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Facility Energy Decision System (FEDS) Assessment Report for U.S. Army Garrison, Japan – Honshu Installations

AR Kora
DR Brown
DR Dixon, Program Manager

March 2010



Pacific Northwest
NATIONAL LABORATORY

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U.S. Army Installation Management Command Pacific Region
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Pacific Northwest National Laboratory
Richland, Washington 99352

Executive Summary

This assessment was performed by a team of engineers from Pacific Northwest National Laboratory (PNNL) under contract to the Installation Management Command (IMCOM) Pacific Region Office (PARO). The effort used the Facility Energy Decision System (FEDS) model to determine how energy is consumed at five U.S. Army Garrison-Japan (USAG-J) installations in the Honshu area, identify the most cost-effective energy retrofit measures, and calculate the potential energy and cost savings.

The PNNL team visited Akasaka Press Center, Camp Zama, Sagami General Depot, Sagami-hara Family Housing Area, and Yokohama North Docks on July 20-27, 2009 to collect data for the FEDS assessment. During this visit, PNNL engineers collected energy-related information and data from over 51 representative buildings, central plants, and other energy systems for input into the FEDS model.

The economic analysis results presented in this report are based on the use of appropriated funds to implement the energy projects. The FEDS software is capable of performing the comprehensive assessment using other sources of capital (e.g., energy savings performance contract [ESPC] or utility financing) with their distinct economic inputs. If desired, the site can re-run the FEDS software using site-specific alternative financing options and reassess the results.

This report documents the findings of the FEDS assessment and model results for appropriated funding sources of capital for the projects. A complete list of the cost-effective energy- and cost-reducing retrofit measures is included in Appendix C.

Table ES.1 summarizes the results of the energy assessment by retrofit category for all five installations combined. The summarized results for each installation can be found in the main body of this report.

Table ES. 1. Summary of Potential Energy and Cost Savings for Five Honshu Installations

Retrofit Category	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR*	Simple Payback (yr)
Cooling	6,435	357,170	3,021,865	1,669,229	2.1	8.5
Heating	2,527	63,282	400,204	1,502,359	4.8	6.3
Envelope	34,249	1,788,004	12,367,732	18,277,442	2.5	6.9
Heating/Cooling	16,996	741,638	3,879,356	2,074,902	2.2	5.2
Hot Water	13,336	367,388	1,248,661	5,809,169	4.7	3.4
Lighting	17,183	1,306,529	3,810,912	17,080,442	5.5	2.9
Grand Total	90,726	4,624,011	24,728,730	46,413,543	3.2	5.3

*Savings to investment ratio.

From Table ES.1, if all cost-effective energy- and cost-reducing projects identified in this report were implemented, 90,726 MMBtu/year and \$4,624,011/year could be saved. This represents 17% in energy savings and 18% energy cost savings based on CY 2008 energy data.

In addition to this report, the energy manager will receive a complete record of the FEDS input and output files. The FEDS input files consist of the relevant building and equipment data collected and the assumptions made to perform the complex engineering analysis. The FEDS output files contain considerably more detail in support of future project development.

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1.0 Background

U.S. Army Garrison-Japan (USAG-J) is headquartered at Camp Zama, which is located about 25 miles southwest of central Tokyo in Kanagawa Prefecture, Japan. In addition to USAG-J, Camp Zama is home to the U.S. Army Japan/ I Corps (Forward); the United Nations Command (Rear); the 500th Military Intelligence Group; the U.S. Army Engineer District, Japan; the 78th Signal Battalion; the 4th Engineer Group Zama Sub-Post Japan Ground Self-Defense Force; and other units.

In addition to Camp Zama, USAG-J has four sub-facilities in the Tokyo area as well as installations in Hiroshima and Okinawa. The five Tokyo area installations, Akasaka Press Center, Camp Zama, Sagami General Depot, Sagamihara Family Housing Area, and Yokohama North Dock were involved in this assessment.

There were approximately 1,561 buildings at the five assessed installations in FY 2008, totaling almost 8.64 million square feet of floor area, which includes 324 family housing units totaling 1.63 million square feet.

2.0 Introduction

This report contains the results of the Facility Energy Decision System (FEDS) assessment conducted at five U.S. Army Garrison-Japan (USAG-J) installations in the Honshu area by Pacific Northwest National Laboratory (PNNL). The scope of this activity was based on performing a site-wide energy assessment using the FEDS process to identify cost-effective energy- and cost-reduction projects.

2.1 Purpose

The purpose of this report is to present the findings resulting from the site visit performed July 20-27, 2009, and subsequent modeling and analysis. The objective of the site visit was to collect the necessary data to conduct a detailed site assessment using the FEDS process, which would result in a list of cost-effective energy and cost-reduction projects for USAG-J.

2.2 Site Visits and Teams

The formal kickoff of the site assessment was held on the morning of July 20, 2009 at Camp Zama. The PNNL team presented an overview of the FEDS assessment process, data requirements, and schedule for the work. Participating in this meeting were representatives from the IMCOM Headquarters, Directorate of Public Works (DPW), PNNL, and other staff agencies, including the following:

1. David Yin – Acting Director of Public Works
2. Felix Mariani – Chief, Environmental Division
3. Paul Volkman – Headquarters IMCOM
4. Jeff Molony – Energy Manager
5. Butch Malone, Chief, Mechanical & Sanitation Branch
6. Fred Minato, Chief, Master Planning Division
7. Robert Weaver, Chief, Yokohoma Sub Facility
8. Tetsu Tomota – Project Manager
9. Hidemi Takagi – Environmental Division
10. Tony Magnuson – Chief, Project Management Branch
11. Tim Walton – Chief, Operation & Maintenance (O&M) Division
12. Ian McNesby – MEDDAC-Japan
13. Edward Devlin – AAFES Manager
14. Kikuo Tanaka – DPW, Master Planning Division
15. Dan Hew – G-8, Cost Sharing Division
16. Takayuki Sasaki – Sagami Sub-Facility Engineer, DPW
17. Youichi Ishibashi – Sagami Sub-Facility Engineer, DPW
18. Michael Vinson – Directorate of Logistics, Environmental Engineer

-
19. Doug Dixon – PNNL
 20. Daryl Brown – PNNL
 21. Angela Kora – PNNL

3.0 Current Status

The Energy Policy Act (EPAcT) of 2005 set annual energy reduction goals in British thermal unit (Btu) per gross square foot (sq ft) (Btu/sq ft) of 2% per year for FY 2006 through FY 2015. The overall goal is 20% reduction by FY 2015 using FY 2003 as the baseline year. EPAcT 2005 goals apply equally to all buildings: standard and industrial. Executive Order (E.O.) 13423 *Strengthening Federal Environmental, Energy, and Transportation Management (January 26, 2007)*, increased the energy reduction goal to 3% per year or 30% reduction by FY 2015. In addition, the E.O. established a water reduction goal for federal facilities. Agencies are to reduce water consumption intensity, relative to a FY 2007 baseline, by 2% annually through FY 2015, or 16% total by FY 2015.

USAG-J is well ahead of the compliance glide path — 15.9% below the baseline, compared to the FY 2008 targeted reduction of 9.0%. The historical energy intensity for USAG-J is shown in Figure 1.

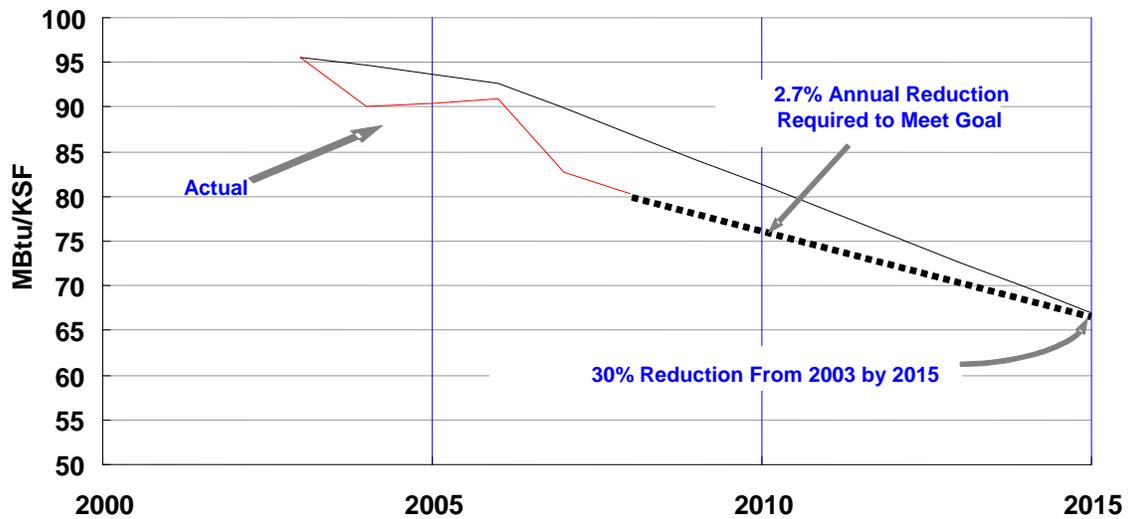


Figure 1. USAG-J Energy Reduction Glide Path

4.0 Description of Facilities

In FY 2008, the five assessed USAG-J installations consisted of approximately 1,561 buildings totaling nearly 8.64 million square feet, which includes 324 family housing facilities totaling 1.63 million square feet.

The scope of the FEDS assessment included all energy-consuming facilities on each of the five sites. To minimize the required on-site auditing time, the buildings on all five sites were combined for the purposes of selecting proxy facilities, and split into 51 categories. Once building data were collected, the sites were re-separated according to location and models were completed for each site. In some cases, categories were modified once sites were re-separated to ensure that the audited proxy facility was the best representation of each category.

Tables 1a through 1e identify the list of facility categories for the FEDS assessment and the facility proxies for each category. A complete listing of the facilities (buildings) associated with each FEDS facility category (including subgroups) is provided in Appendix B.

Table 1a. Akasaka Press Center List of Facilities by Facility Category Description

Facility Category Description	Proxy Facility No.	Proxy Site Location	FEDS Facility Category Code	Facility Quantity	Category Area (sq ft)	Percent of Total Area
Access Control Facilities	906	Sagami	10i	2	231	0.1%
Hardy Barracks	1	Akasaka	30b-3	1	57,892	37.2%
Stars and Stripes Building	8	Akasaka	50a	1	97,383	62.6%
Total	-	-	-	4	155,506	100.0%

Table 1b. Camp Zama List of Facilities by Facility Category Description

Facility Category Description	Proxy Facility No.	Proxy Site Location	FEDS Facility Category Code	Facility Quantity	Category Area (sq ft)	Percent of Total Area
1960s Medium School/Admin	913	Zama	10a	3	70,743	2%
1990s Large School/Admin	642	Zama	10b	8	282,110	10%
1950s Small School/Admin	1039	Sagami	10c	7	30,888	1%
1980s Small School/Admin	1022	Zama	10d	9	51,144	2%
Large Admin	102	Zama	10g	1	139,607	5%
Very Large Admin	101	Zama	10h	1	248,831	9%
Access Control Facilities	906	Sagami	10i	8	469	0%
Medical Facilities	704	Zama	21a	6	55,351	2%
Electronics/Sim Bldgs	121	Zama	23a	6	73,536	3%
1950s Medium Lodging/Barracks	793	Zama	30b-1	12	201,804	7%
1980s Large Lodging/Barracks	585	Zama	30b-2	6	183,485	6%
1950s Family Housing Single Units	232	Sagamihara	30sf-1	9	33,172	1%
1990s Family Housing Single Units	872	Zama	30sf-2	14	30,787	1%
1990s Family Housing Triple Units	88	Zama	30sf-4	2	10,083	0%
1980s Family Housing Quad Units	972	Zama	30sf-6	21	148,176	5%
1990s Family Housing Quad Units	972	Zama	30sf-7	21	146,007	5%
2000s Family Housing Quad Units	88	Zama	30sf-8	1	6,556	0%
2000s Family Housing 6-Units	88	Zama	30sf-9	5	51,253	2%
2000s Family Housing Towers	1050	Zama	30sf-10	2	291,649	10%
Small unconditioned storage	16314	Sagami	40a	3	527	0%
1960s Large Storage	671	Zama	40f*	4	91,729	3%
1950s Small Storage	605	Zama	40g*	3	18,202	1%
1980s Large Storage	3	Sagamihara	40n	2	43,646	2%
CEPs (Lighting only)	131	Zama	40o	6	28,655	1%
Medium Utility/Maintenance Buildings	624	Zama	50c*	8	82,342	3%
Large Maintenance Buildings	1611	Sagami	50e*	2	73,461	3%
Small Maintenance Bldgs	112-07	Sagamihara	50f	36	20,439	1%
Exchange Facilities	344	Zama	60a	6	37,578	1%
Emergency Bldgs	None	None	60b	5	21,035	1%
Dining Facilities/Commissary	457	Zama	60c	5	72,296	3%
PX	425	Zama	60d*	1	60,091	2%
Miscellaneous	500	Zama	80a	5	52,678	2%
MWR Facilities	915	Zama	80b	18	130,727	5%
Fitness Center	205	Zama	80d*	1	71,536	3%
Total	-	-	-	247	2,860,593	100%

* Category split into two or more FEDS categories to analyze use areas separately.

Table 1c. Sagami General Depot List of Facilities by Facility Category Description

Facility Category Description	Proxy Facility No.	Proxy Site Location	FEDS Facility Category Code	Facility Quantity	Category Area (sq ft)	Percent of Total Area
1950s Large Admin	913	Zama	10a	1	26,483	1.0%
2000s Large Admin	642	Zama	10b	1	25,659	0.9%
1950s Small Admin	1039	Sagami	10c	2	9,248	0.3%
1980s School/Admin	1022	Zama	10d	4	9,040	0.3%
Access Control Facilities	906	Sagami	10i	7	688	0.0%
Medical Facilities	704	Zama	21a	3	5,297	0.2%
Electronics/Sim Bldgs	121	Zama	23a	2	5,363	0.2%
1950s Family Housing Single Units	225	Sagamihara	30sf-1	3	5,218	0.2%
1950s Family Housing Duplex Units	547	Sagamihara	30sf-3	13	31,730	1.1%
1950s Family Housing Triple Units	547	Sagamihara	30sf-4	2	13,022	0.5%
1950s Family Housing Quad Units	547	Sagamihara	30sf-5	13	77,060	2.8%
Unconditioned Storage	16314	Sagami	40a	23	127,318	4.6%
1950s Large Storage	1371	Sagami	40c	2	391,035	14.1%
1950s Very Large Storage	1751	Sagami	40d	1	339,666	12.2%
1990s Medium Conditioned Warehouse	1061	Sagami	40e	4	212,356	7.6%
1950s Small Warehouse	671	Zama	40f*	4	28,427	1.0%
1950s Small Conditioned Warehouse	605	Zama	40g*	19	171,009	6.2%
1950s Medium Warehouse	1391	Sagami	40i	6	472,136	17.0%
1990s Large Conditioned Storage	15710	Sagami	40k	3	243,556	8.8%
2000 Very Large Storage	1045	Sagami	40l*	1	111,262	4.0%
1990s Small Storage	918	Zama	40m	4	10,960	0.4%
1950s Medium Utility/Maintenance	635	Yokohama	50b	3	49,998	1.8%
1990s Medium Utility/Maintenance	624	Zama	50c	7	35,477	1.3%
1950s Large Utility/Maintenance	1654	Sagami	50d*	2	137,055	4.9%
2000s Large Utility/Maintenance	1611	Sagami	50e*	2	147,358	5.3%
Small Utility/Maintenance	11207	Sagamihara	50f	14	7,624	0.3%
Exchange/Emergency Facilities	344	Zama	60a	5	33,197	1.2%
Laundry Facility	1544	Sagami	60b	1	31,785	1.1%
Fitness Center	1454	Sagami	80a	1	11,831	0.4%
Separate Toilet/Shower/Changing Rooms	1454	Sagami	80b	6	5,959	0.2%
Total	-	-	-	159	2,776,817	100%

* Category split into two or more FEDS categories to analyze use areas separately.

