U.S. DEPARTMENT OF ENERGY

PNNL-19679

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Building Energy Audit Report for Camp Smith, HI

WD Chvála, Jr.
MI De La Rosa
DR Brown
DR Dixon

September 2010

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Pacific Northwest National Laboratory
Richland, Washington 99352

Executive Summary

A detailed energy assessment was performed by a team of engineers from Pacific Northwest National Laboratory (PNNL) under contract to the Department of Energy/Federal Energy Management program (FEMP). The effort used the Facility Energy Decision System (FEDS) model to determine how energy is consumed at Camp Smith, identify the most cost-effective energy retrofit measures, and calculate the potential energy and cost savings.

A team of engineers from PNNL visited Camp Smith on January 25-27, 2010 to collect data for the FEDS assessment. During this visit, PNNL engineers collected energy-related information and data from 27 representative buildings, central plants, and other energy systems for input into the FEDS model.

The economic results presented in this report are based on the use of two different sources of capital funds to implement the energy projects; appropriated funds, and alternative financing (e.g., energy savings performance contract [ESPC]). The alternative financing economic input assumptions are for generic ESPC financing to illustrate the differences that the source of capital makes on the technology choices. The FEDS software is capable of performing the comprehensive assessment using other sources of capital (e.g., utility financing) with their distinct economic inputs. Thus, the site is encouraged to re-run the FEDS software using site-specific alternative financing options and reassess the results. This assessment does not include costs for design; supervision, inspection and overhead (SIOH); or any contingency funds, but only the direct capital cost. These additional costs are usually estimated as a % of direct capital cost. A capital cost multiplier (e.g., typically 1.16 for design and SIOH) can be entered in FEDS and new results produced, or the results can be manually adjusted by increasing capital costs by the appropriate percentage and recalculating net present value (NPV), savings-to-investment ratio (SIR), and payback period.

This report documents the findings of the FEDS assessment and model results for appropriated funds and alternative financing sources of capital for the projects. A complete list of the 107 cost-effective energy- and cost-reducing retrofit measures is included in Appendix C-1 for projects funded using appropriated funding sources of capital and a complete list of 72 cost-effective energy and cost-reducing retrofit measures is included in Appendix C-2 for projects funded using alternative financing source of capital.

Table ES.1 summarizes the results of the energy assessment by retrofit category for appropriated funding sources of capital. Table ES.2 summarizes the results of the energy assessment by retrofit category for alternative financing sources of capital.

For appropriated funds source of capital in Table ES.1, Camp Smith can save 9,337 MMBtu/year and $461,713/year if all cost-effective retrofits are implemented. The site can reduce its energy consumption by 10.3% by implementing the 107 cost-effective energy- and cost-reducing projects identified in this report.

Table ES. 1 Summary of Potential Energy and Cost Savings for Camp Smith Using Appropriated Source of Capital

	Retrofit Category	Energy Savings (MM Btu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR	Simple Payback (yr)
Camp Smith Buildings	Cooling	3,479	198,210	1,092,408	1,258,879	2.9	5.5
	Envelope	153	9,487	115,786	48,489	1.4	12.2
	Hot Water	939	27,759	276,904	184,991	1.5	10.0
	Lighting	1,484	96,351	440,604	1,229,702	3.8	4.6
	Motors	22	1,030	956	6,523	12.6	0.9
	Windows	27	1,609	23,036	4,845	1.2	14.3
	SubTotal	**6,104**	**334,446**	**1,949,694**	**2,733,429**	**2.4**	**5.8**
PACOM Building 700	Hot Water	63	1,656	1,036	42,331	41.9	0.6
	Lighting	3,170	125,611	1,138,501	1,037,719	2.0	9.1
	Sub-Total	**3,233**	**127,267**	**1,139,537**	**1,080,050**	**1.9**	**9.0**
Total		**9,337**	**461,713**	**3,089,231**	**3,813,479**	**2.4**	**6.7**

Table ES. 2 Summary of Potential Energy and Cost Savings for Camp Smith Using Alternative Financing Source of Capital

	Retrofit Category	Energy Savings (MM Btu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR	Simple Payback (yr)
Camp Smith Buildings	Cooling	2,667	146,415	644,945	235,975	1.4	4.4
	Hot Water	293	11,372	51,866	30,358	2.5	4.6
	Lighting	1,273	91,409	304,339	248,993	1.8	3.3
	Motors	22	1,030	956	5,242	6.5	0.9
	SubTotal	**4,255**	**250,226**	**1,002,106**	**520,568**	**1.5**	**4.0**
PACOM Building 700	Hot Water	63	1,656	1,036	12,619	13.2	0.6
	Lighting	8	1,172	5,921	1,243	1.2	5.1
	Sub-Total	**71**	**2,828**	**6,957**	**13,862**	**3.0**	**2.5**
Total		**4,326**	**253,054**	**1,009,063**	**534,430**	**1.6**	**4.0**

When third party financing is used, the additional project costs reduce the number of cost-effective retrofits. For alternative financing source of capital in Table ES.2, Camp Smith can save 4,326 MMBtu/year and $253,054/year if all cost-effective retrofits are implemented. The site can reduce its energy consumption by 4.5% by implementing the 72 cost-effective energy- and cost-reducing projects identified in this report.

In addition to this report, the Camp Smith 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.

Emissions Reduction

Implementing all the cost-effective building retrofits using appropriated funds will result in a 9% reduction in greenhouse gas emissions. These reductions are summarized in table ES.3 and included for each building in appendix D.

Table ES.3. Emissions Reduction from Cost-Effective Retrofits

Greenhouse Gas	Reduction
Sulfur Oxides (lb)	21,263
Nitrogen Oxides (lb)	10,441
Carbon Monoxide (lb)	18,153
Carbon Dioxide (tons)	2,225
Particulate Matter (lb)	427
Hydrocarbons (lb)	7,434

Job Creation

The number of jobs created from implementation of all the cost-effective retrofits using appropriated funds is estimated to represent 33.6 job-years. One job-year is equal to $92,000 in capital spending for implementation.

Contents

Figures

Tables

Description of ARRA program

On February 13, 2009, Congress passed the American Recovery and Reinvestment Act (ARRA) of 2009 at the urging of President Obama, who signed it into law 4 days later. A direct response to the economic crisis, the Recovery Act has three immediate goals:

- Create new jobs and save existing ones
- Spur economic activity and invest in long-term growth
- Foster unprecedented levels of accountability and transparency in government spending.[1]

The U.S. Pacific Command (PACOM) is facing significant energy challenges and has identified the need for a comprehensive and integrated approach to addressing these challenges. In a letter dated March 30, 2009, the PACOM Director of Resources and Assessments requested the support of the Department of Energy Federal Energy Management Program (DOE FEMP) in specific assessment, analysis, and training tasks to work toward the accomplishment of PACOM's energy security strategy. An integrated set of ARRA proposals for FEMP assistance requested national laboratory support for the execution of the identified tasks. The resulting 2009-2010 FEMP PACOM scope of work includes renewable energy and efficiency assessments, energy manager training and development, smart grid and islanding feasibility studies, alternative contracting assistance, and technology demonstrations.

In a competitive grant approach across the services and commands, the national labs were awarded over $3,000,000 from DOE FEMP to support PACOM needs. The funds are dedicated to technical assistance projects aimed at bringing the most advanced energy-efficiency, renewable power generation, and microgrid assessments and analyses to Department of Defense (DOD) installations in Hawai`i and throughout the Pacific region.

This comprehensive building energy-efficiency assessment represents a single task (Task 2.1, FEMP project 237) in the larger PACOM, ARRA-funded energy program.

[1] http://www.recovery.gov/

Background

As the United States' oldest combatant command, PACOM has been a force for peace and a committed partner in the Asia-Pacific region for more than 60 years. With an area of responsibility (AOR) that includes more than 3.4 billion people and encompasses about half the Earth's surface, the Command remains a significant stabilizing influence in the world. PACOM is supported by four component commands: U.S. Pacific Fleet, U.S. Pacific Air Forces, U.S. Army Pacific, and U.S. Marine Corps Forces, Pacific. These commands are headquartered in Hawai'i and have forces stationed and deployed throughout the region.

Camp H.M. Smith is home of the command headquarters of U.S. Pacific Command and the Commanding General of Marine Forces Pacific (MARFORPAC), and is located on O`ahu's Halawa Heights at an elevation of about 600 feet above Pearl Harbor (near the community of Aiea).

The camp, originally the Aiea Naval Hospital, was named for General Holland McIntyeire Smith, the first commanding general of the Fleet Marine Force Pacific, on June 8, 1955. Camp Smith today consists of 220 acres at Camp Smith proper, 137 acres at Puuloa Rifle Range in Ewa Beach, and 62 acres in Manana Housing. Camp Smith is unique in that it's the only Marine Corps installation that supports a unified commander, Commander, Pacific Command (CDRUSPACOM). There are approximately 59 buildings totaling 879,043 square feet of floor area.

On an average day U.S. military forces in Hawai'i require 3 GW of electricity, representing approximately 10% of the total electricity needs of the islands. A map of military sites on O'ahu is included in Figure 1 below. Facilities on other islands include: Pacific Missile Range Facility (PMRF) on Kaua`i, Pohakuloa Training Area (PTA) and Kilauea Military Center (KMC) on Hawai`i Island, and the Maui High Performance Computing Center (MHPCC) on Maui. In addition to most of these sites, the FEMP PACOM program tasks are performing work in Alaska, Guam, and Japan.

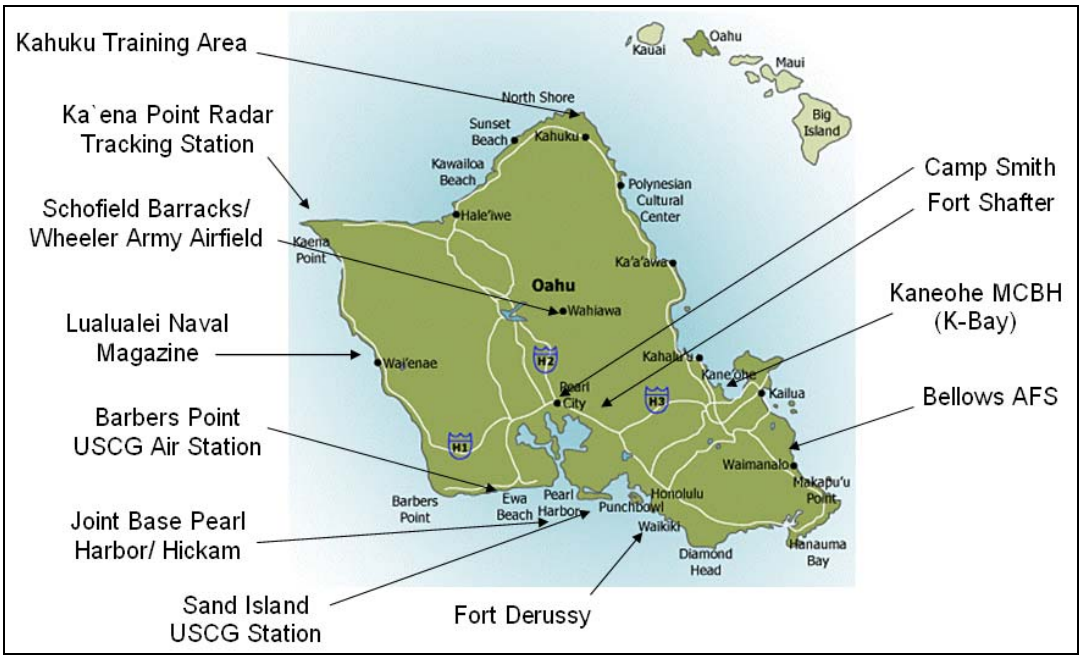

Figure 1. Military Installations on O`ahu, Hawai`i

Introduction

This report contains the results of the comprehensive building energy-efficiency assessment conducted at Camp Smith, Hawai'i, by Pacific Northwest National Laboratory (PNNL). The scope of this activity was based on performing a site-wide energy assessment using the Facility Energy Decision System (FEDS) process to identify cost-effective energy- and cost-reduction projects. In addition, 22 buildings were selected for detailed energy audits of sufficient scope to comply with Energy Independence and Security Act (EISA), section 432 requirements for energy and water evaluations at covered facilities. The results of the FEDS assessment will be used by the installation to develop an implementation plan for the energy conservation measures identified, and outline how Camp Smith will meet the goals of Executive Order 13423 by FY 2015.

Purpose

The purpose of this report is to present the findings resulting from the site visit performed January 25-27, 2010, 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 Camp Smith.

Site Visits and Teams

The formal kickoff of the site assessment at Camp Smith was held on the morning of January 25, 2010. The PNNL team presented an overview of the FEDS assessment process, the data requirements, and schedule for the Camp Smith work. Participating in this meeting was:

1. Ed Urabe – Camp Smith Energy Manager
2. Jill Sims – Project Manager/Technical lead, SENTECH Hawai'i
3. Lincoln Oshiro – Electrical Engineer, Camp Smith
4. Doug Dixon – PNNL
5. Daryl Brown – PNNL
6. Bill Chvála – PNNL
7. Marcus De La Rosa – PNNL

Current Status

The Energy Policy Act (EPAct) of 2005 set annual energy reduction goals in British thermal units (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.

The Marine Corps Base Hawai'i (MCBH) is behind the compliance glide path — 6.8% below the 2003 baseline, compared to the FY 2009 targeted reduction of 9.0%. The historical energy intensity for MCBH is shown in Figure 2. Camp Smith is included in this glide path, but is not broken out separately.

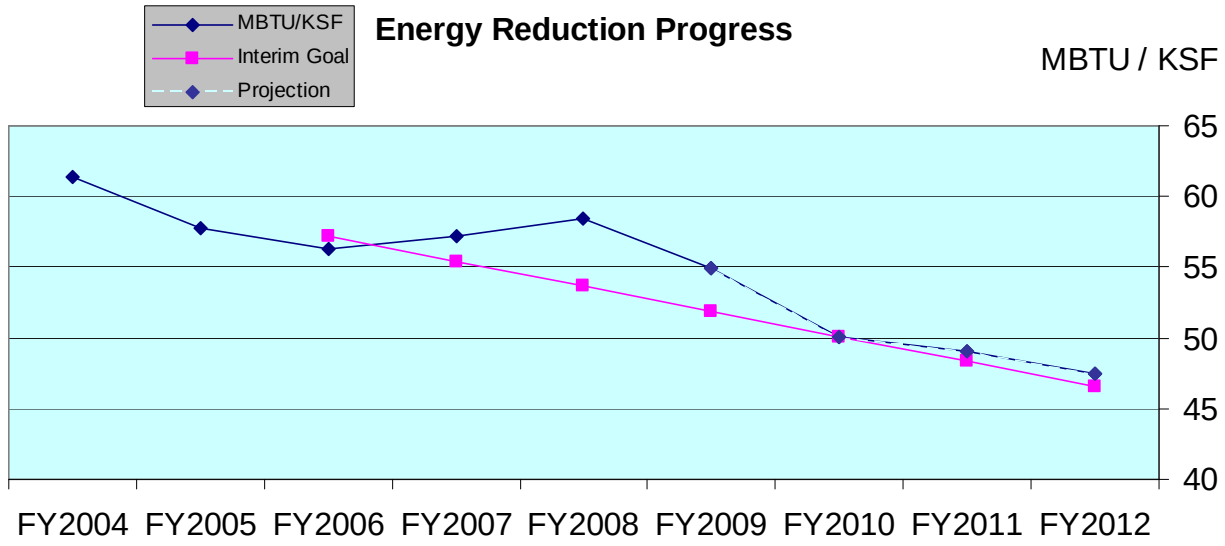

Figure 2. MCBH Energy Reduction Glide Path

Description of Facilities

Camp Smith is a small US Marine Corps installation consisting of 59 buildings totaling approximately 879,043 square feet. The scope of the FEDS assessment performed at Camp Smith included all facilities in the primary cantonment area.

