income households introduced by United Illuminating in 1990 and currently in operation. The basic approach was to make an intensive pass through a targeted area to install as many measures for as many customers as possible. In this way, the program provided a number of energy-efficient measures at no cost to the customer. Compact fluorescent light bulb installation was the primary focus of the program. The program was promoted through direct mailings and door-to-door canvassing.

A.8.2 Seattle City Light's Low Income Electric (and Multifamily) Program

The Low Income Electric Program was created under the Comprehensive Residential Weatherization Program as part of an effort to acquire energy savings through the installation of conservation measures, particularly weatherization measures, in electric space-heat residential buildings. When the program began in 1981, eligible customers for the Low Income Electric Program were homeowners who heated their homes electrically and had annual incomes of less than or equal to 90% of the average income in the Standard Metropolitan Seattle Area. Multiplex buildings (2 to 4 units) were also eligible if the owner lived in one of the units. In 1985, eligibility was changed to less than or equal to 70% of the state median income for homeowners and a provision was added to provide weatherization for renters whose income was 125% of the federal poverty level or less. Qualified applicants were eligible to receive a grant of up to \$3,300 per single family building, \$4,000 per duplex, \$5,000 per triplex, and \$7,000 per fourplex. The grant was designed to provide 100% of the costs of: an energy audit to identify appropriate insulation, ventilation, and other infiltration measures; installation of measures; and inspection of all work performed.

In January of 1986 the Multifamily Conservation Program was introduced to install energy efficiency measures, especially weatherization, in multifamily structures of five units or more. In order for a building to be eligible for the Multifamily Conservation Program, at least 75% of its units must be electrically heated and inhabited by households whose annual incomes were 125% of the federal poverty level or less.

The Low Income Electric program began in 1981 and is scheduled to operate until 2000. The Multifamily Conservation Program began in 1986 and is scheduled to operate until 1997.

Marketing techniques to promote the program included: television advertising; print advertising in community and ethnic newspapers; direct mailings; and bill inserts.

A.9 Residential Air Conditioning Cycling Programs

A.9.1 Residential Water Heating Control and Air Conditioning Cycling Programs

In these programs, participants were asked to allow their water heating and air conditioning to have external controls placed on them to reduce their energy use at peak times of the day and during peak months of the year. The controls were often installed in such a way that the participant could remove it temporarily, so that their participation was completely voluntary at all times. Often financial incentives were offered, and these vary by program. Some programs do not offer financial incentives because the participants receive lower energy prices directly from the program savings. Marketing methods used to inform customers about the program included mailings, phone solicitation, mass media advertisements, bill inserts, door-to-door contacts, presentations in meetings, etc. Several water heating control programs were instituted in the early 1950's and one dates back to the late 1920's when energy costs were a more significant part of the household budget. The older programs have especially high participation rates given their longevity, while even the more recent programs which started in the 1970's have high participation rates as well.

A.10 Residential Water Heating Control Programs

A.10.1 Central Maine Power Company's Water Heating Cycling Program

This program included a full scale installation of direct load control of electric water heaters. The program contained: (1) control periods between 7:00 - 11:00 a.m. and 4:00 - 8:00 p.m., weekdays during the four winter months (excludes holidays and weekdays); (2) \$6.85 per month cycling credit offered during the four month cycling period; and (3) no overriding devices. The program originated in the Spring of 1987 and was marketed through direct mailings and telemarketing.

See Section A.9 for a more general discussion of residential water heating control programs.

A.11 Commercial Programs--General Retrofit and Rebate Programs

A.11.1 Wisconsin Electric's Smart Money For Business

The Smart Money for Business originated with a pilot program in 1987 and was established as a permanent DSM program later that same year. The program offered commercial, industrial, and agricultural customers the opportunity to install energy-efficient equipment during

renovations/replacements or new construction projects. Energy efficiency measures that apply to lighting, HVAC, water heating, refrigeration, control processes and farm equipment were eligible for rebate. The program was delivered either through rebates to customers or rebates to dealers. Also combinations of rebate and low- or no-interest loans were offered to meet the customer's financing needs. Additionally, some projects were referred to Energy Service Companies (ESCO's) who assisted customers with project design, project financing and rebate applications, installation and construction. The program was promoted through advertisements on radio, in newspapers, in market specific trade publications, bill inserts, special mailings, and a quarterly newsletter.

A.11.2 British Columbia Hydro's Power Smart Program

In the Power Smart program, originated in 1989, British Columbia Hydro performed free leak tests on the compressed air systems of industrial customers, targeting pulp and paper customers. The test identified the general location of leaks, estimated how much they were costing the customer, and suggested a leak reduction target (generally down to 15% leakage of air volume). Either the customer repaired the leaks and the utility performed a follow-up leakage test three to six months later, or--if the customer agreed to do quarterly leak testing for 2 1/2 years--the customer and the utility split the cost of the leak testing equipment. This program was marketed primarily through seminars and computer software illustrating the technique.

A.11.3 NEES' Small Commercial and Industrial Program

The New England Electric System (NEES) Small Commercial and Industrial Program was a direct installation program that provided energy efficiency analyses and free measure installation to small commercial and industrial customers. The Small C/I Program began in June, 1990 and is scheduled to run through 1995 with a five year extension planned. The measures were mostly related to efficient lighting, but some heating and water heating measures were included in 1991. The program was marketed and delivered by private energy service companies (ESCOs) that bid and were selected to carry out the program.

A.12 Commercial New Construction Programs

A.12.1 PG&E'S Commercial New Construction Program

PG&E's Commercial New Construction program originated in 1990. The program was designed to encourage the design and construction of new non-residential buildings that exceeded the California Energy Commission's Title 24 standards by 10% or more. The program was designed to supplement Title 24 standards, increase market acceptance of advanced-energy efficient building technologies and materials, and present lost opportunities in new building construction. PG&E provided information and technical assistance to help builders, architects, engineers, and developers early in the planning and design stages of new commercial buildings to maximize the level of achievable

savings. "New " construction also referred to "major" remodels as defined by the code. About 40% of the program's activity was related to remodels. In 1992, the Commercial New Construction program was revised to include three new programs that offered cash incentives for exceeding Title 24 standards for new construction.

PG&E provided cash incentives to program participants. Rebates of up to 100% of the incremental cost for demonstrated improvements over Title 24 standards were available for the following categories: lighting, high performance glazing with daylighting, motors and adjustable speed drives, cooling, and energy-efficient refrigeration. The program was marketed through personal customer contact by the utility and informational brochures.

A.12.2 Northeast Utilities' Energy Conscious Construction

The Energy Conscious Construction (ECC) program was designed to increase the electric efficiency of new, nonresidential construction. A variety of incentives were in place to encourage investment. The ECC was divided into two program sections, the Prescriptive Area and the Comprehensive Area. The Prescriptive Area offered a menu of efficient measures and incentives and were available for small projects (less than 50,000 ft²) in any stage of design or construction. The Comprehensive Area took advantage of each stage of the design process to capture savings opportunities that may be too expensive to pursue in later stages.

The ECC program evolved from the Energy Value Building Program which originated in 1983. Originally, it was an informational program designed to educate builders, designers, and building owners about energy efficiency in construction. In 1985, the program then changed to the ECC with the added feature of free DOE-2 simulations of building design for proposed projects. In 1988 the collaborative process began which then led to the redesign of the program to its current status which includes incentives to pay the full incremental design and construction costs of the measures. The program in its current form has funding through 2006.

A.13 Commercial and Industrial Lighting Programs

A.13.1 SMUD'S Commercial Lighting Installation Program (CLIP)

The Commercial Lamp Installation Program (CLIP) involved the replacement of standard fluorescent lamps with energy-efficiency lamps and was targeted toward the 20,000 eligible small commercial SMUD customers. CLIP was directed at small commercial customers (less than 50 kW). SMUD paid for the full cost of relamping including installation. The six month pilot program began in July of 1986. Based on the success of the pilot, SMUD pursued a full scale program starting in January of 1987. The program continued for two years, moving from one zip code area to the next. By the end of these two years, SMUD determined that all eligible customers had been contacted at

least twice. Initially SMUD relied on direct-mailings as the primary marketing effort, but later found cold-canvassing to be equally effective.

A.13.2 Wisconsin Power and Light's Bright Ideas for Business Program

The Bright Ideas for Business program, originating in June 1989, was initially designed as a shared-savings conservation program targeted at the company's largest commercial and industrial customers. Under this arrangement, participants were paid the full cost of a pre-approved electricity and/or gas-savings project upon completion of measure installation. At this stage, the customer and the utility signed a contract guaranteeing the savings, guaranteeing that the customer would have positive cash flow, and stating that the customer agreed to pay the utility for the cost of the project based on a monthly surcharge on their electric bill. Modifications were made to the program in 1989 with the addition of prescriptive and customer rebates which were paid upon completion of the project. Prescriptive rebates were offered for energy-efficient lighting and motor retrofits. Customer rebates were offered for customer-designed, utility approved projects. The program was primarily marketed through the use of field representatives.

A.13.3 City of Austin, Resource Management Department's Small Commercial Direct Implementation Project

In August 1986, the City of Austin's Resource Management Department began the first phase of its pilot program to bring energy efficient savings to small businesses. The program consisted of full audits of the lighting, mechanical and distribution systems as well as the building envelope, and then direct installation of recommended measures. The program was offered to small businesses with demand of less than 30 kW, which typically occupy buildings of about 5,000 square feet or less. In the first phase of the project, the measures were installed at no cost to the participants, but in the second phase a fee of \$75 was charged for the whole service. The method of marketing the program changed from phone contacts in the first phase to a mailing in the second phase. Both the first and second phases were pilot programs that were considered successful, but implementation of a larger program was cancelled due to severe budget limitations.

A.13.4 NEES' Commercial/Industrial High Efficiency Lighting Program

The New England Electric System provided free audits and free installation of lighting retrofits to commercial and industrial customers from August 1985 and December 1986. The program took place in 20 economically depressed communities. Audits were done for 60% of eligible customers, but only 34% qualified for new lighting based on a cost-effectiveness test.

A.14 Commercial/Industrial Interruptible and Energy Cooperatives Programs

A.14.1 Southern California Edison's Commercial/Industrial Interruptible Tariffs Program

Edison's Commercial/Industrial Interruptible Tariffs Program originated in the early 1980's. Typically, commercial/industrial interruptible tariffs programs offer financial incentives to firms for participating in load control programs.

A.14.2 Southern California Edison's Commercial/Industrial Energy Cooperatives Program

Southern California Edison's Commercial/Industrial Energy Cooperatives Program originated in 1978. Energy Cooperatives were facilitated through a firm matching effort whereby the firms agree as a whole to reduce electricity consumption upon demand. The allocation of the reduction among firms was left to the cooperative to decide.

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Residential Programs-General Retrofit and Rebate Programs			
Hood River Conservation Project (1983-1985)	Residential Retrofit	91% Audits 85% Retrofits	Utility paid 99% of installation costs; High profile research and development effort
NEES (1991)	Residential Retrofit (specifically lighting and water heating); Residential Electric Space Heat Program	12%	Utility pays percentage of measure cost; Direct installation
Osage Municipality (1974)	Education, Rebates, Giveaways, Load Management	100%	Educational materials; Rebates; Giveaways; and Load Mgt. Incentives
Western Mass. Electric (1991)	Residential Retrofit (also Low Income)	50%	Utility pays percentage of measure cost; Direct installation
Ontario Hydro: Espanola Power Savers Project (1991-1995)	Residential and Commercial Retrofit	Residential Audits (Electric)--96% (Non-electric)--80% Commercial (Electric)--96% (Non-electric)--84% Residential Installations (Electric)--78% (Non-electric)--97% Commercial (Electric)--51% (Non-electric)--44%	Customer-Utility agreement regarding the percentage of payment allocated to each for cost of measures; Audits

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
PG&E (1991) Delta Project	Residential Retrofit Infiltration Repair	20%	Free service; Direct mailing, community sweepstakes opportunity, detailed letter explaining program later
PG&E (1991) Delta Project	Residential Retrofit Insulation and Shading	20%	Rebate; Direct mailing, community sweepstakes opportunity, detailed letter explaining program later
PG&E (1991) Delta Project	Residential Retrofit Air Conditioner Tune-up	20%	Rebate; Direct mailing, community sweepstakes opportunity, detailed letter explaining program later
PG&E (1991) Delta Project	Residential Retrofit Air Conditioning Duct Repair	50%	Rebate; Direct mailing, community sweepstakes opportunity, detailed letter explaining program later
PG&E (1991) Delta Project	Residential Retrofit Air Conditioner Early Changeout	5%	Rebate; Direct mailing, community sweepstakes opportunity, detailed letter explaining program later
PG&E (1991) Delta Project	Residential Retrofit Air Conditioner Replacement	50%	Rebate; Direct mailing, community sweepstakes opportunity, detailed letter explaining program later

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
PG&E (1991) Delta Project	Residential Retrofit Refrigerator Rebate	3%	Rebate; Direct mailing, community sweepstake opportunity, detailed letter explaining program later
PG&E (1991) Delta Project	Residential New Shading and Air Conditioner Upgrade	50%	Rebate; Direct mailing, community sweepstake opportunity, detailed letter explaining program later
PG&E (1991) Delta Project	Residential New High Performance Windows and Air Conditioner	50%	Rebate; Direct mailing, community sweepstake opportunity, detailed letter explaining program later
Home Energy Rating System (HERS) Programs			
Alabama Power (1978)	HERS	35%	Advert. through builders
Arkansas Power and Light (1982-1987)	HERS for Manufactured Housing	2% (50 eligible)	Advert. through builders
Mississippi Valley Gas (1982)	HERS	10% (60 eligible)	Advert. through builders
Public Service Company of New Mexico (1976)	HERS (SF homes)	approx. 100%	Advert. through builders
BPA (1984)	HERS (SF and MF)	19%	Advert. through builders
Kansas City Power and Light (Missouri) (1983)	HERS (SF)	approx. 100%	Advert. through builders
Salt River Project (Arizona) (1980)	HERS (SF, MF)	60%	Advert. through builders

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Oklahoma Natural Gas (1979)	HERS (SF, MF)	15%	Advert. through builders
Virginia Electric Power	HERS (SF)	25-30%	Utility guarantees rated home will perform to an estimated energy use level for 1 year; Cooperative advertising for builders and real estate firms began in 1986
City of Austin	HERS (SF)	25-30%	Advert. through builders
Delmarva Power and Light (De., Md., and Va.) (1982)	HERS (SF)	18%	Advert. through builders
Duke Power (1958)	HERS (SF)	90-95%	Advert. through builders
Florida Power (1983-1986)	HERS (SF)	39%	Advert. through builders
Georgia Power (1978)	HERS (SF)	50%	Advert. through builders
Mississippi Power and Light	HERS	10%	Advert. through builders
Owens-Corning (1980)	HERS (SF)	15%	Advert. through builders
Tennessee Valley Authority (1984)	HERS (SF, MF)	14%	Direct mailings (newsletters and brochures), local tours of homes, open houses, and home shows

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Texas Utilities Electric Company (1986)	HERS (SF)	60%	Advert. through builder
Austin Electric Utility (1985)	Energy Star Rating (HERS)	75% (3,548 participants)	Advert. through builder
Wisconsin Electric Power (1985)	HERS (SF)	8% (50 eligible)	Advert. through builder
BPA (1992)	Manufactured Housing Retrofit Program (MAP)	92%	Utility pays \$2,500 acquisition payment to manufacturer
Energy, Mines, & Resources Canada (1981)	HERS (SF)	6000 homes	Advert. through builder
BPA-SGC (1986)	Res. New Construction	25.2%	Marketing through various venues; financial incentives
Appliance Buy-back Programs			
Wisconsin Electric (1987)	Residential	25%	Buy-back of refrigerators, freezers, and air conditioners
SMUD (1990)	Residential		Rebate for energy efficient refrigerator purchase; Buy-back of operable old refrigerators
BC Hydro (1990)	Residential/Commercial	16,688 Refrigerators were bought-back thus far	Refrigerator buy-back program

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Residential Lighting Program			
PG&E (1991) Delta Project	Residential Retrofit Lighting	70%	Free installation; Direct mailing, community sweepstakes opportunity, detailed letter explaining program later
PG&E (1991)	Residential New Lighting	50%	Rebate; Direct mailing, community sweepstakes opportunity, detailed letter explaining program later
Burlington Electric Department (1989)	Residential Smartlight (Lightbulb Leasing Program)	38% (5,624 out of 14,800 eligible)	Positive participant cash flow through lease payments (bill savings exceed lease payments)
Central Maine Power Company (1988)	Residential Lighting Program (Operation Lightswitch)	21% where: 8% Phase 1 3% Phase 2 10% Phase 3	Utility pays for a percentage of the cost of the cfb's (rebate coupons available in Phase 3); Distribution through local club (Phases 1 and 2)
Northeast Utilities (1990)	Residential Lighting Program (Lighting Catalog Program)	5% (38,721 out of 1,150,357 eligible)	Energy-efficient lighting products were available to participants at subsidized prices; Direct mailing (mail-order catalog)

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Boston Edison Company (1987)	Residential Efficient Lighting	13% (88,929 out of 642,967 eligible)	\$1.50-\$5.00 to participants (1987) similar instant rebates offered at storefront billing centers (1989), rebates changed to % of purchase price, rebates available at selected retail outlets (1991); Free light bulb promotion and bulbs sold for small fee by fund-raising groups (1991)
Residential Low Income Program			
United Illuminating (1990)	Residential Lighting Program (Homeworks Direct Installation Program)	23% (22,540 out of 642,967)	Utility pays for 100% of implementation costs
Southern California Edison (1985)	Residential Lighting Program	48%	Utility pays for costs and installation of lamp
Seattle City Light (1981 Low-Income Program) (1986 MF Program)	Low-Income Electric (SF and MF) Grant Program	68% for Low-Income Program; 22.4% for Multi-family Program	Grant to provide 100% cost of audit, infiltration measures, and inspection

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Residential Air Conditioning Cycling			
Cobb Electric Membership Coop. (1976)	Air Conditioning Control Program (Residential)	70-75%	No financial incentive first two years, afterward \$1.00/kW (summer) credited on bill; News releases, feature stories, direct mailings, phone solicitation, public meetings
SCE, Laguna Hills (1977)	Air Conditioning Control (Residential)	96%	\$1.50/month credited on bill; News releases, public meetings, TV advert., direct mailings
SCE, Valencia (1979)	Air Conditioning Control (Residential)	52%	\$3.00/month credit on bill; Public meetings, press releases, direct mailings, door-to-door solicitation
PG&E (1977)	Air Conditioning Control Program (Concord and Fresno)	Concord 85% Fresno 83%	\$4.50/ton/month credit on bill; Direct mailings and personal contact by a market research firm
PG&E (1978)	Air Conditioning Control Program	75-80%	\$4.50/ton/month credit on bill; Direct mailings and telephone contact
PG&E (1979)	Air Conditioning Control Program (Concord, Fresno, and Stockton)	12-13%	\$2/month credit on bill; Mass mailings only