**Table 1d. Sagamihara Family Housing Area List of Facilities by Facility Category
Description**

Facility Category Description	Proxy Facility No.	Proxy Site Location	FEDS Facility Category Code	Facility Quantity	Category Area (sq ft)	Percent of Total Area
1950s Small School/Admin	1039	Sagami	10c	2	10,978	1.2%
1980s School/Admin	1022	Zama	10d	2	17,227	1.9%
Large, New school	12201	Sagamihara	10f	1	104,972	11.3%
Access Control Facilities	906	Sagami	10i	4	266	0.0%
Electronics/Sim Bldgs	121	Zama	23a	1	2,989	0.3%
1950s Family Housing Single Units	225	Sagamihara	30sf-1	68	113,434	12.2%
1950s Family Housing Duplex Units	547	Sagamihara	30sf-3	32	90,551	9.8%
1950s Family Housing Triple Units	547	Sagamihara	30sf-4	26	110,532	11.9%
1950s Family Housing Quad Units	547	Sagamihara	30sf-5	20	99,620	10.7%
1990s Family Housing Quad Units	972	Zama	30sf-7	14	102,648	11.1%
2000s Family Housing 6-Units	88	Zama	30sf-8	19	126,580	13.7%
1950s Small Storage	605	Zama	40g*	1	6,092	0.7%
1990s Small Storage	918	Zama	40m	9	5,880	0.6%
1970s Large Storage	3	Sagamihara	40n	1	34,570	3.7%
1950s Utility/Maintenance	635	Yokohama	50b	1	6,177	0.7%
CEPs (Lighting only)	134	Zama	50d	4	31,186	3.4%
Exchange Facilities	344	Zama	60a	1	4,491	0.5%
Emergency Facilities	None	None	60b	2	5,102	0.6%
Commissary	104	Sagamihara	60c	2	30,640	3.3%
Miscellaneous	500	Zama	80a	5	20,565	2.2%
Pool	205	Zama	80b	1	2,505	0.3%
Total	-	-	-	216	927,005	100.0%

* Category split into two or more FEDS categories to analyze use areas separately.

Table 1e. Yokohama North Dock List of Facilities by Facility Category Description

Facility Category Description	Proxy Facility No.	Proxy Site Location	FEDS Facility Category Code	Facility Quantity	Category Area (sq ft)	Percent of Total Area
1950s Small Admin	1039	Sagami	10c	2	16,442	5%
1980s School/Admin	1022	Zama	10d	3	11,016	3%
Large Admin	200	Yokohama	10e	1	63,787	19%
Access Control Facilities	906	Sagami	10i	4	369	0%
Electronics/Sim Bldgs	121	Zama	23a	1	3,642	1%
1980s Small Storage	16314	Sagami	40a	4	5,170	2%
1950s Medium Storage	458	Yokohama	40g*	5	24,816	7%
1940s Large Storage	500	Yokohama	40h	1	49,677	15%
1970s Large Storage	3	Sagamihara	40n	1	42,266	12%
1950s Utility/Maintenance	635	Yokohama	50b	6	38,130	11%
2000s Utility/Maintenance	624	Zama	50c	2	13,055	4%
Large Maintenance	1654	Sagami	50d*	1	34,527	10%
1970s Small Utility/Maintenance	11207	Sagamihara	50f	11	4,944	1%
Exchange/Emergency Facilities	344	Zama	60a	3	17,482	5%
Fitness/Changing Rooms	1454	Sagami	80c	5	15,559	5%
Total	-	-	-	50	340,882	100%

* Category split into two or more FEDS categories to analyze use areas separately.

5.0 Analytical Approach

The general approach was to develop a model of the buildings and other energy-related infrastructure at each site, calibrate that model to actual CY 2008 energy use, and then utilize the model to predict energy consumption and identify cost-effective retrofits under typical meteorological year (TMY) weather conditions.

5.1 Buildings

Building inventory data for Akasaka Press Center, Camp Zama, Sagami General Depot, Sagamihara Family Housing Area, and Yokohama North Dock were obtained from the Headquarters Executive Information System (HQEIS) databases. A total of 51 building groups were developed to represent the five Tokyo-area sites, and each of the buildings at each site was assigned to one of the groups. The mean building size (square footage) and vintage (age) were then calculated for each group based on the building inventory specific to the combined site. Building characteristics were developed from a combination of inferencing relationships within the FEDS model (driven by building type, size, climate, and vintage), walk-through audits of selected buildings at each site, and additional building data collected while visiting the sites.

5.2 Central Energy Plants

Four of the five Tokyo-area installations utilize central energy plants to provide heating, cooling, and/or domestic hot water to a significant percentage of each site. Camp Zama has six central energy plants that serve 2,673,828 square feet of building space. Sagami General Depot has two central energy plants that serve 1,838,144 square feet of building space. Sagamihara Family Housing Area has three central energy plants that serve 770,242 square feet of building space, and Yokohama North Dock has one central energy plant that serves 151,630 square feet of building space. Tables 2a through 2d provide summaries of the central energy plants and the buildings they serve.

Table 2a. Camp Zama Central Energy Plants

Central Plant Building #	Type of Energy Consumed	Type of Energy Produced	Number of Buildings Served	Total Floor Area (sq ft)
131	Fuel Oil	HW/CHW*	12	520,297
1024	Fuel Oil	Steam/HW	42	261,267
60-H1	Natural Gas	HW/CHW*	3	30,924
350	Fuel Oil	Steam	78	1,699,500
881	Steam	HW/CHW*	11	24,100
951	Steam	HW/CHW*	20	137,740

Table 2b. Sagami General Depot Central Energy Plants

Central Plant Building #	Type of Energy Consumed	Type of Energy Produced	Number of Buildings Served	Total Floor Area (sq ft)
1741	Fuel Oil	Steam	43	1,806,359
1547	Fuel Oil	Steam	1	31,785

Table 2c. Sagamihara Family Housing Area Central Energy Plants

Central Plant Building #	Type of Energy Consumed	Type of Energy Produced	Number of Buildings Served	Total Floor Area (sq ft)
134	Fuel Oil	HW	176	643,662
112-07	Natural Gas	HW/CHW*	11	73,124
123-15	Natural Gas/ Co-gen	HW/CHW*/ Electricity	8	53,456

Table 2d. Yokohama North Dock Central Energy Plants

Central Plant Building #	Type of Energy Consumed	Type of Energy Produced	Number of Buildings Served	Total Floor Area (sq ft)
210	Fuel Oil	Steam/ Electricity	19	151,630

* HW/CHW - Hot water/Chilled water

FEDS has the capability to analyze central plants and, if cost-effective, recommend abandonment of either an entire central plant or a loop connected to the plant. Because central plants are the primary heating and/or cooling source for significant portions of each site, this capability was restricted, and it was assumed that no central plant or loop would be abandoned. However, because the economic analysis is performed at the building level, it is still possible that the FEDS analysis will recommend replacing central heating and/or cooling systems with building level systems, i.e., removing a portion of a loop connected to a central plant.

Although central plant retrofit recommendations are not automated in the current version of FEDS, additional calculations and analysis can be performed using the modeled energy consumption. Refer to Section 7 for an example of this additional analysis.

5.3 Energy Prices

Camp Zama is served by a relatively complex combination of tariffs offered by the Tokyo Electric Power Company (TEPCO). The rate structure consists of a time-of-use (TOU) energy charge, and a fixed demand charge set to the peak hourly demand during the prior year. There is a fuel surcharge that varies by month, and is added to the energy charge. In addition, the rate structure is different for each of the sub-installations, and for specific buildings on the Sagami Depot (industrial, housing), and Akasaka (Press Center, Hardy Barracks). For the purposes of this report, the Sagami Depot Industrial rate structure was used for all Sagami facilities because it was unclear which buildings would fall under the housing rate.

The TOU rate structure was characterized as shown in Table 3 to be consistent with the electricity tariff modeling capabilities within FEDS. The price data are first split into “summer” and “other” months. The “summer” months include July, August, and September. The TOU rates apply to Monday through Saturday, with the lowest rate applied to Sunday and holidays. The demand charge is essentially a 100% ratchet based on the highest demand for the year. This characterization would also be useful for analyses conducted outside of FEDS, where electricity load impacts could be grouped into the same periods.

Fuel prices for natural gas and fuel oil were developed from the Army Energy and Water Reporting system (AEWRS). The average energy price for calendar year 2008 was used for this analysis. The average price for natural gas was \$17.04/MBtu, or \$1.704/therm. The average price for fuel oil was \$3.21/gallon.

Because natural gas or fuel oil piping infrastructure is typically not in place on any of the sites, it was assumed that electricity was the only available fuel source for retrofits.

Table 3. Tokyo Electric Power Tariff Characterization

Season	Hours	Tariff, Yen/kWh	Fuel Surcharge, Yen kWh	Tax Exemption Adjustment	Total, Yen/ kWh	Total, cents/ kWh	Demand Charge, Yen/kW	Tax Exemption Adjustment	Demand Charge, \$/kW
Camp Zama									
Summer	1300-1600	13.75	0.80	0.952	13.86	14.83	1395.03	0.952	14.21
	800-1300; 1600-2200	13.17	0.80	0.952	13.30	14.23		0.952	
	2200-800	8.81	0.80	0.952	9.15	9.79		0.952	
Other	800-2200	12.07	0.80	0.952	12.26	13.11		0.952	
	2200-800	8.81	0.80	0.952	9.15	9.79		0.952	
Sagami Depot Industrial									
Summer	all	11.47	0.80	0.952	11.69	12.50	1379.70	0.952	14.06
Other	all	10.59	0.80	0.952	10.85	11.61		0.952	
Sagami Depot Housing									
Summer	1300-1600	13.75	0.80	0.952	13.86	14.83	1379.70	0.952	14.06
	800-1300; 1600-2200	13.17	0.80	0.952	13.30	14.23		0.952	
	2200-800	8.81	0.80	0.952	9.15	9.79		0.952	
Other	800-2200	12.07	0.80	0.952	12.26	13.11		0.952	
	2200-800	8.81	0.80	0.952	9.15	9.79		0.952	
Sagamihara Housing									
Summer	1300-1600	16.60	0.81	0.952	16.58	17.74	1392.30	0.952	14.19
	800-1300; 1600-2200	15.92	0.81	0.952	15.93	17.05		0.952	
	2200-800	9.20	0.81	0.952	9.53	10.20		0.952	
Other	800-2200	14.56	0.81	0.952	14.64	15.66		0.952	
	2200-800	9.20	0.81	0.952	9.53	10.20		0.952	
Yokohama North Dock									
Summer	1300-1600	16.60	0.81	0.952	16.58	17.74	1326.00	0.952	13.51
	800-1300; 1600-2200	15.92	0.81	0.952	15.93	17.05		0.952	
	2200-800	9.20	0.81	0.952	9.53	10.20		0.952	
Other	800-2200	14.56	0.81	0.952	14.64	15.66		0.952	
	2200-800	9.20	0.81	0.952	9.53	10.20		0.952	

Season	Hours	Tariff, Yen/kWh	Fuel Surcharge, Yen kWh	Tax Exemption Adjustment	Total, Yen/ kWh	Total, cents/ kWh	Demand Charge, Yen/kW	Tax Exemption Adjustment	Demand Charge, \$/kW
Akasaka Press Center									
Summer	all	12.44	0.81	0.952	12.62	13.50	1402.50	0.952	14.29
Other	all	11.47	0.81	0.952	11.70	12.51		0.952	
Hardy Barracks Tokyo									
Summer	1300-1600	16.60	0.81	0.952	16.58	17.74	1326.00	0.952	13.51
	800-1300; 1600-2200	15.92	0.81	0.952	15.93	17.05		0.952	
	2200-800	9.20	0.81	0.952	9.53	10.20		0.952	
Other	800-2200	14.56	0.81	0.952	14.64	15.66		0.952	
	2200-800	9.20	0.81	0.952	9.53	10.20		0.952	

5.4 Other Loads

An estimation of street lighting electricity consumption was provided by the site. Annual exterior lighting electric consumption estimates for each site are shown in Table 4.

Table 4. Annual Electricity Consumption for Exterior Lighting

Site	kWh
Akasaka Press Center	54,750
Camp Zama	1,155,486
Sagami General Depot	547,500
Sagamihara Family Housing Area	328,500
Yokohama North Docks	164,250

The estimated annual electricity consumption for water pumping (potable water and sewage) is shown in Table 5. These estimates are based on available metered data provided by the site contacts.

Table 5. Annual Electricity Consumption for Water Pumping

Site	kWh
Akasaka Press Center	57,402
Camp Zama	1,055,927
Sagami General Depot	296,710
Sagamihara Family Housing Area	458,412
Yokohama North Docks	125,829

Electricity distribution losses were assumed to be 5% of purchased electricity.

5.5 Model Calibration

Building energy use was simulated with FEDS and combined with the non-building energy infrastructure characterization to predict the total site energy consumption for CY 2008. Uncertain elements of the modeling assumptions were adjusted until the model's energy consumption prediction matched "reasonably well" with actual energy consumption for CY 2008. Specific model calibration results are shown in Tables 6a through 6d.¹ Yokohama North Dock electricity consumption was not calibrated because of uncertainty in the actual CY 2008 energy consumption totals.

Table 6a. Akasaka Press Center Calibration

Model Element	Fuel Type	Actual CY08 Consumption	Error
Total by Fuel Type	Electricity	2,871,921 kWh	-0.3%
	Fuel Oil	35,685 gallons	0.4%
Total Energy	All		-0.4%

Table 6b. Camp Zama Calibration

Model Element	Fuel Type	Actual CY08 Consumption	Error
Total by Fuel Type	Electricity	40,773,360 kWh	-1.6%
	Fuel Oil	1,644,844 gallons	-0.6%
	Natural Gas	85,415 cubic meters	-0.8%
Total Energy	All		-0.9%

Table 6c. Sagami General Depot Calibration

Model Element	Fuel Type	Actual CY08 Consumption	Error
Total by Fuel Type	Electricity	10,852,144 kWh	-1.7%
	Fuel Oil	792,430 gallons	-1.5%
Total Energy	All		-1.5%

¹ For example, an error of +0.5% means that the model predicts energy consumption 0.5% higher than reported consumption.

Table 6d. Sagamihara Family Housing Area Calibration

Model Element	Fuel Type	Actual CY08 Consumption	Error
Total by Fuel Type	Electricity	12,186,820 kWh	0.2%
	Fuel Oil	264,524 gallons	-1.1%
	Natural Gas	1,245,725 cubic meters	0.2%
Total Energy	All		-0.2%

6.0 Description of Opportunities Identified

The number of conceivable energy conservation measures, fuel-switching opportunities, and renewable-energy projects at federal sites is very large. The FEDS model is used to cost-effectively identify energy saving opportunities for the site. FEDS is a software tool that provides a comprehensive method to quickly and objectively identify energy improvements that offer maximum life-cycle cost savings. FEDS determines the optimum set of cost-effective retrofits from a current database of hundreds of proven technologies. These include retrofits for heating, cooling, lighting, motors, building envelope, and hot water systems. Interactive effects are also evaluated as part of the optimization process so that energy savings are not double counted or undercounted. The results are based on life-cycle cost economics consistent with 10 CFR 436.

FEDS identifies the package of retrofits that individually and collectively minimize the life-cycle cost of building energy services, resulting in projects where the net present value (NPV) of the investment is greater than or equal to zero and the savings-to-investment ratio (SIR) is greater than or equal to one. Results are developed for government (appropriated) financing assumptions.