Table 1 identifies the list of facility categories for the FEDS assessment and the facility proxies for each category. The facilities at Camp Smith were divided into 27 categories for the purpose of building audits. A complete listing of the facilities (buildings) associated with each FEDS facility category (including subgroups) is provided in Appendix B.

Table 1. List of Facilities by Facility Category Description

FEDS Facility Category Code	Facility Category Description	Proxy Facility No.	Facility Quantity	Category Area (sq. ft.)
1	Overhead Protection	N/A	11	10,136
10_a	Building 20, Admin	20	1	75,585
10_OldHosp_1	Old Hospital, Building 1	1	1	67,986
10_OldHosp_2c	Old Hospital, Building 2C, Admin + basement fitness center	2C	1	37,336
10_OldHosp_2D	Old Hospital, Building 2D	2D	1	37,336
10_OldHosp_3A	Old Hospital, Building 3A, Floors 1&2 admin, Floor 3 renovation	3A	1	31,582
10_OldHosp_3B	Old Hospital, Building 3B, Admin + 1st floor clinic	3B	1	30,165
10_OldHosp_4	Old Hospital, Building 4 Admin plus food service	4	1	72,129
10_OldHosp_PXAud	Old Hospital, Building 4/PX and Auditorium			12,000
10_OldHosp_5	Old Hospital, Building 5	5, 5A	2	24,125
10_OldHosp_80	Old Hospital, Building 80, Admin/Control Room/Computers	80	1	37,300
10_OldHosp_81	Old Hospital, Building 81 phones	81	1	3,299
10_OldHosp_Connectors	Old Hospital, Buildings 1A, 1B, 2AA, 3AA	1A, 1B, 3AA, 2AA	4	28,291
10_PACOM	Bldg 700 PACOM Center, 701, 705	700	3	284,658
10_PACOM_food	Bldg 700 PACOM Food Service	700 café		
10b	Building 20E, Admin/Training	20E	1	2,520
31_barracks	barracks complex (401-404)	402	4	43,596
40_Maint	Maintenance B600	600	1	20,900
50_GEN	Generator Buildings/Shelters	N/A	6	5,338
50_UPS	UPS Building 602	602	2	2,184
80_Fire	Fire Station B612	612	1	7,126
80_Misc	Everything else	366	10	12,887
80_NCO	NCO Club, B500	500	1	7,020
80_Police	B601 Police Station	601	1	3,888
80_RB	Courts	450, 451	2	3,322
80_Pool	Outdoor Pool	125	N/A	N/A
80_RecCntr	Bldg 501 Rec center	501	1	5,518
TOTAL			59	866,227

Analytical Approach

The general approach was to develop a model of the buildings and other energy-related infrastructure at Camp Smith, calibrate that model to actual FY 2009 energy use, and then utilize the model to predict energy consumption and identify cost-effective retrofits under typical meterological year (TMY) weather conditions.

Buildings

Building inventory data for Camp Smith were obtained from the Internet Navy Facility Asset Data Store (iNFADS). A total of 27 building groups were developed to represent the Base and each of the buildings at Camp Smith 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 Camp Smith. 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 Camp Smith, and additional building data collected while visiting the Base.

Central Energy Plants

Camp Smith has one chiller plant, Building 701, which provides chilled water to Building 700 (see Table 2). Building 701 also provides hot water to Building 700 (see Table 3). Building 701 uses a de-superheater to recover waste heat from the chillers for use in the hot water loop. There are also two smaller hot water "mini-plants" that provide service hot water to multiple buildings.

Table 2. Central Chiller Plants at Camp Smith

Chilled Water Plant	Number of Chillers	Total Capacity (Tons)	Total Floor Area (ft^2)	Buildings Served
701	3	1,977	283,958 ft^2	PACOM HQ, Building 700

Table 3. Central Hot Water Plants at Camp Smith

Hot Water Plant	Number of Boilers	Total Capacity (MMBtu/hr)	Total Floor Area (ft^2)	Buildings Served
701	2	1.05†	283,958 ft^2	PACOM HQ, Building 700
402	2	1.4	43,596 ft^2	401, 402, 403, 404
5	1	1.36	139,200 ft^2	4, 5, 80

† Building 700 also has a de-superheater that provides heat recovered from the chillers to the hot water system.

More details on each central plant can be found in Appendix D.

Energy Prices

Hickam AFB, Pearl Harbor, and Camp Smith (hereinafter, Hickam, Pearl, and Smith) are all served by Hawai'ian Electric Company (HECO) under Schedule PP, Large Power Primary Voltage Service. Minor differences in the marginal electricity costs for the three organizations stem from differences in their power factors and the use of Rider M, Off-Peak and Curtailable Services, by Pearl.

The root marginal demand charge for Schedule PP is $11.85/kW. Energy charges are billed per a declining block structure that is a function of the peak demand. This effectively results in an additional $2.78/kW demand charge as an increase in demand shifts more energy into higher-priced blocks. The first 200 kWh/kW are billed at $0.121534/kWh, and the second 200 kWh/kW are billed at $0.113702/kWh. All kWh in excess of 400 kWh/kW are billed at $0.110668/kWh. The demand profiles at Hickam, Pearl, and Smith all result in the marginal kWh being billed at the rate for the third block.

Several adjustments are applied that affect the marginal electricity cost. The total bill is decreased by 0.1% for each 1% that power factors are above 85% (and vice-versa if the power factor is below 85%). "Interim" increases in the rates established in 2007 and 2009 add 2.82% to the total bill. Finally, the combination of public benefit funds, energy cost, and integrated resource planning surcharges add a little more than $0.03 to the cost of each kWh.

The billing demand for each month is the higher of the actual peak demand for that month or the average of peak demand for that month and the peak demand for the previous 11 months. This structure cannot be directly modeled in FEDS, but was found to be equivalent to a 92% annual demand ratchet, which can be modeled in FEDS.

Pearl utilizes Rider M to reduce its demand charge by agreeing to reduce its load from 5-9 PM, Monday through Friday. This rider reduces its billing demand by 75% of the difference between its overall peak demand and its peak demand during the 5-9 PM period. For Pearl, the Rider M billing demand averaged 96% of its actual peak demand during 2009. This is equivalent to using the actual peak demand as the billing demand and reducing the demand charge by 4%, which was the modeling approach used for FEDS.

The resulting marginal electricity costs are summarized in Table 4.

Table 4. Marginal Electricity Rates for Hickam, Pearl, and Smith

	Hickam	Pearl	Smith
Demand Charge, $/kW	14.92	14.24	14.86
Energy Charge, $/kWh	0.1433	0.1426	0.1431
Demand Ratchet, %	92%	N/A	92%

Camp Smith uses a modest amount of propane, which is delivered regularly. Propane cost is $22.25/MMBtu.

Other Loads

The building audits captured typical exterior lighting loads fed from each building. These include wall-mounted security lighting, pathway lighting, and parking lot lighting. Street lighting and other security lighting was inventoried during the site visit. Actual wattages and lighting on-time hours were estimated to determine exterior lighting loads. The resulting exterior lighting (not associated with a specific building) was estimated at 72,932 kWh.

Camp Smith does not produce potable water nor treat waste water. Electricity distribution losses were assumed to be 4% of purchased electricity.

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 FY 2009. Uncertain elements of the modeling assumptions were adjusted until the model's energy consumption prediction matched "reasonably well" with actual energy consumption for FY 2009. Specific model calibration results are shown in Table 5.[2]

Table 5. FEDS Calibration Results

Model Element	Fuel Type	Error
Building 20	Electric	0.1%
Building 700	Electric	0.7%
	Propane	-1.1%
Building 402	Propane	-1.6%
Building 5	Propane	-1.3%
Total by Fuel Type	Electric	0.8%
	Propane	0.6%
Total Energy	All	0.8%

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

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) and alternative (e.g., energy savings performance contract [ESPC] and utility energy services contract [UESC]) 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. Alternative financing assumptions are not prescribed, but set by negotiation between the energy services company (ESCO) and the Federal organization. An economic evaluation life of 10 years and a real discount rate of 10% are used to represent alternative financing conditions in this assessment, based on a collection of prior site experiences in the Army. This assessment does not include costs for design; supervision, inspection and overhead (SIOH); or any contingency funds, but only the direct capital cost. These additional costs are usually estimated as a % of direct capital cost. A capital cost multiplier (e.g., typically 1.16 for design and SIOH) can be entered in FEDS and new results produced or the results can be manually adjusted by increasing capital costs by the appropriate percentage and recalculating NPV, SIR, and payback period.

Table 6a summarizes 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. Table 6b summarizes the FEDS results by retrofit category using alternative financing 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 Appendices C-1 (appropriated funds) and C-2 (alternative financing).[3]

[3] It should be noted that in addition to this report, the Camp Smith 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 Appendices C-1 and C-2.

Table 6a. Summary of All Cost-Effective Projects Identified from the FEDS Assessment for Camp Smith Using Appropriated Source of Capital (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)
Camp Smith Buildings							
Cooling	Package AC	47	4,339	42,218	4,694	1.3	9.7
	Water-Cooled Chiller	3,014	170,276	817,412	1,231,438	3.2	4.8
	Window AC	418	23,595	232,778	22,747	1.2	9.9
	Sub-total	**3,479**	**198,210**	**1,092,408**	**1,258,879**	**2.9**	**5.5**
Envelope	Roof Insulation	119	7,454	88,005	41,082	1.5	11.8
	Slab Insulation	34	2,033	27,781	7,407	1.2	13.7
	Windows	27	1,609	23,036	4,845	1.2	14.3
	Sub-total	**153**	**9,487**	**115,786**	**48,489**	**1.4**	**12.2**
Hot Water	Heat Pump Water Heater	818	22,732	271,994	121,845	1.3	12.0
	Misc Measures	121	5,027	4,910	63,146	26.9	1.0
	Sub-total	**939**	**27,759**	**276,904**	**184,991**	**1.5**	**10.0**
Lighting	CFL	283	17,376	15,473	285,895	19.4	0.9
	Exit Lighting	69	10,853	52,061	136,612	3.6	4.8
	Fluoresent Lighting	1,123	67,483	362,942	806,247	3.2	5.4
	HID	9	639	10,128	948	1.1	15.8
	Sub-total	**1,484**	**96,351**	**440,604**	**1,229,702**	**3.8**	**4.6**
Motors	Motors	22	1,030	956	6,523	12.6	0.9
	Sub-total	**22**	**1,030**	**956**	**6,523**	**12.6**	**0.9**
Total Camp Smith		**6,104**	**334,446**	**1,949,694**	**2,733,429**	**2.4**	**5.8**
PACOM Building 700							
Hot Water	Misc Measures	63	1,656	1,036	42,331	41.9	0.6
	Sub-total	63	1,656	1,036	42,331	41.9	0.6
Lighting	Exit Lighting	8	1,077	5,921	12,780	3.2	5.5
	Fluoresent Lighting	3,162	124,534	1,132,580	1,024,939	1.9	9.1
	Sub-total	**3,170**	**125,611**	**1,138,501**	**1,037,719**	**2.0**	**9.1**
Total PACOM Building 700		**3,233**	**127,267**	**1,139,537**	**1,080,050**	**1.9**	**9.0**
Total Installation		**9,337**	**461,713**	**3,089,231**	**3,813,479**	**2.4**	**6.7**

From Table 6a, the total cost-effective energy savings is estimated at 9,337 MMBtu/year representing $461,713/year savings with an overall savings to investment ratio (SIR) of 2.4. This represents 10.3% in energy savings based on FY 2009 energy data reported to Defense Utility Energy Reporting System (DUERS).

The greatest energy saving potential was found replacing air-cooled chillers with water-cooled chillers, saving an estimated 3,014 MMBtu/year. Although T8 fluorescent lighting is good, advanced, "super" T8 lighting can yield additional savings – 3,162 MMBtu/year in PACOM Building 700. The quantity of energy saved is large because fluorescent lighting is widely used, but payback is fairly long.

Table 6b. Summary of All Cost-Effective Projects Identified from the FEDS Assessment for Camp Smith Using Alternative Financing as the Source of Capital (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)
Camp Smith Buildings							
Cooling	Water-Cooled Chillers	2,667	146,415	644,945	235,975	1.4	4.4
	Sub-total	**2,667**	**146,415**	**644,945**	**235,975**	**1.4**	**4.4**
Hot Water	Heat Pump Water Heater	192	7,003	49,789	3,317	1.6	7.1
	Misc Measures	101	4,369	2,077	27,041	13.9	0.5
	Sub-total	**293**	**11,372**	**51,866**	**30,358**	**2.5**	**4.6**
Lighting	CFL	283	17,884	15,473	92,717	7.1	0.9
	Exit Lighting	71	11,728	52,061	19,589	1.4	4.4
	Fluorescent Lighting	919	61,797	236,805	136,687	1.6	3.8
	Sub-total	**1,273**	**91,409**	**304,339**	**248,993**	**1.8**	**3.3**
Motors	Motors	22	1,030	956	5,242	6.5	0.9
	Sub-total	**22**	**1,030**	**956**	**5,242**	**6.5**	**0.9**
Total Camp Smith		**4,255**	**250,226**	**1,002,106**	**520,568**	**1.5**	**4.0**
PACOM Building 700							
Hot Water	Misc Measures	63	1,656	1,036	12,619	13.2	0.6
	Sub-total	**63**	**1,656**	**1,036**	**12,619**	**13.2**	**0.6**
Lighting	Exit Lighting	8	1,172	5,921	1,243	1.2	5.1
	Sub-total	**8**	**1,172**	**5,921**	**1,243**	**1.2**	**5.1**
Total PACOM Building 700		**71**	**2,828**	**6,957**	**13,862**	**3.0**	**2.5**
Total Installation		**4,326**	**253,054**	**1,009,063**	**534,430**	**1.6**	**4.0**

From Table 6b, the total cost-effective energy savings is estimated at 4,326 MMBtu/year representing $253,054/year savings with an overall savings to investment ratio (SIR) of 1.6. This represents 4.5% in energy savings based on FY 2009 energy data reported to DUERS.

The greatest energy saving potential is found in replacing air-cooled chillers with water-cooled chillers (2,667 MMBtu/year), followed by advanced fluorescent lighting.