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Appalachian Power Company (1978)	Air Conditioning Control Program	70%	\$5/month (summer) \$10/month (winter); Public meetings, direct mailings, personal contact and news articles
Dayton Power and Light (1975)	Air Conditioning Control Program	62%	No financial incentive; Personal contact
Residential Water Heating Control			
Connecticut Light and Power (early 1970's)	Time Clock Water Heating Control (Residential)	<1%	Lower rate from 301-800 kW with maximum savings of \$6.30/month; Bill inserts
Wisconsin Electric Power Company (1979)	Time Clock Water Heating Control (Residential)	28% with a 1990 projection of 75%	\$1.50/month lump sum initially, then raised to \$4.00/month; Multiple direct mailing;
Buckeye Power (1974)	Time Clock Water Heating Control (Residential)	34%	\$1.00-\$2.00/month lump sum; Direct mailings and limited personal contact
Vernon Cooperative (Wisconsin Area) (early 1950's)	Time Clock Water Heating Control (Residential)	95%	Lower rate on middle step of block rate structure, maximum savings of \$1.90/month (1981 dollars); Information on program included in standard rate information

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Oakdale Cooperative (Wisconsin Area) (early 1950's)	Water Heating Control (Residential)	90%	Lower rate on first 200 kWh, maximum savings of \$1.40/month (1981 dollars); Information on program included in standard rate information
Detroit Edison (1934)	Water Heating Control (Residential)	99.5%	36% reduction in kWh charge relative to standard rates; Heavy marketing (mailings, media, personal contact) (1934-mid-1960's)
Western Mass. (early 1950's)	Water Heating Control (Residential)	95%	Lower rate from 301 to 800 kWh, maximum savings of \$6.30/month at 800 kWh; Media and dealer marketing in 1950's
Hartford Electric Light (early 1950's)	Water Heating Control (Residential)	98%	Lower rate from 301 to 800 kWh, maximum savings of \$6.30/month at 800 kWh; Media and dealer marketing in 1950's
Central Vermont Public Service (1929)	Water Heating Control (Residential)	80-90%	\$1.00-2.00/month in summer months. \$15-20/month in winter months

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Buckeye Cooperatives (Ohio)			
(1) Guernsey-Muskegon Electric Coop. Inc. (early 1970's)	Water Heating Control (Residential)	78%	No financial incentive; Magazine and newspaper promotion starting in 1974
(2) Northwestern Electric Coop. (early 1970's)	Water Heating Control (Residential)	75%	Penalty of \$2.00/month if 40 gal. heater not controlled; Direct mailings and media advertisement
(3) Pioneer Rural Electric Coop. (early 1970's)	Water Heating Control (Residential)	72%	\$1.00/month built into rate structure; Newspaper, radio, direct mailings, lobby displays, county fair demos, home shows, magazine ads
(4) Licking Rural Electric Inc. (early 1970's)	Water Heating Control (Residential)	70%	No financial incentive; 10% participation in response to direct mailings, newspaper articles, radio advert., later door-to-door solicitation yielded 82% of total cumulative participation
(5) Darke Rural Electric Coop. (early 1970's)	Water Heating Control (Residential)	70%	No financial incentive; Direct mailings with return postcard, monthly magazine advert., door-to-door promotion

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
(6) Butler Rural Electric Coop. (early 1970's)	Water Heating Control (Residential)	67%	\$15 credit once per year; Monthly magazine advert.
(7) Hancock-2 Wood Electric Coop. (early 1970's)	Water Heating Control (Residential)	65%	\$1.50/month maximum savings built into rate; Direct mailings, mandatory participation for new members
(8) Midwest Electric (early 1970's)	Water Heating Control (Residential)	62%	\$1.00/month credit on bill; Newsletters, articles in magazines
(9) Frontier Power Co. (early 1970's)	Water Heating Control (Residential)	62%	\$3.00 credit annually; Direct mailings, radio advert., monthly bill stuffers, personal contact
(10) Holmes-Wayne Electric (early 1970's)	Water Heating Control (Residential)	60%	No financial incentive; Newsletters, mandatory participation by new members
(11) Washington Electric Coop. (early 1970's)	Water Heating Control (Residential)	60%	\$2.00/month credit on bill; Radio advert., state magazine advert., counter displays, personal contact
(12) Fire Lands Electric (early 1970's)	Water Heating Control (Residential)	58%	Lottery promotion (cash and valuables available as prizes for participants); Magazine advert., news releases, radio advert., direct mailing

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
(13) Tri-County Rural Electric (early 1970's)	Water Heating Control (Residential)	50%	No financial incentive; Magazine advert., hom contacts, telephone solicitation
Central Maine Power Company (1987)	Water Heating Control (Residential)	25% (1987) 40% (1988)	\$6.85/month credit on bill; 1987 direct mailing, 1988 second mailing and telemarketing
Commercial Programs-General Retrofit and Rebate Programs			
Ontario Hydro: Espanola Power Savers Project (1991-1995)	Residential and Commercial Retrofit	Residential Audits (Electric)--96% (Non-electric)--80% Commercial (Electric)--96% (Non-electric)--84% Residential Installations (Electric)--78% (Non-electric)--97% Commercial (Electric)--51% (Non-electric)--44%	Customer-Utility agreement regarding the percentage of payment allocated to each for cost of measures; Audi
Wisconsin Electric (1987-1991)	Smart Money for Business--Commercial/Industrial/Agricultural Retrofit and Rebate Program	49%	Rebates and/or loans to participants and dealers
SMUD (1988)	Commercial and Industrial Retrofit Audit and Load Control	50%	Financial Incentive
New England Electric System (NEES) (1989-1991)	Small Commercial and Industrial Installation Program	9.5% (5,225 out of 55,000 eligible)	Utility pays % of cost of installation

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Boston Edison Company (1989)	Small Commercial and Industrial Retrofit Program	2.3% (1,718 out of 76,000 eligible)	Rebates
Mass. Electric Company	Small Commercial and Industrial Retrofit Program	14.2%	Utility pays full cost
Northeast Utilities (1988)	Large Commercial and Industrial Retrofit and Financial Incentive Program	37% (1,000 out of 2,700 eligible)	Energy analysis surveys, financial incentives which bring cost down to a maximum three year payback
Boston Edison (1990)	Commercial and Industrial Audit/Retrofit/ Rebate Program (Energy Efficiency Partnership Program)	7% (Annual Rate) 100 of 1,500 eligible industrial participants	Utility pays a % of measure cost, financial incentives generally buy down the payback period to one year
Commonwealth Electric (1990)	Commercial and Industrial Audit/Retrofit/ Rebate Program (Customer Rebate Program)	10.5% (Annual Rate) 44 out of 420 eligible industrial customers	Utility pays up to 100% of project's costs; Contractors promoted program
Central Maine Power (1987)	Commercial and Industrial Retrofit Program (Power Partners Program)	7.4% (Cumulative Rate) 25 out of 339 eligible industrial customers	Incentive payments were paid over the lifetime of the measure and usually equal 100% of the cost

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
Central Maine Power (1986)	Commercial and Industrial Rebate and Efficiency Buy-Back Program	Rebate Program: 21.8% (Cumulative Rate - 3/89-4/92) 5.6% (Annual Rate - 3/91-4/92) Buy-Back Program: 2.1% (Cumulative Rate - 11/86 - 4/92) .9% (Annual Rate - 3/91-4/92) (All rates apply to industrial customers only)	Until recently, participants received \$.01 per kWh expected to be saved over measure-life, recently, incentive capped to 90% of material costs, more recently it was capped to 80%; Marketed through vendors and one-on-one meetings with industrial customers
Puget Power (1991)	Industrial Conservation Incentive Program	4.5% or 107 out of 2,355 eligible industrial customers (Cumulative Rate) .8% or 29 out of 3,574 eligible industrial customers (Annual Rate)	Financial incentive usually covers 75% of materials and installation costs of the project

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
United Illuminating (1990)	Commercial and Industrial Energy Savings Research (Energy Opportunity Program)	3.2% or 81 out of 2,500 eligible industrial customers	Financial incentives usually cover 40% of project costs, \$.15/kWh saved in the first year is offered for measures with pay-back periods of more than 5 years, measures with shorter payback periods receive rebates as a percent of project cost; 1992: financial incentive increased to \$.30/kWh for the first year
Southern California Edison (1988)	EMHRP Commercial/Industrial/Agricultural	19,049 measures installed in 1991	Rebates for retrofits
PG&E	Commercial/Industrial/Agricultural	over 30 million measures installed thus far; 14,314 applications processed in 1991	Rebates for retrofits
Consolidated Edison (1990)	Commercial/Industrial (Lighting/HVAC/Motors)	40 applications (1987) 14,000 applications (1991)	Rebates for retrofits
British Columbia Hydro (1989)	Efficient Compressed Air Systems Program (Power Smart)	60% (Cumulative Rate 9/89-12/91) 26.7% (Annual Rate 1/91-12/91)	Utility performs free test on compressed air systems, utility pays % of leak testing; Seminars and computer software packages used for marketing

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
BPA (1988)	Energy Smart Design Commercial/Industrial/Agricultural	660 Projects thus far	Rebates based upon approved customized design
PG&E (1990)	Commercial/ Industrial/ Agricultural Customized Electric Rebate Program	<1% (3,801 out of 552,229 eligible)	Rebates
PG&E (1991) Delta Project	Commercial/Industrial Retrofit	38% (Mean of 5 C/I programs under the Delta Project)	Rebate; Direct mailing detailed letter explaining the program later
BPA (1988)	Industrial-Customized Energy Savers Program	10%	Rebates for customized designs
Western (1986)	Agriculture Pump Testing	10%	\$100 fee charged to customer
Commercial New Construction Programs			
PG&E (1990)	Com. New Construction-exceeds Title 24 by 10%	25%	Incentives to builders for exceeding the Title 24 by 10%
Northeast Utilities (1985)	Prescriptive and Customized	20%	Variable financial incentives to builders
Commercial Lighting Programs			
Wisconsin Power and Light (1989)	Commercial and Industrial Lighting Rebate Program (Bright Ideas for Business)	14.2% (Cumulative Rate) of 142 out of 1,000 eligible industrial customers	Rebates for custom projects results in 50% of installation costs; Field rep.s performed marketing
PG&E (1991) Delta Project	Commercial Retrofit Lighting	20%	Rebate; Direct mailing, detailed letter explaining program later

APPENDIX B

SYNTHESIS OF CUMULATIVE PARTICIPATION RATES (Continued)

Utility or Relevant Entity	Characteristics of Program	Participation Rate (% of eligible)	Mechanism (Incentive or Strategy)
NEES (1988)	Commercial and Industrial High Efficiency Lighting	60%	Rebates for lighting measures
SMUD (1987)	Small Commercial Lighting (CLIP)	45%	Rebates for and free installation of lamps
City of Austin (1986)	Small Commercial Direct Lighting Implementation Program	approx. 50%	Phase 1 - no cost to participant, participants obtained through phone contact; Phase 2 - \$75 fee charged, participants obtained through the mail
Energy Cooperatives			
Southern California Edison (early 1980's)	California Energy Coalition Large Commercial and Industrial Firms	1.5%	Edison facilitates the formation of a cooperative through a firm matching effort

APPENDIX C

GLOSSARY

APPENDIX C

GLOSSARY

The following glossary is designed to define commonly used demand-side management terms.

Annual Program Penetration	The rate of adoption of a given energy efficient measure for a given year.
Administrative Costs	The costs of administering a program include payroll costs, overhead, and material costs, but exclude the costs that consist of financial incentives or benefits that are given to program participants.
Energy Conservation Measure (ECM)	The installation or implementation of an energy efficient product or practice designed to reduce energy demand levels and peak loads. It is commonly abbreviated as ECMs.
Free Driver	A non-participant who adopted a particular efficiency measure or practice as a result of a utility program.
Free Rider	A program participant who would have implemented the program measure or practice in the absence of the program.
Intra-active Effects	Applying two DSM measures to the same end-use may have the affect of providing less cumulative DSM impact than the summation of the individual impacts from each measure.
Levelized Cost	Cost levelization is the process of discounting both capital and operation and maintenace costs to their present value and amortizing them over the measure's lifetime.
Load Impact	Changes in electric energy use, electric peak demand, or natural gas use.
Load Shape	The time-of-use pattern of customer or equipment energy use. This pattern can be over 24 hours or over a year (8760 hours).
Maximum Cumulative Potential	The maximum expected cumulative rate of adoption of DSM measures by program participants over the life of the program.
Measure	See Energy Conservation Measure (ECM).

Measure Cost	There are two aspects to measure cost. The first aspect is the purchase price for the device. The second is any maintenance cost associated with the proper operation of the device. For DSM analysis, measure costs are generally expressed as incremental costs. Incremental costs being the difference between the first cost and annual maintenance cost of the baseline device and the DSM device.
Measure Decay	Impacts from DSM measures are generally expressed in terms of first year impacts. However, the cumulative total from the installation of DSM measures will likely decrease due to two factors. The first is that the effectiveness of the DSM measure may decline over time. The second is the impact of measure life. At the utility level, the DSM impacts for a particular DSM measure represent the implementation of many DSM measures. There is an average life associated with the DSM measure with a probability that some measures will fail before the average measure life and some after. Measure decay functions attempt to capture the effects of both of these factors.
Measure Life	Measure life is defined as the point where 50% of the installed DSM measures have failed.
Measure Re-participation	The measure re-participation rate is an estimate of the percentage of those who have installed DSM measures who will continue to implement or purchase a DSM measure of at least the same DSM impact level after the DSM measure has failed.
Metering	The collection of energy consumption data over time at a customer's premises through the use of meters. These meters may collect information about kW, kWh or therms, with respect to an end-use, a circuit, a piece of equipment or a whole building. "Short-term metering" usually refers to data collection for no more than a few weeks. "End-use metering" refers specifically to separate data collection for one or more end uses in a building, such as lighting, air-conditioning, or refrigeration.
Mutual Exclusivity	The implementation of one DSM measure may preclude the possibility of implementing another DSM measure.
Natural Change	The change in base usage over time. Natural change represents the effects of energy-related decisions that would have been made in the absence of the utility programs by both program participants and non-participants.
Net Load Impact	The total change in load that is attributable to the DSM program. This change in load may include the effects of free riders, free riders, state or federal energy efficient standards, changes in the level of energy service, and natural change effects.

Net-to-Gross Ratio	A factor representing net program load impacts divided by gross program load impacts that is applied to gross program load impacts to convert them into net program load impacts.
Participant	An individual, household, business, or other utility customer that received the service or financial assistance offered through a particular utility DSM program, set of utility programs, or particular aspect of a utility program in a given program year.
Participation	The cumulative rate of adoption of DSM measures by program participants over the life of the program.
Peak Hour	The peak hour is the hour of highest energy demand over a period of time. The period of time could be a year, a season, a month, or a day. The peak hour may be identified for the utility system as a whole or for subsectors such as the residential sector or the commercial sector.
Percent Unwilling to Participate	The percent unwilling to participate is the percent of eligible participants who choose not to participate in a DSM program even if they are not required to pay anything. The percent unwilling to participate is not necessarily equal to the difference between the maximum cumulative participation rate and 100% since many programs offer the measures at some cost to the eligible participants.
Persistence	Changes in net program load impacts over time.
Remaining Market Potential	Refers to the population of installations where a DSM measure could be implemented but in which the DSM measure has not been implemented.
Renewal Rate	The percentage of program participants who choose to replace energy conservation measures at their own expense after the program is over.
Re-participation	See Renewal Rate.
Transmission and Distribution Adjustment Factor	The transmission and distribution adjustment factor is used to increase the savings from DSM measures. This increase is designed to reflect energy not lost in the distribution system before delivery to the customer.

Sources: NEOS Corporation, 1995; BPA, 1992; and Hirst and Sabo, 1993.