In general, the discount rate is higher and the economic evaluation life is shorter for alternative financing compared to government financing. The economic life for the latter is set at 25 years with the discount rate adjusted each year in response to market conditions. The currently prescribed government discount rate is 3.0% in real terms, i.e., in excess of general inflation.

Tables 7a through 7e summarize the FEDS results by retrofit category (e.g., cooling) and type (e.g., chillers) using appropriated funding as the source of capital for the projects. The complete list of cost-effective energy- and cost-reduction projects resulting from the FEDS modeling and analysis are presented Appendix C.²

² It should be noted that in addition to this report, the energy manager will also receive a CD-ROM, which includes all the FEDS input data and output project files. The input data files reflect information collected during the site visits and additional assumptions required to perform the FEDS modeling and assessment. The output project files contain significantly more detailed information to support the list of cost-effective energy projects identified in Appendix C.

Table 7a. Summary of All Cost-Effective Projects Identified from the FEDS Assessment for Akasaka Press Center (by Retrofit Category and Type)

Retrofit Category	Retrofit Type	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
Envelope	Foundation Insulation	36	843	5,796	12,655	3.2	6.9
	Roof Insulation	181	6,099	67,886	53,414	1.8	11.1
	Wall Insulation	615	20,175	296,883	103,766	1.3	14.7
	Efficient Windows	1,799	47,830	441,386	566,981	2.3	9.2
Envelope Total		2,631	74,947	811,951	736,816	1.9	10.8
Heating/Cooling	Heat Pumps	371	17,233	130,356	38,128	1.7	7.6
Heating/Cooling Total		371	17,233	130,356	38,128	1.7	7.6
Hot Water	Water Heater with Misc. Measures ³	55	1,061	5,951	14,999	3.9	5.6
Hot Water Total		55	1,061	5,951	14,999	3.9	5.6
Lighting	Exit Lighting	20	2,742	8,450	37,503	5.4	3.1
	T8s and Other Fluorescents	881	60,173	184,342	798,705	5.3	3.1
	CFLs	24	1,360	2,388	20,520	9.6	1.8
Lighting Total		925	64,275	195,180	856,728	5.4	3.0
Grand Total		3,982	157,516	1,143,438	1,646,671	2.5	7.3

From Table 7a, the total cost-effective energy savings for Akasaka Press Center is estimated at 3,982 MMBtu/year, representing \$157,516/year savings with an overall savings to investment ratio (SIR) of 2.5. This represents 30% in energy savings and 24% energy cost savings based on CY 2008 energy data. The greatest energy saving potential was found in building envelope measures (2,631 MMBtu/year), followed by lighting (925 MMBtu/year). The largest estimated dollar savings was also building envelope (\$74,947/year) followed by lighting (\$64,275/year) and heating/cooling (\$17,223/year). Compact fluorescent lighting (9.6) followed by exit lighting (5.4) show the greatest SIR.

³ Installing low-flow fixtures and/or wrapping tanks or heat exchangers with insulation are examples of miscellaneous hot water measures.

Table 7b. Summary of All Cost-Effective Projects Identified from the FEDS Assessment for Camp Zama (by Retrofit Category and Type)

Retrofit Category	Retrofit Type	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
Cooling	AC Units	8	3,222	24,583	6,466	1.5	7.6
	Chillers	6,104	319,400	2,684,927	1,496,286	2.2	8.4
Cooling Total		6,112	322,622	2,709,510	1,502,752	2.2	8.4
Envelope	Efficient Windows	11,940	580,005	6,492,615	4,748,124	1.7	11.2
	Foundation Insulation	565	25,868	181,154	347,599	3.0	7.0
	Roof Insulation	5,326	307,192	712,849	5,166,366	8.0	2.3
	Wall Insulation	2,141	94,455	1,166,411	796,788	1.6	12.3
Envelope Total		19,972	1,007,520	8,553,029	11,058,877	2.3	8.5
Heating	IR Heating	1,828	48,446	283,207	1,154,836	5.1	5.8
Heating Total		1,828	48,446	283,207	1,154,836	5.1	5.8
Heating/Cooling	Heat Pumps	15,167	563,171	3,065,335	1,346,556	2.1	5.4
Heating/Cooling Total		15,167	563,171	3,065,335	1,346,556	2.1	5.4
Hot Water	Misc. Measures ⁴	2,767	85,541	12,594	1,635,347	134.1	0.1
	Water Heater and Misc. Measures	5,159	129,826	943,428	2,345,320	3.0	7.3
Hot Water Total		7,926	215,367	956,022	3,980,667	4.3	4.4
Lighting	CFLs	3,306	195,561	90,857	3,173,998	35.9	0.5
	Exit Lighting	742	71,023	152,138	1,039,838	7.8	2.1
	T8s and Other Fluorescents	7,964	681,164	2,162,089	9,235,973	5.3	3.2
Lighting Total		12,012	947,748	2,405,084	13,449,809	6.6	2.5
Grand Total		63,017	3,104,874	17,972,187	32,493,497	3.2	5.8

From Table 7b, the total cost-effective energy savings for Camp Zama is estimated at 63,017 MMBtu/year, representing \$3,104,874/year savings with an overall savings to investment ratio (SIR) of 3.2. This represents 23% in energy savings and 21% energy cost savings based on CY 2008 energy data. The greatest energy saving potential was found in building envelope measures (19,972 MMBtu/year), followed by heat pumps (15,167 MMBtu/year). The largest estimated dollar savings was also building envelope (\$1,007,520/year) followed by lighting (\$947,748/year) and heat pumps (\$563,171/year). Miscellaneous hot water measures (134.1) followed by compact fluorescent lighting (35.9) show the greatest SIR.

⁴ Installing low-flow fixtures and/or wrapping tanks or heat exchangers with insulation are examples of miscellaneous hot water measures.

Table 7c. Summary of All Cost-Effective Projects Identified from the FEDS Assessment for Sagami General Depot (by Retrofit Category and Type)

Retrofit Category	Retrofit Type	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
Cooling	Chillers	314	29,231	256,546	166,199	2.1	8.8
Cooling Total		314	29,231	256,546	166,199	2.1	8.8
Heating	IR Heating	699	14,836	116,997	347,523	4.0	7.9
Heating Total		699	14,836	116,997	347,523	4.0	7.9
Heating/Cooling	Heat Pumps	1,196	105,105	338,711	590,178	3.8	3.2
Heating/Cooling Total		1,196	105,105	338,711	590,178	3.8	3.2
Hot Water	Misc. Measures ⁵	426	13,014	11,550	510,674	95.5	0.9
	Water Heater with Misc. Measures	1,337	14,295	248,246	477,669	2.4	17.4
Hot Water Total		1,763	27,309	259,796	988,343	3.9	9.5
Envelope	Efficient Windows	1,439	74,642	702,137	561,616	1.8	9.4
	Foundation Insulation	160	8,408	58,266	93,408	2.6	6.9
	Roof Insulation	3,171	119,981	714,197	1,666,777	3.3	6.0
	Wall Insulation	2,411	78,220	497,315	1,213,736	3.5	6.4
Envelope Total		7,181	281,251	1,971,915	3,535,537	2.8	7.0
Lighting	CFLs	219	10,510	8,869	168,352	20.0	0.8
	Exit Lighting	153	13,476	34,062	194,864	6.7	2.5
	HIDs	158	9,547	144,069	18,130	1.1	15.1
	T8s and Other Fluorescents	1,256	90,513	478,541	1,038,557	3.2	5.3
Lighting Total		1,786	124,046	665,541	1,419,903	3.1	5.4
Grand Total		12,939	592,288	3,609,506	7,047,683	3.1	6.1

From Table 7c, the total cost-effective energy savings for Sagami General Depot is estimated at 12,939 MMBtu/year, representing \$592,288/year savings with an overall savings to investment ratio (SIR) of 3.1. This represents 10% in energy savings and 11% energy cost savings based on CY 2008 energy data. The greatest energy saving potential was found in building envelope measures (7,181 MMBtu/year), followed by lighting (1,786 MMBtu/year). The largest estimated dollar savings was also building envelope (\$281,251/year), followed by lighting (\$124,046/year) and heat pumps (\$105,105/year). Implementing miscellaneous measures to hot water systems (95.5), followed by compact fluorescent lighting (20.0) show the greatest SIR.

⁵ Installing low-flow fixtures and/or wrapping tanks or heat exchangers with insulation are examples of miscellaneous hot water measures.

Table 7d. Summary of All Cost-Effective Projects Identified from the FEDS Assessment for Sagamihara Family Housing Area (by Retrofit Category and Type)

Retrofit Category	Retrofit Type	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
Envelope	Efficient Windows	696	68,021	335,131	39,384	1.1	4.9
	Foundation insulation	297	10,966	56,590	3,787	1.1	5.2
	Roof insulation	2,160	207,771	361,816	797,761	3.2	1.7
	Wall Insulation	6	1,096	6,224	1	1.0	5.7
Envelope Total		3,159	287,854	759,761	840,933	2.1	2.6
Heating/Cooling	Heat Pumps	4	1,373	3,749	3,731	2.0	2.7
Heating/Cooling Total		4	1,373	3,749	3,731	2.0	2.7
Hot Water	Misc. Measures ⁶	3,364	116,439	17,803	739,441	42.5	0.2
Hot Water Total		3,364	116,439	17,803	739,441	42.5	0.2
Lighting	CFLs	999	48,407	40,093	233,682	6.8	0.8
	Exit Lighting	46	4,147	8,284	15,617	2.9	2.0
	T8s and Other Fluorescents	524	34,274	116,760	75,115	1.7	3.4
Lights Total		1,569	86,828	165,137	324,414	3.0	1.9
Grand Total		8,096	492,494	946,450	1,908,519	3.0	1.9

From Table 7d, the total cost-effective energy savings for Sagamihara Family Housing Area is estimated at 8,096 MMBtu/year, representing \$492,494/year savings with an overall savings to investment ratio (SIR) of 3.0. This represents 8% in energy savings and 13% energy cost savings based on CY 2008 energy data. The greatest energy saving potential was found in hot water measures (3,364 MMBtu/year), followed by building envelope measures (3,159 MMBtu/year). The largest estimated dollar savings was building envelope (\$287,854/year), followed by hot water (\$116,439/year) and lighting (\$86,828/year). Miscellaneous hot water measures (42.5) followed by compact fluorescent lighting (6.8) show the greatest SIR.

⁶ Installing low-flow fixtures and/or wrapping tanks or heat exchangers with insulation are examples of miscellaneous hot water measures.

Table 7e. Summary of All Cost-Effective Projects Identified from the FEDS Assessment for Yokohama North Dock (by Retrofit Category and Type)

Retrofit Category	Retrofit Type	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
Cooling	Packaged AC Units	9	5,317	55,809	278	1.1	10.5
Cooling Total		9	5,317	55,809	278	1.1	10.5
Envelope	Efficient Windows	102	6,981	102,482	25,022	1.2	14.7
	Foundation Insulation	76	3,881	29,771	43,952	2.5	7.7
	Roof Insulation	1,087	110,527	118,455	1,805,291	16.2	1.1
	Wall Insulation	41	15,043	20,368	231,014	12.3	1.4
Envelope Total		1,306	136,432	271,076	2,105,279	8.0	2.0
Heating/Cooling	Heat Pumps	258	54,756	341,205	96,309	1.7	6.2
Heating/Cooling Total		258	54,756	341,205	96,309	1.7	6.2
Hot Water	Misc. Measures ⁷	197	5,088	1,665	65,152	64.2	0.3
	Water Heater with Misc. Measures	31	2,124	7,424	20,567	3.2	3.5
Hot Water Total		228	7,212	9,089	85,719	9.3	1.3
Lighting	Exit Lighting	48	4,254	7,573	64,556	9.5	1.8
	T8s and Other Fluorescents	843	79,378	372,397	965,032	3.6	4.7
Lighting Total		891	83,632	379,970	1,029,588	3.7	4.5
Grand Total		2,692	287,349	1,057,149	3,317,173	5.0	3.7

From Table 7e, the total cost-effective energy savings for Yokohama North Dock is estimated at 2,692 MMBtu/year, representing \$287,349/year savings with an overall savings to investment ratio (SIR) of 5.0. This represents 14% in energy savings and 27% energy cost savings based on CY 2008 energy data. Peak electric demand is reduced by 42%, which accounts for the greater percentage energy cost savings. The greatest energy saving potential was found in building envelope measures (1,306 MMBtu/year), followed by lighting (891 MMBtu/year). The largest estimated dollar savings was also building envelope (\$136,432/year) followed by lighting (\$83,632/year) and heat pumps (\$54,756/year). Implementing miscellaneous measures to hot water systems (64.2) followed by adding roof insulation (16.2) show the greatest SIR.

⁷ Installing low-flow fixtures and/or wrapping tanks or heat exchangers with insulation are examples of miscellaneous hot water measures.

Ground-source heat pumps (GSHPs) are a common technology recommended for heating and cooling retrofits. At Camp Zama and Yokohama North Docks, all three kinds of GSHPs were recommended: open-loop, vertical closed loop, and horizontal closed loop. Depending on the site-specific soil characteristics and land space constraints, such technologies may or may not be feasible in all places. It is recommended that more information on the soil characteristics of each location be obtained before GSHPs projects are further developed.

The complete list of cost-effective energy- and cost-reduction projects is given Appendix C.⁸

⁸ The energy manager will also receive a CD, which includes all the FEDS input data and output project files. The input data files reflect information collected during the site visits and additional assumptions required to perform the FEDS modeling and assessment.

7.0 Recommendations for More In-Depth Assessments

The FEDS model can provide an unbiased assessment of literally hundreds of energy conservation projects; unfortunately, it is not all-inclusive. While the scope of this project is limited to energy-saving projects included in the FEDS model, the energy-saving opportunities identified below were recognized during the site visit and may be worth additional consideration by the site energy staff. It is recommended that the site consider additional assessment of these potential projects.

7.1 Absorption Chiller Replacement

The installations commonly use double-effect absorption chillers to produce chilled water for building space cooling. While this may have been the economically preferred choice in the past, rising fuel oil prices coupled with improvement in the efficiency of water-cooled electric-driven chillers make the latter technology a better choice for both retrofit and new construction.

The analysis documented here was conducted specifically for the cooling load currently served by the two absorption chillers in the Camp Zama, Building 131 central energy plant (CEP). Building 131 has two steam-powered double-effect absorption chillers, each rated at 441 tons of cooling (1 ton = 12,000 Btu/hour). The FEDS energy simulation indicated a peak hourly demand on the CEP of 459 tons with a total annual load of 519,919 ton-hours. The coefficient of performance (COP) of the absorption chillers is 0.995.

The current American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) standard full load performance for a water-cooled electric chiller is 0.58 kW/ton, while the standard integrated part-load value (IPLV) performance is 0.55 kW/ton. This performance corresponds to a COP of 6.39.

The average price of fuel oil during 2008 was \$3.22/gallon or \$23.22/MMBtu. Incorporating an 80% efficiency for converting fuel oil energy to steam energy results in an effective marginal cost of \$29.03/MMBtu. Electricity to run an electric chiller would cost \$14.21/month per kW of incremental peak demand plus \$0.14/kWh.

Two new 450-ton electric chillers were estimated to cost \$377,000 to purchase and install. Replacement of the absorption chillers would save \$202,426 per year in fuel oil costs while incurring an additional \$89,042 in electricity charges. The net savings would result in a payback period of only 3.90 years. This calculation excludes savings associated with reduced maintenance costs for the electric chillers compared to the

absorption chillers. In addition, no credit was taken for avoiding or delaying absorption chiller replacement.

The results of this assessment so strongly favor retrofit to electric chillers that replacement of building absorption chillers is recommended as well. For example, absorption chillers were observed in Camp Zama building sets 10b, 30b-2, 30sf-10, 50e, and 80d. Refer to the FEDS results in Appendix C for detailed information on recommended retrofits for these buildings.