As would be expected, the total number of cost-effective retrofits is fewer (and installed cost/ capital investment is significantly less) under alternative financing sources of capital, and thus, the energy and dollar savings are likewise less. The total number of cost-effective retrofits using appropriated sources of capital is 107 and the total number of cost-effective retrofits using alternative financing sources of capital is 72. Using appropriated funding will save 5,011 MMBtu/year and $208,659/year more than alternative financing. Utilizing alternative financing reduces the simple payback from 6.7 to 4.0 years because some projects with longer paybacks are eliminated under the alternative financing scenario.

The complete list of cost-effective energy- and cost-reduction projects is given Appendix C-1 for the appropriated funding sources of capital and in Appendix C-2 for the alternative financing sources of capital.[4]

[4] The Camp Smith 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.

Conversion to Water-Cooled Chillers

Water-cooled condensing of cooling equipment refrigerant results in a significant improvement in efficiency compared to air-cooled condensing chillers. This advantage stems from two factors. Condenser water from an evaporative cooling tower is generally cooler than ambient air (except when the relative humidity is very high) and water is a more effective heat transfer fluid than air. The two factors work together to lower the refrigerant condensing temperature, hence improving both theoretical and actual refrigeration cycle efficiency. Combining cooling loads met by multiple smaller cooling units into fewer central units allows additional efficiency gains by using centrifugal compressors, a more efficient technology than alternative compressor types commonly used in smaller cooling equipment. These advantages do come at a price, however. Condensing refrigerant with water requires additional costs associated with a cooling tower, condenser water pumps and piping, and a shell to enclose the water as it passes by the condenser tubing. The condenser pump also represents an additional power consuming device that an air-cooled unit does not have. Finally, the distribution of centrally chilled water incurs pumping and piping costs and pumping energy not required by distributed direct expansion coolers (e.g., window air conditioner [AC] and packaged rooftop AC).

For the reasons noted above, water-cooled chillers offer significant performance advantages over air-cooled equipment that must be weighed against their additional capital costs. During the last few decades, space cooling has become much more common in Hawaiian military facilities because internal heating loads (e.g., personal computers and other office equipment) have increased, building designs have become less suitable for natural ventilation, and occupants expect a more comfortable working environment. The FEDS model generated retrofit recommendations for replacing air-cooled chillers with water-cooled chillers at the building level. The following paragraphs discuss the impact of combining these energy conservation measures (ECMs) into a centralized chilled-water plant. More details of the assessment of water-cooled chillers at Hickam AFB, Pearl Harbor, and Camp Smith are provided in Appendix E.

Buildings 401, 402, 403, and 404 are currently served by window air-conditioning units. The proposed retrofit would replace the window units with room fan coil units, external chilled water supply and return piping and a central water-cooled chiller plant serving all four buildings. The same plant would also serve Building 20, which already has air-cooled chillers, hence chilled water piping within the building, but will need chilled water supply and return piping from the new central plant to Building 20. The new chiller plant was assumed to be sited on the west side of Bailey Road, opposite Building 401.

The peak and annual building cooling loads were estimated with the FEDS model and the performance of the existing window air-conditioning units and air-cooled chillers were estimated from manufacturer's specifications for the two types of units. From this information, the annual kWh and peak kW electrical loads were calculated and then combined with Smith's electricity rates to calculate the current annual electricity costs. The existing system performance and electricity cost figures are presented in Table 7.

Table 7. Smith Buildings 20, 401-404 Existing System Performance and Electricity Cost

Building	Peak Load, Tons	Annual Load, Ton-hours	Annual Capacity Factor	Existing Air Cooled kW/ton	Existing Annual Electricity kWh	Existing Peak Electricity kW	Existing Annual Electricity Cost
401	65.7	147,804	0.26	1.16	171,515	76.2	
402	65.7	147,804	0.26	1.16	171,515	76.2	
403	65.7	147,804	0.26	1.16	171,515	76.2	
404	65.7	147,804	0.26	1.16	171,515	76.2	
20	142.8	419,327	0.34	1.44	603,203	205.3	
Totals	405.5	1,010,544	0.28	1.26	1,289,263	510	$275,500

In this size range, the water-cooled chillers were assumed to use a centrifugal compressor rated at 0.57 kW/ton. In addition, the chilled water pumps, condenser water pumps, and cooling tower fan would be expected to consume 0.18 kW/ton for a total cooling plant performance of 0.75 kW/ton. The annual electricity bill for the water-cooled system was calculated to be $164,200 based on these assumptions, resulting in an annual savings of $111,300 and a peak electric load reduction of 206 kW.

A new 400-ton water-cooled chiller plant (chillers, cooling tower, pumps, plant piping, electrical, controls, and structure) was estimated to cost $520,000. Chilled water piping that would be mounted on the exterior of Buildings 401-404 was estimated to cost $85,000. Chilled water piping running to and from the new central plant to Buildings 401-404 and 20 was estimated to cost $189,000. The cost of the new chilled water coils for Buildings 401-404 was estimated to be $75,000. These figures include all direct construction costs, but do not include any allowance for design or SIOH costs. Based on the direct cost, the payback period is 8 years. With an additional 16% for design and SIOH, the payback period rises to 9 years.

Before implementing this project, Camp Smith should consider other possible means of serving these five buildings with water-cooled chillers. An expansion of the chilled water plant serving Building 700 may offer some economies over the new plant proposed here, but the chilled water distribution piping would be longer. Integration with a new chilled-water plant serving the eventual replacement of the Old Hospital Complex would probably be ideal if the complex is going to be replaced relatively soon.

Installation Load Reduction Potential

Using the FEDS model, the impact on electric demand can be estimated from implementing all the cost-effective projects at Camp Smith. The existing peak electric demand from all building loads[5] at Camp Smith is 4,270 kW. This peak occurs at 1300 hours during a September weekday. By implementing all the FEDS recommended retrofits, the peak demand can be reduced by 465 kW to 3,806 kW. This represents a 11% reduction in peak demand.

Annual Installation Electric Demand

	Demand (kW)	Dollars (2009)
Installation Peak Demand:		
existing	4,270	722,191
post-retrofit	3,806	642,948
difference	-465	-79,243
% change	-11	-11
Time of Installation Peak Demand:	Existing	Post-Retrofit
Month	September	September
Day Type	Weekday	Weekday
Hour	1300	1300

The above data looks only at building-level retrofit recommendations. This total package of recommendations does include some building-level water-cooled chiller retrofits (e.g., Building 20), but does not include the centralized chilled-water plant[6] as discussed in the previous section. The building-level retrofits can be combined with the centralized chilled-water plant results after removing the building-level water-cooled chiller retrofits that would no longer be needed. The total peak reduction Camp Smith would be able to achieve is 542 kW or 13.4%.

[5] The modeled electric demand in FEDS is for all building loads and may not include certain non-building electric loads (e.g., booster pumps, lift stations, transmission losses, etc.).

[6] The central chilled-water plant calculations did not address the “old hospital” complex because of uncertain future plans to retain those facilities.

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.

Cool Roofs. FEDS does not evaluate the potential savings for cool roof projects.

Building Controls. Recommendations for building controls cannot be easily inferred by the FEDS model engine. A detailed building assessment focused on all heating, ventilation and air conditioning (HVAC) equipment is required to develop project proposals.

Programmable Thermostats. The FEDS model does not consider programmable thermostats in the energy analysis. Programmable thermostats are considered a conservation measure rather than an equipment replacement or building improvement. Programmable thermostats could be a useful conservation measure in smaller commercial buildings or any building that is unoccupied during part of the day.

Implementation Options

Camp Smith would have a number of options for implementing the energy conservation measures (ECMs) identified in this assessment. As shown in Table 8, implementing the building level ECMs at Camp Smith (not including building 700) using appropriated funds would require an investment of about $1.95M, and result in 6,104 MMBtu/year representing $334,446/year savings with an overall savings to investment ratio (SIR) of 2.4. Using alternative financing (ESPC or UESC) would result in 4,255 MMBtu/year representing $250,226/year savings with an overall savings to investment ratio (SIR) of 1.5, for an investment cost of $1.0M. However, the investment cost under alternative financing does not include the financing charges over the life of the project.

The recommended option for implementing the building level ECMs would be to pursue appropriated funds either through the Energy Conservation Investment Program (ECIP) or sustainment, renovation, and modernization (SRM) at the Base level. This would result in the greatest energy and cost savingsf (see Table 8). The ECIP program within the Navy/Marines may not be an option for these building energy-efficiency ECMs as the focus of the current program is on renewable energy projects. If appropriated funds are not available, then alternative financing would provide the means to get most of the projects implemented without the upfront investment on the part of the USMC.

Table 8. Comparison of Funding Sources

Funding Source	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Estimated Financing Costs ($)	Total Cost ($)	SIR
Appropriated funding	6,104	334,446	1,949,694	0	1,949,694	2.4
Alternative financing	4,255	250,226	1,002,106	720,950	1,723,056	1.5

Public benefit funds may be available for some of these ECMs through Hawai'i Energy. Hawai'i Energy operates the new and expanded Hawai'i Energy-Efficiency Programs under contract to the Hawai'i Public Utilities Commission (HPUC) and they are paid for by electric utility ratepayer fees.

Emissions Reduction

Implementing all the cost-effective building retrofits using appropriated funds will result in a 9% reduction in greenhouse gas emissions. These reductions are summarized in table 9 and included for each building in appendix C.

Table 9. Reduction in Greenhouse Gas Emissions

Greenhouse Gas	Site Total
Sulfur Oxides (lb)	
existing	239,187
post-retrofit	217,924
difference	-21,263
% change	-9%
Nitrogen Oxides (lb)	
existing	115,152
post-retrofit	104,711
difference	-10,441
% change	-9%
Carbon Monoxide (lb)	
existing	198,676
post-retrofit	180,523
difference	-18,153
% change	-9%

Greenhouse Gas	Site Total
Carbon Dioxide (tons)	
existing	24,433
post-retrofit	22,209
difference	-2,225
% change	-9%
Particulate Matter (lb)	
existing	4,752
post-retrofit	4,325
difference	-427
% change	-9%
Hydrocarbons (lb)	
existing	81,979
post-retrofit	74,545
difference	-7,434
% change	-9%

Job Creation

The number of jobs created from implementation of all the cost-effective retrofits using appropriated funds is estimated to represent 33.6 job-years. One job-year is equal to $92,000 in capital spending for implementation.

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Appendix A

FEDS Data Collection Form

Appendix A
FEDS Data Collection Form

The following form is used to collect FEDS input data during building audits. Note that not all data types indicated on this form are applicable to all buildings. Nor is all the information indicated on this form always available. Where necessary, the FEDS model infers the values for missing data based on other known building characteristics.

FEDS Building Information for _____

Building Number / Description / Size:						
	Description	**% of building**	**# of floors**	**Occupancy Schedule:**	**Start**	**End**
Use Area 1				**Weekday:**		
Use Area 2				*(military time)* **Saturday:**		
Use Area 3				**Sunday:**		
Aspect ratio (N:E):				# Occupants: (occupied);		(unoccupied)
Zones: Single (1) Perimeter w/ halls (4) Central w/ perimeter (5)				**Unoccupied Months:**		

ENVELOPE

Roof type: BUILT-UP METAL PANEL SHINGLES/SHAKES	**Floor type:** SLAB ON GRADE CRAWL SPACE
- if built-up, deck type: WOOD CONCRETE METAL	- insulation? type / thickness / R-value:
- insulation? type / thickness / R-value:	- ground floor carpet (crawlspace only)? YES NO
- floor-floor height:	
- floor-ceiling height:	**Windows - #panes:** 1 2 3
- suspended ceiling? YES NO	**- frame type:** WOOD/VINYL METAL THERMAL BREAK METAL
Wall: WOOD SIDING MASONRY/WOOD MASONRY CURTAIN MET PANEL	- TINTING SHADING FILM
- insulation? type / thickness / R-value:	**- % of wall area that is glass:**

LIGHTING

Technology Type	**Fixture Description (size, #lamps, wattage, reflectors,** ballasts, application, etc.**)***	**Use Area or % of building served**	**Fixture density or count**	**Mounting Method**	Utilization
Exit Signs					
		Exterior		**--**	
		Exterior		**--**	
		Exterior		**--**	

INC = incandescent CFL = compact fluorescent FL = fluorescent MV = mercury vapor MH = metal halide HPS = high pressure sodium
LPS = low pressure sodium EX = exit sign *2-tube T12=2T12; 4-tube T12=4T12; 2-tube T8=2T8; 2-tube T5=2T5; 4-tube Biax=4BIAX

SERVICE HOT WATER

Portion of building set served (whole buildings) (sq. ft, %, # of buildings, or USE AREA)	**System 1:**	**System 2:**	**System 3:**
Fuel type			
System type	DISTRIBUTED LOOP	DISTRIBUTED LOOP	DISTRIBUTED LOOP
Equipment vintage			
Tank capacity (gallons, #tanks**)**			
Heating capacity (loop only)			
Thermostat set point, °F			
Tank insulation – thickness/R-value			
Efficiency			
Loop length (perimeter or stacked service)			
#Faucets / aerators installed (%)			
#Showers / low-flow showerheads installed (%)			
Note presence of: bottom boards, near tank pipe insul., tank wrap, heat traps, electronic pilots			

Auditor: _____ Date: _____ Sheet _____ of _____

HVAC

Portion of set NOT heated (ft^2, %, # of bldgs, use area):	**HEATING**		
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			
Portion of set NOT cooled (ft^2, %, # of bldgs, use area):	**COOLING**		
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 table identifies the buildings in the 27 facility categories defined by the assessment team (see Table B1). 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. Overall, PNNL audited 803,401 ft^2 of building space out of a total of 866,227 ft^2, or 93%.