APPENDIX D

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APPENDIX D

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APPENDIX E
PERSONAL CONTACTS

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TABLE 1-1
CHARACTERISTICS OF BUILDINGS FROM ON-SITE SURVEYS

Building Type	Commercial Sector Energy Use	Sample Size	Average Square Footage	Average Number of Buildings	Average Number of Floors	Dominant Air Conditioning	Dominant Water Heating Fuel
Hotel	25%	9	537,700	3	17	Chiller	Gas
Apartment	15%	5	146,000	1	20	Chiller	Gas
Restaurant	14%	5	2,600	1	1.2	DX	Gas
Large Office	12%	7	353,00	1	22	Chiller	Electric
Large Retail	8%	4	72,000	1	1.8	Chiller	Electric
Resort	6%	4	430,900	1.8	10	Chiller	Diesel
Hospital	6%	4	258,000	3.5	6	Chiller	Gas
Grocery	6%	4	235,000	1	1.3	DX	Gas
College	5%	4	116,40	35	4	Chiller	Gas
School	3%	4	24,40	7	1.5	Chiller	Gas
TOTAL	100%	50					

TABLE 2-1
THE STATE OF HAWAII POTENTIAL DSM RESOURCE
ELECTRIC ENERGY

TECHNICAL POTENTIAL (MWH)									
	RESIDENTIAL			COMMERCIAL			TOTAL		
	1999	2006	2014	1999	2006	2014	1999	2006	2014
HONOLULU	98,643	337,383	428,43	452,075	913,609	758,05	550,718	1,250,992	1,186,49
HAWAII	18,896	59,918	69,95	54,583	110,620	93,80	73,479	170,538	163,75
MAUI	19,582	66,484	82,29	78,319	147,957	117,09	97,901	214,441	199,38
KAUAI	8,018	25,275	30,92	30,698	57,744	44,88	38,716	83,019	75,81
TOTAL	145,139	489,060	611,60	615,675	1,229,930	1,013,84	760,814	1,718,990	1,625,44
ECONOMIC POTENTIAL									
HONOLULU	74,551	230,201	262,82	443,361	901,440	747,34	517,912	1,131,641	1,010,16
HAWAII	15,941	47,862	51,75	53,513	108,923	92,29	69,454	156,785	144,05
MAUI	14,395	45,317	52,43	76,698	145,874	115,68	91,093	191,191	168,11
KAUAI	6,141	18,820	21,59	30,191	57,048	44,33	36,332	75,868	65,92
TOTAL	111,028	342,200	388,60	603,763	1,213,285	999,66	714,791	1,555,485	1,388,27
MARKET POTENTIAL									
HONOLULU	61,300	192,120	221,87	354,689	721,152	597,87	415,989	913,272	819,75
HAWAII	13,103	39,959	43,69	43,279	88,200	74,61	56,382	128,159	118,30
MAUI	11,828	37,838	44,27	62,302	118,774	94,02	74,130	156,612	138,30
KAUAI	5,032	15,689	18,22	24,556	46,515	36,08	29,588	62,204	54,31
TOTAL	91,263	285,606	328,06	484,826	974,641	802,59	576,089	1,260,247	1,130,66
HAWAII PROGRAM									
HONOLULU	35,207	111,550	129,88	177,345	360,576	298,93	212,552	472,126	428,82
HAWAII	7,523	23,207	25,57	21,405	43,569	36,91	28,928	66,776	62,49
MAUI	6,790	21,977	25,92	30,679	58,350	46,27	37,469	80,327	72,19
KAUAI	2,882	9,102	10,66	12,077	22,819	17,73	14,959	31,921	28,40
TOTAL	52,402	165,836	192,05	241,506	485,314	399,86	293,908	651,150	591,92

TABLE 2-2
THE STATE OF HAWAII POTENTIAL DSM RESOURCE
ELECTRIC PEAK

TECHNICAL POTENTIAL (KW)									
	RESIDENTIAL			COMMERCIAL			TOTAL		
	1999	2006	2014	1999	2006	2014	1999	2006	2014
HONOLULU	23,160	66,840	78,37	70,616	142,027	117,67	93,776	208,867	196,04
HAWAII	4,030	10,520	10,84	8,029	16,759	14,38	12,059	27,279	25,22
MAUI	4,850	13,950	16,45	12,695	23,859	18,72	17,545	37,809	35,17
KAUAI	2,060	5,600	6,45	4,696	9,092	6,97	6,756	14,692	13,42
TOTAL	34,100	96,910	112,11	96,036	191,737	157,75	130,136	288,647	269,86
ECONOMIC POTENTIAL									
HONOLULU	15,440	43,100	47,44	67,288	136,301	112,22	82,728	179,401	159,66
HAWAII	3,160	7,900	7,45	7,747	16,294	13,96	10,907	24,194	21,41
MAUI	3,050	8,770	10,07	12,330	23,394	18,40	15,380	32,164	28,47
KAUAI	1,340	3,720	4,21	4,584	8,940	6,85	5,924	12,660	11,06
TOTAL	22,990	63,490	69,17	91,949	184,929	151,44	114,939	248,419	220,61
MARKET POTENTIAL									
HONOLULU	12,310	35,250	39,73	53,831	109,041	89,77	66,141	144,291	129,50
HAWAII	2,510	6,430	6,21	6,251	13,157	11,25	8,761	19,587	17,46
MAUI	2,430	7,190	8,45	9,965	18,938	14,88	12,395	26,128	23,33
KAUAI	1,060	3,040	3,53	3,732	7,294	5,58	4,792	10,334	9,11
TOTAL	18,310	51,910	57,92	73,779	148,430	121,50	92,089	200,340	179,42
HAWAII PROGRAM									
HONOLULU	6,910	20,170	23,12	26,915	54,520	44,88	33,825	74,690	68,00
HAWAII	1,400	3,670	3,61	3,099	6,518	5,58	4,499	10,188	9,19
MAUI	1,370	4,120	4,92	4,932	9,358	7,36	6,302	13,478	12,28
KAUAI	590	1,740	2,06	1,934	3,576	2,74	2,524	5,316	4,80
TOTAL	10,270	29,700	33,71	36,880	73,972	60,57	47,150	103,672	94,28

TABLE 2-3
THE STATE OF HAWAII POTENTIAL DSM RESOURCE
GAS

TECHNICAL POTENTIAL (K THERM)									
	RESIDENTIAL			COMMERCIAL			TOTAL		
	1999	2006	2014	1999	2006	2014	1999	2006	2014
HONOLULU	324	984	1,10	412	959	72	736	1,943	1,82
HAWAII	342	925	93	72	179	13	414	1,104	1,07
MAUI	56	146	14	77	179	12	133	325	27
KAUAI	58	153	15	34	79	5	92	232	20
TOTAL	780	2,208	2,33	595	1,396	1,04	1,375	3,604	3,37
ECONOMIC POTENTIAL									
HONOLULU	324	984	1,10	412	959	72	736	1,943	1,82
HAWAII	342	925	93	72	179	13	414	1,104	1,07
MAUI	56	146	14	77	179	12	133	325	27
KAUAI	58	153	15	34	79	5	92	232	20
TOTAL	780	2,208	2,33	595	1,396	1,04	1,375	3,604	3,37
MARKET POTENTIAL									
HONOLULU	275	836	93	330	767	57	605	1,603	1,51
HAWAII	291	786	79	58	143	11	349	929	90
MAUI	47	124	12	61	143	10	108	267	22
KAUAI	49	130	12	27	63	4	76	193	17
TOTAL	662	1,876	1,98	476	1,116	83	1,138	2,992	2,81
HAWAII PROGRAM									
HONOLULU	162	492	55	165	383	28	327	875	84
HAWAII	171	462	46	29	72	5	200	534	52
MAUI	28	73	7	31	72	5	59	145	12
KAUAI	29	76	7	14	32	2	43	108	9
TOTAL	390	1,103	1,16	239	559	41	629	1,662	1,58

TABLE 2-4
COMMERCIAL SECTOR DSM MEASURES SCREENED
OUT BY THE TRC TEST

Electricity Measures *	LOFF		SOFF		LRET		SRET		FFRE		SDRE		GROC		RWAR	
	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E	N
Duct Insulation		X	X								X	X	X	X		
Energy Management System		X				X										
Light Colored Roofs	X	X		X	X	X		X		X	X	X		X	X	X
VSD Cooling Tower Fans	X	X														
Chiller Strainer Cycle		X				X										
High Eff. DX-COP 3.2				X				X		X		X		X		X
Elec. Ballast-4'T12 Base EEM				X								X				
Point of Use Water Heat				X												
Elec. Ballast-4'T12 Base SMC			X													
Double Pane Heat Mirr. Glaz.						X						X		X		
Variable Air Volume Box					X											
Window Film Retrofit					X		X						X			
Active Solar Water Heat									X	X	X	X				
Smoke Sens. Act. Vent Hood									X		X	X				
Grease Extractor Vent Hood									X	X	X	X				
15W Comp. Fluor. Lamps											X	X				
Shade Screens												X	X	X		
High Eff. Evap. Fan Motor													X	X		
Heat Pump Water Heater															X	X
Elec. Defrost Demand Control															X	X
Therm. En. Stor.-Ice on Coil																
4'T8 Lamps and Elec. Ballast																
Elec. Ballast-8'T12 Base SMC																
Occup. Sensor Pack-200 SF																
Waste Heat Recovery																
Gas Measures																
Point of Use Water Heat		X												X		X
Active Solar Water Heat											X					

* E = Existing

N = New

LOFF = Large Office

SOFF = Small Office

LRET = Large Retail

SRET = Small Retail

FFRE = Fast Food Restaurant

SDRE = Sit Down Restaurant

GROC = Grocery

RWAR = Refrigerated Warehouse

TABLE 2-4 (CONTINUED)
COMMERCIAL SECTOR DSM MEASURES SCREENED
OUT BY THE TRC TEST

* Electricity Measures	NRWA		HOSP		SCHL		COLL		HOTEL		RESORT		APTM	
	E	N	E	N	E	N	E	N	E	N	E	N	E	N
Duct Insulation					X									
Energy Management System							X						X	
Light Colored Roofs					X	X								
VSD Cooling Tower Fans			X	X					X	X	X	X		
Chiller Strainer Cycle				X			X		X		X			
High Eff. DX-COP 3.2						X								
Elec. Ballast-4'T12 Base EEM	X	X			X	X	X							
Point of Use Water Heat		X												
Elec. Ballast-4'T12 Base SMC	X	X			X									
Double Pane Heat Mirr. Glaz.		X				X	X				X			
Variable Air Volume Box							X							
Window Film Retrofit														
Active Solar Water Heat														
Smoke Sens. Act. Vent Hood														
Grease Extractor Vent Hood														
15W Comp. Fluor. Lamps														
Shade Screens														
High Eff. Evap. Fan Motor														
Heat Pump Water Heater														
Elec. Defrost Demand Control														
Therm. En. Stor.-Ice on Coil			X				X				X			
4'T8 Lamps and Elec. Ballast						X								
Elec. Ballast-8'T12 Base SMC							X							
Occup. Sensor Pack-200 SF									X		X			
Waste Heat Recovery											X	X		
Gas Measures														
Point of Use Water Heat		X				X								
Active Solar Water Heat														

* E = Existing
 N = New
 NRWA = Non-Refrigerated Warehouse
 HOSP = Hospital
 SCHL = School
 COLL = College
 HOTEL = Hotel
 RESORT = Resort
 APTM = Apartment

TABLE 2-5
ELECTRIC DSM MEASURES
HONOLULU COUNTY RESIDENTIAL SECTOR

MEASURE	COST (\$/kWh)	YEAR 2006 (Percent)
Solar Water W/Electric Backup (Single Family)	\$0.06	20.40
Heat Pump Water Heat (Single Family)	\$0.07	12.67
Heatpump Clothesdryer (Single Family)	\$0.08	7.83
Compact Fluorescent - 3 Bulbs (Single Family)	\$0.06	5.89
Horizontal Axis Clotheswasher (Single Family)	\$0.06	5.59
Efficient Tank (Single Family)	\$0.03	5.29
Low Flow Shower -New & Replace (Single Family)	\$0.01	4.69
Remove Second Refrigerator (Single Family)	\$0.01	2.87
Pipe Insulation (Single Family)	\$0.00	2.69
Exist- Room A/C to 10.5 EER (Single Family)	\$0.03	2.53
Freezer >10% 93 Standards (Single Family)	\$0.05	1.94
Moisture Sensor (Single Family)	\$0.03	1.19
Faucet Aerators (4 per Home) (Single Family)	\$0.01	1.17
New- Room A/C to 10.5 EER (Single Family)	\$0.03	1.11
Halogen Lamps (Single Family)	\$0.05	0.95
Exist- Central A/C to 12 EER (Single Family)	\$0.05	0.44
Ex Cent- R-0 to R-19 Ceiling Insulation (Single Family)	\$0.05	0.30
Compact Fluorescent - 3 Bulbs (Multi-Family)	\$0.06	5.45
Efficient Tank (Multi-Family)	\$0.03	5.33
Low Flow Shower -New & Replace (Multi-Family)	\$0.02	2.81
Pipe Insulation (Multi-Family)	\$0.00	2.11
Freezer >10% 93 Standards (Multi-Family)	\$0.05	1.79
Exist- Room A/C to 10.5 EER (Multi-Family)	\$0.05	1.41
Moisture Sensor (Multi-Family)	\$0.03	0.89
Faucet Aerators (4 per Home) (Multi-Family)	\$0.02	0.79
Ex Cent- R-0 to R-19 Ceiling Insulation (Multi-Family)	\$0.05	0.53
Exist- Central A/C to 12 EER (Multi-Family)	\$0.06	0.46
Halogen Lamps (Multi-Family)	\$0.05	0.44
New- Room A/C to 10.5 EER (Multi-Family)	\$0.07	0.44

GAS DSM MEASURES

MEASURE	COST (\$/therm)	YEAR 2006 (Percent)
Solar Water W/Electric Backup (Single Family)	\$1.05	36.3
Efficient Tank (Single Family)	\$0.35	17.3
Horizontal Axis Clotheswasher (Single Family)	\$1.46	7.6
Pipe Insulation (Single Family)	\$0.03	5.1
Low Flow Shower -New & Replace (Single Family)	\$0.51	3.8
Faucet Aerators (4 per Home) (Single Family)	\$0.34	1.6
Moisture Sensor (Single Family)	\$0.80	1.4
Efficient Tank (Multi-Family)	\$0.45	18.0
Pipe Insulation (Multi-Family)	\$0.04	4.3
Low Flow Shower -New & Replace (Multi-Family)	\$0.83	2.6
Faucet Aerators (4 per Home) (Multi-Family)	\$0.50	1.2
Moisture Sensor (Multi-Family)	\$1.26	0.8

TABLE 2-6
ELECTRIC DSM MEASURES
HAWAII COUNTY RESIDENTIAL SECTOR

MEASURE	COST (\$/kWh)	YEAR 2006 (Percent)
Solar Water W/Electric Backup (Single Family)	\$0.06	24.46
Heat Pump Water Heat (Single Family)	\$0.07	15.25
Heatpump Clothesdryer (Single Family)	\$0.08	9.26
Compact Fluorescent - 3 Bulbs (Single Family)	\$0.07	9.13
Horizontal Axis Clotheswasher (Single Family)	\$0.06	6.73
Efficient Tank (Single Family)	\$0.03	6.59
Low Flow Shower -New & Replace (Single Family)	\$0.01	5.64
Remove Second Refrigerator (Single Family)	\$0.01	4.53
Pipe Insulation (Single Family)	\$0.00	3.28
Freezer >10% 93 Standards (Single Family)	\$0.05	2.95
Moisture Sensor (Single Family)	\$0.03	1.47
Halogen Lamps (Single Family)	\$0.05	1.47
Faucet Aerators (4 per Home) (Single Family)	\$0.01	1.43
Exist- Central A/C to 12 EER (Single Family)	\$0.05	0.70
Ex Cent- R-0 to R-19 Ceiling Insulation (Single Family)	\$0.05	0.49
Exist- Room A/C to 10.5 EER (Single Family)	\$0.03	0.20
New- Room A/C to 10.5 EER (Single Family)	\$0.03	0.06
Compact Fluorescent - 3 Bulbs (Multi-Family)	\$0.07	1.75
Efficient Tank (Multi-Family)	\$0.03	1.62
Low Flow Shower -New & Replace (Multi-Family)	\$0.02	0.77
Pipe Insulation (Multi-Family)	\$0.00	0.65
Freezer >10% 93 Standards (Multi-Family)	\$0.05	0.54
Faucet Aerators (4 per Home) (Multi-Family)	\$0.02	0.24
Moisture Sensor (Multi-Family)	\$0.03	0.24
Ex Cent- R-0 to R-19 Ceiling Insulation (Multi-Family)	\$0.05	0.19
Exist- Central A/C to 12 EER (Multi-Family)	\$0.06	0.17
Halogen Lamps (Multi-Family)	\$0.05	0.14
Exist- Room A/C to 10.5 EER (Multi-Family)	\$0.05	0.06

GAS DSM MEASURES

MEASURE	COST (\$/therm)	YEAR 2006 (Percent)
Solar Water W/Electric Backup (Single Family)	\$1.05	48.0
Efficient Tank (Single Family)	\$0.35	22.7
Horizontal Axis Clotheswasher (Single Family)	\$1.46	9.5
Pipe Insulation (Single Family)	\$0.03	6.9
Low Flow Shower -New & Replace (Single Family)	\$0.51	5.1
Faucet Aerators (4 per Home) (Single Family)	\$0.34	2.1
Moisture Sensor (Single Family)	\$0.83	1.3
Efficient Tank (Multi-Family)	\$0.45	3.1
Pipe Insulation (Multi-Family)	\$0.04	0.7
Low Flow Shower -New & Replace (Multi-Family)	\$0.83	0.4
Faucet Aerators (4 per Home) (Multi-Family)	\$0.50	0.2
Moisture Sensor (Multi-Family)	\$1.29	0.1

TABLE 2-7
ELECTRIC DSM MEASURES
MAUI COUNTY RESIDENTIAL SECTOR

MEASURE	COST (\$/kWh)	YEAR 2006 (Percent)
Solar Water W/Electric Backup (Single Family)	\$0.06	20.20
Heat Pump Water Heat (Single Family)	\$0.07	12.56
Heatpump Clothesdryer (Single Family)	\$0.08	8.70
Compact Fluorescent - 3 Bulbs (Single Family)	\$0.06	6.48
Horizontal Axis Clotheswasher (Single Family)	\$0.06	5.54
Efficient Tank (Single Family)	\$0.03	5.50
Low Flow Shower -New & Replace (Single Family)	\$0.01	4.65
Exist- Room A/C to 10.5 EER (Single Family)	\$0.03	3.25
Remove Second Refrigerator (Single Family)	\$0.01	3.25
Pipe Insulation (Single Family)	\$0.00	2.73
Freezer >10% 93 Standards (Single Family)	\$0.05	2.09
Moisture Sensor (Single Family)	\$0.03	1.39
Faucet Aerators (4 per Home) (Single Family)	\$0.01	1.19
Halogen Lamps (Single Family)	\$0.05	1.04
New- Room A/C to 10.5 EER (Single Family)	\$0.03	0.85
Exist- Central A/C to 12 EER (Single Family)	\$0.05	0.49
Ex Cent- R-0 to R-19 Ceiling Insulation (Single Family)	\$0.05	0.34
Compact Fluorescent - 3 Bulbs (Multi-Family)	\$0.06	4.52
Efficient Tank (Multi-Family)	\$0.03	4.04
Exist- Room A/C to 10.5 EER (Multi-Family)	\$0.05	2.71
Low Flow Shower -New & Replace (Multi-Family)	\$0.02	2.06
Pipe Insulation (Multi-Family)	\$0.00	1.59
Freezer >10% 93 Standards (Multi-Family)	\$0.05	1.45
Moisture Sensor (Multi-Family)	\$0.03	1.09
Faucet Aerators (4 per Home) (Multi-Family)	\$0.02	0.59
New- Room A/C to 10.5 EER (Multi-Family)	\$0.07	0.50
Ex Cent- R-0 to R-19 Ceiling Insulation (Multi-Family)	\$0.05	0.44
Exist- Central A/C to 12 EER (Multi-Family)	\$0.06	0.38
Halogen Lamps (Multi-Family)	\$0.04	0.36

GAS DSM MEASURES

MEASURE	COST (\$/therm)	YEAR 2006 (Percent)
Solar Water W/Electric Backup (Single Family)	\$1.05	41.0
Efficient Tank (Single Family)	\$0.35	18.1
Horizontal Axis Clotheswasher (Single Family)	\$1.46	7.4
Pipe Insulation (Single Family)	\$0.03	6.0
Low Flow Shower -New & Replace (Single Family)	\$0.51	4.3
Moisture Sensor (Single Family)	\$0.80	2.0
Faucet Aerators (4 per Home) (Single Family)	\$0.34	1.8
Efficient Tank (Multi-Family)	\$0.45	12.4
Pipe Insulation (Multi-Family)	\$0.04	3.3
Low Flow Shower -New & Replace (Multi-Family)	\$0.83	1.9
Moisture Sensor (Multi-Family)	\$1.21	1.0
Faucet Aerators (4 per Home) (Multi-Family)	\$0.50	0.9