7.2 Abandonment of Central Energy Plants

While central energy plants are currently the main source of heating, cooling, and/or domestic hot water for many of the buildings, the FEDS results found multiple cases where it is cost-effective to replace the central systems with building level systems. These retrofits were found to be cost-effective even without considering the savings from full or partial central plant abandonment.

Thermal losses in steam and hot water distribution systems are significant. Distribution losses estimated for the steam and hot water plants are shown in Table 8. In general, central boilers and distribution systems are always less efficient than distributed boilers because of losses in the distribution systems. The cost of these losses is high in Japan because fuel oil, the most commonly used boiler fuel, is very expensive.

Table 8. Central Energy Plant Distribution Losses

Site	Central Plant ID#	Type of Energy Produced	Annual Plant Output (MMBtu/yr)	Total Delivered Energy (MMBtu/yr)	Total Loop Losses (MMBtu/yr)
Camp Zama	131	Hot Water	11,926	5,649	6,277
Camp Zama	1024	Steam	8,613	4,642	3,970
Camp Zama	1024	Hot Water	3,990	2,765	1,225
Camp Zama	60-H1	Hot Water	1,874	1,213	661
Camp Zama	350	Steam	155,756	65,634	90,122
Camp Zama	881	Hot Water	1,332	727	605
Camp Zama	951	Hot Water	7,711	5,470	2,240
Sagami	1741	Steam	77,174	37,004	40,171
Sagamihara	134	Hot Water	28,899	14,266	14,633
Sagamihara	112-07	Hot Water	5,562	3,469	2,094
Sagamihara	123-15	Hot Water	2,904	1,556	1,348
Yokohama	210	Steam	10,928	3,226	7,702

Even though electricity is also expensive, it is cost-effective to replace absorption chillers using steam from oil-fired boilers with electrically-driven chillers, thus removing one of the current demands for central steam, and the largest summer demand. With the need for summer absorption chiller steam removed, conversion to building-level domestic water heating and summer shut down of the central boiler plants will be cost-effective

because essentially one-half of the annual distribution thermal losses would be eliminated.⁹

Conversion to building-level boilers for space heating and elimination of the central plants and steam distribution systems will likely be cost-effective, given the high cost of boiler fuel. The energy savings and avoided maintenance on the central boilers and distribution systems would have to be compared to the costs of installing and maintaining building-level boilers. The additional costs and environmental concerns of distributed storage of fuel oil would also need to be considered where natural gas is not available.

Further analysis of complete or partial central plant abandonment is recommended. Modifications could be made to the existing FEDS model to assist in this analysis if needed.

⁹ Note that distribution thermal losses are largely proportional to the time the piping is kept hot and not the thermal delivery rate.

APPENDIX A
FEDS Data Collection Form

HVAC

HEATING			
Portion of set <u>NOT</u> heated (ft ² , %, # of bldgs, use area):			
Portion of building set served (whole buildings) (sq. ft, percent, number of buildings, or USE AREA)	Type 1:	Type 2:	Type 3:
Fuel type			
Equipment type: 0=Elec. resistance baseboard 1=Forced air furnace 2=Air-source HP 3=Ground-coupled HP 4=Radiator/central steam/hw 5=Fan coils/central steam/hw/electricity 6=AHU/central steam/hw 7=Radiator/boiler 8=Fan coils/boiler 9=AHU/boiler 10=Radiant/central steam/hw 11=Radiant/single bldg boiler 12=Infrared			
Output capacity (total per building)			
Number of pieces of equipment			
Efficiency (%)			
Equipment vintage (approximate if necessary – new/old)			
Thermostat set point(s), °F			
COOLING			
Portion of set <u>NOT</u> cooled (ft ² , %, # of bldgs, use area):			
Portion of building set served (whole buildings) (sq. ft, percent, number of buildings, or USE AREA)	Type 1:	Type 2:	Type 3:
Fuel type			
Equipment type: 0 = Evap. cooler 1 = Window/wall units 2 = Air source heat pump 3 = Ground-coupled heat pump 4 = Package or split DX 5 = Fan coils/central chilled water 6 = AHU/central chilled water 7 = Fan coils/absorption chiller 8 = AHU/absorption chiller 9 = Fan coils/conventional chiller 10 = AHU/conventional chiller			
Output capacity (total per building)			
Number of units			
Manufacturer & model #			
Equipment vintage (approximate if necessary – new/old)			
Thermostat set point(s), °F			
VENTILATION			
Ventilation control mode: 0=cycle 1=constant 2=constant occupied hours/cycle unoccupied hours 3=constant occupied hours/off unoccupied hours 4=no mechanical ventilation			
Ventilation supply air (cfm)			
Outdoor air (NONE, 100%, OTHER?)			
Infiltration (note cracks, open windows, CFM or ACH)			
Desiccant dehumidification (and heat source)?			

MISC. EQUIPMENT

Refrigeration, food prep, or other - note if irregular. Atypical equipment: description including type, fuel, capacity, utilization.

MOTORS

	Type 1:	Type 2:	Type 3:	Type 4:
Horsepower				
# Motors of this type				
Utilization				
Other nameplate data				

NOTES/DRAWINGS	

APPENDIX B

Facility Category Descriptions and Associated Buildings

APPENDIX B. Facility Category Descriptions and Associated Buildings

The following tables identify the buildings in the facility categories for each site defined by the assessment team. The table below includes the FEDS facility category code, the proxy building number(s) audited for the purpose of developing the FEDS model, the proxy building total square footage, the total number of buildings in the category, the total square footage in that category and the percentage of square footage represented by the proxy buildings.

Table B1. Akasaka Press Center Facility Category Descriptions and Associated Buildings

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft ²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
Access Control Facilities [10i]	906	Sagami		2	231	
	Buildings in this Category					
	4	7				
Hardy Barracks [30b-3]	1	Akasaka	-	1	57,892	-
	Buildings in this Category					
	1					
Stars and Stripes Building [50a]	8	Akasaka	-	1	97,383	-
	Buildings in this Category					
	8					

Table B2. Camp Zama Facility Category Descriptions and Associated Buildings

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft ²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
1960s Medium School/Admin [10a]	913	Zama	38,303	3	70,743	23,581
	Buildings in this Category					
1990s Large School/Admin [10b]	104	322	533			
	642	Zama	37,936	8	282,110	35,264
	Buildings in this Category					
1950s Small School/Admin [10c]	103	123	250	278	642	906
	913	919				
	1039	Sagami	8430	7	30,888	4,413
	Buildings in this Category					
1980s Small School/Admin [10d]	106	116	160	376	722	723
	680					
	1022	Zama	7510	9	51,144	5,683
Large Admin [10g]	Buildings in this Category					
	227	393	402	691	912	997
	998	1000	1022			
	102	Zama	139,607	1	139,607	139,607
Very Large Admin [10h]	Buildings in this Category					
	101	Zama	248,831	1	248,831	248,831
	101					
Access Control Facilities [10i]	906	Sagami	98	8	469	59
	Buildings in this Category					
	100	108	221	281	792	856
Medical Facilities [21a]	859	9131				
	704	Zama	38,280	6	55,351	9,225
	Buildings in this Category					
Electronics/Sim Bldgs [23a]	110	681	704	721	1042	1044
	121	Zama	8,218	6	73,536	12,256
	Buildings in this Category					
1950s Medium Lodging/ Barracks [30b-1]	121	125	696	715	771	1038
	793	Zama	18,731	12	201,804	16,817
	Buildings in this Category					
	550	551	563	581	760	761
1980s Large Lodging/ Barracks [30b-2]	762	763	780	781	782	793
	585	Zama	32,630	6	183,485	30,581
	Buildings in this Category					
1950s Family Housing Single Units [30sf-1]	332	341	552	585	742	795
	232	Sagamihara	2,602	9	33,172	3,686
	Buildings in this Category					
	1001	1002	1003	1004	1005	1006
1990s Family Housing	1007	1008	1009			
	872	Zama	2,342	14	30,787	2,199

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft ²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
Single Units [30sf-2]	Buildings in this Category					
	871	872	873	874	875	876
	877	878	879	880	1010	1011
	1012	1036				
1990s Family Housing Triple Units [30sf-4]	88	Zama	6,556	2	10,083	5,042
	Buildings in this Category					
1980s Family Housing Quad Units [30sf-6]	46	86				
	972	Zama	7,048	21	148,176	7,056
	Buildings in this Category					
	1064	1065	1066	1067	1068	1070
	1071	1072	1073	1074	1075	1076
	1077	1078	1079	1090	1091	1092
	1093	1094	1095			
1990s Family Housing Quad Units [30sf-7]	972	Zama	7,048	21	146,007	6,953
	Buildings in this Category					
	45	47	48	955	956	957
	958	959	963	964	965	971
	972	973	974	983	984	985
2000s Family Housing Quad Units [30sf-8]	88	Zama	6,556	1	6,556	6,556
	Buildings in this Category					
	88					
2000s Family Housing 6-Units [30sf-9]	88	Zama	6,556	5	51,253	10,251
	Buildings in this Category					
	80	81	82	89	962	
2000s Family Housing Towers [30sf-10]	1050	Zama	150,051	2	291,649	145,825
	Buildings in this Category					
Small unconditioned storage [40a]	743	1050				
	16314	Sagami	11,265	3	527	176
1960s Large Storage [40f]	Buildings in this Category					
	634	8071	715H2			
	671	Zama	64,263	4	91,729	22,932
1950s Small Storage [40g]	Buildings in this Category					
	253	625	671	685		
1980s Large Storage [40n]	605	Zama	8,559	3	18,202	6,067
	Buildings in this Category					
CEPs (Lighting only) [40o]	320	570	605			
	3	Sagamihara	34,570	2	43,646	21,823
Medium Utility/Maintenance Buildings [50c]	Buildings in this Category					
	683	694				
CEPs (Lighting only) [40o]	131	Zama	8,162	6	28,655	4,776
	Buildings in this Category					
Medium Utility/Maintenance Buildings [50c]	350	131	1024	060H1	881	951
	624	Zama	9,503	8	82,342	10,293
	Buildings in this Category					
	111	138	602	645	649	858

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft ²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
	1101	10241				
Large Maintenance Buildings [50e]	1611	Sagami	76,827	2	73,461	36,731
	Buildings in this Category					
	646	1039				
Small Maintenance Bldgs [50f]	112-07	Sagamihara	1,408	36	20,439	568
	Buildings in this Category					
	44	109	129	155	264	325
	337	387	422	455	501	584
	606	726	753	770	783	813
	914	981	992	1014	1015	1023
	1025	1029	1102	1120	1122	7431
	10321	10325	10422	102H2	333H2	683H1
Exchange Facilities [60a]	344	Zama	5,083	6	37,578	6,263
	Buildings in this Category					
	344	375	378	379	383	406
Emergency Bldgs [60b]	None	None	None	5	21,035	4,207
	Buildings in this Category					
	228	229	235	238	1018	
Dining Facilities/Commissary [60c]	457	Zama	45,399	5	72,296	14,459
	Buildings in this Category					
	333	450	457	690	851	
PX [60d]	425	Zama	60,091	1	60,091	60,091
	Buildings in this Category					
	425					
Miscellaneous [80a]	500	Zama	16,913	5	52,678	10,536
	Buildings in this Category					
	316	500	502	505	621	
MWR Facilities [80b]	915	Zama	17,252	18	130,727	7,263
	Buildings in this Category					
	267	314	381	389	719	801
	802	803	806	807	808	812
	915	1027	1030	1045	10421	10423
Fitness Center [80d]	205	Zama	71,536	1	71,536	71,536
	Buildings in this Category					
	205					

Table B3. Sagami General Depot Facility Category Descriptions and Associated Buildings

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft ²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
1950s Large Admin [10a]	913	Zama	38,303	1	26,483	26,483
	Buildings in this Category					
2000s Large Admin [10b]	642	Zama	37,936	1	25,659	25,659
	Buildings in this Category					
1950s Small Admin [10c]	1039	Sagami	8,430	2	9,248	4,624
	Buildings in this Category					
1980s School/Admin [10d]	1022	Zama	7,510	4	9,040	2,260
	Buildings in this Category					
Access Control Facilities [10i]	906	Sagami	98	7	688	98
	Buildings in this Category					
	906	1301	1307	14114	14115	14117
Medical Facilities [21a]	704	Zama	38,280	3	5,297	1,766
	Buildings in this Category					
Electronics/Sim Bldgs [23a]	121	Zama	8,218	2	5,363	2,682
	Buildings in this Category					
	1445	14410				
1950s Family Housing Single Units [30sf-1]	225	Sagamihara	2,602	3	5,218	1,739
	Buildings in this Category					
1950s Family Housing Duplex Units [30sf-3]	806	904	918			
	547	Sagamihara	4,759	13	31,730	2,441
	Buildings in this Category					
	807	818	819	821	916	917
1950s Family Housing Triple Units [30sf-4]	919	924	925	926	927	8110
	Buildings in this Category					
	9110					
1950s Family Housing Quad Units [30sf-5]	547	Sagamihara	4,759	2	13,022	6,511
	Buildings in this Category					
Unconditioned Storage [40a]	706	7011				
	547	Sagamihara	4,759	13	77,060	5,928
	Buildings in this Category					
	707	708	709	901	902	903
Unconditioned Storage [40a]	911	912	914	7010	7012	7013
	Buildings in this Category					
	7014					
	16314	Sagami	11,265	23	127,318	5,536
Unconditioned Storage [40a]	Buildings in this Category					
	1047	1051	1535	1555	1556	1593
	1674	1737	15130	15131	15510	15511
	16114	16311	16312	16313	16314	16315

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft ²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
	16316	16317	1741	7111	1547	
1950s Large Storage [40c]	1371	Sagami	194,056	2	391,035	195,518
	Buildings in this Category					
	1371	1071				
1950s Very Large Storage [40d]	1751	Sagami	339,666	1	339,666	339,666
	Buildings in this Category					
	1751					
1990s Medium Conditioned Warehouse [40e]	1061	Sagami	75,713	4	212,356	53,089
	Buildings in this Category					
	1061	1163	1861	1862		
1950s Small Warehouse [40f]	671	Zama	64,263	4	28,427	7,107
	Buildings in this Category					
	1022	1031	1222	1501		
1950s Small Conditioned Warehouse [40g]	605	Zama	8,559	19	171,009	9,000
	Buildings in this Category					
	1308	1312	1323	1341	1342	1351
	1431	1502	1514	1541	1646	1718
	1727	1729	1732	1735	1736	1742
	17210					
1950s Medium Warehouse [40i]	1391	Sagami	83,179	6	472,136	78,689
	Buildings in this Category					
	1291	1391	1522	1532	1764	17110
1990s Large Conditioned Storage [40k]	15710	Sagami	81,579	3	243,556	81,185
	Buildings in this Category					
	1666	1771	15710			
2000 Very Large Storage [40l]	1045	Sagami	111,262	1	111,262	111,262
	Buildings in this Category					
	1045					
1990s Small Storage [40m]	918	Zama	1,339	4	10,960	2,740
	Buildings in this Category					
	1046	1358	1438	16517		
1950s Medium Utility/Maintenance [50b]	635	Yokohama	4,186	3	49,998	16,666
	Buildings in this Category					
	1432	1647	16211			
1990s Medium Utility/Maintenance [50c]	624	Zama	9,503	7	35,477	5,068
	Buildings in this Category					
	1026	1423	1671	15128	15129	15717
1950s Large Utility/Maintenance [50d]	1654	Sagami	62,810	2	137,055	68,528
	Buildings in this Category					
	1654	1731				
2000s Large Utility/Maintenance [50e]	1611	Sagami	76,827	2	147,358	73,679
	Buildings in this Category					
	1557	1611				
Small Utility/Maintenance [50f]	11207	Sagamihara	1,408	14	7,624	545