Table B 1. FEDS Building Groups

Category Description [FEDS Facility Category Code]	Proxy (Audited) Building Number	Proxy Building (ft2)	Total Bldgs. in Category	Non-Audited Buildings in Group	Total Sq. Ft. in Category	Proxy Ft^2 % of category
1	11	--	11	49, 58, 67, 69, 70, 304, 306, 605, 605A, 606, 610	10,136	0%
10_a	20	75,585	1	--	75,585	100%
10_OldHosp_1	1	67,986	1	--	67,986	100%
10_OldHosp_2c	2C	37,336	1	--	37,336	100%
10_OldHosp_2D	2D	37,336	1	--	37,336	100%
10_OldHosp_3A	3A	31,582	1	--	31,582	100%
10_OldHosp_3B	3B	30,165	1	--	30,165	100%
10_OldHosp_4	4	84,129	1	--	84,129	100%
10_OldHosp_PXAud						
10_OldHosp_5	5, 5A	24,125	2	--	24,125	100%
10_OldHosp_80	80	37,300	1	--	37,300	100%
10_OldHosp_81	81	3,299	1	--	3,299	100%
10_OldHosp_Connectors	1A, 1B, 3AA, 2AA	28,291	4	--	28,291	100%
10_PACOM	700	284,658	3	701, 705	284,658	100%
10_PACOM_food	700 café					
10b	20E	2,520	1	--	2,520	100%
31_barracks	402	10,899	4	401, 403, 404	43,596	25%
40_Maint	600	20,900	1	--	20,900	100%
50_GEN	N/A	--	6	82, 603, 613, 600A, 601A, 20A	5,338	0%
50_UPS	602	374	2	20C	2,184	17%
80_Fire	612	7,126	1	--	7,126	100%
80_Misc	366	1,764	10	6, 17, 50, 52, 56, 367, 452, 453, 611	12,887	14%
80_NCO	500	7,020	1	--	7,020	100%
80_Police	601	3,888	1	--	3,888	100%

Category Description [FEDS Facility Category Code]	Proxy (Audited) Building Number	Proxy Building (ft2)	Total Bldgs. in Category	Non-Audited Buildings in Group	Total Sq. Ft. in Category	Proxy Ft² % of category
80_RB	450, 451	1600	2	450, 451	3322	100%
80_Pool	125	--	--	--	-	100%
80_RecCntr	501	5,518	1	--	5,518	100%
TOTALS		803,401	59		866,227	93%

Appendix C

Comprehensive List of Cost-Effective Projects Identified from the FEDS Assessment Using Appropriated/Alternative Financed Sources of Capital

Appendix C-1
Comprehensive List of Cost-Effective Projects Identified from the FEDS Assessment Using Appropriated Sources of Capital

Table C-1 identifies the 107 cost-effective energy- and cost-reducing retrofit projects identified from the FEDS modeling and analysis based on the assumption that the projects will be funded using appropriated source of capital funds. 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 C 1. Comprehensive Project List based on Appropriated Funding

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_a: Building 20	Replace existing air-cooled chiller with ultra-high efficiency water-cooled chiller and cooling tower.	1,110	62,639	207,657	682,402	4.4
	Replace existing water heater with heat pump water heater. Install aerators.	16	876	3,551	2,726	2.4
	Replace existing water heater with heat pump water heater. Install aerators.	7	327	447	1,495	7.2
	Replace existing 2, 75-W INC lamps with 2, 15-W CFL	248	15,223	13,012	250,896	20.3
	Replace existing 60-W INC flood light with 18-W CFL	5	403	97	6,872	72.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	417	2,440	4,811	3.0
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	349	20,200	86,293	263,560	4.1
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	239	13,872	60,144	180,133	4.0
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	86	4,408	9,768	66,576	7.8
	Replace existing 2x2 2-lamp U-tube T12 with 2x2 2-lamp U-tube T8.	36	2,979	9,807	41,877	5.3
	TOTAL	2,098	121,344	393,216	1,501,348	4.9
10_OldHosp_1: Old Hospital, Building 1	Replace existing window air-conditioners with ultra high efficiency window units.	53	3,065	30,679	2,724	1.2
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	10	540	674	2,630	11.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	4	830	4,674	9,754	3.1
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp 28-W super T8 with reflector.	80	4,953	36,785	49,059	2.3
	Replace existing 1x8 T12 with 1x8 T8.	55	3,718	30,709	33,723	2.1
	TOTAL	202	13,106	103,521	97,890	2.1
10_OldHosp_2c: Old Hospital, Building 2C	Replace existing window air-conditioners with ultra high efficiency window units.	90	5,181	56,980	1,931	1.1
	Replace existing water heater with heat pump water heater. Install aerators.	19	898	3,457	2,894	2.5
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install	4	246	389	1,168	9.2

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	aerators.					
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	489	2,804	5,715	3.0
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	163	935	1,905	3.0
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp 28-W super T8 with reflector.	73	4,521	25,756	52,576	3.0
	Replace existing 2x4 2-lamp T8 with 2x4 2-lamp 28-W super T8 with reflector.	13	583	8,897	1,195	1.1
	Replace existing 2x4 2-lamp T8 with 2x4 2-lamp 28-W super T8 with reflector.	13	583	8,897	1,195	1.1
	TOTAL	215	12,664	108,115	68,579	1.9
10_OldHosp_2D: Old Hospital, Building 2D	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	6	313	407	1,519	11.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	659	3,739	7,724	3.1
	TOTAL	9	972	4,146	9,243	3.4
10_OldHosp_3A: Old Hospital, Building 3A	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	182	10,662	68,056	50,042	2.3
	Replace existing window air-conditioners with ultra high efficiency window units.	35	1,939	19,779	1,531	1.1
	Insulate perimeter slab on grade by R-15.	5	304	4,116	1,149	1.3
	Increase insulation above suspended ceiling by R-19.	16	933	13,613	2,547	1.2
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	6	320	400	1,554	11.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	664	3,739	7,806	3.1
	Replace existing 1x4 2-lamp T12 with 1x4 2-lamp T8.	89	6,150	32,887	73,748	3.2
	TOTAL	336	20,972	142,590	138,377	2.3
10_OldHosp_3B: Old Hospital, Building 3B	Replace existing package A/C with very high efficiency unit.	22	2,316	19,995	3,845	1.4
	Replace existing water heater with heat pump water heater. Install aerators.	36	2,034	3,456	8,941	5.8
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	3	183	264	880	10.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	462	2,617	5,415	3.1

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	198	1,122	2,321	3.1
	TOTAL	64	5,193	27,454	21,402	2.4
10_OldHosp_4: Old Hospital, Building 4	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	355	19,356	105,617	100,844	2.7
	Replace existing window air-conditioners with ultra high efficiency window units.	236	13,193	123,315	16,293	1.3
	Service Hot Water: Wrap tank with insulation and install aerators.	19	647	286	13,775	49.2
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	10	559	663	2,734	12.3
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	421	2,384	4,918	3.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	74	421	868	3.1
	TOTAL	622	34,250	232,686	139,432	2.2
10_OldHosp_5: Old Hospital, Building 5	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	294	16,270	82,282	88,636	2.9
	Insulate perimeter slab on grade by R-15.	10	494	5,088	3,460	1.7
	Increase insulation above suspended ceiling by R-19.	33	1,657	20,797	7,898	1.4
	Service Hot Water: Wrap tank with insulation and install aerators.	29	976	258	20,949	82.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	337	1,870	3,985	3.1
	TOTAL	368	19,734	110,295	124,928	2.7
10_OldHosp_80: Old Hospital, Building 80	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	522	27,815	151,553	145,125	2.7
	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	378	20,206	95,081	114,048	3.1
	Service Hot Water: Wrap tank with insulation and install aerators.	16	541	244	11,500	48.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	242	1,402	2,801	3.0
	TOTAL	917	48,804	248,280	273,474	2.9
10_OldHosp_81: Old	Replace existing package A/C with very high efficiency unit.	25	2,023	22,223	849	1.1

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
Hospital, Building 81	Replace existing window air-conditioners with ultra high efficiency window units.	4	217	2,025	268	1.3
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	1	61	126	280	7.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	162	935	1,888	3.0
	Replace existing 2x4 4-lamp T8 with 2x4 4-lamp 28-W super T8 with reflector.	13	636	8,101	2,897	1.4
	TOTAL	44	3,099	33,410	6,182	1.4
10_OldHosp_Connectors: Old Hospital, Buildings	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	5	275	562	1,257	7.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	7	1,307	7,479	15,254	3.0
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp 28-W super T8 with reflector.	27	1,662	12,246	16,545	2.4
	TOTAL	39	3,244	20,287	33,056	2.7
10_OldHosp_PXAud: Old Hospital, Building 4/PX and Auditorium	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	173	13,328	107,166	50,341	1.8
	Insulate perimeter slab on grade by R-15.	4	225	3,242	652	1.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	188	1,084	2,188	3.0
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	67	393	792	3.0
	Replace existing 2x4 4-lamp T8 with 2x4 4-lamp 28-W super T8 with reflector.	21	1,251	14,774	6,919	1.5
	TOTAL	199	15,059	126,659	60,892	1.7
10_PACOM: Bldg 700 PACOM	Service Hot Water: Wrap tank with insulation.	62	1,633	982	41,786	43.6
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	7	867	4,768	10,289	3.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	153	841	1,818	3.2
	Replace existing 2x4 2-lamp T8 with 2x4 2-lamp 28-W super T8 with reflector.	237	9,330	127,209	34,428	1.3
	Replace existing 2x4 2-lamp T8 with 2x4 2-lamp 28-W super T8 with reflector.	42	1,657	22,449	6,268	1.3
	Replace existing 2x4 3-lamp T8 with 2x4 3-lamp 28-W super T8 with reflector.	1,498	61,025	539,121	518,280	2.0
	Replace existing 2x4 3-lamp T8 with 2x4 3-lamp 28-W super T8 with reflector.	267	10,835	95,139	92,605	2.0

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	Replace existing 2x4 4-lamp T8 with 2x4 4-lamp 28-W super T8 with reflector.	949	35,402	296,363	316,799	2.1
	Replace existing 2x4 4-lamp T8 with 2x4 4-lamp 28-W super T8 with reflector.	169	6,285	52,299	56,559	2.1
	TOTAL	3,232	127,187	1,139,171	1,078,832	2.0
10_PACOM_food: Bldg 700 PACOM Food Service	Service Hot Water: Wrap tank with insulation.	1	23	54	545	11.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	57	312	673	3.2
	TOTAL	1	80	366	1,218	4.4
10b: Building 20E, Admin/Training	Replace existing water heater with heat pump water heater.	11	639	3,439	1,526	1.8
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	54	312	638	3.0
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp T8.	25	1,721	14,304	15,538	2.1
	TOTAL	36	2,414	18,055	17,702	2.1
31_barracks: barracks complex (401-404)	Replace existing central hot water heat exchanger with heat pump water heater. Wrap tank with insullation and install LFSHs.	718	17,409	255,624	102,398	1.3
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	5	975	5,609	11,354	3.0
	TOTAL	723	18,384	261,233	113,752	1.3
40_Maint: Maintenance B600	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	42	249	487	3.0
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	63	374	730	3.0
	TOTAL	<1	105	623	1,217	3.0
50_GEN: Generator Buildings/Shelters	Replace existing INC exit signs with electroluminescent panel retrofit kit.	28	2,065	1,870	33,953	19.2
	TOTAL	28	2,065	1,870	33,953	19.2
50_UPS: UPS Building 602	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	102	623	1,155	2.9
	TOTAL	<1	102	623	1,155	2.9
80_Fire: Fire Station B612	Service hot water: Wrap tank with insulation and insulate pipes.	<1	21	112	76	1.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	110	623	1,281	3.1
	TOTAL	1	131	735	1,357	2.9
80_Misc:	Insulate perimeter slab on grade by R-15.	15	1,010	15,335	2,146	1.1

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	Add 4" fiberglass insulation to interior surface of metal roof.	60	4,101	44,081	26,929	1.6
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	543	3,116	6,322	3.0
	TOTAL	78	5,654	62,532	35,397	1.5
80_NCO: NCO Club, B500	Service hot water: Wrap tank with insulation.	9	198	124	4,182	34.8
	Replace existing 25-W INC lamp with 9-W CFL	7	326	2,084	3,606	2.7
	Replace existing 60-W INC lamp with 13-W CFL	21	1,263	232	21,833	95.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	57	312	668	3.1
	Replace existing metal frame, single-pane window with aluminum double-pane super Low-e window.	17	999	13,809	3,496	1.3
	TOTAL	54	2,843	16,561	33,785	3.3
80_Police: B601 Police Station	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	106	623	1,225	3.0
	TOTAL	<1	106	623	1,225	3.0
80_Pool: Outdoor Pool	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators. Lower tank temperature.	3	147	401	642	5.4
	Replace existing 7.5hp ODP motor with 91.7% efficient motor.	22	1,030	956	6,523	12.6
	TOTAL	25	1,177	1,357	7,165	11.1
80_RB: Indoor racquetball/handball courts (450 & 451)	Replace 400-W metal halide with 310-W high pressure sodium lamp.	9	639	10,128	948	1.1
	TOTAL	9	639	10,128	948	1.1
80_RecCntr: Bldg 501 Rec center	Increase insulation above suspended ceiling by R-19.	10	763	9,514	3,708	1.4
	Replace existing water heater with heat pump water heater.	11	549	2,020	1,865	2.7
	Replace existing 75-W INC lamp with 23-W CFL	2	161	48	2,688	56.6
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	56	312	654	3.1
	Replace existing 2x4 3-lamp T8 with 2x4 3-lamp 28-W super T8 with reflector.	4	246	3,574	706	1.2
	Replace existing metal frame, single-pane window with aluminum double-pane super Low-e window.	10	610	9,227	1,349	1.1

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	TOTAL	37	2,385	24,695	10,970	1.4

Appendix C-2
Comprehensive List of Cost-Effective Projects Identified from the FEDS Assessment Using Alternative Financing Source of Capital

Table C-2 identifies the 72 cost-effective energy- and cost-reducing retrofit projects identified from the FEDS modeling and analysis based on the assumption that they will be funded using alternative financing source of capital funds. Alternative financing includes UESC and ESPC, as well as any other third party financing. Key energy and economic results are presented for each cost-effective retrofit measure. The projects are grouped by building category.