TABLE 2-8
ELECTRIC DSM MEASURES
KAUAI COUNTY RESIDENTIAL SECTOR

MEASURE	COST (\$/kWh)	YEAR 2006 (Percent)
Solar Water W/Electric Backup (Single Family)	\$0.06	22.50
Heat Pump Water Heat (Single Family)	\$0.07	14.40
Compact Flourescent - 3 Bulbs (Single Family)	\$0.06	9.31
Horizontal Axis Clotheswasher (Single Family)	\$0.06	6.35
Efficient Tank (Single Family)	\$0.03	6.27
Low Flow Shower -New & Replace (Single Family)	\$0.01	5.20
Exist- Room A/C to 10.5 EER (Single Family)	\$0.03	4.67
Remove Second Refrigerator (Single Family)	\$0.01	4.65
Heatpump Clothesdryer (Single Family)	\$0.08	4.21
Pipe Insulation (Single Family)	\$0.00	3.04
Freezer >10% 93 Standards (Single Family)	\$0.05	3.00
Halogen Lamps (Single Family)	\$0.05	1.50
Faucet Aerators (4 per Home) (Single Family)	\$0.01	1.33
New- Room A/C to 10.5 EER (Single Family)	\$0.03	1.27
Exist- Central A/C to 12 EER (Single Family)	\$0.05	0.71
Moisture Sensor (Single Family)	\$0.03	0.67
Ex Cent- R-0 to R-19 Ceiling Insulation (Single Family)	\$0.05	0.49
Compact Flourescent - 3 Bulbs (Multi-Family)	\$0.06	2.52
Efficient Tank (Multi-Family)	\$0.03	2.32
Exist- Room A/C to 10.5 EER (Multi-Family)	\$0.05	1.29
Low Flow Shower -New & Replace (Multi-Family)	\$0.02	1.17
Pipe Insulation (Multi-Family)	\$0.00	0.90
Freezer >10% 93 Standards (Multi-Family)	\$0.05	0.81
Faucet Aerators (4 per Home) (Multi-Family)	\$0.02	0.34
New- Room A/C to 10.5 EER (Multi-Family)	\$0.07	0.25
Ex Cent- R-0 to R-19 Ceiling Insulation (Multi-Family)	\$0.05	0.25
Exist- Central A/C to 12 EER (Multi-Family)	\$0.06	0.21
Halogen Lamps (Multi-Family)	\$0.04	0.20
Moisture Sensor (Multi-Family)	\$0.03	0.19

GAS DSM MEASURES

MEASURE	COST (\$/therm)	YEAR 2006 (Percent)
Solar Water W/Electric Backup (Single Family)	\$1.05	45.0
Efficient Tank (Single Family)	\$0.35	20.5
Horizontal Axis Clotheswasher (Single Family)	\$1.46	8.5
Pipe Insulation (Single Family)	\$0.03	6.5
Low Flow Shower -New & Replace (Single Family)	\$0.51	4.7
Moisture Sensor (Single Family)	\$0.80	2.5
Faucet Aerators (4 per Home) (Single Family)	\$0.34	2.0
Efficient Tank (Multi-Family)	\$0.45	6.7
Pipe Insulation (Multi-Family)	\$0.04	1.7
Low Flow Shower -New & Replace (Multi-Family)	\$0.83	1.0
Faucet Aerators (4 per Home) (Multi-Family)	\$0.50	0.5
Moisture Sensor (Multi-Family)	\$1.22	0.4

TABLE 2-9
SHARE OF RESIDENTIAL DSM POTENTIAL
BY BUILDING TYPE - YEAR 2006

	ELECTRIC		GAS	
	Single Family	Multi-Family	Single Family	Multi-Family
Honolulu	77.5%	22.5%	73.2%	26.8%
Hawaii	93.5%	6.5%	95.5%	4.5%
Maui	80.3%	19.7%	83.0%	17.0%
Kauai	89.5%	10.5%	90.2%	9.8%
TOTAL	80.8%	19.2%	84.4%	15.6%

TABLE 2-10
ELECTRIC DSM MEASURES
IN LARGE OFFICES

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Optical Reflectors-2X4 Recessed	\$0.017	22.6%	14.5%
X - 4' T8 Lamps And Electronic Ballasts	\$0.035	12.5%	8.0%
X - Energy Management System	\$0.075	7.1%	8.9%
X - Electronic Ballasts-4' T12-Base EEM	\$0.066	6.5%	4.2%
X - Variable Air Volume Box	\$0.072	5.5%	7.1%
X - Electronic Ballasts-4' T12-Base SMC	\$0.063	4.6%	3.0%
N - Optical Reflectors-2X4 Recessed	\$0.022	4.0%	2.6%
X - Compact Fluorescent Lamp EXIT Signs	\$0.011	3.2%	3.7%
X - Occupancy Sensor Pack-1000 SF	\$0.009	2.9%	2.3%
X - Chiller Optimizer Controls	\$0.003	2.8%	3.5%
X - Gas Absorption Chiller	\$0.013	2.6%	5.5%
X - Chiller Strainer Cycle	\$0.030	2.5%	3.5%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.003	2.5%	1.6%
X - High Pressure Sodium-250 Watts	\$0.015	2.3%	3.8%
X - VSD Chilled Water Loop Pump	\$0.017	2.2%	4.2%
X - LED Lamp EXIT Signs	\$0.022	2.0%	2.3%
X - Duct Insulation Material	\$0.012	1.6%	2.9%
X - Window Film Retrofit	\$0.038	1.5%	2.9%
X - Chilled Water Reset Controls	\$0.000	1.2%	1.7%
X - High Pressure Sodium-100 Watts	\$0.021	1.2%	1.9%
X - High Efficiency Centrifugal Chiller	\$0.006	1.1%	2.5%
X - HID Exterior Floods-70 Watts	\$0.033	1.0%	1.6%
X - Compact Fluorescent Lamps-26W	\$0.046	0.9%	0.6%
N - 4' T8 Lamps And Electronic Ballasts	\$0.056	0.8%	0.5%
X - High Efficiency Office Copier	\$0.014	0.7%	0.6%
N - Electronic Ballasts-4' T12-Base EEM	\$0.083	0.6%	0.4%
N - Double Pane Heat Mirror Glazing	\$0.061	0.5%	0.8%
N - Occupancy Sensor Pack-1000 SF	\$0.011	0.4%	0.4%
X - VSD Centrifugal Chiller	\$0.048	0.4%	0.9%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	0.3%	0.4%
X - Compact Fluorescent Lamps-15W	\$0.041	0.3%	0.3%
X - Heat Pump Water Heater	\$0.059	0.3%	0.2%
N - Compact Fluorescent Lamps-26W	\$0.041	0.2%	0.1%
N - LED Lamp EXIT Signs	\$0.012	0.2%	0.2%
N - High Pressure Sodium-100 Watts	\$0.017	0.2%	0.3%
N - Gas Absorption Chiller	\$0.019	0.2%	0.4%
N - HID Exterior Floods-70 Watts	\$0.028	0.1%	0.2%
N - High Efficiency Office Copier	\$0.015	0.1%	0.1%
X - Point of Use Water Heating	\$0.009	0.1%	0.1%
X - Cooling Tower Propeller Fans	\$0.000	0.1%	0.2%
N - VSD Chilled Water Loop Pump	\$0.009	0.1%	0.1%
N - Compact Fluorescent Lamps-15W	\$0.037	0.1%	0.1%
N - High Efficiency Centrifugal Chiller	\$0.015	0.0%	0.1%
N - Heat Pump Water Heater	\$0.066	0.0%	0.0%

TABLE 2-11
ELECTRIC DSM MEASURES
IN SMALL OFFICES

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Optical Reflectors-2X4 Recessed	\$0.020	17.6%	18.6%
X - HVAC System Time Clocks	\$0.002	13.7%	-0.8%
X - Occupancy Sensor Pack-200 SF	\$0.053	12.2%	11.7%
X - 4' T8 Lamps And Electronic Ballasts	\$0.043	9.3%	9.8%
X - High Efficiency DX AC-COP 3.2	\$0.029	8.6%	14.7%
X - High Efficiency DX AC-COP 2.9	\$0.015	6.5%	11.1%
X - Electronic Ballasts-4' T12-Base EEM	\$0.079	4.9%	5.2%
X - Compact Fluorescent Lamp EXIT Signs	\$0.010	3.4%	2.9%
X - Light Colored Roof	\$0.070	3.2%	4.4%
N - Optical Reflectors-2X4 Recessed	\$0.026	3.1%	3.3%
X - LED Lamp EXIT Signs	\$0.021	3.0%	2.5%
X - HID Exterior Floods-70 Watts	\$0.033	2.6%	3.3%
N - Occupancy Sensor Pack-200 SF	\$0.066	2.0%	1.9%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.003	1.9%	2.0%
X - Shade Screens	\$0.034	1.5%	2.2%
X - Window Film Retrofit	\$0.039	1.0%	1.5%
X - Heat Pump Water Heater	\$0.028	0.9%	0.6%
X - High Pressure Sodium-100 Watts	\$0.021	0.8%	1.0%
X - High Efficiency Office Copier	\$0.014	0.8%	0.7%
N - 4' T8 Lamps And Electronic Ballasts	\$0.065	0.7%	0.7%
N - HID Exterior Floods-70 Watts	\$0.028	0.4%	0.5%
N - Double Pane Heat Mirror Glazing	\$0.050	0.3%	0.5%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	0.3%	0.3%
N - LED Lamp EXIT Signs	\$0.011	0.3%	0.2%
N - Shade Screens	\$0.050	0.2%	0.3%
X - Point of Use Water Heating	\$0.088	0.2%	0.1%
X - Clean Condenser Coils	\$0.007	0.2%	0.3%
N - High Efficiency Office Copier	\$0.014	0.1%	0.1%
N - Duct Insulation Material	\$0.024	0.1%	0.1%
N - Heat Pump Water Heater	\$0.032	0.1%	0.1%
N - High Pressure Sodium-100 Watts	\$0.017	0.1%	0.1%
X - Tank Insulation-Fiber Blanket	\$0.007	0.0%	0.0%

TABLE 2-12
ELECTRIC DSM MEASURES
IN LARGE RETAIL

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Optical Reflectors-2X4 Recessed	\$0.012	28.3%	29.0%
X - 4' T8 Lamps And Electronic Ballasts	\$0.026	15.2%	15.6%
X - Electronic Ballasts-4' T12-Base EEM	\$0.046	8.3%	8.4%
X - HID Interior Spots-70W	\$0.020	5.7%	6.0%
X - Electronic Ballasts-4' T12-Base SMC	\$0.047	5.6%	5.9%
X - Energy Management System	\$0.063	4.7%	0.3%
N - Optical Reflectors-2X4 Recessed	\$0.015	4.6%	5.3%
X - High Pressure Sodium-250 Watts	\$0.015	3.8%	4.4%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.002	3.2%	3.2%
X - Gas Absorption Chiller	\$0.007	2.8%	3.1%
X - Water Cooled Condensers	\$0.031	2.1%	2.3%
X - Heat Pump Water Heater	\$0.006	1.8%	2.7%
X - HID Exterior Floods-70 Watts	\$0.033	1.6%	1.9%
X - Compact Fluorescent Lamp EXIT Signs	\$0.013	1.6%	1.0%
X - High Pressure Sodium-100 Watts	\$0.021	1.6%	1.8%
X - LED Lamp EXIT Signs	\$0.027	1.4%	0.9%
X - High Efficiency Reciprocating Chiller	\$0.006	1.3%	1.5%
N - 4' T8 Lamps And Electronic Ballasts	\$0.040	0.9%	1.1%
X - Chiller Strainer Cycle	\$0.087	0.8%	-0.0%
X - VSD Chilled Water Loop Pump	\$0.006	0.8%	0.8%
X - Compact Fluorescent Lamps-15W	\$0.036	0.7%	0.7%
N - Electronic Ballasts-4' T12-Base EEM	\$0.060	0.6%	0.7%
X - Chilled Water Reset Controls	\$0.000	0.4%	-0.0%
N - HID Interior Spots-70W	\$0.022	0.4%	0.5%
N - Gas Absorption Chiller	\$0.008	0.3%	0.4%
N - HID Exterior Floods-70 Watts	\$0.028	0.2%	0.2%
N - Heat Pump Water Heater	\$0.007	0.2%	0.3%
N - High Pressure Sodium-100 Watts	\$0.017	0.2%	0.2%
N - Water Cooled Condensers	\$0.041	0.2%	0.2%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	0.2%	0.1%
N - LED Lamp EXIT Signs	\$0.012	0.1%	0.1%
X - Point of Use Water Heating	\$0.038	0.1%	0.1%
N - Compact Fluorescent Lamps-15W	\$0.038	0.1%	0.1%
N - Duct Insulation Material	\$0.012	0.1%	0.0%
N - VSD Chilled Water Loop Pump	\$0.006	0.1%	0.0%
N - High Efficiency Reciprocating Chiller	\$0.008	0.1%	0.1%
X - Tank Insulation-Fiber Blanket	\$0.005	0.0%	0.0%
N - Point of Use Water Heating	\$0.079	0.0%	0.0%
N - Thermal Energy Storage-Ice On Coil	(\$0.150)	-0.1%	1.0%

TABLE 2-13
ELECTRIC DSM MEASURES
IN SMALL RETAIL

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Optical Reflectors-2X4 Recessed	\$0.013	20.6%	23.4%
X - 4' T8 Lamps And Electronic Ballasts	\$0.028	10.9%	12.4%
X - High Efficiency DX AC-COP 3.2	\$0.023	9.5%	12.9%
X - HVAC System Time Clocks	\$0.010	9.1%	-0.8%
X - High Efficiency DX AC-COP 2.9	\$0.012	7.2%	9.7%
X - Electronic Ballasts-4' T12-Base EEM	\$0.051	5.8%	6.6%
N - Optical Reflectors-2X4 Recessed	\$0.017	4.5%	5.1%
X - Electronic Ballasts-4' T12-Base SMC	\$0.049	4.1%	4.7%
X - Light Colored Roof	\$0.080	4.0%	4.0%
X - Compact Fluorescent Lamp EXIT Signs	\$0.011	3.3%	2.3%
X - HID Exterior Floods-70 Watts	\$0.033	3.3%	3.5%
X - LED Lamp EXIT Signs	\$0.022	2.9%	2.1%
X - Point of Use Water Heating	\$0.026	2.5%	1.4%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.002	2.2%	2.5%
X - High Pressure Sodium-100 Watts	\$0.021	1.9%	2.1%
X - Compact Fluorescent Lamps-15W	\$0.034	1.4%	1.6%
X - Tank Insulation-Fiber Blanket	\$0.002	1.1%	0.6%
N - 4' T8 Lamps And Electronic Ballasts	\$0.043	0.9%	1.1%
X - Duct Insulation Material	\$0.084	0.7%	0.7%
N - Double Pane Heat Mirror Glazing	\$0.084	0.6%	0.8%
N - Electronic Ballasts-4' T12-Base EEM	\$0.064	0.6%	0.7%
N - HID Exterior Floods-70 Watts	\$0.028	0.6%	0.6%
N - Point of Use Water Heating	\$0.047	0.4%	0.2%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	0.4%	0.3%
N - Compact Fluorescent Lamps-15W	\$0.038	0.4%	0.4%
N - High Pressure Sodium-100 Watts	\$0.017	0.3%	0.4%
N - LED Lamp EXIT Signs	\$0.012	0.3%	0.2%
X - Clean Condenser Coils	\$0.024	0.3%	0.4%
N - Duct Insulation Material	\$0.042	0.2%	0.1%

TABLE 2-14
ELECTRIC DSM MEASURES
IN FAST FOOD RESTAURANTS

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Optical Reflectors-2X4 Recessed	\$0.038	11.5%	12.0%
X - HVAC System Time Clocks	\$0.010	10.6%	-0.4%
X - Compact Fluorescent Lamp EXIT Signs	\$0.011	9.8%	8.6%
X - High Efficiency DX AC-COP 3.2	\$0.030	9.4%	14.0%
X - LED Lamp EXIT Signs	\$0.022	8.6%	7.6%
X - High Efficiency DX AC-COP 2.9	\$0.016	7.1%	10.6%
X - 4' T8 Lamps And Electronic Ballasts	\$0.028	6.2%	6.5%
X - Light Colored Roof	\$0.054	5.9%	5.5%
X - High Pressure Sodium-100 Watts	\$0.021	4.6%	6.7%
X - HID Exterior Floods-70 Watts	\$0.033	3.9%	5.8%
X - Electronic Ballasts-4' T12-Base EEM	\$0.050	3.3%	3.5%
N - Optical Reflectors-2X4 Recessed	\$0.015	3.1%	3.0%
X - Electronic Ballasts-4' T12-Base SMC	\$0.049	2.4%	2.5%
X - Compact Fluorescent Lamps-15W	\$0.041	2.3%	1.9%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.002	1.3%	1.3%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	1.3%	1.1%
N - LED Lamp EXIT Signs	\$0.012	1.1%	0.9%
X - Shade Screens	\$0.042	0.9%	0.7%
N - High Pressure Sodium-100 Watts	\$0.017	0.9%	1.3%
N - Smoke Sensor Activated Vent Hood	\$0.053	0.9%	1.6%
N - HID Exterior Floods-70 Watts	\$0.028	0.8%	1.2%
N - 4' T8 Lamps And Electronic Ballasts	\$0.043	0.7%	0.7%
X - Window Film Retrofit	\$0.048	0.6%	0.6%
X - Duct Insulation Material	\$0.087	0.5%	0.7%
X - Heat Pump Water Heater	\$0.054	0.5%	0.6%
N - Electronic Ballasts-4' T12-Base EEM	\$0.063	0.5%	0.5%
N - Compact Fluorescent Lamps-15W	\$0.076	0.3%	0.3%
N - Double Pane Heat Mirror Glazing	\$0.080	0.3%	0.2%
N - Shade Screens	\$0.056	0.2%	0.2%
X - Clean Condenser Coils	\$0.031	0.2%	0.3%
N - Duct Insulation Material	\$0.079	0.1%	0.1%
N - Heat Pump Water Heater	\$0.069	0.1%	0.1%
X - Tank Insulation-Fiber Blanket	\$0.006	0.1%	0.0%