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
	Buildings in this Category					
	1025	1094	1293	1353	1354	1434
	1453	1546	1765	9115	10313	15127
	17528	12316				
Exchange/Emergency Facilities [60a]	344	Zama	5,083	5	33,197	6,639
	Buildings in this Category					
	1303	1352	1435	8011	10317	
Laundry Facility [60b]	1544	Sagami	31,785	1	31,785	31,785
	Buildings in this Category					
	1544					
Fitness Center [80a]	1454	Sagami	11,831	1	11,831	11,831
	Buildings in this Category					
	1454					
Separate Toilet/Showers/ Changing Rooms [80b]	1454	Sagami	11,831	6	5,959	993
	Buildings in this Category					
	1125	1146	1644	1658	14516	14515

Table B4. Sagamihara Family Housing Area Facility Category Descriptions and Associated Buildings

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft ²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
1950s Small School/Admin [10c]	1039	Sagami	8,430	2	10,978	5,489
	Buildings in this Category					
	108	114				
1980s School/Admin [10d]	1022	Zama	7,510	2	17,227	8,614
	Buildings in this Category					
	107	337				
Large, New school [10f]	12201	Sagamihara	104,972	1	104,972	104,972
	Buildings in this Category					
	12201					
Access Control Facilities [10i]	906	Sagami	98	4	266	67
	Buildings in this Category					
	99	254	11001	12204		
Electronics/Sim Bldgs [23a]	121	Zama	8,218	1	2,989	2,989
	Buildings in this Category					
	124					
1950s Family Housing Single Units [30sf-1]	225	Sagamihara	2,327	68	113,434	1,668
	Buildings in this Category					
	135	139	143	152	153	204
	206	208	210	212	217	224
	226	231	232	233	234	340
	356	400	404	406	415	417
	418	419	421	425	427	430
	433	435	439	441	443	445
	446	551	553	555	559	561
	563	567	573	575	577	601
	603	606	610	612	613	614
	615	616	618	623	625	628
	629	630	631	632	633	634
	635	636				
1950s Family Housing Duplex Units [30sf-3]	547	Sagamihara	4,759	32	90,551	2,830
	Buildings in this Category					
	133	137	151	154	200	205
	211	213	225	228	309	311
	335	342	366	401	407	408
	410	413	416	447	448	449
	450	545	549	605	607	609
611	626					
1950s Family Housing Triple Units [30sf-4]	547	Sagamihara	4,759	26	110,532	4,251
	Buildings in this Category					
	145	149	155	201	214	218
	222	230	236	237	241	243

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft ²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
	247	344	350	358	362	422
	426	434	451	600	617	620
	621	624				
1950s Family Housing Quad Units [30sf-5]	547	Sagamihara	4,759	20	99,620	4,981
	Buildings in this Category					
	147	156	209	216	245	249
	251	348	360	411	414	424
	452	547	557	565	608	619
	622	627				
1990s Family Housing Quad Units [30sf-7]	972	Zama	7,048	14	102,648	7,332
	Buildings in this Category					
	158	238	253	262	263	264
	301	303	304	305	306	373
2000s Family Housing 6-Units [30sf-8]	88	Zama	6,556	19	126,580	6,662
	Buildings in this Category					
	11101	11102	11103	11301	11302	11303
	11304	12301	12302	12303	12304	12305
	12306	12307	12308	12309	12310	12311
	12312					
1950s Small Storage [40g]	605	Zama	8,559	1	6,092	6,092
	Buildings in this Category					
	126					
1990s Small Storage [40m]	918	Zama	1,339	9	5,880	653
	Buildings in this Category					
	174	720	721	1501	1503	1505
	7391	12203	107H3			
1970s Large Storage [40n]	3	Sagamihara	34,570	1	34,570	34,570
	Buildings in this Category					
	3					
1950s Utility/Maintenance [50b]	635	Yokohama	4,186	1	6,177	6,177
	Buildings in this Category					
	150					
CEPs (Lighting only) [50d]	134	Sagamihara	15,737	4	31,186	7,797
	Buildings in this Category					
	134	16	12315	11207		
Exchange Facilities [60a]	344	Zama	5,083	1	4,491	4,491
	Buildings in this Category					
	113					
Emergency Facilities [60b]	None	None	None	2	5,102	2,551
	Buildings in this Category					
	101	146				
Commissary [60c]	104	Sagamihara	22,463	2	30,640	15,320

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
	Buildings in this Category					
	104	4				
	500	Zama	16,913	5	20,565	4,113
Miscellaneous [80a]	Buildings in this Category					
	112	116	117	637	120	
	None	None	None	1	2,505	2,505
Pool [80b]	Buildings in this Category					
	123					

Table B5. Yokohama North Docks Facility Category Descriptions and Associated Buildings

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft ²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
1950s Small Admin [10c]	1039	Sagami	8,430	2	16,442	8,221
	Buildings in this Category					
1980s School/Admin [10d]	305	347				
	1022	Zama	7,510	3	63,787	3,672
Large Admin [10e]	Buildings in this Category					
	200	Yokohama	63787	1	63,787	63,787
Access Control Facilities [10i]	Buildings in this Category					
	200					
Electronics/Sim Bldgs [23a]	906	Sagami	98	4	369	92
	Buildings in this Category					
1980s Small Storage [40a]	231	345	349	620		
	121	Zama	8,218	1	3,642	3,642
1950s Medium Storage [40g]	Buildings in this Category					
	208					
1940s Large Storage [40h]	16314	Sagami	11,265	4	5,170	1293
	Buildings in this Category					
1970s Large Storage [40n]	519	520	637	638		
	458	Yokohama	11,257	5	24,816	4,963
1950s Utility/Maintenance [50b]	Buildings in this Category					
	303	306	313	406	458	
2000s Utility/Maintenance [50c]	500	Yokohama	49,677	1	49,677	49,677
	Buildings in this Category					
1970s Small Utility/Maintenance [50f]	500					
	3	Sagamihara	34,570	1	42,266	42,266
Exchange/Emergency Facilities [60a]	Buildings in this Category					
	642					
Large Maintenance [50d]	635	Yokohama	4,186	6	38,130	6,355
	Buildings in this Category					
1970s Small Utility/Maintenance [50f]	316	327	403	631	633	635
	624	Zama	9,503	2	13,055	6,528
Large Maintenance [50d]	Buildings in this Category					
	207	210				
1970s Small Utility/Maintenance [50f]	1654	Sagami	62,810	1	34,527	34,527
	Buildings in this Category					
1970s Small Utility/Maintenance [50f]	328					
	11207	Sagamihara	1,408	11	4,944	449
Exchange/Emergency Facilities [60a]	Buildings in this Category					
	213	215	216	246	300	307
Exchange/Emergency Facilities [60a]	324	325	340	410	508	
	344	Zama	5,083	3	17,482	5,827

Category Description [FEDS Facility Category Code]	Proxy Building Number	Proxy Location	Proxy Building (ft²)	Total Bldgs in Category	Total Sq Ft in Category	Average Building Sq Ft
	Buildings in this Category					
	219	331	437			
	1454	Sagami	11831	5	15,559	3,112
Fitness/Changing Rooms [80c]	Buildings in this Category					
	320	334	600	601	614	

APPENDIX C

Comprehensive List of Cost-Effective Projects Identified from the FETS Assessment

APPENDIX C. Comprehensive List of Cost-Effective Projects Identified from the FEDS Assessment

The following tables identify the cost-effective energy- and cost-reducing retrofit projects for each site identified from the FEDS modeling and analysis. Key energy and economic results are presented for each cost-effective retrofit measure. The projects are grouped by building category. More detail, supporting each line-item project recommendation, is contained in the FEDS input and output files, which are delivered to the site energy manager on a CD in conjunction with this report.

Table C1. Akasaka Press Center Cost-Effective Projects

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
10i	Add 4 inches of Fiberglass Insulation to Interior Metal Roof	1	25	290	129	1.4	11.6
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 25-watt Super T-8 Lamps and Electronic Ballasts and Reflectors	4	210	486	3,056	7.3	2.3
10i Total		5	235	776	3,185	4.9	3.3
30b-3	Add R-12.4 Interior Masonry Surface Wall Insulation	184	9,574	153,182	18,675	1.1	16.0
	Add R-19 Insulation Above Suspended Ceiling	24	1,495	15,678	10,851	1.7	10.5
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	11	1,124	2,337	16,835	8.2	2.1
	Replace 25-watt Incandescent Lamps with 5-watt CFLs	2	111	1,773	88	1.0	16.0
	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit Signs	1	305	2,337	2,901	2.2	7.7
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 25-watt Super T-8 Lamps and Electronic Ballasts and Reflectors	21	1,420	5,550	18,307	4.3	3.9
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	37	3,946	13,263	52,924	4.9	3.4
	Replace 75% Efficient Oil-fired Boiler and Electric Split System AC units with High Efficiency Vertical Closed-loop Ground Source Heat Pumps (COP = 4.4)	371	17,233	130,356	38,128	1.7	7.6
	Replace 75% Efficient Oil-fired Boiler with 86.6% Efficient Model; Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	55	1,061	5,951	14,999	3.9	5.6
	Replace 75-watt Incandescent Lamps with 18-watt CFLs	22	1,249	615	20,432	34.2	0.5
Replace Existing Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Low-e Film	201	13,141	139,560	92,789	1.7	10.6	
30b-3 Total		929	50,659	470,602	286,929	1.7	9.3
50a	Add R-12.4 Interior Masonry Surface Wall Insulation	431	10,601	143,701	85,091	1.6	13.6
	Add R-38 Insulation Above Suspended Ceiling	156	4,579	51,918	42,434	1.8	11.3
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	36	843	5,796	12,655	3.2	6.9
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	8	1,196	2,786	16,785	7.0	2.3
	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit	-	117	990	982	2.0	8.5

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Signs						
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 25-watt Super T-8 Lamps and Electronic Ballasts and Reflectors	619	40,266	122,934	532,285	5.3	3.1
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	200	14,331	42,109	192,133	5.6	2.9
	Replace Existing Metal Frame, Single Pane Windows with Aluminum Frame, Thermal Break, Double Pane, Argon-Filled Windows with Low-e Film	1,598	34,689	301,826	474,192	2.6	8.7
50a Total		3,048	106,622	672,060	1,356,557	3.0	6.3
	Grand Total	3,982	157,516	1,143,438	1,646,671	2.5	7.3

Table C2. Camp Zama Cost-Effective Projects

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
10a	Add R-12.4 Interior Masonry Surface Wall Insulation	244	12,030	188,815	52,791	1.3	15.7
	Add R-19 Insulation Above Suspended Ceiling	59	3,452	47,897	20,044	1.4	13.9
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	32	1,646	12,942	20,493	2.6	7.9
	Replace 2x20-watt Incandescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	90	6,245	5,479	97,200	18.7	0.9
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	266	29,191	98,856	383,377	4.9	3.4
	Replace Existing Central Hot Water Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.92); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	64	1,323	17,938	32,305	2.2	13.6
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.83); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	186	4,601	29,997	91,011	3.4	6.5
	Replace Existing Electric Air-cooled Chiller (COP = 2.35) with Water-cooled Reciprocating Electric Chiller (COP = 3.67) and Cooling Tower	170	26,385	223,684	75,160	1.6	8.5
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	217	11,658	141,996	91,693	1.6	12.2
10a Total		1,328	96,531	767,604	864,074	2.3	8.0
10b	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	77	7,179	14,457	107,959	8.5	2.0
	Replace Existing Central Steam Heating System and Central Steam Absorption Chiller (COP = 0.48) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	1,340	25,131	146,405	52,541	2.0	5.8
	Replace Existing Electric Air-cooled Chiller (COP = 2.28) with Water-cooled Reciprocating Electric Chiller (COP = 3.67) and Cooling Tower	442	83,110	508,406	111,756	2.2	6.1
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film	596	35,337	607,081	96,310	1.2	17.2
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	663	20,123	1,709	428,982	252.0	0.1

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
10b Total		3,118	170,880	1,278,058	797,548	2.2	7.5
10c	Add R-12.4 Interior Masonry Surface Wall Insulation	154	8,806	141,969	34,050	1.2	16.1
	Add R-19 Attic Insulation with Blow-In Insulation	277	17,397	33,117	301,120	10.1	1.9
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	40	2,361	19,939	28,046	2.4	8.4
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	138	14,641	45,393	196,815	5.3	3.1
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	181	13,929	151,252	110,160	1.7	10.9
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	9	305	441	5,321	13.1	1.4
10c Total		799	57,439	392,111	675,512	2.6	6.8
10d	Increase Attic Insulation by R-13 from R-30 to R-43 with Blow-In Insulation	22	1,425	25,410	1,148	1.0	17.8
	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit Signs	4	748	5,479	7,287	2.3	7.3
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 30-watt Super T-8 Lamps and Electronic Ballasts	96	10,134	50,497	116,736	3.3	5.0
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	231	24,341	77,166	326,273	5.2	3.2
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	50	4,532	47,464	34,789	1.7	10.5
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	6	206	330	3,192	10.7	1.6
10d Total		409	41,386	206,346	489,425	3.3	5.0
10g	Add R-11 Insulation Above Suspended Ceiling	54	4,107	69,930	7,323	1.1	17.0
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	47	1,944	24,299	17,040	1.7	12.5
	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit Signs	1	253	1,888	2,430	2.3	7.5
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	1,312	121,645	385,239	1,633,692	5.2	3.2
	Replace Existing Central Chilled Water System with Water-cooled Centrifugal Electric Chiller (COP = 5.24) and Cooling Tower	1,157	14,399	263,073	246,508	1.8	18.3

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Replace Existing Central Hot Water Heat Exchanger with Central Heat Pump Hot Water System (COP = 3.7); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	233	5,076	53,159	73,831	2.1	10.5
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	768	42,935	651,702	175,419	1.3	15.2
10g Total		3,572	190,359	1,449,290	2,156,243	2.5	7.6
10h	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	71	2,902	40,160	22,187	1.6	13.8
	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit Signs	2	374	2,786	3,627	2.3	7.4
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	1,451	146,826	469,292	1,977,727	5.2	3.2
	Replace Existing Central Chilled Water System with Water-cooled Centrifugal Electric Chiller (COP = 5.43) and Cooling Tower	2,317	30,057	367,578	699,358	2.6	12.2
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	1,321	73,423	1,196,778	217,503	1.2	16.3
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	174	5,226	417	98,330	237.0	0.1
10h Total		5,336	258,808	2,077,011	3,018,732	2.5	8.0
10i	Add R-12.4 Interior Masonry Surface Wall Insulation	28	890	11,689	3,183	1.3	13.1
	Add R-19 Attic Insulation with Blow-In Insulation	8	231	503	3,364	7.7	2.2
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	5	352	782	5,160	7.6	2.2
	Replace Existing Electric Packaged AC Units (COP = 2.72) with Ultra High Efficiency Window AC Units (COP = 3.37)	7	839	8,877	9	1.0	10.6
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	62	2,076	21,607	13,074	1.6	10.4
10i Total		110	4,388	43,458	24,790	1.6	9.9
21a	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit Signs	5	744	5,479	7,500	2.4	7.4
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	459	36,961	135,222	505,713	4.7	3.7
	Replace 60-watt Incandescent Lamps with 13-watt CFLs	26	1,340	281	22,281	80.4	0.2