Table C 2. Comprehensive Project List based on Alternative Funding

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_a: Building 20	Replace existing air-cooled chiller with ultra-high efficiency water-cooled chiller and cooling tower.	1,110	62,639	207,657	169,296	1.8
	Service hot water: Install faucet aerators and lower tank temperature.	8	462	124	2,661	22.5
	Replace existing water heater with heat pump water heater. Install aerators.	7	327	447	1,519	4.4
	Replace existing 2, 75-W INC lamps with 2, 15-W CFL	248	15,637	13,012	81,553	7.3
	Replace existing 60-W INC flood light with 18-W CFL	5	408	97	2,371	25.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	457	2,440	356	1.1
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	349	22,839	86,293	51,626	1.6
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	239	15,711	60,144	34,745	1.6
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	86	4,641	9,768	18,222	2.9
	Replace existing 2x2 2-lamp U-tube T12 with 2x2 2-lamp U-tube T8.	36	3,428	9,807	11,007	2.1
	TOTAL	2,090	126,549	389,789	373,356	2.0
10_OldHosp_1: Old Hospital, Building 1	Service hot water: Install faucet aerators.	8	466	114	2,690	24.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	4	908	4,674	878	1.2
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp T8.	42	3,161	15,944	3,204	1.2
	TOTAL	54	4,535	20,732	6,772	1.3
10_OldHosp_2c: Old Hospital, Building 2C	Service hot water: Install faucet aerators.	3	202	54	1,159	22.6
	Service hot water: Install faucet aerators and lower tank temperature.	8	408	30	2,423	82.9
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	541	2,804	513	1.2

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	180	935	171	1.2
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp T8.	56	4,116	16,654	8,256	1.5
	TOTAL	71	5,447	20,477	12,522	1.6
10_OldHosp_2D: Old Hospital, Building 2D	Service hot water: Install faucet aerators.	5	268	72	1,545	22.6
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	720	3,739	668	1.2
	TOTAL	8	988	3,811	2,213	1.6
10_OldHosp_3A: Old Hospital, Building 3A	Service hot water: Install faucet aerators.	5	275	64	1,589	25.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	4	740	3,739	787	1.2
	Replace existing 1x4 2-lamp T12 with 1x4 2-lamp T8.	97	6,847	32,887	8,552	1.3
	TOTAL	106	7,862	36,690	10,928	1.3
10_OldHosp_3B: Old Hospital, Building 3B	Service hot water: Install faucet aerators.	3	154	40	885	23.1
	Replace existing water heater with heat pump water heater. Install aerators.	36	2,034	3,456	8,779	3.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	506	2,617	477	1.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	217	1,122	204	1.2
	TOTAL	42	2,911	7,235	10,345	2.5
10_OldHosp_4: Old Hospital, Building 4	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	351	19,044	105,617	8,898	1.1
	Service hot water: Install faucet aerators.	8	485	103	2,815	28.2
	Replace existing central hot water heat exchanger with heat pump water heater and abandon loop.	51	1,418	17,213	(4,564)	
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	462	2,384	442	1.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	81	421	78	1.2
	TOTAL	412	21,490	125,738	7,669	1.1

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_5: Old Hospital, Building 5	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	306	16,711	85,037	15,538	1.2
	Replace existing central hot water heat exchanger with heat pump water heater and abandon loop.	56	1,653	12,953	1,449	1.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	366	1,870	365	1.2
	TOTAL	364	18,730	99,860	17,352	1.2
10_OldHosp_80: Old Hospital, Building 80	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	522	27,815	151,553	15,766	1.1
	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	378	20,206	95,081	26,477	1.3
	Replace existing central hot water heat exchanger with electric water heater with R-24 insulation, install aerators, and lower tank temperature (abandon loop).	20	383	10,261	(5,600)	
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	265	1,402	217	1.2
	TOTAL	921	48,669	258,297	36,860	1.2
10_OldHosp_81: Old Hospital, Building 81	Service hot water: Install faucet aerators.	1	46	14	265	19.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	178	935	161	1.2
	TOTAL	2	224	949	426	1.5
10_OldHosp_Connectors: Old Hospital, Buildings 1A, 1B, 2AA, 3AA	Service hot water: Install faucet aerators.	4	216	114	1,181	11.3
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	7	1,430	7,479	1,266	1.2
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp T8.	14	1,054	5,308	1,075	1.2
	TOTAL	25	2,700	12,901	3,522	1.3
10_OldHosp_PXAud: Old Hospital, Building 4/PX and Auditorium	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	212	1,084	212	1.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	76	393	77	1.2
	TOTAL	1	288	1,477	289	1.2

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_PACOM: Bldg 700 PACOM Center	Service Hot Water: Wrap tank with insulation.	62	1,633	982	12,484	13.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	7	945	4,768	1,002	1.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	166	841	176	1.2
	TOTAL	70	2,744	6,591	13,662	3.0
10_PACOM_food: Bldg 700 PACOM Food Service	Service Hot Water: Wrap tank with insulation.	1	23	54	135	3.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	61	312	65	1.2
	TOTAL	1	84	366	200	1.5
10b: Building 20E	Replace existing water heater with heat pump water heater.	11	639	3,439	403	1.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	59	312	53	1.2
	TOTAL	11	698	3,751	456	1.1
31_barracks: barracks complex (401-404)	Service hot water: Wrap tank with insulation and install LFSHs.	37	1,068	1,061	7,743	8.3
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	5	1,067	5,609	921	1.2
	TOTAL	42	2,135	6,670	8,664	2.5
40_Maint: Maintenance B600	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	46	249	35	1.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	69	374	52	1.1
	TOTAL	<1	115	623	87	1.1
50_GEN: Generator Buildings/Shelters	Replace existing INC exit signs with electroluminescent panel retrofit kit.	28	2,089	1,870	10,793	6.8
	TOTAL	28	2,089	1,870	10,793	6.8
50_UPS: UPS Building 602	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	113	623	65	1.1
	TOTAL	<1	113	623	65	1.1
80_Fire: Fire Station B612	Service hot water: Wrap tank with insulation and insulate pipes.	<1	21	112	13	1.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	121	623	109	1.2

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	TOTAL	1	142	735	122	1.2
80_Misc:	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	587	3,116	480	1.2
	TOTAL	3	587	3,116	480	1.2
80_NCO: NCO Club, B500	Service hot water: Wrap tank with insulation.	9	198	124	1,511	13.2
	Replace existing 25-W INC lamp with 9-W CFL	7	432	2,084	529	1.3
	Replace existing 60-W INC lamp with 13-W CFL	21	1,245	232	7,349	32.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	61	312	62	1.2
	TOTAL	37	1,936	2,752	9,451	4.9
80_Police: B601 Police Station	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	117	623	90	1.1
	TOTAL	<1	117	623	90	1.1
80_Pool: Outdoor Pool	Service hot water: Install faucet aerators and lower tank temperature.	2	100	51	561	12.0
	Replace existing 7.5hp ODP motor with 91.7% efficient motor.	22	1,030	956	5,242	6.5
	TOTAL	24	1,130	1,007	5,803	6.8
80_RecCntr: Bldg 501 Rec center	Replace existing water heater with heat pump water heater.	11	549	2,020	1,331	1.7
	Replace existing 75-W INC lamp with 23-W CFL	2	162	48	915	19.9
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	60	312	57	1.2
	TOTAL	13	771	2,380	2,303	2.0

Appendix D

Building Details

Appendix D
Building Details

The following information identifies the cost-effective energy- and cost-reducing retrofit projects for the buildings visited during the FEDS modeling and analysis. Key energy and economic results are presented for each cost-effective retrofit measure.

Building 1 Administration Building

Building 1 is the only building in FEDS building group: 10_OldHosp_1. Building 1 is a 4-floor administrative building that is part of the old hospital complex. The building, constructed in 1942 as part of the original hospital complex, has a total area of 67,986 square feet. The building includes a basement with occupied space. The building is connected on 3 floors to Buildings 1A, 1B, and 4.

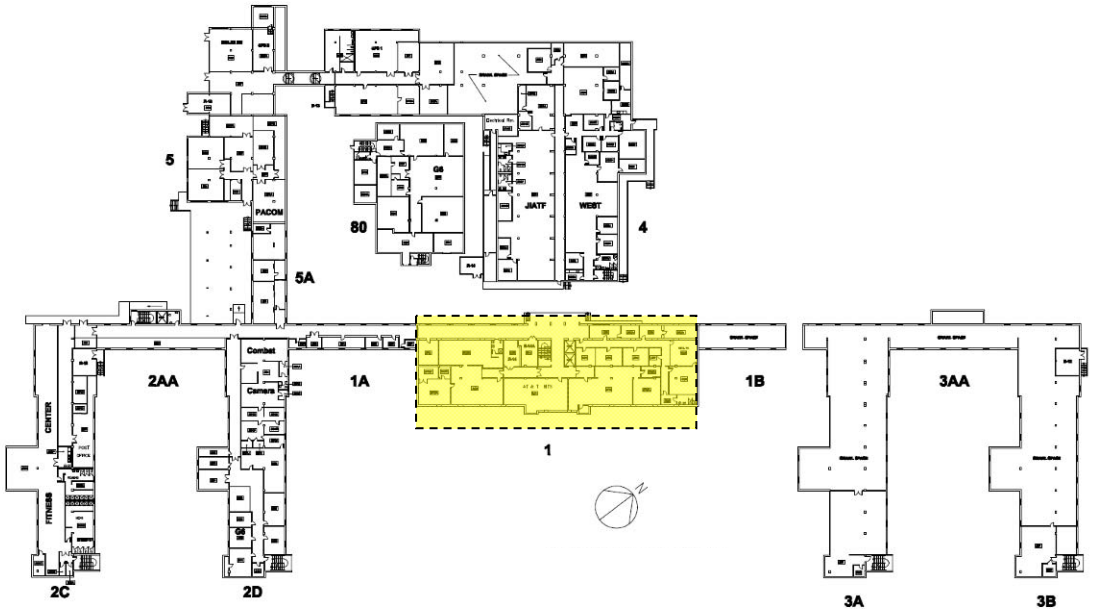


Figure D 1. Camp Smith "Old Hospital" Office Complex, Building 1

Space cooling is provided through a combination of 23 window air-conditioning units, 3 larger package units (total 104 tons), and 14 smaller to mid-size package units totaling 54 tons. Cooling was obviously added in stages over time with no unified approach to space cooling this building.

Similar to the cooling system, lighting has been replaced in an ad hoc fashion over time. Building 1 has 1x4 two-lamp T8 (25%); 1x8 one-lamp T12 (16%); 1x8 one-lamp T8

(16%); 2x4 two-lamp T12; 2x4 three-lamp T8 (30%); and CFL ceiling fixtures. These lights include pendent-mounted, flush-mounted, and recessed-mounted fixtures.

Service hot water is provided by electric hot water heaters installed near restroom locations.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 1,155,079 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 1,139,598 kWh before retrofits and 1,080,194 kWh after proposed retrofits are implemented. The energy use intensity goes from 57.2 MBtu/Ksf to 54.2 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type

Building Set ... 10_OldHosp_1
Old Hospital, Building 1

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	1,139,598	16,762.2	57.2	199,572
post-retrofit	1,080,194	15,888.5	54.2	188,513
difference	-59,403	-873.8	-3.0	-11,059
% change	-5	-5	-5	-6
Total (MBtu)				
existing	3,889	57.2	57.2	199,572
post-retrofit	3,687	54.2	54.2	188,513
difference	-203	-3.0	-3.0	-11,059
% change	-5	-5	-5	-6

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Space cooling is the largest load in the building with 426,736 kWh/year, followed by motors and miscellaneous equipment with 349,258 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_1
Old Hospital, Building 1

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	426,736	89,321	267,458	349,258	6,825
post-retrofit	0	402,044	86,968	237,908	349,258	4,015
difference	0	-24,691	-2,352	-29,549	0	-2,810
% change	0	-6	-3	-11	0	-41
Total (MBtu)						
existing	0	1,456	305	913	1,192	23
post-retrofit	0	1,372	297	812	1,192	14
difference	0	-84	-8	-101	0	-10
% change	0	-6	-3	-11	0	-41
Total (MBtu/1000ft2)						
existing	0	21	4	13	18	0
post-retrofit	0	20	4	12	18	0
difference	0	-1	0	-1	0	0
% change	0	-6	-3	-11	0	-41

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Building Set... 10_OldHosp_1
Old Hospital, Building 1

Sulfur Oxides (lb)	
existing	10,302
post-retrofit	9,765
difference	-537
% change	-5
Nitrogen Oxides (lb)	
existing	4,923
post-retrofit	4,666
difference	-257
% change	-5
Carbon Monoxide (lb)	
existing	8,467
post-retrofit	8,026
difference	-441
% change	-5
Carbon Dioxide (tons)	
existing	1,043
post-retrofit	988
difference	-54
% change	-5
Particulate Matter (lb)	
existing	204
post-retrofit	193
difference	-11
% change	-5
Hydrocarbons (lb)	
existing	3,504
post-retrofit	3,322
difference	-183
% change	-5

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_1: Old Hospital, Building 1	Replace existing window air-conditioners with ultra high efficiency window units.	53	3,065	30,679	2,724	1.2
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	10	540	674	2,630	11.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	4	830	4,674	9,754	3.1
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp 28-W super T8 with reflector.	80	4,953	36,785	49,059	2.3
	Replace existing 1x8 T12 with 1x8 T8.	55	3,718	30,709	33,723	2.1
	TOTAL	202	13,106	103,521	97,890	2.1

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_1: Old Hospital, Building 1	Service hot water: Install faucet aerators.	8	466	114	2,690	24.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	4	908	4,674	878	1.2

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp T8.	42	3,161	15,944	3,204	1.2
	TOTAL	54	4,535	20,732	6,772	1.3

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model. A new central chiller plant for the entire "old hospital" complex was not considered during this assessment because the long-term plans call for these facilities to be replaced.

The rear part of the library on the second floor of Building 1 has a wall that was installed over existing windows. When the wall was installed, the windows were not properly filled in and insulated. The wall temperature inside the library was 125°F on a mild day. These windows should be properly insulated and/or reflective material installed to help maintain library temperatures.

Photos

Because of security concerns, interior photos were not permitted during the assessment.

Figure D 2. Building 1 Front Side Main Entrance

Figure D 3. Building 1 Rear View

Building 1A Administration Building Connectors

Building 1A, 2AA, 1B, and 3AA were all audited during the site visit and modeled as a single building group. These buildings are the "connectors" between the other larger buildings. Although they provide connecting hallways for traffic to flow between buildings, they also have office suites on all levels. These buildings have a higher hallway to office space ratio than typical administration buildings.

This FEDS building group, 10_OldHosp_connectors, has four buildings with a total of 148,853ft^2.

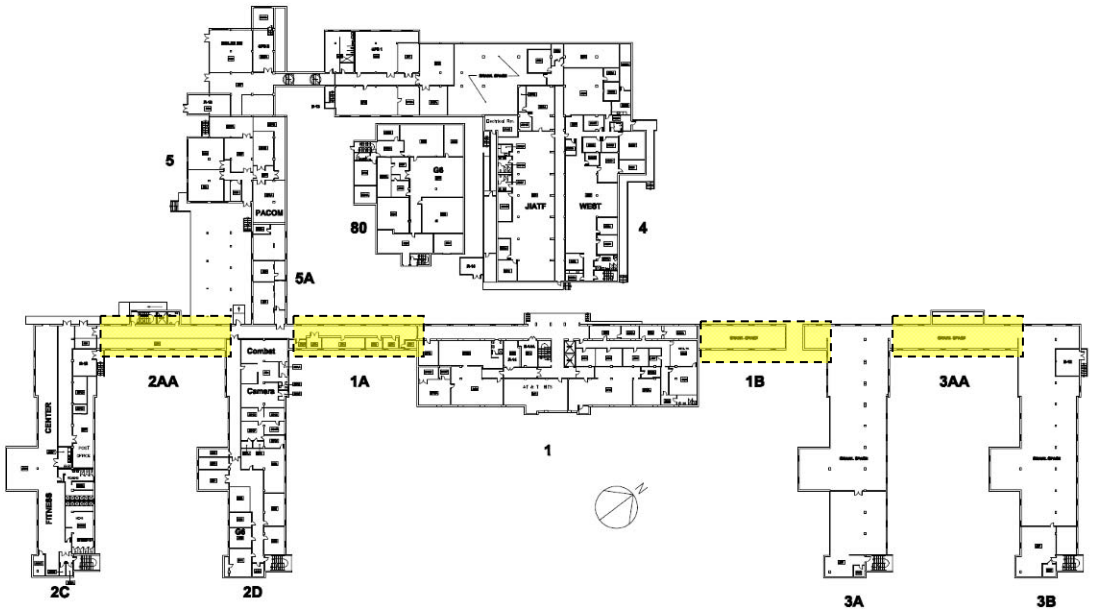


Figure D 4. Camp Smith "Old Hospital" Office Complex Connectors

Space cooling is provided entirely by window units in the office suites. Hallways are only partially cooled by cool air that moves from the offices or flows from the other connected buildings.

The lighting has been mostly updated over time with only 8% of lights using T12 and magnetic ballasts. Lighting consists of 2x4 four-tube T8 fixtures (25%), 2x4 two-tube T8 fixtures (67%), and 2x4 two-tube T12 fixtures (8%).