TABLE 2-15
ELECTRIC DSM MEASURES
IN SIT-DOWN FOOD RESTAURANTS

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - HVAC System Time Clocks	\$0.013	16.0%	-1.8%
X - Optical Reflectors-2X4 Recessed	\$0.020	13.1%	14.4%
X - High Efficiency DX AC-COP 3.2	\$0.045	11.9%	19.5%
X - Compact Fluorescent Lamp EXIT Signs	\$0.021	9.5%	7.6%
X - High Efficiency DX AC-COP 2.9	\$0.024	9.0%	14.7%
X - LED Lamp EXIT Signs	\$0.043	8.3%	6.6%
X - HID Exterior Floods-70 Watts	\$0.067	7.4%	9.3%
X - 4' T8 Lamps And Electronic Ballasts	\$0.044	6.8%	7.5%
X - Electronic Ballasts-4' T12-Base SMC	\$0.049	4.1%	4.8%
X - Electronic Ballasts-4' T12-Base EEM	\$0.077	3.8%	4.1%
X - Heat Pump Water Heater	\$0.045	3.6%	5.2%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.003	1.4%	1.6%
N - Optical Reflectors-2X4 Recessed	\$0.022	1.2%	1.5%
X - Shade Screens	\$0.083	1.0%	1.4%
X - Window Film Retrofit	\$0.077	0.8%	1.2%
N - HID Exterior Floods-70 Watts	\$0.057	0.5%	0.6%
N - Compact Fluorescent Lamp EXIT Signs	\$0.005	0.4%	0.3%
N - LED Lamp EXIT Signs	\$0.023	0.3%	0.3%
N - 4' T8 Lamps And Electronic Ballasts	\$0.065	0.3%	0.3%
X - Clean Condenser Coils	\$0.046	0.3%	0.4%
N - Heat Pump Water Heater	\$0.048	0.2%	0.3%
X - Tank Insulation-Fiber Blanket	\$0.016	0.1%	0.1%

TABLE 2-16
ELECTRIC DSM MEASURES
IN GROCERY STORES

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Optical Reflectors-1X8 Fixtures	\$0.005	38.2%	37.4%
N - Optical Reflectors-1X8 Fixtures	\$0.006	7.4%	7.3%
X - 8' Fluor. Energy Saver Lamps-F96T12ES	\$0.001	6.5%	6.4%
X - Electronic Ballasts-8' T12-Base EEM	\$0.023	5.6%	5.4%
X - Variable Speed Refrig. Compressors	\$0.022	4.5%	4.6%
X - Low Head Pressure-Floating Head	\$0.006	3.0%	3.1%
X - Optical Reflectors-2X4 Recessed	\$0.009	2.9%	3.0%
X - Electronic Ballasts-8' T12-Base SMC	\$0.039	2.9%	2.8%
X - Light Colored Roof	\$0.075	2.5%	2.4%
X - High Efficiency DX AC-COP 3.2	\$0.024	2.2%	2.9%
X - Remote Evaporative Subcooler	\$0.013	2.1%	2.1%
X - High Pressure Sodium-250 Watts	\$0.015	1.9%	3.7%
X - Coffin Display Case Night Covers	\$0.004	1.8%	-0.0%
X - High Efficiency DX AC-COP 2.9	\$0.013	1.6%	2.2%
X - 4' T8 Lamps And Electronic Ballasts	\$0.019	1.5%	1.6%
X - HVAC System Time Clocks	\$0.004	1.4%	-0.1%
X - Parallel Unequal Compressor Rack	\$0.024	1.3%	1.3%
X - High Efficiency Refrig. Compressors	\$0.006	1.3%	1.3%
X - Hot Gas Defrost	\$0.011	0.9%	0.8%
X - Compact Fluorescent Lamp EXIT Signs	\$0.013	0.8%	0.8%
X - HID Exterior Floods-70 Watts	\$0.033	0.8%	1.6%
X - Electronic Ballasts-4' T12-Base EEM	\$0.036	0.8%	0.8%
N - Optical Reflectors-2X4 Recessed	\$0.011	0.8%	0.9%
X - LED Lamp EXIT Signs	\$0.026	0.7%	0.7%
N - Variable Speed Refrig. Compressors	\$0.025	0.7%	0.7%
X - Electronic Ballasts-4' T12-Base SMC	\$0.034	0.6%	0.6%
N - Low Head Pressure-Floating Head	\$0.007	0.5%	0.6%
N - Electronic Ballasts-8' T12-Base EEM	\$0.018	0.5%	0.5%
X - Electric Defrost Demand Control	\$0.043	0.5%	0.1%
X - Refrigerator Case Glass Doors	\$0.050	0.4%	0.5%
X - Heat Pump Water Heater	\$0.032	0.4%	0.9%
X - High Pressure Sodium-100 Watts	\$0.021	0.4%	0.7%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.001	0.3%	0.3%
N - Remote Evaporative Subcooler	\$0.014	0.3%	0.3%
N - Coffin Display Case Night Covers	\$0.005	0.3%	-0.0%
N - Parallel Unequal Compressor Rack	\$0.027	0.3%	0.3%
N - High Efficiency Refrig. Compressors	\$0.007	0.2%	0.2%
N - HID Exterior Floods-70 Watts	\$0.028	0.2%	0.3%
N - 4' T8 Lamps And Electronic Ballasts	\$0.029	0.2%	0.2%
N - Hot Gas Defrost	\$0.011	0.1%	0.1%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	0.1%	0.1%
N - Electronic Ballasts-4' T12-Base EEM	\$0.044	0.1%	0.1%
N - LED Lamp EXIT Signs	\$0.014	0.1%	0.1%
N - Heat Pump Water Heater	\$0.034	0.1%	0.2%

TABLE 2-17
ELECTRIC DSM MEASURES
IN REFRIGERATED WAREHOUSES

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Metal Halide Lamps-250W	\$0.015	40.2%	21.9%
X - Variable Speed Refrig. Compressors	\$0.029	9.2%	14.9%
X - Optical Reflectors-1X8 Fixtures	\$0.009	8.0%	3.2%
X - Compact Fluorescent Lamp EXIT Signs	\$0.010	5.4%	7.1%
X - LED Lamp EXIT Signs	\$0.020	4.8%	6.2%
N - Optical Reflectors-1X8 Fixtures	\$0.012	4.2%	2.0%
X - HID Exterior Floods-70 Watts	\$0.033	2.8%	8.3%
X - High Pressure Sodium-100 Watts	\$0.021	2.8%	8.3%
X - Remote Evaporative Subcooler	\$0.011	2.6%	4.2%
X - Low Head Pressure-Floating Head	\$0.006	2.4%	2.2%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	2.0%	2.8%
N - LED Lamp EXIT Signs	\$0.011	1.8%	2.4%
N - HID Exterior Floods-70 Watts	\$0.028	1.7%	5.0%
N - High Pressure Sodium-100 Watts	\$0.017	1.7%	5.0%
N - Variable Speed Refrig. Compressors	\$0.087	1.4%	2.1%
X - 8' Fluor. Energy Saver Lamps-F96T12ES	\$0.002	1.4%	0.5%
X - Optical Reflectors-2X4 Recessed	\$0.016	1.2%	0.2%
X - Electronic Ballasts-8' T12-Base EEM	\$0.045	1.2%	0.5%
N - Optical Reflectors-2X4 Recessed	\$0.021	0.9%	0.1%
N - Remote Evaporative Subcooler	\$0.019	0.7%	1.1%
X - 4' T8 Lamps And Electronic Ballasts	\$0.034	0.6%	0.1%
X - Electronic Ballasts-8' T12-Base SMC	\$0.077	0.6%	0.2%
N - Low Head Pressure-Floating Head	\$0.020	0.4%	0.3%
X - Electronic Ballasts-4' T12-Base EEM	\$0.064	0.3%	0.0%
X - Oversized Evaporative Condensers	\$0.018	0.3%	0.5%
N - Electronic Ballasts-8' T12-Base EEM	\$0.034	0.3%	0.1%
X - Electronic Ballasts-4' T12-Base SMC	\$0.060	0.2%	0.0%
N - 4' T8 Lamps And Electronic Ballasts	\$0.054	0.2%	0.0%
X - High Efficiency Refrig. Compressors	\$0.015	0.1%	0.2%
X - HVAC System Time Clocks	\$0.008	0.1%	0.3%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.003	0.1%	0.0%
N - Electronic Ballasts-4' T12-Base EEM	\$0.078	0.1%	0.0%
N - High Efficiency Refrig. Compressors	\$0.013	0.1%	0.1%
N - Double Pane Heat Mirror Glazing	\$0.082	0.1%	0.0%
N - Oversized Evaporative Condensers	\$0.060	0.0%	0.1%
X - High Efficiency DX AC-COP 3.2	\$0.041	0.0%	0.0%
X - High Efficiency DX AC-COP 2.9	\$0.059	0.0%	0.0%
X - Point of Use Water Heating	\$0.040	0.0%	0.0%
N - Point of Use Water Heating	\$0.075	0.0%	0.0%
X - Tank Insulation-Fiber Blanket	\$0.007	0.0%	0.0%
X - Clean Condenser Coils	\$0.085	0.0%	0.0%

TABLE 2-18
ELECTRIC DSM MEASURES
IN NON-REFRIGERATED WAREHOUSES

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Metal Halide Lamps-250W	\$0.018	39.5%	43.8%
X - High Pressure Sodium-100 Watts	\$0.021	9.7%	20.1%
X - Optical Reflectors-2X4 Recessed	\$0.025	9.7%	1.7%
N - 4' T8 Lamps And Electronic Ballasts	\$0.003	8.8%	7.9%
X - Optical Reflectors-1X8 Fixtures	\$0.016	5.3%	1.0%
X - 4' T8 Lamps And Electronic Ballasts	\$0.053	5.1%	0.9%
X - HID Exterior Floods-70 Watts	\$0.033	4.2%	8.6%
X - Compact Fluorescent Lamp EXIT Signs	\$0.014	3.9%	4.2%
X - LED Lamp EXIT Signs	\$0.029	3.5%	3.7%
N - Optical Reflectors-2X4 Recessed	\$0.031	1.8%	0.3%
N - High Pressure Sodium-100 Watts	\$0.017	1.5%	3.0%
X - HVAC System Time Clocks	\$0.002	1.3%	1.9%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.004	1.1%	0.2%
X - 8' Fluor. Energy Saver Lamps-F96T12ES	\$0.004	0.9%	0.2%
X - Electronic Ballasts-8' T12-Base EEM	\$0.078	0.8%	0.2%
N - Optical Reflectors-1X8 Fixtures	\$0.020	0.7%	0.1%
N - HID Exterior Floods-70 Watts	\$0.028	0.6%	1.3%
X - High Efficiency DX AC-COP 3.2	\$0.028	0.4%	0.0%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	0.4%	0.4%
N - LED Lamp EXIT Signs	\$0.015	0.3%	0.4%
X - High Efficiency DX AC-COP 2.9	\$0.015	0.3%	0.0%
X - Heat Pump Water Heater	\$0.064	0.1%	0.0%
N - Electronic Ballasts-8' T12-Base EEM	\$0.062	0.0%	0.0%
X - Point of Use Water Heating	\$0.050	0.0%	0.0%
X - Shade Screens	\$0.061	0.0%	0.0%
X - Window Film Retrofit	\$0.078	0.0%	0.0%
N - High Efficiency DX AC-COP 3.2	\$0.090	0.0%	0.0%
X - Clean Condenser Coils	\$0.015	0.0%	0.0%
X - Tank Insulation-Fiber Blanket	\$0.006	0.0%	0.0%
N - Heat Pump Water Heater	\$0.083	0.0%	0.0%
N - Shade Screens	\$0.086	0.0%	0.0%

TABLE 2-19
ELECTRIC DSM MEASURES
IN HOSPITALS

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Optical Reflectors-2X4 Recessed	\$0.008	25.4%	26.3%
X - 4' T8 Lamps And Electronic Ballasts	\$0.017	13.4%	13.9%
X - Energy Management System	\$0.033	7.3%	5.7%
X - Electronic Ballasts-4' T12-Base EEM	\$0.030	7.3%	7.5%
X - Optical Reflectors-1X8 Fixtures	\$0.004	6.8%	7.0%
X - Electronic Ballasts-4' T12-Base SMC	\$0.029	5.2%	5.4%
X - Occupancy Sensor Pack-200 SF	\$0.013	4.6%	3.6%
X - VSD Chilled Water Loop Pump	\$0.009	4.5%	3.0%
X - Chiller Optimizer Controls	\$0.002	3.2%	2.8%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.001	2.8%	2.9%
X - Compact Fluorescent Lamp EXIT Signs	\$0.009	2.4%	2.1%
X - Chiller Strainer Cycle	\$0.014	2.3%	2.8%
X - Gas Absorption Chiller	\$0.007	2.3%	3.0%
X - LED Lamp EXIT Signs	\$0.019	2.1%	1.9%
X - Compact Fluorescent Lamps-26W	\$0.022	1.2%	1.2%
X - 8' Fluor. Energy Saver Lamps-F96T12ES	\$0.001	1.2%	1.2%
X - Duct Insulation Material	\$0.007	1.1%	1.3%
X - Chilled Water Reset Controls	\$0.000	1.0%	1.3%
X - High Efficiency Centrifugal Chiller	\$0.003	1.0%	1.3%
X - Electronic Ballasts-8' T12-Base EEM	\$0.017	1.0%	1.0%
X - Active Solar Water Heating	\$0.072	1.0%	1.1%
X - High Pressure Sodium-250 Watts	\$0.015	0.7%	1.1%
X - Electronic Ballasts-8' T12-Base SMC	\$0.030	0.5%	0.5%
X - Compact Fluorescent Lamps-15W	\$0.024	0.5%	0.5%
X - High Pressure Sodium-100 Watts	\$0.021	0.4%	0.6%
X - VSD Centrifugal Chiller	\$0.026	0.4%	0.3%
X - HID Exterior Floods-70 Watts	\$0.033	0.3%	0.4%
X - Waste Heat Recovery	\$0.048	0.1%	0.1%
X - Cooling Tower Propeller Fans	\$0.000	0.1%	0.1%
X - Two-Speed Cooling Tower Fans	\$0.006	0.0%	0.0%
X - Shade Screens	\$0.013	0.0%	0.0%
X - Window Film Retrofit	\$0.014	0.0%	0.0%
N - Optical Reflectors-2X4 Recessed	\$0.010	0.0%	0.0%
N - 4' T8 Lamps And Electronic Ballasts	\$0.026	0.0%	0.0%
N - Optical Reflectors-1X8 Fixtures	\$0.005	0.0%	0.0%
N - Electronic Ballasts-4' T12-Base EEM	\$0.039	0.0%	0.0%
N - Energy Management System	\$0.035	0.0%	0.0%
N - Gas Absorption Chiller	\$0.010	0.0%	0.0%
N - Occupancy Sensor Pack-200 SF	\$0.040	0.0%	0.0%
N - VSD Chilled Water Loop Pump	\$0.004	0.0%	0.0%
N - Compact Fluorescent Lamp EXIT Signs	\$0.002	0.0%	0.0%
N - Active Solar Water Heating	\$0.075	0.0%	0.0%
N - LED Lamp EXIT Signs	\$0.011	0.0%	0.0%
N - Compact Fluorescent Lamps-15W	\$0.025	0.0%	0.0%

TABLE 2-20
ELECTRIC DSM MEASURES
IN SCHOOLS

MEASURE	COST (\$/kWh)	YEAR 2006 SAVINGS (MWH) (Percent)	YEAR 2006 SAVINGS (MW) (Percent)
X - Optical Reflectors-2X4 Recessed	\$0.046	33.2%	18.4%
X - 4' T8 Lamps And Electronic Ballasts	\$0.074	22.7%	12.7%
X - Compact Fluorescent Lamp EXIT Signs	\$0.014	10.3%	22.3%
X - LED Lamp EXIT Signs	\$0.029	6.4%	13.7%
N - Optical Reflectors-2X4 Recessed	\$0.055	6.3%	3.9%
X - Occupancy Sensor Pack-1000 SF	\$0.017	5.6%	4.5%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.007	3.6%	2.0%
X - HVAC System Time Clocks	\$0.001	3.0%	8.1%
X - High Efficiency DX AC-COP 3.2	\$0.025	1.2%	0.0%
X - HID Exterior Floods-70 Watts	\$0.033	1.1%	4.6%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	1.0%	2.5%
N - Occupancy Sensor Pack-1000 SF	\$0.021	0.9%	0.8%
X - High Efficiency DX AC-COP 2.9	\$0.013	0.9%	0.0%
X - Metal Halide Lamps-250W	\$0.042	0.8%	0.5%
X - High Pressure Sodium-100 Watts	\$0.021	0.6%	2.7%
N - LED Lamp EXIT Signs	\$0.015	0.6%	1.4%
X - Active Solar Water Heating	\$0.070	0.4%	0.2%
X - Clean Condenser Coils	\$0.008	0.4%	0.0%
X - Heat Pump Water Heater	\$0.058	0.4%	0.2%
N - HID Exterior Floods-70 Watts	\$0.028	0.2%	0.7%
X - Point of Use Water Heating	\$0.034	0.1%	0.2%
N - High Pressure Sodium-100 Watts	\$0.017	0.1%	0.4%
X - Window Film Retrofit	\$0.083	0.1%	0.0%
N - Active Solar Water Heating	\$0.082	0.1%	0.0%
N - Heat Pump Water Heater	\$0.067	0.1%	0.0%
X - Tank Insulation-Fiber Blanket	\$0.006	0.0%	0.1%
N - Point of Use Water Heating	\$0.063	0.0%	0.0%
N - Duct Insulation Material	\$0.048	0.0%	0.0%