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Replace Existing Central Hot Water Heating System and Electric Air-cooled Chiller (COP = 2.35) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	21	3,459	23,697	5,955	1.4	6.9
	Replace Existing Central Steam Heating System and Electric Air-cooled Chiller (COP = 2.34) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	68	11,079	75,831	19,145	1.4	6.8
	Replace Existing Central Steam Heating System and Electric Air-cooled Chiller (COP = 2.35) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	292	54,327	327,023	135,268	1.7	6.0
	Replace Existing Electric Water Heater with Heat Pump Hot Water System (COP = 3.7); Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	25	2,472	8,511	7,190	2.6	3.4
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	116	3,531	912	60,498	61.4	0.3
21a Total		1,012	113,913	576,956	763,550	2.9	5.1
23a	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	12	972	1,888	14,646	8.8	1.9
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	223	21,611	137,251	229,602	2.7	6.4
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.4); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	132	2,210	29,514	51,239	2.3	13.4
	Replace Existing Central Steam Heating System and Electric Air-cooled Chiller (COP = 2.26) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	52	7,798	39,436	2,274	1.9	5.1
	Replace Existing Electric Air-cooled Chiller (COP = 2.26) with Water-cooled Reciprocating Electric Chiller (COP = 3.67) and Cooling Tower	840	69,456	416,074	33,034	2.2	6.0
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	2	52	118	901	8.6	2.3
23a Total		1,261	102,099	624,281	331,696	2.6	6.1
30b-1	Add R-12.4 Interior Masonry Surface Wall Insulation	1,384	52,805	583,915	554,482	1.9	11.1
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	185	7,089	38,527	115,836	4.0	5.4
	Replace 100-watt Incandescent Lamps with 26-watt CFLs	166	9,169	3,075	141,297	46.9	0.3
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt	141	15,322	32,413	219,959	7.8	2.1

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Electroluminescent Exit Signs						
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	278	15,320	12,300	228,895	19.6	0.8
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	325	22,079	35,179	321,464	10.1	1.6
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP =2.88); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	1,210	28,383	180,687	565,247	3.5	6.4
	Replace Existing Electric Air-cooled Chiller (COP = 2.24) with Water-cooled Reciprocating Electric Chiller (COP = 3.67) and Cooling Tower	524	46,259	514,446	6,262	1.2	11.1
	Replace Existing Electric Central Boiler with Central Heat Pump Hot Water System (COP =2.88); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	180	10,198	27,035	109,096	4.2	2.7
	Replace Existing Electric Furnace with High Efficiency Packaged Terminal Air Source Heat Pumps (PHTPs) (COP = 3.53)	135	6,490	48,075	5,779	1.2	7.4
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	803	35,193	276,487	450,822	2.6	7.9
30b-1 Total		5,331	248,307	1,752,139	2,719,139	3.0	7.1
30b-2	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	82	7,968	16,253	118,258	8.3	2.0
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 25-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	21	1,197	6,860	13,238	2.9	5.7
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 3.26); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	884	19,962	172,287	418,743	2.9	8.6
	Replace Existing Central Steam Heating System and Central Steam Absorption Chiller (COP = 0.48) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	6,657	172,059	518,700	346,489	3.7	3.0
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	532	27,965	411,689	143,921	1.3	14.7

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
30b-2 Total		8,176	229,151	1,125,789	1,040,649	2.2	4.9
30sf-1	Increase Attic Insulation by R-30 from R-11 to R-41 with Blow-In Insulation	51	3,283	17,783	37,080	3.1	5.4
	Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm; Install Faucet Aerators	52	1,670	536	31,014	58.9	0.3
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	63	3,467	14,523	43,409	4.0	4.2
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	24	1,255	923	20,215	22.9	0.7
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	171	11,429	106,230	84,751	1.8	9.3
30sf-1 Total		361	21,104	139,995	216,469	2.6	6.6
30sf-10	Add R-19 Insulation Above Suspended Ceiling	57	2,511	43,880	6,258	1.1	17.5
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	84	7,991	17,270	114,773	7.6	2.2
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	66	3,187	2,460	51,204	21.8	0.8
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	557	34,681	62,932	527,694	9.4	1.8
	Replace 75-watt Incandescent Lamps with 18-watt CFLs	61	3,277	1,230	54,495	45.3	0.4
	Replace Existing Central Steam Heating System and Central Steam Absorption Chiller (COP = 1.19) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	3,574	70,023	454,296	370,561	2.3	6.5
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	1,243	58,383	773,695	382,995	1.5	13.3
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	153	4,663	673	106,531	136.3	0.1
30sf-10 Total		5,795	184,716	1,356,436	1,614,511	2.3	7.3
30sf-2	Increase Attic Insulation by R-19 from R-30 to R-49 with Blow-In Insulation	43	1,399	20,865	8,014	1.4	14.9
	Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	22	705	113	15,372	123.6	0.2
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	53	2,241	1,794	33,346	19.6	0.8

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Replace Existing Central Steam Heating System and Electric Packaged Unit with High Efficiency Packaged Terminal Air Source Heat Pumps (PTHPs) (COP = 2.77)	16	552	2,362	2,210	2.5	4.3
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Low-e Film and Thermal Breaks	276	9,854	82,612	127,972	2.5	8.4
30sf-2 Total		410	14,751	107,746	186,914	2.7	7.3
30sf-4	Increase Attic Insulation by R-19 from R-30 to R-49 with Blow-In Insulation	5	280	3,417	1,275	1.4	12.2
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	3	179	1,173	1,856	2.6	6.6
	Replace 75-watt Incandescent Lamps with 18-watt CFLs	5	277	103	4,573	45.6	0.4
	Replace Existing Electric Water Heater with Residential Add-on Heat Pump Water Heater (COP = 3.2); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	12	833	4,973	228	1.5	6.0
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	117	7,281	49,985	71,691	2.4	6.9
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	11	293	121	134	2.1	0.4
30sf-4 Total		153	9,143	59,772	79,757	2.4	6.5
30sf-6	Increase Attic Insulation by R-19 from R-30 to R-49 with Blow-In Insulation	61	3,700	50,211	11,612	1.2	13.6
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	234	12,323	8,610	198,729	24.1	0.7
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	64	3,844	24,625	40,354	2.6	6.4
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	1,230	80,811	585,562	764,826	2.3	7.2
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	629	20,103	2,640	288,361	137.1	0.1
30sf-6 Total		2,218	120,781	671,648	1,303,882	2.9	5.6
30sf-7	Increase Attic Insulation by R-19 from R-30 to R-49 with Blow-In Insulation	108	3,810	49,476	27,731	1.6	13.0
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	303	11,783	8,610	175,767	21.4	0.7

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	82	3,714	24,625	34,583	2.4	6.6
	Replace Existing Electric Water Heater with Residential Add-on Heat Pump Water Heater (COP = 3.2); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	42	2,594	14,381	4,443	1.6	5.5
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	2,840	99,695	667,920	1,339,137	3.0	6.7
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	389	12,198	1,100	279,417	218.1	0.1
30sf-7 Total		3,764	133,794	766,112	1,861,078	3.5	5.7
30sf-8	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	2	117	770	1,209	2.6	6.6
	Replace 75-watt Incandescent Lamps with 18-watt CFLs	3	182	67	2,990	45.4	0.4
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	13	397	140	2,413	37.6	0.4
30sf-8 Total		18	696	977	6,612	8.4	1.4
30sf-9	Increase Attic Insulation by R-19 from R-30 to R-49 with Blow-In Insulation	39	1,232	17,368	10,949	1.6	14.1
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	12	596	5,863	3,336	1.6	9.8
	Replace 75-watt Incandescent Lamps with 18-watt CFLs	20	845	513	12,057	24.5	0.6
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	922	28,321	210,017	438,219	3.1	7.4
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low-Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	41	1,239	244	19,342	135.5	0.2
30sf-9 Total		1,034	32,233	234,005	483,903	3.1	7.3
40f_office	Add 4 inch Fiberglass Insulation to Interior Metal Roof Surface	67	4,537	34,593	51,171	2.5	7.6
	Add R-12.4 Interior Masonry Surface Wall Insulation	81	4,879	21,215	74,831	4.5	4.3
	Insulate Perimeter of Slab on Grade Foundation with R-15	40	1,989	8,833	32,183	4.6	4.4

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Insulation						
	Insulate Pipes Near Tank	-	1	4	0	1.1	4.0
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	5	580	1,279	8,338	7.5	2.2
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	41	4,796	13,681	65,340	5.8	2.9
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	31	957	214	3,826	18.9	0.2
40f_office Total		265	17,739	79,819	235,689	4.0	4.5
40f_warehouse	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	6	549	1,290	8,075	7.3	2.3
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	231	25,455	84,430	343,779	5.1	3.3
	Replace Existing Central Steam Heating System with Electric Infrared Heating	814	21,791	140,436	501,935	4.6	6.4
	Replace Existing Electric Furnace with Electric Infrared Heating	17	539	2,866	2,713	2.9	5.3
40f_warehouse Total		1,068	48,334	229,022	856,502	4.8	4.7
40g_offices	Add R-19 Attic Insulation with Blow-In Insulation	29	986	3,701	14,786	5.0	3.8
	Insulate Perimeter of Slab on Grade Foundation with R-10 Insulation	7	250	2,905	1,984	1.7	11.6
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	5	555	1,977	7,244	4.7	3.6
40g_offices Total		41	1,791	8,583	24,014	3.8	4.8
40g_warehouse	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	14	1,419	4,941	18,918	4.8	3.5
	Replace 75-watt Incandescent Lamps with 18-watt CFLs	9	405	86	6,769	79.4	0.2
40g_warehouse Total		23	1,824	5,027	25,687	6.1	2.8
40n	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	55	4,895	12,223	70,260	6.7	2.5
	Replace Existing Central Steam Heating System with Electric Infrared Heating	535	14,098	56,781	361,722	7.4	4.0
40n Total		590	18,993	69,004	431,982	7.3	3.6
40o	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	37	3,543	20,721	39,018	2.9	5.8
40o Total		37	3,543	20,721	39,018	2.9	5.8

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
50c_offices	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	39	3,697	7,275	55,655	8.7	2.0
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 25-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	35	3,842	22,402	42,022	2.9	5.8
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	66	4,236	5,955	65,339	12.0	1.4
	Replace Existing Central Hot Water Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.13); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	46	906	11,707	17,055	2.2	12.9
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.13); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	95	1,703	24,433	31,943	2.0	14.3
	Replace Existing Central Steam Heating System and Electric Packaged Unit with High Efficiency Packaged Terminal Air Source Heat Pumps (PTHPs) (COP = 2.68)	79	1,622	16,907	1,751	1.2	10.4
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film	10	1,452	21,567	2,707	1.1	14.9
50c_offices Total		370	17,458	110,246	216,472	2.8	6.3
50c_shops	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	37	3,386	7,275	50,446	7.9	2.1
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	310	18,517	29,776	282,197	10.5	1.6
50c_shops Total		347	21,903	37,051	332,643	10.0	1.7
50e_offices	Add R-12.4 Interior Masonry Surface Wall Insulation	32	2,148	41,657	1,678	1.0	19.4
	Add R-19 Insulation Above Suspended Ceiling	26	1,690	24,868	7,724	1.3	14.7
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	7	629	1,290	9,285	8.2	2.1
	Replace Existing Absorption Chiller (COP = 0.48) with Water-cooled Reciprocating Electric Chiller (COP = 3.36) and Cooling Tower	496	11,845	69,270	210,666	3.8	5.8
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.56); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	90	1,716	21,627	39,249	2.3	12.6

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	29	2,529	31,328	16,912	1.5	12.4
50e_offices Total		680	20,557	190,040	285,514	2.4	9.2
50e_shops	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	6	550	1,290	8,105	7.3	2.3
	Replace Existing Central Steam Heating System with Electric Infrared Heating	280	7,058	67,864	158,540	3.3	9.6
50e_shops Total		286	7,608	69,154	166,645	3.4	9.1
60a	Add 4 inch Fiberglass Insulation to Interior Metal Roof Surface	1,669	152,293	94,478	2,645,167	29.0	0.6
	Add R-12.4 Interior Masonry Surface Wall Insulation	192	12,098	162,471	72,055	1.4	13.4
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	80	4,220	19,026	66,421	4.5	4.5
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	51	6,964	26,684	86,728	4.3	3.8
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.43); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	288	5,777	53,691	116,822	2.7	9.3
	Replace Existing Electric Packaged AC Units (COP = 3.01) with Ultra High Efficiency Window AC Units (COP = 3.22)	1	2,383	15,706	6,457	1.8	6.6
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	146	10,771	115,977	85,607	1.7	10.8
60a Total		2,427	194,506	488,033	3,079,257	6.9	2.5
60b	Add R-11 Insulation Above Suspended Ceiling	12	862	10,537	4,446	1.4	12.2
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	50	4,639	9,071	69,656	8.7	2.0
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	350	21,718	30,627	333,717	11.9	1.4
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.3); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	150	2,733	31,218	54,707	2.4	11.4
	Replace Existing Central Steam Heating System and Electric Air-cooled Chiller with Electric Air Source Heat Pump (COP = 2.96)	162	13,562	99,893	41,713	1.6	7.4

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	104	7,362	89,220	38,997	1.4	12.1
60b Total		828	50,876	270,566	543,236	3.1	5.3
60c	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	17	1,499	3,085	22,996	8.5	2.1
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	1,745	114,615	41,302	1,917,738	47.4	0.4
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	141	10,510	26,917	152,901	6.7	2.6
	Replace Existing Central Steam Heating System and Electric Air-cooled Chiller (COP = 2.28) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	348	31,391	187,320	23,988	1.7	6.0
	Replace Existing Central Steam Heating System and Electric Air-cooled Chiller (COP = 2.29) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	607	59,630	327,811	75,002	1.9	5.5
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	423	12,833	1,921	273,047	143.7	0.1
60c Total		3,281	230,478	588,356	2,465,672	13.9	2.6
60d_PX and Food Court	Replace 2-watt LED Exit Signs with 0.35-watt Electroluminescent Exit Signs	-	79	640	729	2.1	8.1
	Replace 32-watt T-8 Lamps and Electronic Ballasts with 25-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	104	6,169	21,463	84,781	5.0	3.5
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 25-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	13	862	3,700	11,199	4.0	4.3
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	337	21,736	39,827	336,102	9.4	1.8
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	7	517	977	7,951	9.1	1.9
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 3.24); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	74	1,047	26,736	14,558	1.4	25.5
	Replace Existing Central Steam Heating System and Electric Water-cooled Reciprocating Chiller (COP = 3.33) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	267	23,194	128,860	181,129	2.2	5.6
60d_PX and Food Court Total		802	53,604	222,203	636,449	3.5	4.1
60d_PX	Replace 2-watt LED Exit Signs with 0.35-watt Electroluminescent	-	37	320	328	2.0	8.6

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
warehouse	Exit Signs						
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	61	4,642	11,726	66,433	6.7	2.5
	Replace Existing Central Steam Heating System with Electric Infrared Heating	182	4,960	15,260	129,926	9.5	3.1
60d_PX warehouse Total		243	9,639	27,306	196,687	8.2	2.8
80a	Add 4 inch Fiberglass Insulation to Interior Metal Roof Surface	1,869	77,546	132,442	1,430,824	11.8	1.7
	Replace 100-watt Incandescent Lamps with 26-watt CFLs	250	14,751	8,115	227,529	29.0	0.6
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	13	1,419	3,177	20,373	7.4	2.2
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 30-watt Super T-8 Lamps and Electronic Ballasts	72	6,764	36,408	73,581	3.0	5.4
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	310	27,540	81,403	366,056	5.5	3.0
	Replace Existing Electric Air-cooled Chiller (COP = 2.34) with Water-cooled Reciprocating Electric Chiller (COP = 3.67) and Cooling Tower	158	37,889	322,396	113,542	1.6	8.5
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Low-e Film and Thermal Breaks	291	14,115	238,130	52,981	1.2	16.9
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	33	1,039	961	18,666	20.4	0.9
80a Total		2,996	181,063	823,032	2,303,552	4.2	4.5
80b	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	53	5,237	10,866	77,977	8.2	2.1
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	66	7,377	60,411	62,097	2.0	8.2
	Replace 75-watt Incandescent Lamps with 18-watt CFLs	23	1,907	860	30,492	36.5	0.5
	Replace Existing Central Hot Water Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.70); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	29	870	4,561	15,921	3.7	5.2
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.70); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	1,198	32,527	189,302	590,278	3.4	5.8