Service hot water is provided by electric hot water heaters installed near restroom locations.

Energy Consumption by Fuel Type

Actual metered data for these building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 406,903 kWh for Building 1A, 2AA, 1B, and 3AA. The modeled energy consumption for a typical year (using TMY weather data) was 401,402 kwh before retrofits and 394,312 kWh after proposed retrofits are implemented. The energy use intensity goes from 48.4 MBtu/Ksf to 47.6 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_OldHosp_Connectors
Old Hospital, Buildings 1A, 1B, 2AA, 3AA

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	401,402	14,188.3	48.4	70,296
post-retrofit	394,312	13,937.7	47.6	68,892
difference	-7,090	-250.6	-0.9	-1,403
% change	-2	-2	-2	-2
Total (MBtu)				
existing	1,370	48.4	48.4	70,296
post-retrofit	1,346	47.6	47.6	68,892
difference	-24	-0.9	-0.9	-1,403
% change	-2	-2	-2	-2

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

The motors and other miscellaneous loads are estimated to consume 147,337 kWh/year, while cooling is the second largest consumer with over 147,059 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_Connectors
Old Hospital, Buildings 1A, 1B, 2AA, 3AA

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	147,059	6,572	98,660	145,337	3,774
post-retrofit	0	144,474	6,439	91,630	145,337	2,323
difference	0	-2,585	-133	-7,031	0	-1,452
% change	0	-2	-2	-7	0	-38
Total (MBtu)						
existing	0	502	22	337	496	13
post-retrofit	0	493	22	313	496	8
difference	0	-9	0	-24	0	-5
% change	0	-2	-2	-7	0	-38
Total (MBtu/1000ft2)						
existing	0	18	1	12	18	0
post-retrofit	0	17	1	11	18	0
difference	0	0	0	-1	0	0
% change	0	-2	-2	-7	0	-38

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_OldHosp_Connectors
Old Hospital, Buildings 1A, 1B, 2AA, 3AA

Sulfur Oxides (lb)	
existing	2,204
post-retrofit	2,086
difference	-118
% change	-5
Nitrogen Oxides (lb)	
existing	1,053
post-retrofit	997
difference	-56
% change	-5
Carbon Monoxide (lb)	
existing	1,811
post-retrofit	1,715
difference	-97
% change	-5
Carbon Dioxide (tons)	
existing	223
post-retrofit	211
difference	-12
% change	-5
Particulate Matter (lb)	
existing	44
post-retrofit	41
difference	-2
% change	-5
Hydrocarbons (lb)	
existing	750
post-retrofit	710
difference	-40
% change	-5

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_Connectors: Old Hospital, Buildings	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	5	275	562	1,257	7.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	7	1,307	7,479	15,254	3.0
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp 28-W super T8 with reflector.	27	1,662	12,246	16,545	2.4
	TOTAL	39	3,244	20,287	33,056	2.7

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_Connectors: Old Hospital, Buildings 1A, 1B, 2AA, 3AA	Service hot water: Install faucet aerators.	4	216	114	1,181	11.3
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	7	1,430	7,479	1,266	1.2
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp T8.	14	1,054	5,308	1,075	1.2
	TOTAL	25	2,700	12,901	3,522	1.3

Additional Considerations

A new central chiller plant for the entire “old hospital” complex was not considered during this assessment because the long-term plans call for these facilities to be replaced.

Photos

Because of security concerns, interior photos were not permitted during the assessment.

Figure D 5. Building 1A South Wall Showing Office Suites with Window Units

Figure D 6. Building 1A North Wall with Hallways Along Exterior Wall.

Building 2C Administration Building

Building 2C is the only building in FEDS building group: 10_OldHosp_2c. Building 2c is a three-floor administrative building that is part of the old hospital complex. The building, constructed in 1942, has a total area of 37,336 ft^2. The building is primarily administrative, although the basement was converted to a fitness center when the old fitness center was demolished. The building is connected on three floors to Building 2AA.

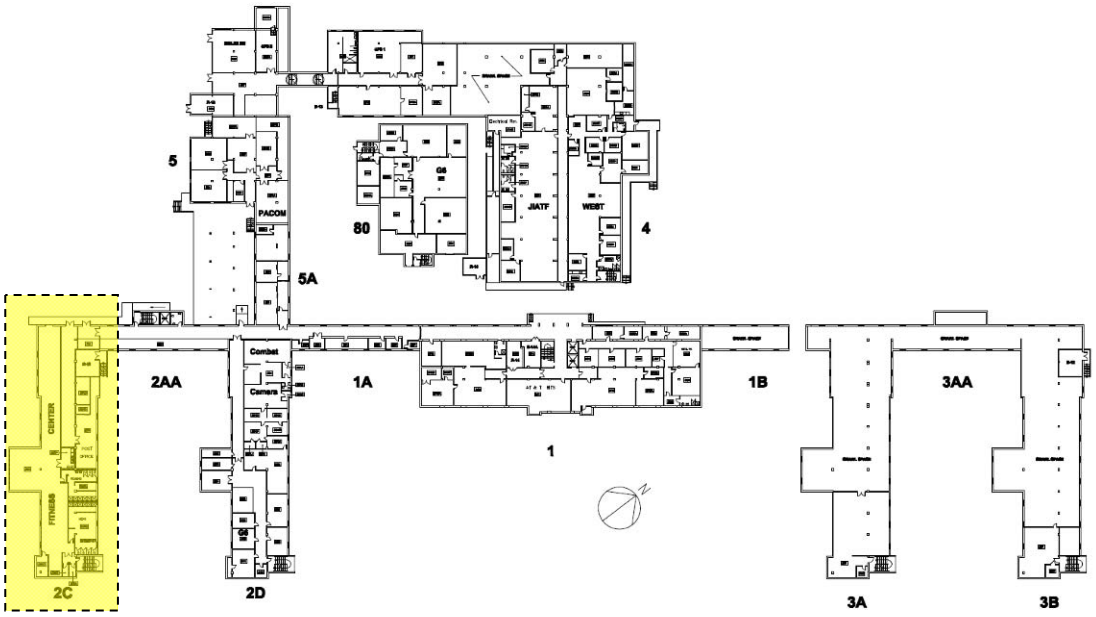


Figure D 7. Camp Smith "Old Hospital" Office Complex, Building 2C

Space cooling is provided predominantly by 69 window air-conditioning units and 2 small package units providing approximately 8 tons of cooling.

Lighting on the admin floors of Building 2C is almost entirely 2x4 two-tube T8 fixtures (83%), but some 2x4 two-tube T12 fixtures are still found. Lighting in the fitness center is a mix of 1x4 and 2x4 two-tube T8 fixtures.

Service hot water is provided by electric water heaters.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 545,840 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 541,644 kWh before retrofits and 477,774 kWh after proposed retrofits are implemented. The energy use intensity goes from 49.5 MBtu/Ksf to 43.7 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_OldHosp_2c
Old Hospital, Building 2C, Admin + basement fitness center

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	541,644	14,507.3	49.5	94,855
post-retrofit	477,774	12,796.6	43.7	83,380
difference	-63,871	-1,710.7	-5.8	-11,475
% change	-12	-12	-12	-12
Total (MBtu)				
existing	1,849	49.5	49.5	94,855
post-retrofit	1,631	43.7	43.7	83,380
difference	-218	-5.8	-5.8	-11,475
% change	-12	-12	-12	-12

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Space cooling is the largest end use in this building consuming 181,337 kWh/year, followed by lighting, which consumes 184,119 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_2c
Old Hospital, Building 2C, Admin + basement fitness center

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water *
Electricity (kWh)						
existing	0	181,337	23,170	184,119	143,852	9,166
post-retrofit	0	146,983	23,133	161,353	143,852	2,453
difference	0	-34,354	-37	-22,766	0	-6,713
% change	0	-19	0	-12	0	-73
Total (MBtu)						
existing	0	619	79	628	491	31
post-retrofit	0	502	79	551	491	8
difference	0	-117	0	-78	0	-23
% change	0	-19	0	-12	0	-73
Total (MBtu/1000ft2)						
existing	0	17	2	17	13	1
post-retrofit	0	13	2	15	13	0
difference	0	-3	0	-2	0	-1
% change	0	-19	0	-12	0	-73

* Energy consumption values for both distributed and central service hot water (SHW) are reported for Hot Water annual energy use.

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_OldHosp_2c
Old Hospital, Building 2C, Admin + basement fitness center

Sulfur Oxides (lb)	
existing	4,896
post-retrofit	4,319
difference	-577
% change	-12
Nitrogen Oxides (lb)	
existing	2,340
post-retrofit	2,064
difference	-276
% change	-12
Carbon Monoxide (lb)	
existing	4,024
post-retrofit	3,550
difference	-475
% change	-12
Carbon Dioxide (tons)	
existing	496
post-retrofit	437
difference	-58
% change	-12
Particulate Matter (lb)	
existing	97
post-retrofit	85
difference	-11
% change	-12
Hydrocarbons (lb)	
existing	1,666
post-retrofit	1,469
difference	-196
% change	-12

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_2c: Old Hospital, Building 2C	Replace existing window air-conditioners with ultra high efficiency window units.	90	5,181	56,980	1,931	1.1
	Replace existing water heater with heat pump water heater. Install aerators.	19	898	3,457	2,894	2.5
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	4	246	389	1,168	9.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	489	2,804	5,715	3.0
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	163	935	1,905	3.0
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp 28-W super T8 with reflector.	73	4,521	25,756	52,576	3.0
	Replace existing 2x4 2-lamp T8 with 2x4 2-lamp 28-W super T8 with reflector.	13	583	8,897	1,195	1.1
	Replace existing 2x4 2-lamp T8 with 2x4 2-lamp 28-W super T8 with reflector.	13	583	8,897	1,195	1.1
	TOTAL	215	12,664	108,115	68,579	1.9

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_2c: Old Hospital, Building 2C	Service hot water: Install faucet aerators.	3	202	54	1,159	22.6
	Service hot water: Install faucet aerators and lower tank temperature.	8	408	30	2,423	82.9
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	541	2,804	513	1.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	180	935	171	1.2
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp T8.	56	4,116	16,654	8,256	1.5
	TOTAL	71	5,447	20,477	12,522	1.6

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model. A new central chiller plant for the entire "old hospital" complex was not considered during this assessment because the long-term plans call for these facilities to be replaced.

Photos

Because of security concerns, interior photos were not permitted during the assessment.

Figure D 8. Building 2C South Side

Figure D 9. Building 2C North Wall

Building 2D Administration Building

Building 2D is the only building in FEDS building group: 10_OldHosp_2d. Building 2D is a three-floor administrative building that is part of the old hospital complex. The building, constructed in 1942, has a total area of 37,336ft^2. The building includes a basement with some occupied space. The building is connected on three floors to Buildings 2AA, 1A, and 5A.

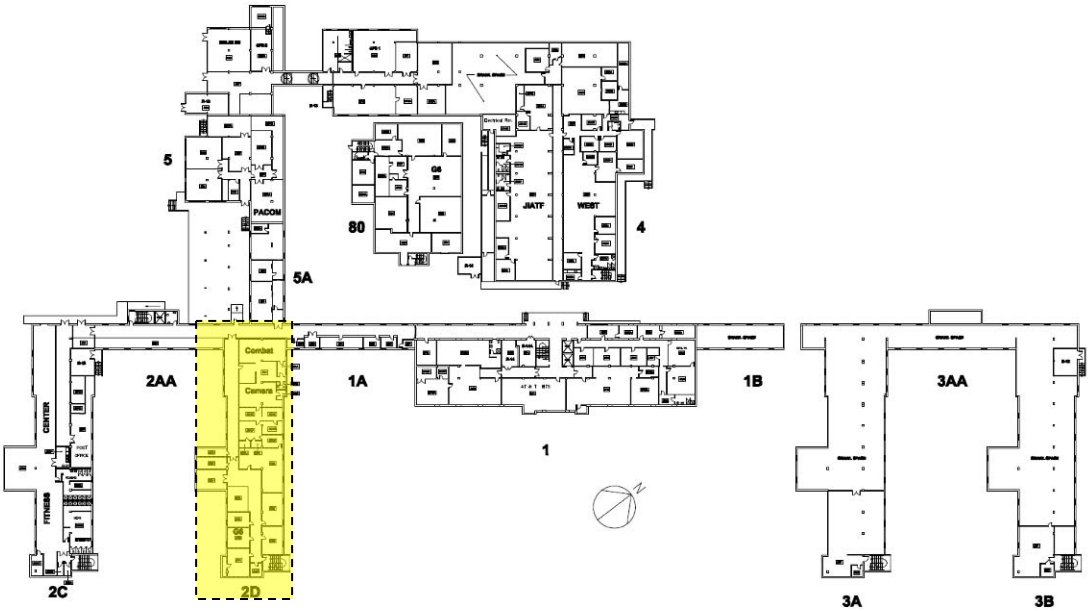


Figure D 10. Camp Smith "Old Hospital" Office Complex, Building 2D

Space cooling for the building is provided by 67 window air-conditioning units in addition to 3 small package units with a total of 14 tons.

Lighting is predominantly 2x4 four-tube T8 fixtures, although a couple of 2x4 two-tube T8 fixtures were found. The basement had a few 2x4 two-tube T12 fixtures.

Service hot water is provided by electric water heaters.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 506,436 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 502,328 kwh before retrofits and 442,276 kWh after proposed retrofits are implemented. The energy use intensity goes from 45.9 MBtu/Ksf to 40.4 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_OldHosp_2D
Old Hospital, Building 2D

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	502,328	13,454.2	45.9	87,970
post-retrofit	499,698	13,383.8	45.7	87,206
difference	-2,630	-70.4	-0.2	-764
% change	-1	-1	-1	-1
Total (MBtu)				
existing	1,714	45.9	45.9	87,970
post-retrofit	1,705	45.7	45.7	87,206
difference	-9	-0.2	-0.2	-764
% change	-1	-1	-1	-1

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

The motors and other miscellaneous loads are estimated to consume 191,803 kWh/year, while cooling is the second largest consumer with over 158,318 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_2D
Old Hospital, Building 2D

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	158,318	24,880	123,060	191,803	4,267
post-retrofit	0	158,059	24,834	122,366	191,803	2,636
difference	0	-259	-46	-694	0	-1,631
% change	0	0	0	-1	0	-38
Total (MBtu)						
existing	0	540	85	420	655	15
post-retrofit	0	539	85	418	655	9
difference	0	-1	0	-2	0	-6
% change	0	0	0	-1	0	-38
Total (MBtu/1000ft2)						
existing	0	14	2	11	18	0
post-retrofit	0	14	2	11	18	0
difference	0	0	0	0	0	0
% change	0	0	0	-1	0	-38

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_OldHosp_2D
Old Hospital, Building 2D

Sulfur Oxides (lb)	
existing	4,541
post-retrofit	4,517
difference	-24
% change	-1
Nitrogen Oxides (lb)	
existing	2,170
post-retrofit	2,159
difference	-11
% change	-1
Carbon Monoxide (lb)	
existing	3,732
post-retrofit	3,713
difference	-20
% change	-1
Carbon Dioxide (tons)	
existing	460
post-retrofit	457
difference	-2
% change	-1
Particulate Matter (lb)	
existing	90
post-retrofit	89
difference	0
% change	-1
Hydrocarbons (lb)	
existing	1,545
post-retrofit	1,537
difference	-8
% change	-1

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_2D	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	6	313	407	1,519	11.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	659	3,739	7,724	3.1
	TOTAL	9	972	4,146	9,243	3.4

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_2D	Service hot water: Install faucet aerators.	5	268	72	1,545	22.6
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	720	3,739	668	1.2
	TOTAL	8	988	3,811	2,213	1.6

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model. A new central chiller plant for the entire "old hospital" complex was not considered during this assessment because the long-term plans call for these facilities to be replaced.