TABLE 2-21
ELECTRIC DSM MEASURES
IN COLLEGES

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Optical Reflectors-2X4 Recessed	\$0.019	29.2%	30.2%
X - 4' T8 Lamps And Electronic Ballasts	\$0.041	15.3%	15.8%
X - Electronic Ballasts-4' T12-Base EEM	\$0.072	8.4%	8.7%
X - Electronic Ballasts-4' T12-Base SMC	\$0.069	6.0%	6.2%
X - Compact Fluorescent Lamp EXIT Signs	\$0.011	5.0%	3.6%
N - Optical Reflectors-2X4 Recessed	\$0.028	4.8%	5.6%
X - Occupancy Sensor Pack-1000 SF	\$0.009	4.1%	4.0%
X - Chiller Optimizer Controls	\$0.004	3.9%	2.6%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.003	3.2%	3.3%
X - LED Lamp EXIT Signs	\$0.022	3.1%	2.2%
X - Energy Management System	\$0.077	2.7%	1.5%
X - Gas Absorption Chiller	\$0.023	1.7%	2.4%
X - VSD Chilled Water Loop Pump	\$0.004	1.7%	1.4%
X - High Efficiency Reciprocating Chiller	\$0.006	1.4%	2.0%
X - Optical Reflectors-1X8 Fixtures	\$0.014	1.1%	1.5%
N - 4' T8 Lamps And Electronic Ballasts	\$0.074	1.0%	1.2%
X - High Pressure Sodium-250 Watts	\$0.015	0.8%	1.0%
X - Chiller Strainer Cycle	\$0.016	0.7%	0.6%
X - Water Cooled Condensers	\$0.033	0.7%	1.0%
X - Duct Insulation Material	\$0.007	0.7%	0.5%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	0.5%	0.4%
N - Occupancy Sensor Pack-1000 SF	\$0.017	0.4%	0.6%
N - Gas Absorption Chiller	\$0.011	0.4%	0.6%
X - Compact Fluorescent Lamps-15W	\$0.045	0.4%	0.5%
X - Window Film Retrofit	\$0.043	0.4%	0.3%
X - High Pressure Sodium-100 Watts	\$0.021	0.4%	0.4%
X - HID Exterior Floods-70 Watts	\$0.033	0.3%	0.4%
N - LED Lamp EXIT Signs	\$0.013	0.3%	0.2%
N - Chiller Optimizer Controls	\$0.014	0.2%	0.0%
X - 8' Fluor. Energy Saver Lamps-F96T12ES	\$0.003	0.2%	0.2%
N - High Efficiency Reciprocating Chiller	\$0.011	0.2%	0.2%
X - Electronic Ballasts-8' T12-Base EEM	\$0.064	0.2%	0.2%
N - Optical Reflectors-1X8 Fixtures	\$0.019	0.1%	0.2%
N - Compact Fluorescent Lamps-15W	\$0.047	0.1%	0.1%
N - Water Cooled Condensers	\$0.057	0.1%	0.1%
N - High Pressure Sodium-100 Watts	\$0.017	0.1%	0.1%
N - VSD Chilled Water Loop Pump	\$0.007	0.1%	0.0%
N - Duct Insulation Material	\$0.010	0.1%	0.1%
N - HID Exterior Floods-70 Watts	\$0.028	0.0%	0.1%
X - Active Solar Water Heating	\$0.046	0.0%	0.0%
N - Electronic Ballasts-8' T12-Base EEM	\$0.055	0.0%	0.0%
N - Active Solar Water Heating	\$0.054	0.0%	-0.0%
X - Hot Water Circulation Pump Timeclock	\$0.003	0.0%	0.0%
N - Hot Water Circulation Pump Timeclock	\$0.005	0.0%	0.0%

TABLE 2-22
ELECTRIC DSM MEASURES
IN HOTELS

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Occupancy Sensor Pack-200 SF	\$0.060	10.9%	8.5%
X - Energy Management System	\$0.060	10.5%	8.4%
X - Compact Fluorescent Lamps-15W	\$0.044	10.5%	13.6%
X - Optical Reflectors-2X4 Recessed	\$0.015	8.2%	10.5%
X - Chiller Optimizer Controls	\$0.001	6.3%	5.1%
X - 4' T8 Lamps And Electronic Ballasts	\$0.024	5.7%	6.6%
X - Chiller Strainer Cycle	\$0.011	5.1%	4.1%
X - HID Interior Spots-70W	\$0.023	3.7%	3.5%
X - Compact Fluorescent Lamps-26W	\$0.019	3.4%	2.7%
X - VSD Chilled Water Loop Pump	\$0.016	3.2%	2.5%
X - Gas Absorption Chiller	\$0.006	3.2%	2.5%
X - Electronic Ballasts-4' T12-Base EEM	\$0.045	3.0%	3.5%
X - Variable Air Volume Box	\$0.036	2.9%	3.3%
X - Compact Fluorescent Lamp EXIT Signs	\$0.011	2.5%	2.0%
X - Chilled Water Reset Controls	\$0.000	2.3%	1.9%
X - Electronic Ballasts-4' T12-Base SMC	\$0.041	2.3%	5.1%
X - LED Lamp EXIT Signs	\$0.022	2.2%	1.8%
X - Optical Reflectors-1X8 Fixtures	\$0.005	1.5%	0.9%
X - High Efficiency Centrifugal Chiller	\$0.003	1.4%	1.1%
X - High Pressure Sodium-250 Watts	\$0.015	1.3%	2.0%
X - Duct Insulation Material	\$0.002	1.3%	1.2%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.002	1.1%	1.3%
N - Optical Reflectors-2X4 Recessed	\$0.015	1.1%	1.3%
X - Window Film Retrofit	\$0.030	0.8%	0.5%
X - High Pressure Sodium-100 Watts	\$0.021	0.7%	1.0%
N - Compact Fluorescent Lamps-15W	\$0.046	0.6%	0.8%
X - HID Exterior Floods-70 Watts	\$0.033	0.6%	0.8%
X - VSD Centrifugal Chiller	\$0.026	0.5%	0.1%
N - Energy Management System	\$0.087	0.4%	0.3%
N - Compact Fluorescent Lamps-26W	\$0.021	0.4%	0.3%
X - Active Solar Water Heating	\$0.061	0.4%	0.8%
X - 8' Fluor. Energy Saver Lamps-F96T12ES	\$0.001	0.2%	0.1%
N - 4' T8 Lamps And Electronic Ballasts	\$0.039	0.2%	0.3%
X - Electronic Ballasts-8' T12-Base EEM	\$0.023	0.2%	0.1%
N - Electronic Ballasts-4' T12-Base EEM	\$0.063	0.1%	0.2%
N - HID Interior Spots-70W	\$0.044	0.1%	0.1%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	0.1%	0.1%
N - Double Pane Heat Mirror Glazing	\$0.054	0.1%	0.1%
N - LED Lamp EXIT Signs	\$0.013	0.1%	0.1%
N - Gas Absorption Chiller	\$0.009	0.1%	0.1%
X - Electronic Ballasts-8' T12-Base SMC	\$0.040	0.1%	0.1%
X - Cooling Tower Propeller Fans	\$0.000	0.1%	0.1%
N - Optical Reflectors-1X8 Fixtures	\$0.008	0.1%	0.0%
N - Chiller Optimizer Controls	\$0.007	0.1%	0.1%

TABLE 2-23
ELECTRIC DSM MEASURES
IN RESORTS

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Energy Management System	\$0.061	8.8%	6.9%
X - Optical Reflectors-2X4 Recessed	\$0.011	8.5%	9.1%
X - Occupancy Sensor Pack-200 SF	\$0.078	7.5%	5.0%
X - Compact Fluorescent Lamps-15W	\$0.064	6.6%	8.5%
X - HID Interior Spots-70W	\$0.012	6.0%	6.0%
X - VSD Chilled Water Loop Pump	\$0.007	6.0%	4.9%
X - Chiller Optimizer Controls	\$0.002	5.1%	4.2%
X - Chiller Strainer Cycle	\$0.010	4.5%	4.2%
X - 4' T8 Lamps And Electronic Ballasts	\$0.023	4.4%	4.7%
X - High Pressure Sodium-250 Watts	\$0.015	3.5%	5.7%
X - Gas Absorption Chiller	\$0.006	3.2%	2.7%
X - High Pressure Sodium-100 Watts	\$0.021	2.9%	4.7%
X - Variable Air Volume Box	\$0.029	2.9%	2.4%
X - HID Exterior Floods-70 Watts	\$0.033	2.5%	4.1%
X - Compact Fluorescent Lamps-26W	\$0.020	2.5%	2.0%
X - Electronic Ballasts-4' T12-Base EEM	\$0.041	2.4%	2.5%
X - Compact Fluorescent Lamp EXIT Signs	\$0.011	2.1%	1.7%
X - Chilled Water Reset Controls	\$0.000	2.1%	1.9%
N - Optical Reflectors-2X4 Recessed	\$0.015	2.0%	2.3%
X - LED Lamp EXIT Signs	\$0.022	1.9%	1.5%
X - Electronic Ballasts-4' T12-Base SMC	\$0.039	1.7%	1.9%
X - High Efficiency Centrifugal Chiller	\$0.003	1.4%	1.2%
X - Optical Reflectors-1X8 Fixtures	\$0.005	1.3%	0.7%
X - Duct Insulation Material	\$0.002	1.2%	1.0%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.002	0.9%	1.0%
N - Compact Fluorescent Lamps-15W	\$0.061	0.9%	1.2%
N - Energy Management System	\$0.086	0.8%	0.7%
N - Compact Fluorescent Lamps-26W	\$0.020	0.6%	0.5%
N - High Pressure Sodium-100 Watts	\$0.017	0.6%	1.0%
X - Window Film Retrofit	\$0.060	0.5%	0.4%
N - HID Exterior Floods-70 Watts	\$0.028	0.5%	0.9%
X - VSD Centrifugal Chiller	\$0.024	0.5%	0.6%
N - 4' T8 Lamps And Electronic Ballasts	\$0.038	0.4%	0.5%
N - VSD Chilled Water Loop Pump	\$0.003	0.4%	0.3%
N - HID Interior Spots-70W	\$0.035	0.3%	0.3%
X - Active Solar Water Heating	\$0.057	0.3%	0.9%
N - Electronic Ballasts-4' T12-Base EEM	\$0.057	0.3%	0.3%
N - Gas Absorption Chiller	\$0.010	0.3%	0.2%
N - Compact Fluorescent Lamp EXIT Signs	\$0.003	0.3%	0.2%
N - LED Lamp EXIT Signs	\$0.013	0.2%	0.2%
X - 8' Fluor. Energy Saver Lamps-F96T12ES	\$0.001	0.2%	0.1%
X - Electronic Ballasts-8' T12-Base EEM	\$0.023	0.2%	0.1%
N - Optical Reflectors-1X8 Fixtures	\$0.008	0.2%	0.1%
N - Chiller Optimizer Controls	\$0.007	0.2%	0.2%

TABLE 2-24
ELECTRIC DSM MEASURES
IN APARTMENT BUILDINGS

MEASURE	COST (\$/kWh)	YEAR 2006	YEAR 2006
		SAVINGS (MWH) (Percent)	SAVINGS (MW) (Percent)
X - Occupancy Sensor Pack-200 SF	\$0.045	12.7%	11.6%
X - Optical Reflectors-2X4 Recessed	\$0.004	11.4%	11.2%
X - Compact Fluorescent Lamp EXIT Signs	\$0.011	10.2%	8.6%
X - Gas Absorption Chiller	\$0.002	10.1%	11.0%
X - LED Lamp EXIT Signs	\$0.008	9.0%	7.5%
X - Compact Fluorescent Lamps-26W	\$0.007	7.0%	5.9%
X - 4' T8 Lamps And Electronic Ballasts	\$0.010	6.9%	7.2%
X - Water Cooled Condensers	\$0.007	4.2%	4.6%
X - Electronic Ballasts-4' T12-Base EEM	\$0.018	3.9%	4.1%
X - High Efficiency Reciprocating Chiller	\$0.001	3.2%	3.5%
X - VSD Chilled Water Loop Pump	\$0.001	3.0%	2.4%
X - Chiller Strainer Cycle	\$0.005	2.7%	2.8%
X - Electronic Ballasts-4' T12-Base SMC	\$0.018	2.6%	2.7%
X - Compact Fluorescent Lamps-15W	\$0.029	2.5%	3.4%
X - High Pressure Sodium-250 Watts	\$0.005	2.0%	3.3%
X - Heat Pump Water Heater	\$0.020	1.6%	2.1%
X - 4' Fluor. Energy Saver Lamps-F40T12ES	\$0.001	1.4%	1.5%
X - Chilled Water Reset Controls	\$0.000	1.2%	1.3%
X - Point of Use Water Heating	\$0.006	1.1%	0.9%
X - High Pressure Sodium-100 Watts	\$0.007	0.8%	1.4%
X - HID Exterior Floods-70 Watts	\$0.011	0.7%	1.2%
X - Window Film Retrofit	\$0.035	0.5%	0.3%
X - Active Solar Water Heating	\$0.014	0.5%	0.7%
X - Tank Insulation-Fiber Blanket	\$0.001	0.4%	0.3%
N - Optical Reflectors-2X4 Recessed	\$0.005	0.1%	0.1%
N - Occupancy Sensor Pack-200 SF	\$0.062	0.1%	0.1%
N - Compact Fluorescent Lamps-26W	\$0.007	0.1%	0.0%
N - Compact Fluorescent Lamp EXIT Signs	\$0.001	0.0%	0.0%
N - Gas Absorption Chiller	\$0.002	0.0%	0.0%
N - Compact Fluorescent Lamps-15W	\$0.028	0.0%	0.0%
N - LED Lamp EXIT Signs	\$0.004	0.0%	0.0%
N - 4' T8 Lamps And Electronic Ballasts	\$0.016	0.0%	0.0%
N - Energy Management System	\$0.090	0.0%	0.0%
N - Water Cooled Condensers	\$0.009	0.0%	0.0%
N - Electronic Ballasts-4' T12-Base EEM	\$0.021	0.0%	0.0%
N - High Efficiency Reciprocating Chiller	\$0.002	0.0%	0.0%
N - VSD Chilled Water Loop Pump	\$0.001	0.0%	0.0%
N - Double Pane Heat Mirror Glazing	\$0.044	0.0%	0.0%
N - Heat Pump Water Heater	\$0.026	0.0%	0.0%
N - Point of Use Water Heating	\$0.010	0.0%	0.0%
N - High Pressure Sodium-100 Watts	\$0.006	0.0%	0.0%
N - HID Exterior Floods-70 Watts	\$0.010	0.0%	0.0%
N - Active Solar Water Heating	\$0.020	0.0%	0.0%
N - Chiller Strainer Cycle	\$0.085	0.0%	0.0%

TABLE 2-25**GAS DSM MEASURES
IN LARGE OFFICES**

MEASURE	COST (\$/Therm)	YEAR 2006 SAVINGS (KTHERM) (Percent)
X - Point of Use Water Heating	\$0.049	70.2%
N - High Efficiency Gas Water Heater	\$0.062	12.0%
X - Tank Insulation-Fiber Blanket	\$0.027	11.0%
X - High Efficiency Gas Water Heater	\$0.888	6.2%
X - Hot Water Circulation Pump Timeclock	\$0.835	0.5%
N - Hot Water Circulation Pump Timeclock	\$0.880	0.1%

TABLE 2-26**GAS DSM MEASURES
IN FAST FOOD RESTAURANTS**

MEASURE	COST (\$/Therm)	YEAR 2006 SAVINGS (KTHERM) (Percent)
X - Active Solar Water Heating	\$1.068	56.0%
X - Tank Insulation-Fiber Blanket	\$0.035	30.6%
X - High Efficiency Gas Water Heater	\$0.724	13.4%

TABLE 2-27**GAS DSM MEASURES
IN SIT-DOWN FOOD RESTAURANTS**

MEASURE	COST (\$/Therm)	YEAR 2006 SAVINGS (KTHERM) (Percent)
X - High Efficiency Gas Water Heater	\$0.904	51.4%
X - Tank Insulation-Fiber Blanket	\$0.070	48.6%

TABLE 2-28**GAS DSM MEASURES
IN GROCERY STORES**

MEASURE	COST (\$/Therm)	YEAR 2006
		SAVINGS (K THERM) (Percent)
X - Point of Use Water Heating	\$0.067	68.8%
N - High Efficiency Gas Water Heater	\$0.067	22.7%
X - High Efficiency Gas Water Heater	\$0.785	6.1%
X - Tank Insulation-Fiber Blanket	\$0.139	2.4%

TABLE 2-29**GAS DSM MEASURES
IN REFRIGERATED WAREHOUSES**

MEASURE	COST (\$/Therm)	YEAR 2006
		SAVINGS (K THERM) (Percent)
X - Point of Use Water Heating	\$0.113	51.0%
N - High Efficiency Gas Water Heater	\$0.142	37.6%
X - Tank Insulation-Fiber Blanket	\$0.034	6.9%
X - High Efficiency Gas Water Heater	\$0.567	4.5%

TABLE 2-30**GAS DSM MEASURES
IN NON-REFRIGERATED WAREHOUSES**

MEASURE	COST (\$/Therm)	YEAR 2006
		SAVINGS (K THERM) (Percent)
X - Point of Use Water Heating	\$0.219	69.0%
X - Tank Insulation-Fiber Blanket	\$0.035	14.0%
N - High Efficiency Gas Water Heater	\$0.327	10.7%
X - High Efficiency Gas Water Heater	\$0.743	6.3%

TABLE 2-31**GAS DSM MEASURES
IN SCHOOLS**

MEASURE	COST (\$/Therm)	YEAR 2006 SAVINGS (K THERM) (Percent)
X - Point of Use Water Heating	\$0.099	41.6
X - Active Solar Water Heating	\$0.818	39.8
X - Tank Insulation-Fiber Blanket	\$0.030	7.9
N - Active Solar Water Heating	\$0.132	7.0
X - High Efficiency Gas Water Heater	\$0.828	3.7

TABLE 2-32**GAS DSM MEASURES
IN COLLEGES**

MEASURE	COST (\$/Therm)	YEAR 2006 SAVINGS (K THERM) (Percent)
X - Active Solar Water Heating	\$0.491	74.6%
N - Hot Water Circulation Pump Timeclock	\$0.819	18.6%
X - Hot Water Circulation Pump Timeclock	\$0.099	5.4%
N - Active Solar Water Heating	\$0.104	1.4%

TABLE 2-33**GAS DSM MEASURES
IN HOTELS**

MEASURE	COST (\$/Therm)	YEAR 2006 SAVINGS (K THERM) (Percent)
X - Point of Use Water Heating	\$0.696	87.4%
N - Point of Use Water Heating	\$1.134	9.5%
X - Hot Water Circulation Pump	\$0.013	2.7%

Timeclock		
N - Hot Water Circulation Pump	\$0.014	0.4%
Timeclock		

TABLE 2-34

**GAS DSM MEASURES
IN RESORTS**

MEASURE	COST (\$/Therm)	YEAR 2006 SAVINGS (K THERM) (Percent)
X - Point of Use Water Heating	\$0.682	88.3%
N - Point of Use Water Heating	\$1.105	10.0%
X - High Efficiency Gas Water Heater	\$0.046	1.3%
N - High Efficiency Gas Water Heater	\$0.049	0.4%