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Replace Existing Central Steam Heating System and Electric Air-cooled Chiller (COP = 2.26) with Vertical Closed-Loop Ground-Coupled Heat Pumps (COP = 4.41)	649	70,091	525,053	19,432	1.6	7.5
80b Total		2,018	118,009	791,053	796,197	3.2	6.7
80d_fitness center	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	11	926	1,888	14,236	8.5	2.0
	Replace 250-watt Metal Halide Lamps with 40-watt Biaxial Fluorescent Lamps and Electronic Ballasts with Reflectors	33	2,286	8,440	30,976	4.7	3.7
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	40	2,684	528	45,621	87.4	0.2
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 25-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	28	1,670	11,721	17,000	2.5	7.0
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	350	23,042	43,954	353,505	9.0	1.9
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 3.22); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	138	3,089	26,126	68,881	2.8	8.5
	Replace Existing Central Steam Heating System and Central Steam Absorption Chiller (COP = 1.19) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	900	12,763	143,666	63,319	1.5	11.3
80d_fitness center Total		1,500	46,460	236,323	593,538	3.6	5.1
80d_pool	Add 4 inch Fiberglass Insulation to Interior Metal Roof Surface	870	26,451	32,373	576,330	18.8	1.2
	Add R-12.4 Interior Masonry Surface Wall Insulation	26	799	14,680	3,718	1.3	18.4
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.85); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	83	1,806	15,545	42,573	2.9	8.6
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Low-e Film and Thermal Breaks	31	954	14,316	7,638	1.5	15.0
80d_pool Total		1,010	30,010	76,914	630,259	8.6	2.6
Grand Total		63,017	3,104,874	17,972,187	32,493,497	3.2	5.8

Table C3. Sagami General Depot Cost-Effective Projects

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
10a	Replace 2x20-watt Incandescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	27	1,734	1,888	26,885	15.2	1.09
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	93	6,766	37,007	74,992	3.0	5.47
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	6	164	155	3,592	20.7	0.95
10a Total		126	8,664	39,050	105,469	3.7	4.51
10b	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	9	792	1,888	11,342	7.0	2.38
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation	38	1,037	91	23,775	261.7	0.09
10b Total		47	1,829	1,979	35,117	18.7	1.08
10c	Add R-30 Attic Insulation with Blow-In Insulation	52	2,844	9,915	45,849	5.6	3.49
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	10	412	5,832	2,935	1.5	14.16
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	36	2,699	13,591	30,281	3.2	5.04
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators; Insulate Pipes Near Tank	2	102	205	418	6.6	2.01
10c Total		100	6,057	29,543	79,483	3.7	4.88
10d	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit Signs	1	155	1,290	1,368	2.1	8.32
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 30-watt Super T-8 Lamps and Electronic Ballasts	17	1,135	8,926	10,195	2.1	7.86
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	41	2,805	13,639	33,669	3.5	4.86
	Replace Existing Electric Furnace and Packaged AC Unit (COP = 2.72) with High Efficiency Packaged Terminal Air Source Heat Pumps (PTHPs) (COP = 3.38)	49	5,128	34,998	6,440	1.3	6.82
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt	31	850	55	5,290	97.8	0.06

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Insulation						
10d Total		139	10,073	58,908	56,962	2.3	5.85
10i	Add R-30 Attic Insulation with Blow-In Insulation	7	283	738	4,192	6.7	2.61
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	5	295	684	4,284	7.3	2.32
	Replace Existing Air Source Heat Pump (COP = 2.71) with Horizontal Closed-Loop Ground-Coupled Heat Pump (COP = 3.54)	7	1,976	16,856	3,710	1.5	8.53
10i Total		19	2,554	18,278	12,186	2.4	7.16
21a	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit Signs	2	354	2,786	3,305	2.2	7.87
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	35	2,544	12,941	29,789	3.3	5.09
	Replace 60-watt Incandescent Lamps with 13-watt CFLs	2	114	27	1,906	72.0	0.24
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	82	2,243	147	42,227	288.6	0.07
21a Total		121	5,255	15,901	77,227	5.9	3.03
23a	Add R-11 Insulation Above Suspended Ceiling	(1)	349	5,373	459	1.1	15.40
	Replace 13-watt Fluorescent Exit Signs with 0.35-watt Electroluminescent Exit Signs	3	256	640	3,741	6.8	2.50
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	15	1,167	10,010	9,870	2.0	8.58
23a Total		17	1,772	16,023	14,070	1.9	9.04
30sf-1	Add R-30 Attic Insulation with Blow-In Insulation	16	890	5,595	9,290	2.7	6.29
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	9	540	308	8,752	29.5	0.57
	Replace Existing Electric Water Heater with Residential Add-on Heat Pump Water Heater (COP = 3.2); Install Faucet Aerators	17	812	4,904	1,168	1.4	6.04
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	29	1,507	17,200	7,989	1.5	11.41
30sf-1 Total		71	3,749	28,007	27,199	2.1	7.47
30sf-3	Add R-30 Attic Insulation with Blow-In Insulation	49	2,884	17,010	31,179	2.8	5.90

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	75	4,850	17,740	63,295	4.6	3.66
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	30	1,385	1,777	21,560	13.1	1.28
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Low-e Film and Thermal Breaks	296	16,932	178,708	104,242	1.6	10.55
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators; Insulate Pipes Near Tank	19	816	2,645	2,950	4.1	3.24
30sf-3 Total		469	26,867	217,880	223,226	2.1	8.11
30sf-4	Add R-30 Attic Insulation with Blow-In Insulation	29	1,765	6,981	22,518	4.2	3.96
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	10	458	615	7,109	12.6	1.34
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	141	7,184	57,816	62,226	2.1	8.05
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators; Insulate Pipes Near Tank	4	188	610	681	4.1	3.24
30sf-4 Total		184	9,595	66,022	92,534	2.4	6.88
30sf-5	Add R-30 Attic Insulation with Blow-In Insulation	172	10,317	41,310	131,097	4.2	4.00
	Replace 40-watt Incandescent Lamps with 9-watt CFLs	84	3,972	5,330	61,637	12.6	1.34
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	877	44,354	358,577	382,592	2.1	8.08
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators; Insulate Pipes Near Tank	28	1,224	3,967	4,424	4.1	3.24
30sf-5 Total		1,161	59,867	409,184	579,750	2.5	6.83
40c	Add 2-layer Reflective Bubble Pack Interior Metal Surface Wall Insulation	543	14,996	219,460	125,033	1.6	14.63
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.62); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	365	4,022	55,450	132,626	2.9	13.79
40c Total		908	19,018	274,910	257,659	1.9	14.46

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
40e	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	6	532	1,290	7,931	7.1	2.42
	Replace 250-watt Metal Halide Lamps with 200-watt High Pressure Sodium Lamps	60	3,439	41,163	17,195	1.4	11.97
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	38	2,913	15,635	34,808	3.2	5.37
	Replace Existing Air-cooled Electric Chiller (COP = 2.33) with Water-cooled Centrifugal Electric Chiller (COP = 5.24) and Cooling Tower	38	21,168	214,052	32,113	1.3	10.11
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.82); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	111	1,144	18,582	49,211	2.8	16.24
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.86); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	215	1,590	44,906	84,665	2.3	28.24
	Replace Existing Central Steam Heating System with Infra-red Heating	699	14,836	116,997	347,523	4.0	7.89
40e Total		1,167	45,622	452,625	573,446	2.5	9.92
40f_offices	Add 4 inch Fiberglass Interior Metal Surface Wall	9	809	11,810	3,005	1.3	14.60
	Insulate Perimeter of Slab on Grade Foundation with R-10 Insulation	4	249	4,185	655	1.2	16.81
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	6	556	1,290	8,128	7.3	2.32
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	19	1,406	6,650	16,888	3.5	4.73
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	1	30	93	477	6.1	3.10
40f_offices Total		39	3,050	24,028	29,153	2.4	2.4
40f_warehouse	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	6	520	1,290	7,547	6.9	2.48
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	72	5,202	27,457	59,630	3.2	5.28

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
40f_warehouse Total		78	5,722	28,747	67,177	3.4	3.4
40g_offices	Add R-19 Attic Insulation with Blow-In Insulation	125	4,850	34,769	57,496	2.7	7.17
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	45	3,371	18,568	37,653	3.0	5.51
	Replace Existing Electric Furnace and Packaged AC Unit (COP = 2.72) with Standard Efficiency Packaged Terminal Air Source Heat Pumps (PTHPs) (COP = 2.35)	161	21,798	42,073	94,739	4.6	1.93
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	59	1,612	166	30,287	182.5	0.10
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators; Insulate Pipes Near Tank; Lower Tank Temperature from 140F to 120F	8	372	850	1,475	5.8	2.28
40g_offices Total		398	32,003	96,426	221,650	3.8	3.8
40g_warehouse	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	116	8,473	46,421	96,564	3.1	5.48
	Replace 75-watt Incandescent Lamps with 18-watt CFLs	84	4,041	812	67,388	84.0	0.20
40g_warehouse Total		200	12,514	47,233	163,952	4.5	4.5
40i	Replace 250-watt Metal Halide Lamps with 200-watt High Pressure Sodium Lamps	98	6,108	102,906	935	1.0	16.85
	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit Signs	1	227	1,888	2,053	2.1	8.32
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators; Insulate Pipes Near Tank; Lower Tank Temperature from 140F to 120F	18	850	874	3,755	12.8	1.03
40i Total		117	7,185	105,668	6,743	1.1	14.71
40k	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	8	745	1,888	10,560	6.6	2.53
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.86); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	209	1,520	47,493	76,573	2.1	31.25
40k Total		217	2,265	49,381	87,133	2.2	21.80

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
40l_high bay	Replace 13-watt Fluorescent Exit Signs with 0.35-watt Electroluminescent Exit Signs	3	253	640	3,633	6.7	2.53
	Replace 250-watt Metal Halide Lamps with 40-watt Biaxial Lamps and Electronic Ballasts with Reflectors	28	2,027	22,789	10,751	1.5	11.24
40l_high bay Total		31	2,280	23,429	14,384	1.7	1.6
40l_offices	Add R-19 Insulation Above Suspended Ceiling	9	524	7,533	2,540	1.3	14.38
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	9	828	1,888	11,917	7.3	2.28
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	54	4,215	20,983	48,491	3.3	4.98
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.62); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	68	1,047	11,430	28,172	2.7	10.92
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Super Low-e Film and Thermal Breaks	18	908	16,933	1,398	1.1	18.65
40l_offices Total		158	7,522	58,767	92,518	2.5	2.5
40m	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.13); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	40	285	12,500	2,617	1.2	43.86
40m Total		40	285	12,500	2,617	1.2	43.86
50b	Add 4 inch Fiberglass Insulation to Interior Surface of Metal Roof	392	10,813	125,704	123,127	2.0	11.63
	Add 4 inch Fiberglass Interior Metal Surface Wall	340	9,376	89,884	125,880	2.4	9.59
	Replace 250-watt Metal Halide Lamps with 40-watt Biaxial Lamps and Electronic Ballasts with Reflectors	37	2,972	37,442	11,623	1.3	12.60
50b Total		769	23,161	253,030	260,630	2.0	10.92
50c	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	30	2,700	6,377	40,847	7.4	2.36
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	166	9,443	20,092	145,504	8.2	2.13
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation	32	746	58	183,854	3274.0	0.08

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
50c Total		228	12,889	26,527	370,205	14.9	2.06
50d_office	Add 4 inch Fiberglass Insulation to Interior Surface of Metal Roof	835	40,323	68,916	707,043	11.3	1.71
	Add 4 inch Fiberglass Interior Metal Surface Wall	841	34,325	58,148	648,037	12.1	1.69
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	24	1,018	7,849	13,365	2.7	7.71
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	88	7,123	37,820	76,974	3.0	5.31
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	54	4,903	25,848	53,827	3.1	5.27
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.69); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	153	2,410	25,197	49,904	2.6	10.46
	Replace Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Low-e Film	78	3,757	72,903	3,169	1.0	19.40
50d_office Total		2,073	93,859	296,681	1,552,319	1.0	6.1
50d_shop	Add 4 inch Fiberglass Insulation to Interior Surface of Metal Roof	757	20,898	275,665	204,290	1.7	13.19
	Add 4 inch Fiberglass Interior Metal Surface Wall	678	18,714	118,013	311,781	3.6	6.31
50d_shop Total		1,435	39,612	393,678	516,071	2.3	2.3
50e_offices	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	6	527	1,290	7,636	6.9	2.45
	Replace Existing Air-cooled Absorption Chiller (COP = 0.48) with Air-cooled Electric Chiller (COP = 2.37)	276	8,063	42,494	134,086	3.9	5.27
	Replace Existing Central Steam Heating System and Central Steam Air-cooled Absorption Chiller (COP = 0.48) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	420	9,727	80,475	71,760	2.1	8.27
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation	11	308	913	6,183	7.8	2.96
50e_offices Total		713	18,625	125,172	219,665	2.9	2.9
50e_shops	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	5	502	1,290	7,131	6.5	2.57
50e_shops Total		5	502	1,290	7,131	6.5	6.5

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
50f	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	10	687	10,058	1,591	1.2	14.64
50f Total		10	687	10,058	1,591	1.2	14.64
60a	Add 4 inch Fiberglass Insulation to Interior Surface of Metal Roof	581	19,096	83,463	264,115	4.2	4.37
	Insulate Perimeter of Slab on Grade Foundation with R-10 Insulation	30	1,281	13,893	8,813	1.6	10.85
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	169	11,423	37,858	155,006	5.1	3.31
	Replace Existing Central Steam Heating System and Electric Air-cooled Chiller (COP = 2.35) with Standard Efficiency Packaged Terminal Air Source Heat Pumps (PTHPs) (COP = 3.38)	272	13,396	43,857	95,315	3.5	3.27
	Replace Existing Central Steam Heating System and Electric Packaged Units (COP = 2.56) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	89	13,730	36,136	86,113	6.7	2.63
	Replace Existing Central Steam Heating System and Electric Packaged Units (COP = 2.72) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	116	18,055	51,192	105,563	5.9	2.84
	Replace Existing Electric Furnace and Electric Packaged Units (COP = 2.56) with Open-Loop Ground-Coupled Heat Pumps (COP = 4.41)	82	21,295	33,124	126,538	10.1	1.56
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation	66	1,831	163	191,868	1180.3	0.09
60a Total		1,405	100,107	299,686	1,033,331	5.6	2.99
60b	Replace 13-watt Fluorescent Exit Signs with 0.35-watt Electroluminescent Exit Signs	2	130	320	1,908	7.0	2.46
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	105	7,653	41,931	87,227	3.1	5.48
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.73); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	81	173	13,130	29,937	2.6	75.90
60b Total		188	7,956	55,381	119,072	3.0	6.96
80a	Add 4 inch Fiberglass Insulation to Interior Surface of Metal Roof	146	4,020	29,745	62,767	3.1	7.40

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	13	360	4,285	4,009	1.9	11.90
	Replace 13-watt Fluorescent Exit Signs with 0.35-watt Electroluminescent Exit Signs	2	244	640	3,432	6.4	2.62
	Replace 250-watt Metal Halide Lamps with 54-watt High Output T5 Lamps with Electronic Ballasts	8	891	10,139	4,528	1.4	11.38
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	5	400	2,052	4,412	3.2	5.13
	Replace Existing Central Steam Heat Exchanger with Central Heat Pump Hot Water System (COP = 2.78); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	78	1,292	14,654	22,796	2.2	11.34
80a Total		252	7,207	61,515	101,944	2.5	8.54
80b	Add R-13 Attic Insulation with Blow-In Insulation	2	125	1,480	815	1.6	11.84
	Insulate Perimeter of Slab on Grade Foundation with R-10 Insulation	4	238	4,482	336	1.1	18.83
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	27	2,421	5,479	35,500	7.5	2.26
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	17	467	61	8,765	145.1	0.13
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators; Insulate Pipes Near Tank	4	174	497	653	4.6	2.86
80b Total		54	3,425	11,999	46,069	5.4	3.50
Grand Total		12,939	581,778	3,609,506	7,047,683	3.1	6.20