Photos

Because of security concerns, interior photos were not permitted during the assessment.

Figure D 11. Building 2D North Wall

Figure D 12. Building 2D South Wall

Building 3A Administration Building

Building 3A is the only building in FEDS building group: 10_OldHosp_3a. Building 3A is a three-floor administrative building that is part of the old hospital complex. The building, constructed in 1942, has a total area of 31,582 ft^2. The building has a partial, unfinised basement. The building is connected on three floors to Buildings 1B and 3AA.

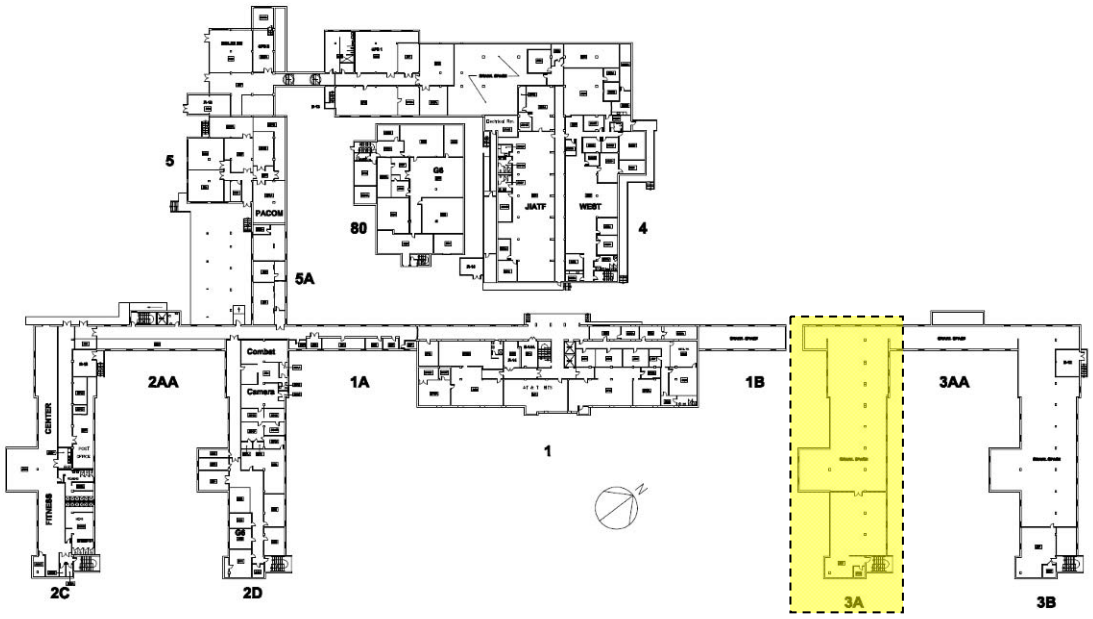


Figure D 13. Camp Smith "Old Hospital" Office Complex, Building 3A

Space cooling for the building is provided by 19 window air-conditioning units and a single 50-ton air-cooled reciprocating chiller.

Approximately two-thirds of the building lighting is provided by 2x4 two-tube T8 fluoresent lights. The remainder is 1x4 two-tube T12 fluoresent lighting.

Service hot water is provided by electric water heaters.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 491,312 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 557,492 kWh before retrofits and 454,534 kWh after proposed retrofits are implemented. The energy use intensity goes from 60.2 MBtu/Ksf to 49.1 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_OldHosp_3A
Old Hospital, Building 3A, Floors 1&2 admin, Floor 3 renovation

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	557,492	17,652.2	60.2	97,631
post-retrofit	454,534	14,392.2	49.1	79,324
difference	-102,957	-3,260.0	-11.1	-18,306
% change	-18	-18	-18	-19
Total (MBtu)				
existing	1,903	60.2	60.2	97,631
post-retrofit	1,551	49.1	49.1	79,324
difference	-351	-11.1	-11.1	-18,306
% change	-18	-18	-18	-19

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Cooling is the largest end use consuming 217,091 kWh/year, while motors and other miscellaneous loads are the second largest consumer with over 162,243 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_3A
Old Hospital, Building 3A, Floors 1&2 admin, Floor 3 renovation

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	217,091	50,726	123,304	162,243	4,128
post-retrofit	0	137,215	49,206	103,404	162,243	2,466
difference	0	-79,876	-1,519	-19,900	0	-1,662
% change	0	-37	-3	-16	0	-40
Total (MBtu)						
existing	0	741	173	421	554	14
post-retrofit	0	468	168	353	554	8
difference	0	-273	-5	-68	0	-6
% change	0	-37	-3	-16	0	-40
Total (MBtu/1000ft2)						
existing	0	23	5	13	18	0
post-retrofit	0	15	5	11	18	0
difference	0	-9	0	-2	0	0
% change	0	-37	-3	-16	0	-40

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_OldHosp_3A
Old Hospital, Building 3A, Floors 1&2 admin, Floor 3 renovation

Sulfur Oxides (lb)	
existing	5,040
post-retrofit	4,109
difference	-931
% change	-18
Nitrogen Oxides (lb)	
existing	2,408
post-retrofit	1,964
difference	-445
% change	-18
Carbon Monoxide (lb)	
existing	4,142
post-retrofit	3,377
difference	-765
% change	-18
Carbon Dioxide (tons)	
existing	510
post-retrofit	416
difference	-94
% change	-18
Particulate Matter (lb)	
existing	100
post-retrofit	81
difference	-18
% change	-18
Hydrocarbons (lb)	
existing	1,714
post-retrofit	1,398
difference	-317
% change	-18

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_3A: Old Hospital, Building 3A	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	182	10,662	68,056	50,042	2.3
	Replace existing window air-conditioners with ultra high efficiency window units.	35	1,939	19,779	1,531	1.1
	Insulate perimeter slab on grade by R-15.	5	304	4,116	1,149	1.3
	Increase insulation above suspended ceiling by R-19.	16	933	13,613	2,547	1.2
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	6	320	400	1,554	11.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	664	3,739	7,806	3.1
	Replace existing 1x4 2-lamp T12 with 1x4 2-lamp T8.	89	6,150	32,887	73,748	3.2
	TOTAL	336	20,972	142,590	138,377	2.3

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_3A: Old Hospital, Building 3A	Service hot water: Install faucet aerators.	5	275	64	1,589	25.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	4	740	3,739	787	1.2
	Replace existing 1x4 2-lamp T12 with 1x4 2-lamp T8.	97	6,847	32,887	8,552	1.3
	TOTAL	106	7,862	36,690	10,928	1.3

Additional Considerations

A new central chiller plant for the entire “old hospital” complex was not considered during this assessment because the long-term plans call for these facilities to be replaced.

Photos

Because of security concerns, interior photos were not permitted during the assessment.

Figure D 14. Building 3A North Wall.

Figure D 15. Building 3A East Wall.

Building 3B Administration/Clinic

Building 3B is the only building in FEDS building group: 10_OldHosp_3b. Building 3B is a three-floor administrative building that is part of the old hospital complex. The building, constructed in 1942, has a total area of 30,165ft^2. The building has a clinic on one floor and a partial unfinished basement. The building is connected to the rest of the complex through Building 3AA.

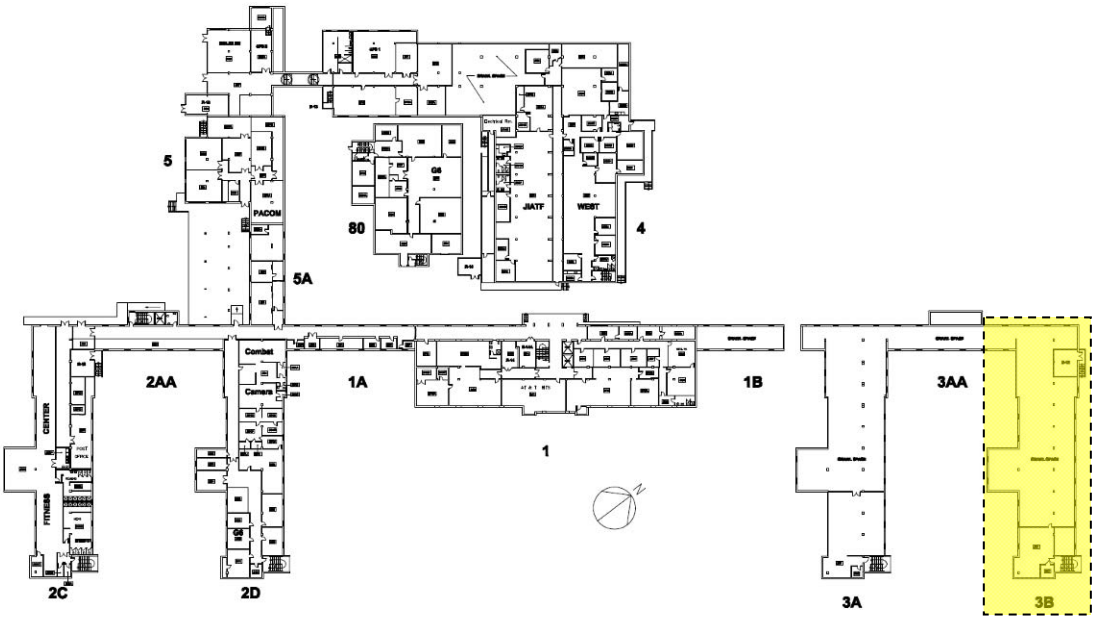


Figure D 16. Camp Smith "Old Hospital" Office Complex, Building 3AA

Space cooling is provided by 43 window air-conditioning units, 1 small 2.5-ton DX unit, and 1 38-ton package unit.

Lighting in this building consists of 2x4 two-tube T8 fixtures in the office spaces and 2x4 four-tube T8 fixtures in the clinic.

Service hot water is provided by electric water heaters.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 398,263 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 394,600 kwh before retrofits and 324,543 kWh after proposed retrofits are implemented. The energy use intensity goes from 44.6 MBtu/Ksf to 36.7 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_OldHosp_3B
Old Hospital, Building 3B, Admin + 1st floor clinic

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	394,600	13,081.4	44.6	69,104
post-retrofit	368,033	12,200.7	41.6	64,228
difference	-26,567	-880.7	-3.0	-4,876
% change	-7	-7	-7	-7
Total (MBtu)				
existing	1,347	44.6	44.6	69,104
post-retrofit	1,256	41.6	41.6	64,228
difference	-91	-3.0	-3.0	-4,876
% change	-7	-7	-7	-7

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

The major end uses reflect the fact that part of this building houses a clinc. Space cooling is the largest load estimated to consume 127, 293 kWh/year, while lighting is the second largest consumer with over 124,915 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_3B
Old Hospital, Building 3B, Admin + 1st floor clinic

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water *
Electricity (kWh)						
existing	0	127,293	19,530	124,915	108,475	14,388
post-retrofit	0	118,791	19,174	118,640	108,475	2,954
difference	0	-8,502	-355	-6,275	0	-11,434
% change	0	-7	-2	-5	0	-79
Total (MBtu)						
existing	0	434	67	426	370	49
post-retrofit	0	405	65	405	370	10
difference	0	-29	-1	-21	0	-39
% change	0	-7	-2	-5	0	-79
Total (MBtu/1000ft2)						
existing	0	14	2	14	12	2
post-retrofit	0	13	2	13	12	0
difference	0	-1	0	-1	0	-1
% change	0	-7	-2	-5	0	-79

* Energy consumption values for both distributed and central SHW are reported for Hot Water annual energy use.

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_OldHosp_3B
Old Hospital, Building 3B, Admin + 1st floor clinic

Sulfur Oxides (lb)	
existing	3,567
post-retrofit	3,327
difference	-240
% change	-7
Nitrogen Oxides (lb)	
existing	1,705
post-retrofit	1,590
difference	-115
% change	-7
Carbon Monoxide (lb)	
existing	2,932
post-retrofit	2,735
difference	-197
% change	-7
Carbon Dioxide (tons)	
existing	361
post-retrofit	337
difference	-24
% change	-7
Particulate Matter (lb)	
existing	71
post-retrofit	66
difference	-5
% change	-7
Hydrocarbons (lb)	
existing	1,213
post-retrofit	1,132
difference	-82
% change	-7

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_3B: Old Hospital, Building 3B	Replace existing package A/C with very high efficiency unit.	22	2,316	19,995	3,845	1.4
	Replace existing water heater with heat pump water heater. Install aerators.	36	2,034	3,456	8,941	5.8
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	3	183	264	880	10.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	462	2,617	5,415	3.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	198	1,122	2,321	3.1
	TOTAL	64	5,193	27,454	21,402	2.4

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_3B: Old Hospital, Building 3B	Service hot water: Install faucet aerators.	3	154	40	885	23.1
	Replace existing water heater with heat pump water heater. Install aerators.	36	2,034	3,456	8,779	3.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	506	2,617	477	1.2

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	217	1,122	204	1.2
	TOTAL	42	2,911	7,235	10,345	2.5

Additional Considerations

A new central chiller plant for the entire “old hospital” complex was not considered during this assessment because the long-term plans call for these facilities to be replaced.

Photos

Because of security concerns, interior photos were not permitted during the assessment.

Figure D 17. Building 3B North Side

Figure D 18. Building 3B South Wall

Building 4 Exchange, Food, Auditorium

Building 4 is the only building in FEDS building group: 10_OldHosp_4. Building 4 is part of the old hospital complex. The building, constructed in 1942, has a total area of 67,986 square feet. Building 4 houses some office space, various retail (e.g., barber shop), food service, the Post Exchange, and a large meeting space. The building includes a basement with some occupied space.

Becaue of the variety of uses for the space, this building was modeled as two linked buildings in FEDS. 10_OldHosp_4 encompasses 72129 ft^2 including office space and the dining facility. 10_OldHosp_PXAud encompasses 12,000 ft^2 and captures the exchange, small retail, and the auditorim space. Together these two groups represent Building 4 in the model.