TABLE 2-35

**GAS DSM MEASURES
IN APARTMENT BUILDINGS**

MEASURE	COST (\$/Therm)	YEAR 2006 SAVINGS (K THERM) (Percent)
X - Point of Use Water Heating	\$0.040	60.3%
X - Tank Insulation-Fiber Blanket	\$0.008	18.0%
X - Active Solar Water Heating	\$0.145	16.0%
X - High Efficiency Gas Water Heater	\$0.241	5.4%
N - High Efficiency Gas Water Heater	\$0.060	0.3%
N - Point of Use Water Heating	\$0.262	0.0%

TABLE 4-1
INITIAL DOE-2 SINGLE FAMILY ELECTRIC UECS

APPLIANCE	ENERGY 2020 UEC (1990)	ENERGY 2020 UEC (1992)	REEPS UEC (1990)	RECOMMENDED VALUE
Air Conditioning	1,712	1,744		
Central A/			4,431	4,431
Room A/			399	
Water Heat: Electric	4,702	4,821	3,154	3,154
Cooking	1,135	1,147	494	494
Refrigerator	1,692	1,700		
Refrigerator			1,148	1,148
Refrigerator			1,487	1,487
Freezer			980	980
Dryer	1,401	1,386	1,105	1,386
Lighting	589	593	1,100	593

TABLE 4-2
INITIAL DOE-2 SINGLE FAMILY GAS UECS (KBTU)

APPLIANCE	ENERGY 2020 UEC (1990)	ENERGY 2020 UEC (1992)	REEPS UEC (1990)	RECOMMENDED VALUE
Water Heat	25,675	26,319	17,000	17,000
Cooking	3,826	3,824	3,800	3,824
Dryer	4,683	4,642	4,000	4,642

TABLE 4-3
INITIAL DOE-2 MULTI-FAMILY ELECTRIC UECS (KWH)

APPLIANCE	ENERGY 2020 UEC (1990)	ENERGY 2020 UEC (1992)	REEPS UEC (1990)	RECOMMENDED VALUE
Air Conditioning	1,264	1,261		
Central A/			2,669	2,669
Room A/			260	
Water Heat: Electric	2,539	2,540	1,645	1,645
Cooking	689	684	391	684
Refrigerator	1,121	1,103		
Refrigerator			1,114	1,114
Refrigerator			1,595	1,595
Freezer			933	930
Dryer	912	890	1,051	890
Lighting	358	353	713	353

TABLE 4-4
INITIAL DOE-2 MULTI-FAMILY GAS UECS (KBTU)

APPLIANCE	ENERGY 2020 UEC (1990)	ENERGY 2020 UEC (1992)	REEPS UEC (1990)	RECOMMENDED VALUE
Water Heat	13,826	13,823	8,520	8,520
Cooking	2,332	2,289	3,049	2,289
Dryer	3,043	2,952	3,500	2,952

TABLE 4-5
AVERAGE APPLIANCE SATURATIONS - SINGLE FAMILY

APPLIANCE	ENERGY 2020 UEC (1990)	ENERGY 2020 UEC (1992)	REEPS UEC (1990)	RECOMMENDED VALUE
Air Conditioning	.221	.225		
Central A/			.010	.010
Room A/			.209	.215
Water Heat: Electric	.640	.642	.648	.642
Water heat: Solar	.216	.216	.207	.216
Water heat: HP	.014	.014	.013	.014
Water heat: Gas	.130	.128	.131	.128
Cooking: Electric	.708	.714	.861	.714
Cooking: Gas	.292	.286	.139	.286
Refrigerator	1.771	1.803		
Refrigerator			1.00	1.00
Refrigerator			.42	.42
Freezer			.304	.304
Dishwasher			.316	.316
Clothes Washer			.924	.924
Dryer: Electric	.426	.438	.570	.438
Dryer: Gas	.158	.156	.032	.156

TABLE 4-6
AVERAGE APPLIANCE SATURATIONS - MULTI-FAMILY

APPLIANCE	ENERGY 2020 UEC (1990)	ENERGY 2020 UEC (1992)	REEPS UEC (1990)	RECOMMENDED VALUE
Air Conditioning	.234	.238		
Central A/			.024	.024
Room A/			.204	.214
Water Heat: Electric	.762	.765	.825	.765
Water heat: Solar	.05	.05	.031	.05
Water heat: HP	.049	.048	.006	.048
Water heat: Gas	.139	.137	.137	.137
Cooking: Electric	.728	.73	.872	.73
Cooking: Gas	.272	.27	.128	.27
Refrigerator	1.235	1.257	1.00	1.257
Refrigerator			1.00	1.00
Refrigerator			.112	.112
Freezer			.145	.145
Dishwasher			.378	.378
Clothes Washer			.698	.698
Dryer: Electric	.413	.421	.536	.421
Dryer: Gas	.134	.135		.135

TABLE 4-7
COMMERCIAL BUILDING CHARACTERISTICS - ELECTRICITY

Building Type	COMMEND					ENERGY 2020	RECOMMENDED		
	Floorspace (MSF)	Electric Saturation	Av. EUI (kWh/Sq.Ft.)	Marg. EUI (kWh/Sq.Ft.)	Sales (GWH)	Sales (GWH)	Floorspace (MSF)	Av. EUI (kWh/Sq.Ft.)	Marg. EUI (kWh/Sq.Ft.)
HOTEL	29.3						29.3		
Refrigeratio		79.7%	0.48	0.48	11.21	30.19		0.50	0.5
Lightin		100%	5.62	5.36	164.67	154.16		5.82	5.5
Water Hea		19.6%	2.59	2.33	14.87	12.02		2.68	2.4
Cookin		32.2%	3.81	3.81	35.95	2.93		3.95	3.9
Ventilatio		100%	1.07	1.07	31.35	40.15		1.11	1.1
Air Conditione		62.6%	8.07	7.67	147.9	109.91		8.36	7.9
Miscellaneous		100%	0.7	0.54	20.51	92.19		0.73	0.5
TOTA					426.46	441.97			
OFFICE	37.0						37.0		
Refrigeratio		3.37%	0.66	0.66	7.40	10.55		0.75	0.7
Lightin		100%	5.67	5.43	209.79	314.77		6.42	6.1
Water Hea		38.4%	0.79	0.71	11.22	2.34		0.89	0.8
Cookin		12.6%	1.86	1.86	8.67	2.34		2.11	2.1
Ventilatio		100%	1.17	1.17	43.29	72.68		1.33	1.3
Air Conditione		84.2%	11.56	10.98	360.01	255.57		13.09	12.4
Miscellaneous		100%	1.92	0.94	71.04	147.42		2.17	1.0
TOTA					711.43	805.69			
RETAIL	21.2						21.2		
Refrigeratio		35.0%	1.15	1.15	8.53	13.48		1.28	1.2
Lightin		100%	6.62	6.33	140.34	186.69		7.34	7.0
Water Hea		31.2%	1.07	0.96	7.08	0.88		1.19	1.0
Cookin		7.7%	2.50	2.50	4.08	0.88		2.77	2.7
Ventilatio		100%	1.40	1.40	29.68	24.33		1.55	1.5
Air Conditione		66.6%	11.73	11.14	166.07	122.51		13.01	12.3
Miscellaneous		100%	1.15	0.68	24.38	72.98		1.28	0.7
TOTA					380.16	421.75			
GROCERY	3.9						3.9		
Refrigeratio		100.0%	23.93	22.93	93.33	89.39		25.79	25.7
Lightin		100%	11.09	10.60	43.25	70.05		11.95	11.4
Water Hea		65.8%	2.22	2.00	5.70	2.05		2.39	2.1
Cookin		10.5%	6.50	6.50	2.66	2.05		7.00	7.0
Ventilatio		100%	2.20	2.20	8.58	2.93		2.37	2.3
Air Conditione		57.5%	12.35	12.68	27.67	20.22		13.31	13.6
Miscellaneous		100%	1.10	0.63	4.29	13.19		1.19	0.6
TOTA					185.48	199.88			
WAREHOUSE	11.8						11.8		
Refrigeratio		45.3%	2.62	2.52	14.00	3.22		1.73	1.6
Lightin		100%	3.61	3.44	42.60	23.15		2.39	2.2
Water Hea		41.2%	0.49	0.44	2.38	0.00		0.32	0.2
Cookin		8.7%	0.77	0.74	0.79	0.00		0.51	0.4
Ventilatio		100%	0.89	0.85	10.50	1.17		0.59	0.5
Air Conditione		46.4%	5.69	5.41	31.12	17.58		3.77	3.5
Miscellaneous		100%	0.64	0.45	7.55	26.96		0.42	0.3
TOTA					108.95	72.10			

TABLE 4-7 (CONTINUED)
COMMERCIAL BUILDING CHARACTERISTICS - ELECTRICITY

Building Type	COMMENT					ENERGY 2020	RECOMMENDED		
	Floorspace (MSF)	Electric Saturation	Av. EUI (kWh/Sq.Ft.)	Marg. EUI (kWh/Sq.Ft.)	Sales (GWH)	Sales (GWH)	Floorspace (MSF)	Av. EUI (kWh/Sq.Ft.)	Marg. EUI (kWh/Sq.Ft.)
EDUCATION	29.2						29.2		
Refrigeratio		79.0%	0.53	0.53	12.23	6.15	No recommendation. Will let DOE-2 determine appropriate value.		
Lightin		100%	4.23	4.03	123.52	58.79			
Water Hea		40.5%	1.06	0.95	12.54	2.05			
Cookin		40.5%	1.37	1.37	16.20	1.76			
Ventilatio		100%	0.80	0.80	23.36	7.03			
Air Conditione		34.5%	5.39	5.12	54.22	17.88			
Miscellaneous		100%	0.46	0.22	13.43	41.03			
TOTA					255.49	135.70			
HEALTH	7.6						7.6		
Refrigeratio		80.0%	0.68	0.68	4.13	9.38	No recommendation. Will let DOE-2 determine appropriate value		
Lightin		100%	4.95	4.72	37.62	69.75			
Water Hea		46.5%	2.31	2.08	8.16	2.64			
Cookin		2.2%	4.36	4.36	0.73	0.00			
Ventilatio		100%	3.56	3.56	27.06	36.05			
Air Conditione		86.0%	11.50	10.93	75.12	61.84			
Miscellaneous		100%	1.14	0.70	8.66	27.55			
TOTA					161.49	207.21			
RESTAURANT	6.0						6.0		
Refrigeratio		100%	6.32	6.32	37.92	61.25		5.31	5.3
Lightin		100%	7.70	7.39	46.20	66.24		6.47	6.2
Water Hea		31.9%	8.22	7.40	15.73	6.15		6.91	6.2
Cookin		21.9%	21.33	21.33	28.03	18.17		17.93	17.9
Ventilatio		100%	2.28	2.38	13.68	7.91		1.92	1.9
Air Conditione		71.6%	14.12	13.41	60.66	58.32		11.87	11.2
Miscellaneous		100%	0.82	0.57	4.92	18.17		0.69	0.4
TOTA					207.14	236.21			
APT. BUILDING	26.6						26.6		
Refrigeratio		79.7%	0.39	0.39	8.27	61.32		0.33	0.3
Lightin		100%	4.55	4.55	121.03	20.78		3.83	3.8
Water Hea		100%	2.10	1.89	55.86	37.39		1.77	1.5
Cookin		32.2%	3.09	3.09	26.47	26.07		2.60	2.6
Ventilatio		100%	0.87	0.87	23.14	70.33		0.73	0.7
Air Conditione		50.0%	6.55	6.22	87.12	26.63		5.51	5.2
Miscellaneous		100%	0.44	0.44	11.70	37.96		0.37	0.3
TOTA					333.59	280.45			

TABLE 4-8
COMMERCIAL BUILDING CHARACTERISTICS - GAS

Building Type	COMMEND					ENERGY 2020	RECOMMENDED		
	Floorspace (MSF)	Electric Saturation	Av. EUI (kWh/Sq.Ft.)	Marg. EUI (kWh/Sq.Ft.)	Sales (GWH)	Sales (GWH)	Floorspace (MSF)	Av. EUI (kWh/Sq.Ft.)	Marg. EUI (kWh/Sq.Ft.)
HOTEL	29.3						29.3		
Water Hea		79.6%	35.10	35.10	818.84	496.0		No recommendation. Will let DOE-2 determine appropriate value.	
Cookin		24.3%	31.14	31.14	221.80	268.0			
Air Conditione		2.5%	12.52	12.52	9.17	24.0			
Miscellaneous		100%	19.17	19.17	561.49	0.0			
TOTA					1,611.49	812.07			
OFFICE	37.0						37.0		
Water Hea		55.3%	2.15	2.15	43.99	36.0		No recommendation. Will let DOE-2 determine appropriate value.	
Cookin		12.8%	0.20	0.20	0.95	0.0			
Air Conditione		4.0%	18.87	18.87	27.93	0.0			
Miscellaneous		100%	0.85	0.85	31.45	0.0			
TOTA					104.32	36.0			
RETAIL	21.2						21.2		
Water Hea		50.9%	8.53	8.53	92.12	0.0		No recommendation. Will let DOE-2 determine appropriate value.	
Cookin		25.0%	11.71	11.71	62.04	0.0			
Air Conditione		2.3%	19.58	19.58	9.55	0.0			
Miscellaneous		100%	2.19	2.19	46.43	0.0			
TOTA					210.13	0.0			
GROCERY	3.9						3.9		
Water Hea		32.2%	27.81	27.81	34.88	35.0		No recommendation. Will let DOE-2 determine appropriate value.	
Cookin		44.6%	48.89	48.89	85.08	35.0			
Air Conditione		1.6%	36.26	32.26	2.26	0.0			
Miscellaneous		100%	22.45	22.45	87.56	0.0			
TOTA					209.78	70.0			
WAREHOUSE	11.8						11.8		
Water Hea		24.0%	3.81	3.81	10.78	0.0		No recommendation. Will let DOE-2 determine appropriate value.	
Cookin		0.8%	3.62	3.62	0.34	0.0			
Air Conditione		1.6%	5.95	5.95	1.12	0.0			
Miscellaneous		100%	2.06	2.06	24.31	0.0			
TOTA					36.55	0.0			
EDUCATION	29.2						29.2		
Water Hea		53.9%	11.28	11.28	177.47	97.0		No recommendation. Will let DOE-2 determine appropriate value.	
Cookin		25.1%	8.57	8.57	62.81	44.0			
Air Conditione		3.7%	13.71	13.71	14.81	0.0			
Miscellaneous		100%	7.40	7.40	216.08	0.0			
TOTA					471.17	141.0			
HEALTH	7.6						7.6		
Water Hea		52.8%	41.81	41.81	167.84	88.0		No recommendation. Will let DOE-2 determine appropriate value.	
Cookin		74.5%	47.61	47.61	269.84	35.0			
Air Conditione		3.3%	52.47	52.47	13.16	0.0			
Miscellaneous		100%	42.99	42.99	326.72	18.0			
TOTA					777.22	141.0			

TABLE 4-8 (CONTINUED)
COMMERCIAL BUILDING CHARACTERISTICS - GAS

Building Type	COMMENT					ENERGY 2020	RECOMMENDED		
	Floorspace (MSF)	Electric Saturation	Av. EUI (kWh/Sq.Ft.)	Marg. EUI (kWh/Sq.Ft.)	Sales (GWH)	Sales (GWH)	Floorspace (MSF)	Av. EUI (kWh/Sq.Ft.)	Marg. EUI (kWh/Sq.Ft.)
RESTAURANT	6.0						6.0		
Water Hea		66.5%	49.65	49.65	198.19	109.0	No recommendati on. Will let DOE-2 determine appropriate value.		
Cookin		73.2%	73.35	73.35	322.20	694.0			
Air Conditione		4.5%	29.73	29.73	8.03	0.0			
Miscellaneous		100%	0.0	0.0	0.01	0.0			
TOTA					528.42	803.0			
APT. BUILDING	26.6						26.6		
Water Hea		0.0%	35.10	35.10	0.00	359.1	No recommendati on. Will let DOE-2 determine appropriate value.		
Cookin		24.3%	31.14	31.14	201.37	8.76			
Air Conditione		2.5%	12.52	12.52	8.33	0.0			
Miscellaneous		100%	19.17	19.17	509.92	70.07			
TOTA					719.61	437.93			

TABLE 4-9
COMMERCIAL OFFICE AND SCHOOL CHARACTERISTICS - ELECTRICITY

Building Type	ESTIMATED VALUES		
	Floorspace (MSF)	Av. EUI (kWh/Sq.Ft.)	Marg. EUI (kWh/Sq.Ft.)
SMALL OFFICE	10.7		
Refrigeratio		0.55	0.59
Lightin		4.68	4.87
Water Hea		0.65	0.63
Cookin		1.54	1.67
Ventilatio		0.97	1.05
Air Conditione		9.55	9.85
Miscellaneous		1.58	0.84
LARGE OFFICE	26.3		
Refrigeratio		0.84	0.91
Lightin		7.18	7.46
Water Hea		0.99	0.97
Cookin		2.36	2.56
Ventilatio		1.49	1.61
Air Conditione		14.63	15.07
Miscellaneous		2.36	1.29
TOTAL			
RETAIL	17.9		
Refrigeratio		0.21	0.22
Lightin		1.65	1.67
Water Hea		0.41	0.39
Cookin		0.54	0.57
Ventilatio		0.31	0.33
Air Conditione		2.10	2.12
Miscellaneous		0.18	0.09
TOTAL			
GROCERY	11.3		
Refrigeratio		0.46	0.49
Lightin		3.67	3.79
Water Hea		0.91	0.87
Cookin		1.19	1.27
Ventilatio		0.69	0.73
Air Conditione		4.67	4.72
Miscellaneous		0.39	0.21
TOTAL			

TABLE 4-10
RESIDENTIAL DSM MEASURES FROM THE BCI DATABASE

Measure	Electric	Gas	Included in NEOS Analysis?
Water Heating:			
Efficient Water Heaters	X	X	X
Faucet Aerators	X	X	X
Heat Traps	X	X	
Low-Flow Showerheads	X	X	X
Pipe Insulation	X	X	X
Tank Wraps	X	X	
Low-Water Dishwasher	X	X	
Low-Water Clothes Washer	X	X	X
Solar-Assisted Water Heating	X	X	X
Heat-Pump Water Heaters	X		X
Lighting:			
Compact Fluorescent Lamps	X		X
Reduced Wattage Incandescent	X		
Refrigeration:			
High-Efficiency Refrigerators and Freezers	X		X
Servicing Refrigerators and Freezers	X		
Removal of Secondary Refrigerators and Freezers	X		X
Cooking:			
Convection Ovens	X		
Induction Cooktops	X		
Reduced Oven Size	X	X	
Reflector Pans	X		X
Self-Cleaning Oven	X	X	
Clothes Drying:			
Moisture Sensor	X	X	X
Cooling:			
High Efficiency Central A/C	X		X
High Efficiency Room A/C	X		X
Servicing	X		