Table C4. Sagamihara Family Housing Area Cost-Effective Projects

FEDS Category	Technology Change	Energy Savings (MMMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
10c	Add R-19 Blow-in Cellulose Insulation to Attic Ceiling	34	2,842	7,440	8,207	2.1	2.6
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	57	3,640	16,133	4,591	1.3	4.4
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	28	968	94	6,248	67.5	0.1
10c Total		119	7,450	23,667	19,046	1.8	3.2
10d	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	82	5,509	25,992	5,189	1.2	4.7
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	39	1,352	170	8,684	52.3	0.1
10d Total		121	6,861	26,162	13,873	1.5	3.8
10f	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	3	59	296	101	1.3	5.0
10f Total		3	59	296	101	1.3	5.0
10i	Add R-30 Blow-in Cellulose Insulation to Attic Ceiling	3	409	285	2,038	8.1	0.7
	Insulation Wall: Increase Interior Masonry Surface Insulation by R-12.4	6	1,096	6,224	1	1.0	5.7
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	3	131	391	361	1.9	3.0
	Replace Air Source Heat Pumps (COP = 2.8) with Standard Efficiency Horizontal Closed-loop Ground Source Heat Pumps (COP = 4.4)	4	1,373	3,749	3,731	2.0	2.7
10i Total		16	3,009	10,649	6,131	1.6	3.5
23a	Replace 40-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Sign Retrofit Kit	1	142	320	498	2.6	2.3
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	4	126	69	759	12.0	0.5
23a Total		5	268	389	1,257	4.3	1.5
30sf-1	Add R-19 Blow-in Cellulose Insulation to Attic Ceiling	306	40,582	76,876	146,559	2.9	1.9

FEDS Category	Technology Change	Energy Savings (MMMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Install Low Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	395	13,477	3,401	84,860	25.9	0.3
	Replace 40-watt Incandescent Lamps with 9-watt CFL Lamps	220	10,404	6,970	51,851	8.4	0.7
30sf-1 Total		921	64,463	87,247	283,270	4.2	1.4
30sf-3	Add R-19 Blow-in Cellulose Insulation to Attic Ceiling	222	25,877	61,368	81,102	2.3	2.4
	Insulate Perimeter of Slab on Grade: Increase Insulation by R-10	297	10,966	56,590	3,787	1.1	5.2
	Replace 40-watt Incandescent Lamps with 9-watt CFL Lamps	148	7,002	6,560	32,921	6.0	0.9
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm; Install Faucet Aerators	327	11,188	4,984	68,279	14.7	0.4
30sf-3 Total		994	55,033	129,502	186,089	2.7	2.4
30sf-4	Add R-19 Blow-in Cellulose Insulation to Attic Ceiling	160	15,788	37,455	49,468	2.3	2.4
	Replace 40-watt Incandescent Lamps with 9-watt CFL Lamps	185	8,767	7,995	41,406	6.2	0.9
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm; Install Faucet Aerators	970	33,135	3,763	213,233	57.7	0.1
30sf-4 Total		1,315	57,690	49,213	304,107	7.1	0.9
30sf-5	Add R-30 Blow-in Cellulose Insulation to Attic Ceiling	355	47,449	106,809	154,437	2.4	2.3
	Install Thermal Break Aluminum Frame Double Pane Argon/Low-e Window	677	64,763	319,991	36,584	1.1	4.9
	Replace 40-watt Incandescent Lamps with 9-watt CFL Lamps	185	8,405	8,200	39,238	5.8	1.0
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm; Install Faucet Aerators	746	25,488	2,894	164,025	57.7	0.1

FEDS Category	Technology Change	Energy Savings (MMMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
30sf-5 Total		1,963	146,105	437,894	394,284	1.8	3.0
30sf-7	Replace 40-watt Incandescent Lamps with 9-watt CFL Lamps	138	7,078	5,741	34,036	6.9	0.8
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	405	13,817	853	89,632	106.1	0.1
30sf-7 Total		543	20,895	6,594	123,668	19.7	0.3
30sf-8	Replace 75-watt Incandescent Lamps with 18-watt CFL Lamps	56	3,089	1,298	17,194	14.2	0.4
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	9	202	357	985	3.8	1.8
30sf-8 Total		65	3,291	1,655	18,179	12.0	0.5
40g_offices	Add R-13 Blow-in Cellulose Insulation to Attic Ceiling	22	793	2,118	2,977	2.4	2.7
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	17	568	43	3,677	87.3	0.1
40g_offices Total		39	1,361	2,161	6,654	4.1	1.6
40g_warehouse	Replace 75-watt Incandescent Lamps with 18-watt CFL Lamps	1	83	12	455	37.7	0.1
40g_warehouse Total		1	83	12	455	37.7	0.1
40n	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	29	2,748	8,306	6,812	1.8	3.0
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	13	445	23	2,878	86.3	0.1
40n Total		42	3,193	8,329	9,690	2.1	2.6
50b	Add 4 inches of Fiberglass Insulation to Interior Metal Roof	94	4,313	15,530	8,219	1.5	3.6
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	10	348	31	2,247	73.0	0.1
50b Total		104	4,661	15,561	10,466	1.6	3.3
50c	Replace 40-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Sign Retrofit Kit	5	436	959	1,575	2.6	2.2

FEDS Category	Technology Change	Energy Savings (MMMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	28	1,769	3,044	6,936	3.3	1.7
50c Total		33	2,205	4,003	8,511	3.1	1.8
50d	Replace 40-watt Incandescent Exit Signs with 0.2-watt Electroluminescent Exit Sign Retrofit Kit	14	1,002	959	4,734	5.9	1.0
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	3	102	5	657	57.7	0.0
50d Total		17	1,104	964	5,391	6.5	0.9
60a	Add R-13 Blow-in Cellulose Insulation to Attic Ceiling	22	840	2,231	2,954	2.3	2.7
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	105	3,575	221	23,193	105.8	0.1
60a Total		127	4,415	2,452	26,147	11.5	0.6
60b	Install Aluminum Frame Double Pane Argon/Low-e Window	19	3,258	15,140	2,800	1.2	4.6
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	6	535	1,290	1,836	2.4	2.4
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	72	4,124	7,429	15,943	3.1	1.8
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Low Flow Showerheads to Reduce Water Flow from 4.8 gpm to 2.0 gpm	20	679	74	4,376	60.4	0.1
60b Total		117	8,596	23,933	24,955	2.1	2.8
60c	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	6	575	1,290	2,004	2.6	2.2
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	50	3,383	8,795	9,984	2.1	2.6
	Replace 96-watt T-12 Lamps and Magnetic Ballasts Fixture with 96-watt T-12 Lamps and Electronic Ballasts and Reflector Fixture	129	8,307	33,428	12,424	1.4	4.0
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	80	2,728	138	17,726	129.2	0.1

FEDS Category	Technology Change	Energy Savings (MMMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
60c Total		265	14,993	43,651	42,138	2.0	2.9
80a	Add 4 inches of Fiberglass Insulation to Interior Metal Roof	942	68,878	51,704	341,800	7.6	0.8
	Replace 100-watt Incandescent Lamps with 26-watt CFL Lamps	60	3,167	3,023	14,642	5.8	1.0
	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	9	929	2,187	3,191	2.5	2.4
	Replace 40-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Sign Retrofit Kit	4	395	959	1,335	2.4	2.4
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	74	4,663	13,242	12,875	2.0	2.8
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	176	7,711	363	44,818	124.2	0.0
80a Total		1,265	85,743	71,478	418,661	6.9	0.8
80b	Replace 40-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Sign Retrofit Kit	1	133	320	444	2.4	2.4
	Replace 40-watt Incandescent Lamps with 9-watt CFL Lamps	6	412	294	1,939	7.6	0.7
	Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation	14	471	24	3,063	126.8	0.1
80b Total		21	1,016	638	5,446	9.6	0.6
Grand Total		8,096	492,494	946,450	1,908,519	3.0	1.9

Table C5. Yokohama North Dock Cost-Effective Projects

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
10c	Add R-30 Attic Insulation with Blow-In Insulation	117	7,379	17,628	118,338	7.7	2.39
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	18	670	7,204	6,291	1.9	10.75
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	80	8,757	31,009	113,479	4.7	3.54
	Replace Existing Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Low-e Film and Thermal Breaks	61	3,939	54,649	17,944	1.3	13.87
	Replace Existing Packaged AC Unit (COP = 2.42) with High Efficiency Window AC Units (COP = 3.22)	2	559	5,539	35	1.1	9.91
	Replace Existing Packaged AC Unit (COP = 2.48) with High Efficiency Single Zone AC Units (COP = 2.96)	7	4,758	50,270	243	1.1	10.57
	Wrap Electric Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	3	127	16	600	102.9	0.13
	Wrap Electric Hot Water Tank with R-11 Fiberglass Batt Insulation; Insulate Pipes Near Tank; Install Faucet Aerators	3	201	239	878	11.1	1.19
10c Total		291	26,390	166,554	257,808	3.2	6.31
10d	Replace 2-watt LED Exit Signs with 0.2-watt Electroluminescent Exit Signs	1	120	990	1,082	2.1	8.25
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 30-watt Super T-8 Lamps and Electronic Ballasts	20	1,932	10,877	21,709	3.0	5.63
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	49	4,728	16,621	63,220	4.8	3.52
	Replace Existing Central Steam Heating System and Electric Packaged AC Units (COP = 2.71) with Vertical Closed-Loop Ground-Coupled Heat Pumps (COP = 4.41)	72	5,537	62,115	3,188	1.1	11.22
	Wrap Electric Hot Water Tank with R-11 Fiberglass Batt Insulation	2	66	62	252	5.0	0.94
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation	15	330	38	3,372	90.3	0.12
10d Total		159	12,713	90,703	92,823	2.8	7.13

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
10e	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	15	1,363	2,786	20,839	8.5	2.04
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 25-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	368	32,661	175,564	377,246	3.1	5.38
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	11	823	2,132	12,005	6.7	2.59
	Replace Existing Air Source Heat Pumps (COP = 2.91) with Open-Loop Ground Source Heat Pumps (3.54)	87	40,788	225,581	68,666	1.7	5.53
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	71	1,537	270	27,476	102.7	0.18
10e Total		552	77,172	406,333	506,232	2.8	5.27
10i	Add R-30 Attic Insulation with Blow-In Insulation	3	163	396	2,476	7.3	2.43
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	3	217	391	3,268	9.4	1.80
	Replace Existing Electric Furnace (100% efficient) and Electric Packaged AC Units (COP = 2.72) with Horizontal Closed-Loop Ground-Coupled Heat Pumps (COP = 3.54)	42	2,459	10,746	8,725	2.9	4.37
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation	3	68	8	935	113.1	0.12
10i Total		51	2,907	11,541	15,404	3.9	3.97
23a	Replace 13-watt Fluorescent Exit Signs with 0.35-watt Electroluminescent Exit Signs	2	143	320	2,135	7.7	2.24
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	9	971	6,798	9,696	2.4	7.00
23a Total		11	1,114	7,118	11,831	2.6	6.39
40g_offices	Wrap Electric Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	-	12	17	52	9.2	1.42
	Wrap Electric Hot Water Tank with R-11 Fiberglass Batt Insulation; Insulate Pipes Near Tank; Install Faucet Aerators; Lower Tank Temperature from 140°F to 120°F	5	332	686	1,341	6.4	2.07
40g_offices Total		5	344	703	1,393	6.47	6.5

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
40g_storage	Replace 175-watt Metal Halide Lamps with 30-watt Super T-8 Lamps and Electronic Ballasts	27	2,793	28,162	18,827	1.7	10.08
40g_storage Total		27	2,793	28,162	18,827	1.70	1.7
40h	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	4	441	2,932	4,499	2.5	6.65
40h Total		4	441	2,932	4,499	2.5	6.65
40n	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	62	5,266	11,837	76,817	7.5	2.25
40n Total		62	5,266	11,837	76,817	7.5	2.25
50b	Replace 250-watt Metal Halide Lamps with 40-watt Bi-axial Lamps and Electronic Ballasts with Reflectors	41	4,785	40,513	41,885	2.0	8.47
50b Total		41	4,785	40,513	41,885	2.0	8.47
50c	Replace 13-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	9	870	1,888	12,934	7.8	2.17
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 30-watt Super T-8 Lamps and Electronic Ballasts	6	557	2,747	6,619	3.4	4.93
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	71	4,437	6,840	67,876	10.9	1.54
50c Total		86	5,864	11,475	87,429	8.6	1.96
50d_office	Add 4 Inches of Fiberglass Insulation to Interior Metal Roof	92	19,444	17,360	307,559	18.7	0.89
	Add 4 Inches of Fiberglass Insulation to Interior Metal Wall	41	15,043	20,368	231,014	12.3	1.35
	Insulate Perimeter of Slab on Grade Foundation with R-10 Insulation	-	202	2,404	973	1.4	11.90
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt Super T-8 Lamps and Electronic Ballasts with Reflectors	33	3,351	9,527	46,616	5.9	2.84
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	20	2,184	6,511	30,185	5.6	2.98
50d_office Total		186	40,224	56,170	616,347	11.94	11.9
50f	Wrap Electric Hot Water Tank with R-11 Fiberglass Batt Insulation	2	61	96	198	3.1	1.57
50f Total		2	61	96	198	3.1	1.57
60a	Add 4 inches of Fiberglass Insulation to Interior Metal Roof	533	41,075	43,953	689,404	16.7	1.07

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings (\$/yr)	Installed Cost (\$)	Net Present Value (\$)	SIR	Simple Payback (yr)
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	30	1,404	9,176	17,511	2.9	6.54
	Replace 40-watt T-12 Lamps and Magnetic Ballasts with 32-watt T-8 Lamps and Electronic Ballasts	39	5,475	19,936	71,085	4.6	3.64
	Replace Existing Central Steam Heating System and Electric Packaged AC Units (COP = 2.71) with Vertical Closed-Loop Ground-Coupled Heat Pumps (COP = 4.41)	57	5,972	42,763	15,730	1.9	7.16
	Replace Existing Electric Boiler with Heat Pump Hot Water Heater (COP = 2.3); Wrap Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	31	2,124	7,424	20,567	3.2	3.50
	Replace Existing Metal Frame, Single Pane Windows with Aluminum Frame, Double Pane, Argon-Filled Windows with Low-e Film	41	3,042	47,833	7,078	1.1	15.72
	Wrap Electric Hot Water Tank with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	27	910	38	4,348	317.1	0.04
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation; Install Faucet Aerators	18	397	61	7,100	117.4	0.15
60a Total		776	60,399	171,184	832,823	5.9	2.83
80c	Add 4 inches of Fiberglass Insulation to Interior Metal Roof	342	42,466	39,118	687,514	18.6	0.92
	Insulate Perimeter of Slab on Grade Foundation with R-15 Insulation	28	1,605	10,987	19,177	2.7	6.85
	Replace 40-watt Fluorescent Exit Signs with 0.2-watt Electroluminescent Exit Signs	21	1,758	1,589	27,566	18.3	0.90
	Wrap Electric Hot Water Tank with R-11 Fiberglass Batt Insulation	-	13	16	48	3.9	1.23
	Wrap Hot Water Heat Exchanger with R-11 Fiberglass Batt Insulation	48	1,034	118	18,552	158.2	0.11
80c Total		439	46,876	51,828	752,857	15.5	1.11
Grand Total		2,692	287,349	1,057,149	3,317,173	5.0	3.68