TABLE 4-11
RESIDENTIAL DSM MEASURES IN NEOS ANALYSIS

Measure	Electricity		Gas	
	Existing	New	Existing	New
Water Heat:				
Efficient Tank	X	X	X	X
Faucet Aerators	X		X	
Low-Flow Showerheads	X	X	X	X
Pipe Insulation	X		X	
Horizontal Axis Clothes Washer	X	X	X	X
Solar Water Heat	X	X	X	X
Heat Pump Water Heat	X	X		
Lighting:				
Compact Fluorescent	X	X		
T-8 Lamp w/ Elec Ballast	X	X		
Halogen Lamp	X	X		
Refrigeration:				
Efficient Refrigerator > 10% 93 Standards	X	X		
Efficient Refrigerator - SERP	X	X		
Efficient Freezer > 10% 93 Standards	X	X		
Remove Second Refrigerator	X	X		
Cooking:				
Reflector Pans	X	X		
Clothes Drying:				
Moisture Sensor	X		X	
Microwave Clothes Dryer	X	X		
Heat Pump Clothes Dryer	X	X		
Cooling:				
Ceiling Insulation R0-R19	X			
Ceiling Insulation R11-R19		X		
Wall Insulation R0-R11	X			
Improve Central A/C to 12 EER	X	X		
Improve Room A/C to 10.5 EER	X	X		
Controls:				
Water Heater	X	X		
Air Conditioning	X	X		

TABLE 4-12
COMMERCIAL SECTOR TECHNOLOGY MATRIX BY BUILDING TYPE

Measure Description	L O F F	S O F F	L R E T	S R E T	S D R E	F F R E	G R O C	R E F W	S T O R	H O S P	S C H L	C O L L	H O T R	A P R T
4' Fluor. Energy Saver Lamps	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Electronic Ballasts	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Optical Reflectors	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8' Fluor. Energy Saver Lamps							X	X	X	X		X	X	
Compact Fluorescent Bulbs	X		X	X	X	X				X		X	X	X
Interior HID Lamps			X										X	
Interior Metal Halide Lamps								X	X		X			
Compact Fluorescent EXIT Sign	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LED Lamp Exit Sign	X	X	X	X	X	X	X	X	X	X	X	X	X	X
High Efficiency Recipricating Chillers			X									X		X
High Efficiency Centrifugal Chillers	X									X			X	
Water Cooled Condenser			X									X		X
Clean Condenser Coils		X		X	X	X	X	X	X		X			
VSD Chilled Water Loop Pump	X		X							X		X	X	X
VSD Centrifugal Chiller	X									X			X	
Gas Absorption Chiller	X		X							X		X	X	X
Chiller Strainer Cycle	X		X							X		X	X	X
Chilled Water Reset	X		X							X		X	X	X
Chiller Optimizer	X									X		X	X	
Thermal Energy Storage-Ice-Full Storage	X		X							X		X		
Cooling Tower Propeller Fans	X									X			X	
Two-Speed Cooling Tower Fans	X									X			X	
VSD Cooling Tower Fans	X									X			X	
Time Clocks (heating/cooling)		X		X	X	X	X	X	X		X			
Energy Management System	X		X							X		X	X	X
Duct Insulation Material	X	X	X	X	X	X	X			X	X	X	X	
Window Film Retrofit	X	X	X	X	X	X	X		X	X	X	X	X	X
Double Pane Heat Mirror Glazing	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Shade Screens		X			X	X	X		X			X		
Light Colored Roof	X	X	X	X	X	X	X	X			X			

TABLE 4-12 (CONTINUED)
COMMERCIAL SECTOR TECHNOLOGY MATRIX BY BUILDING TYPE

Measure Description	L O F F	S O F F	L R E T	S R E T	S D R E	F F R E	G R O C	R E F W	S T O P	H O S P	S C H L	C O L L	H O T R	A P R T
Variable Air Volume Box	X		X									X	X	
Waste Heat Recovery										X			X	
High Efficiency Gas Water Heater	X	X	X	X	X	X	X	X	X		X			X
Point of Use Water Heating	X	X	X	X			X	X	X		X			X
Heat Pump Water Heater	X	X	X		X	X	X	X	X		X			X
Circulation Pump Timeclock Retrofit	X											X	X	
Tank Insulation-Fiber Blanket	X	X	X	X	X	X	X	X	X		X			X
Solar Water Heat					X	X				X	X	X	X	X
Electric Defrost Demand Control							X	X						
Parallel Unequal Compressor Rack							X							
Glass Doors for Refrigerated Display Cases							X							
Extensive Refrigeration Equip. Maintenance							X	X						
High Efficiency Compressors							X	X						
Oversized Evaporative Condenser-TD=15F								X						
Remote Evaporative Subcooler							X	X						
Hot Gas Defrost							X							
Low Head Pressure-Floating Head							X	X						
High Efficiency Evaporator Fan Motors							X							
Coffin Display Case Night Covers							X							
Variable Speed Compressors							X	X						
Electronic Ignition					X	X								
Grease Extractor Hood					X	X								
Smoke Sensor Activated Ventilation Hood					X	X								
High Efficiency Office Copier	X	X												
High Pressure Sodium w/Fixture-100 Watts	X	X	X	X		X	X	X	X	X	X	X	X	X
High Pressure Sodium w/Fixture-250 Watts	X		X				X			X		X	X	X
Metal Halide w/Fixture-250 Watts	X		X				X			X		X	X	X
HID Exterior Floods - 70 Watts	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Occupancy Sensor Pack-200 SF		X								X			X	X
High Efficiency DX AC-COP 2.9		X		X	X	X	X	X	X		X			
High Efficiency DX AC-COP 3.2		X		X	X	X	X	X	X		X			

TABLE 6-1
RESIDENTIAL NET-TO-GROSS FACTORS

PROGRAM CATEGORY	NET-TO-GROSS FACTOR
Room Air Conditioning	98%
Central Air Conditioning	98%
Refrigeration	98%
Lights	83%
Water Heat	98%
Clothes Drying	98%
Cooking	98%
A/C Controls	100%
Water Heater Controls	100%

TABLE 6-2
COMMERCIAL NET-TO-GROSS FACTORS

PROGRAM CATEGORY	NET-TO-GROSS FACTOR
Refrigeration	85%
Cooking	85%
Air Conditioning	85%
Exterior Lights	98%
Water Heat	85%
Interior Lights	98%
Office Equipment	85%
Ventilation	85%

TABLE 8-1
RESIDENTIAL MAXIMUM MARKET PENETRATION

PROGRAM	MARKET SPECIFIC	HAWAII PROGRAM
Room Air Conditioning	85%	50%
Central Air Conditioning	85%	50%
Refrigeration	85%	50%
Lights	75%	40%
Water Heat	85%	50%
Clothes Drying	85%	50%
Cooking	85%	50%
Air Conditioning Controls	85%	70%
Water Heat Controls	95%	70%

TABLE 8-2
COMMERCIAL MAXIMUM MARKET PENETRATION

PROGRAM	MARKET SPECIFIC	HAWAII PROGRAM
Refrigeration	80%	40%
Cooking	80%	40%
Air Conditioning	80%	40%
Exterior Lights	80%	40%
Water Heat	80%	40%
Interior Lights	80%	40%
Office Equipment	80%	40%
Ventilation	80%	40%

TABLE 8-3
RESIDENTIAL SECTOR ANNUAL PARTICIPATION RATES

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Compact Fluorescent - 3 Bulbs	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
T-8 Lamp w/Elec Ballast	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Halogen Lamps	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Moisture Sensor	0.31%	0.63%	1.23%	2.20%	3.54%	4.95%	6.09%	6.84%	7.27%	7.49%
Microwave Clothesdryer	0.31%	0.63%	1.23%	2.20%	3.54%	4.95%	6.09%	6.84%	7.27%	7.49%
Heatpump Clothesdryer	0.31%	0.63%	1.23%	2.20%	3.54%	4.95%	6.09%	6.84%	7.27%	7.49%
Refrigerator>10% 93 Standards	0.20%	0.41%	0.80%	1.43%	2.30%	3.21%	3.96%	4.45%	4.72%	4.87%
Refrigerator-SERP	0.20%	0.41%	0.80%	1.43%	2.30%	3.21%	3.96%	4.45%	4.72%	4.87%
Freezer >10% 93 Standards	0.20%	0.41%	0.80%	1.43%	2.30%	3.21%	3.96%	4.45%	4.72%	4.87%
Remove Second Refrigerator	0.07%	0.14%	0.26%	0.47%	0.76%	1.06%	1.31%	1.47%	1.56%	1.61%
Reflector Pans	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Efficient Tank	0.29%	0.59%	1.14%	2.05%	3.28%	4.59%	5.66%	6.36%	6.75%	6.95%
Faucet Aerators (4 per Home)	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Low Flow Shower -New & Replace	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Pipe Insulation	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Horizontal Axis Clotheswasher	0.31%	0.63%	1.23%	2.20%	3.54%	4.95%	6.09%	6.84%	7.27%	7.49%
Solar Water W/Electric Backup	5.00%	7.00%	10.00%	12.00%	15.00%	15.00%	12.00%	10.00%	5.50%	3.00%
Heat Pump Water Heat	0.29%	0.59%	1.14%	2.05%	3.28%	4.59%	5.66%	6.36%	6.75%	6.95%
Ex Room- R-0 to R-19 Ceiling Insulation	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Wall R0 to R-11 Wall Insulation	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Exist- Room A/C to 10.5 EER	0.27%	0.55%	1.06%	1.91%	3.06%	4.29%	5.28%	5.93%	6.30%	6.49%
New Room- R-11 to R-19 Ceiling Insulation	4.06%	8.23%	15.95%	28.66%	45.96%	64.29%	79.22%	88.97%	94.47%	97.31%
New- Room A/C to 10.5 EER	4.06%	8.23%	15.95%	28.66%	45.96%	64.29%	79.22%	88.97%	94.47%	97.31%
Ex Cent- R-0 to R-19 Ceiling Insulation	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Wall R0 to R-11 Wall Insulation	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
Exist- Central A/C to 12 EER	0.27%	0.55%	1.06%	1.91%	3.06%	4.29%	5.28%	5.93%	6.30%	6.49%
New Cent- R-11 to R-19 Ceiling Insulation	4.06%	8.23%	15.95%	28.66%	45.96%	64.29%	79.22%	88.97%	94.47%	97.31%
New- Central A/C to 12 EER	4.06%	8.23%	15.95%	28.66%	45.96%	64.29%	79.22%	88.97%	94.47%	97.31%
A/C - Cycling	3.45%	6.99%	13.56%	24.36%	39.06%	54.65%	67.33%	75.63%	80.30%	82.71%
Water Heating Controls	3.66%	7.40%	14.35%	25.79%	41.36%	57.86%	71.29%	80.08%	85.02%	87.58%

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Compact Fluorescent - 3 Bulbs	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
T-8 Lamp w/Elec Ballast	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Halogen Lamps	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Moisture Sensor	7.59	7.65	7.67	7.37	7.05	6.46	5.49	4.16	2.75	1.60
Microwave Clothesdryer	7.59	7.65	7.67	7.37	7.05	6.46	5.49	4.16	2.75	1.60
Heatpump Clothesdryer	7.59	7.65	7.67	7.37	7.05	6.46	5.49	4.16	2.75	1.60
Refrigerator>10% 93 Standards	4.94	4.97	4.99	4.99	5.00	5.00	5.00	5.00	5.00	5.00
Refrigerator-SERP	4.94	4.97	4.99	4.99	5.00	5.00	5.00	5.00	5.00	5.00
Freezer >10% 93 Standards	4.94	4.97	4.99	4.99	5.00	5.00	5.00	5.00	5.00	5.00
Remove Second Refrigerator	1.63	1.64	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
Reflector Pans	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Efficient Tank	7.05	7.10	7.12	7.13	6.85	6.55	6.00	5.10	3.86	2.55
Faucet Aerators (4 per Home)	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Low Flow Shower -New & Replace	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Pipe Insulation	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Horizontal Axis Clotheswasher	7.59	7.65	7.67	7.37	7.05	6.46	5.49	4.16	2.75	1.60
Solar Water W/Electric Backup	2.00	1.00	0.50	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Heat Pump Water Heat	7.05	7.10	7.12	7.13	6.85	6.55	6.00	5.10	3.86	2.55
Ex Room- R-0 to R-19 Ceiling Insulation	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Wall R0 to R-11 Wall Insulation	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Exist- Room A/C to 10.5 EER	6.58	6.63	6.65	6.66	6.66	6.39	6.12	5.60	4.76	3.60
New Room- R-11 to R-19 Ceiling Insulation	98.71	99.39	99.71	99.86	99.94	99.97	99.99	99.99	100.00	100.00
New- Room A/C to 10.5 EER	98.71	99.39	99.71	99.86	99.94	99.97	99.99	99.99	100.00	100.00
Ex Cent- R-0 to R-19 Ceiling Insulation	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Wall R0 to R-11 Wall Insulation	1.40	0.68	0.32	0.15	0.07	0.03	0.02	0.01	0.00	0.00
Exist- Central A/C to 12 EER	6.58	6.63	6.65	6.66	6.66	6.39	6.12	5.60	4.76	3.60
New Cent- R-11 to R-19 Ceiling Insulation	98.71	99.39	99.71	99.86	99.94	99.97	99.99	99.99	100.00	100.00
New- Central A/C to 12 EER	98.71	99.39	99.71	99.86	99.94	99.97	99.99	99.99	100.00	100.00
A/C - Cycling	83.90	84.48	84.75	84.88	84.94	84.97	84.99	84.99	85.00	85.00
Water Heating Controls	88.84	89.45	89.74	89.88	89.94	89.97	89.99	89.99	90.00	90.00

TABLE 8-4
COMMERCIAL SECTOR ANNUAL PARTICIPATION RATES

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
EXISTING Electric C-Refrig	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
EXISTING Electric Cooking	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
EXISTING Electric Cooling	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
EXISTING Electric Exlights	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
EXISTING Gas Hotwater	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
EXISTING Electric Hotwater	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
EXISTING Electric Inlights	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
EXISTING Electric Offequip	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
EXISTING Electric Vent	4.06%	4.16%	7.72%	12.71%	17.30%	18.33%	14.93%	9.76%	5.50%	2.84%
NEW Construction	4.06%	8.23%	15.95%	28.66%	45.96%	64.29%	79.22%	88.97%	94.47%	97.31%

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
EXISTING Electric C-Refrig	1.40%	0.68%	0.32%	0.15%	0.07%	0.03%	0.02%	0.01%	0.00%	0.00%
EXISTING Electric Cooking	1.40%	0.68%	0.32%	0.15%	0.07%	0.03%	0.02%	0.01%	0.00%	0.00%
EXISTING Electric Cooling	1.40%	0.68%	0.32%	0.15%	0.07%	0.03%	0.02%	0.01%	0.00%	0.00%
EXISTING Electric Exlights	1.40%	0.68%	0.32%	0.15%	0.07%	0.03%	0.02%	0.01%	0.00%	0.00%
EXISTING Gas Hotwater	1.40%	0.68%	0.32%	0.15%	0.07%	0.03%	0.02%	0.01%	0.00%	0.00%
EXISTING Electric Hotwater	1.40%	0.68%	0.32%	0.15%	0.07%	0.03%	0.02%	0.01%	0.00%	0.00%
EXISTING Electric Inlights	1.40%	0.68%	0.32%	0.15%	0.07%	0.03%	0.02%	0.01%	0.00%	0.00%
EXISTING Electric Offequip	1.40%	0.68%	0.32%	0.15%	0.07%	0.03%	0.02%	0.01%	0.00%	0.00%
EXISTING Electric Vent	1.40%	0.68%	0.32%	0.15%	0.07%	0.03%	0.02%	0.01%	0.00%	0.00%
NEW Construction	98.71%	99.39%	99.71%	99.86%	99.94%	99.97%	99.99%	99.99%	100.00%	100.00%

TABLE 10-1
ESTIMATES OF MEASURE RENEWAL (%'S) FROM
LONG ISLAND LIGHTING COMPANY DATA

	Aggregat e	HID1	HID2	CFL	34-Watt	60-Watt
1987						
Replaced (w/o rebate)	93	69	0	34	93	100
Replaced (w/ rebate)	1	0	0	6	0	0
Still Operational	3	31	100	60	2	0
Inferred Inefficient Replacemt.	4	0	0	0	5	0
Renewal (%)	96	100	0	85	95	100
1988						
Replaced (w/o rebate)	51	35	6	33	54	41
Replaced (w/ rebate)	23	0	0	5	25	19
Still Operational	5	54	92	21	3	13
Inferred Inefficient Replacemt.	21	11	2	41	18	27
Renewal (%)	54	76	75	42	56	47
1989						
Replaced (w/o rebate)	47	2	2	44	51	13
Replaced (w/ rebate)	17	2	0	7	16	48
Still Operational	25	93	93	37	23	29
Inferred Inefficient Replacemt.	11	3	5	12	10	10
Renewal (%)	63	29	29	70	66	18
1990						
Replaced (w/o rebate)	8	0	1	14	5	25
Replaced (w/ rebate)	19	0	0	3	20	15

TABLE 10-1
ESTIMATES OF MEASURE RENEWAL (%'S) FROM
LONG ISLAND LIGHTING COMPANY DATA (CONTINUED)

	Aggregat e	HID1	HID2	CFL	34-Watt	60-Watt
Still Operational	64	100	97	75	66	39
Inferred Inefficient Replacemt.	9	0	2	8	9	21
Renewal (%)	22	0	50	56	15	41
1991						
Replaced (w/o rebate)	2	0	1	1	2	2
Replaced (w/ rebate)	1	0	0	0	1	0
Still Operational	82	100	99	91	80	87
Inferred Inefficient Replacemt.	15	0	0	8	17	11
Renewal (%)	11	0	100	11	10	15

TABLE 10-2
PARTICIPANTS WITH PLANS TO PURCHASE CFLS AFTER END OF PROGRAM
(NIAGARA MOHAWK POWER COMPANY)

	Control	Info Only	Direct Mail Partial Rebate	Direct Mail Full Rebate	In Person Full Rebate.
% Surveyed	45%	50%	49%	54%	70%
No. surveyed	797	807	404	789	108