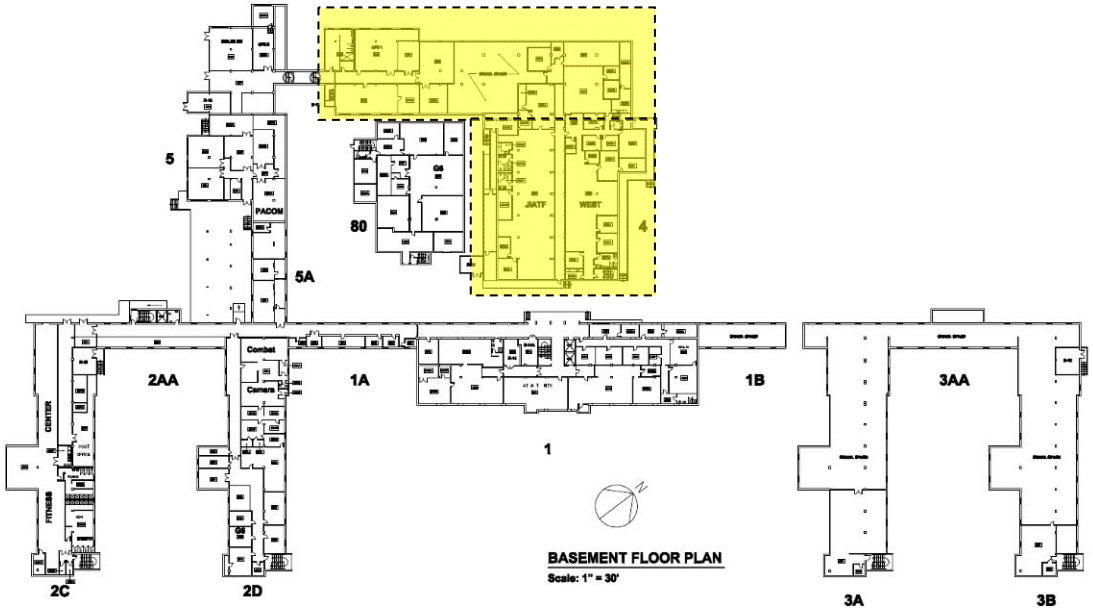


Figure D 19. **Camp Smith "Old Hospital" Office Complex, Building 4**

Space cooling is provided by three 60-ton air-cooled chillers, approximately 40-tons of direct expansion (DX) units of various sizes, and a variety of window air-conditioners.

Lighting consists almost entirely of T8 fluoresent fixtures including 2x4 two-tube, 2x4 three-tube, 2x4 four-tube, and 2x2 U-tube fixtures.

Service hot water is provided by a propane boiler in Building 5 for the food service area in addition to several smaller electric hot water heaters throughout the building.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. The modeled energy consumption for a typical year (using TMY weather data) was 1,669,596 kWh (electric only) and 5,699 MBtu (total) before retrofits and 1,430,254 kWh (electric only) and 4,882 MBtu (total) after proposed retrofits are implemented. The energy use intensity goes from 67.7 MBtu/Ksf to 58.0 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_OldHosp_4
Old Hospital, Building 4 Admin plus food service

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	1,669,596	19,845.7	67.7	292,388
post-retrofit	1,430,254	17,000.7	58.0	249,605
difference	-239,342	-2,844.9	-9.7	-42,783
% change	-14.3	-14.3	-14.3	-14.6
Central Hot Water - Bldg 5 SHW Loop (MBtu)				
existing	56	0.8	0.8	1,858
post-retrofit	36	0.5	0.5	1,211
difference	-19	-0.3	-0.3	-647
% change	-35	-35	-35	-35
Other Fuels (MBtu)				
existing	106	1.5	1.5	2,369
post-retrofit	106	1.5	1.5	2,369
difference	0	0.0	0.0	0
% change	0	0	0	0
Total (MBtu)				
existing	5,699	67.7	67.7	296,615
post-retrofit	4,882	58.0	58.0	253,185
difference	-817	-9.7	-9.7	-43,430
% change	-14.3	-14.3	-14.3	-14.3

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Space cooling is the largest end use with 2,767 MBtu/year, while motors and miscellaneous loads consume 1,416 MBtu/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_4
Old Hospital, Building 4 Admin plus food service

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water *
Electricity (kWh)						
existing	0	810,620	213,179	254,685	383,935	7,176
post-retrofit	0	583,026	209,844	249,178	383,935	4,270
difference	0	(227,594)	(3,335)	(5,507)	-	(2,906)
% change	0	-28.1	-1.6	-2.2	0.0	-40.5
Central Hot Water - Bldg 5 SHW Loop (MBtu)						
existing	0	0	0	0	0	56
post-retrofit	0	0	0	0	0	0
difference	0	0	0	0	0	-56
% change	0	0.0	0.0	0.0	0.0	-100.0
Other Fuels (MBtu)						
existing	0	0	0	0	106	0
post-retrofit	0	0	0	0	106	0
difference	0	0	0	0	0	0
% change	0	0.0	0.0	0.0	0.0	0.0
Total (MBtu)						
existing	0	2,767	728	870	1,416	80
post-retrofit	0	1,990	717	851	1,416	51
difference	0	(777)	(11)	(19)	-	(29)
% change	0	-28.1	-1.5	-2.2	0.0	-36.3
Total (MBtu/1000ft2)						
existing	0	32.9	8.7	10.3	16.8	1.0
post-retrofit	0	23.7	8.5	10.1	16.8	0.6
difference	0	(9)	(0)	(0)	-	(0)
% change	0	-28.1	-1.5	-2.2	0.0	-36.3

* Energy consumption values for both distributed and central SHW are reported for Hot Water annual energy use.

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

```
      Annual Emissions by Building Set and Pollutant Type
      Building Set... 10_OldHosp_4

Sulfur Oxides (lb)
existing                   15,141
post-retrofit              12,970
difference                 -2,171
% change                     14.3

Nitrogen Oxides (lb)
existing                    7,279
post-retrofit               6,234
difference                 -1,045
% change                     14.4

Carbon Monoxide (lb)
existing                   12,550
post-retrofit              10,749
difference                 -1,801
% change                     14.4

Carbon Dioxide (tons)
existing                    1,544
post-retrofit               1,323
difference                   -221
% change                     14.3

Particulate Matter (lb)
existing                     301
post-retrofit                257
difference                   -44
% change                     14.6

Hydrocarbons (lb)
existing                    5,181
post-retrofit               4,438
difference                   -743
% change                     14.3
```

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_4: Old Hospital, Building 4	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	355	19,356	105,617	100,844	2.7
	Replace existing window air-conditioners with ultra high efficiency window units.	236	13,193	123,315	16,293	1.3
	Service Hot Water: Wrap tank with insulation and install aerators.	19	647	286	13,775	49.2
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	10	559	663	2,734	12.3
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	421	2,384	4,918	3.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	74	421	868	3.1
	TOTAL	622	34,250	232,686	139,432	2.2

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_4: Old	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and	351	19,044	105,617	8,898	1.1

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
Hospital, Building 4	cooling tower.					
	Service hot water: Install faucet aerators.	8	485	103	2,815	28.2
	Replace existing central hot water heat exchanger with heat pump water heater and abandon loop.	51	1,418	17,213	(4,564)	
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	462	2,384	442	1.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	81	421	78	1.2
	TOTAL	412	21,490	125,738	7,669	1.1

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model. A new central chiller plant for the entire "old hospital" complex was not considered during this assessment because the long-term plans call for these facilities to be replaced.

Photos

Because of security concerns, interior photos were not permitted during the assessment.

Figure D 20. Building 4

Figure D 21. Building 4 Rear View

Building 5 Administration Building

Building 5 is the only building in FEDS building group: 10_OldHosp_5. Building 5 is contains office space and meeting/classroom space. The building, constructed in 1942, has a total area of 17,771 ft^2.

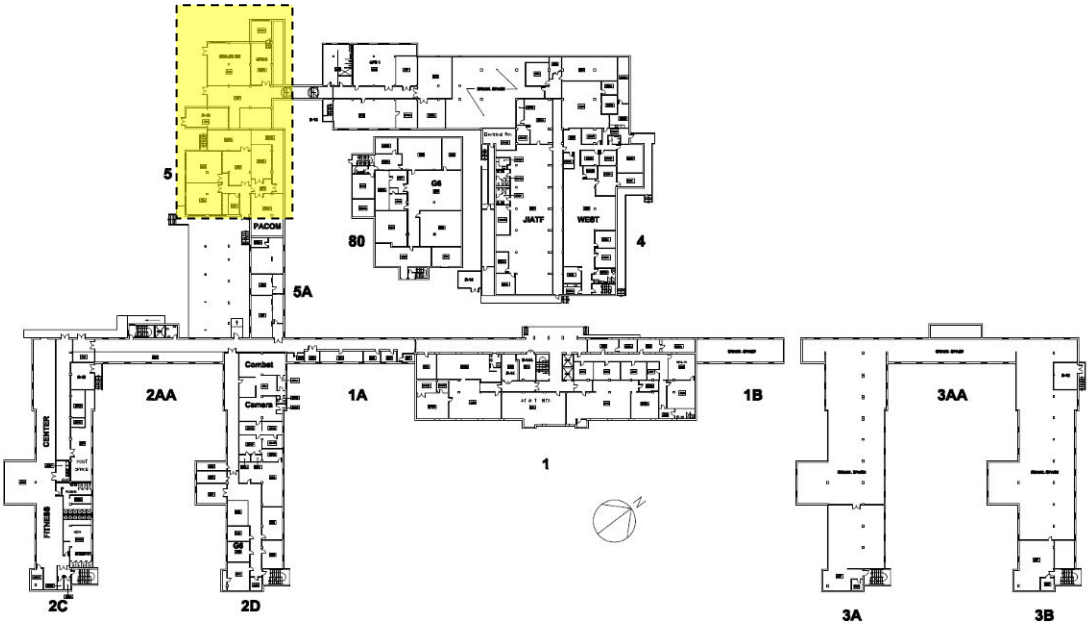


Figure D 22. Camp Smith "Old Hospital" Office Complex, Building 5

Space cooling is provided by one 30-ton packaged air-conditioning unit and a 60-ton air-cooled reciprocating chiller.

Lighting is a mix of 1x4 and 2x4 two-tube T8 fluorescent lighting.

The building has a propane boiler that provides service hot water to Building 4, 5, and 80, forming a mini-central plant for domestic hot water. The plant has two propane boilers with a total capacity of 1.36 MMBtu/hour.

Central Plant & Thermal Loop Annual Energy and Cost Information

Plant ID: Bldg 5 SHW
Description:
Type: Central Hot Water

Plant Information:	Existing
Primary Equipment Consumption	
Other (MBtu)	586
Auxiliary Equipment Consumption	
Electricity (kWh)	957
Total Energy Consumption (MBtu)	590
Annual Plant Output (MBtu)	399
Annual O&M Cost ($)	313
Marginal Value of Output ($/MBtu)	33.24
Average Value of Output ($/MBtu)	33.92

Loop ID: Bldg 5 SHW Loop	Existing
Connected Loads	
10_OldHosp_4 (MBtu)	56
10_OldHosp_5 (MBtu)	60
10_OldHosp_80 (MBtu)	30
Total Delivered Energy (MBtu)	146
Loop Loss	
Thermal Loss (MBtu)	252
Leakage Loss (MBtu)	0
Total Loss (MBtu)	253
Total Energy Input (MBtu)	399
Loop Efficiency (%)	37
Annual O&M Cost ($)	1,210
Marginal Delivered Value ($/MBtu)	33.24
Average Delivered Value ($/MBtu)	101.00

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 418,539 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 607,634 kWh before retrofits and 505,025 kWh after proposed retrofits are implemented. The energy use intensity goes from 86.0 MBtu/Ksf to 71.4 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_OldHosp_5
Old Hospital, Building 5

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	607,634	25,186.9	86.0	106,412
post-retrofit	505,025	20,933.7	71.4	88,136
difference	-102,608	-4,253.2	-14.5	-18,276
% change	-17	-17	-17	-17
Central Hot Water - Bldg 5 SHW Loop (MBtu)				
existing	60	2.5	2.5	2,005
post-retrofit	31	1.3	1.3	1,029
difference	-29	-1.2	-1.2	-976
% change	-49	-49	-49	-49
Total (MBtu)				
existing	2,134	88.5	88.5	108,417
post-retrofit	1,755	72.7	72.7	89,165
difference	-380	-15.7	-15.7	-19,252
% change	-18	-18	-18	-18

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Space cooling is the largest end use in this building consuming 1,113 MBtu/year, followed by motors and miscellaneous commitment 423 MBtu/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_5
Old Hospital, Building 5

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	326,197	78,108	79,393	123,935	0
post-retrofit	0	227,203	74,841	79,046	123,935	0
difference	0	-98,994	-3,267	-347	0	0
% change	0	-30	-4	0	0	0
Central Hot Water - Bldg 5 SHW Loop (MBtu)						
existing	0	0	0	0	0	60
post-retrofit	0	0	0	0	0	31
difference	0	0	0	0	0	-29
% change	0	0	0	0	0	-49
Total (MBtu)						
existing	0	1,113	267	271	423	60
post-retrofit	0	775	255	270	423	31
difference	0	-338	-11	-1	0	-29
% change	0	-30	-4	0	0	-49
Total (MBtu/1000ft2)						
existing	0	46	11	11	18	3
post-retrofit	0	32	11	11	18	1
difference	0	-14	0	0	0	-1
% change	0	-30	-4	0	0	-49

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_OldHosp_5
Old Hospital, Building 5

Sulfur Oxides (lb)	
existing	5,517
post-retrofit	4,577
difference	-939
% change	-17
Nitrogen Oxides (lb)	
existing	2,657
post-retrofit	2,198
difference	-459
% change	-17
Carbon Monoxide (lb)	
existing	4,583
post-retrofit	3,788
difference	-796
% change	-17
Carbon Dioxide (tons)	
existing	564
post-retrofit	466
difference	-98
% change	-17
Particulate Matter (lb)	
existing	110
post-retrofit	91
difference	-19
% change	-17
Hydrocarbons (lb)	
existing	1,891
post-retrofit	1,565
difference	-327
% change	-17

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_5: Old Hospital, Building 5	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	294	16,270	82,282	88,636	2.9
	Insulate perimeter slab on grade by R-15.	10	494	5,088	3,460	1.7
	Increase insulation above suspended ceiling by R-19.	33	1,657	20,797	7,898	1.4
	Service Hot Water: Wrap tank with insulation and install aerators.	29	976	258	20,949	82.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	337	1,870	3,985	3.1
	TOTAL	368	19,734	110,295	124,928	2.7

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_5: Old Hospital, Building 5	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	306	16,711	85,037	15,538	1.2
	Replace existing central hot water heat exchanger with heat pump water heater and	56	1,653	12,953	1,449	1.1

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	abandon loop.					
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	366	1,870	365	1.2
	TOTAL	364	18,730	99,860	17,352	1.2

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model. A new central chiller plant for the entire "old hospital" complex was not considered during this assessment because the long-term plans call for these facilities to be replaced.

Photos

Because of security concerns, interior photos were not permitted during the assessment.

Figure D 23. Building 5 Exterior View

Building 80 Administration Building

Building 80 is the only building in FEDS building group: 10_OldHosp_80. Building 80 is the central command and control center. It has high electronics load and 24-hour operation. The building was constructed as a later addition to the hospital complex in 1967. It has a total area of 37,300 ft^2.

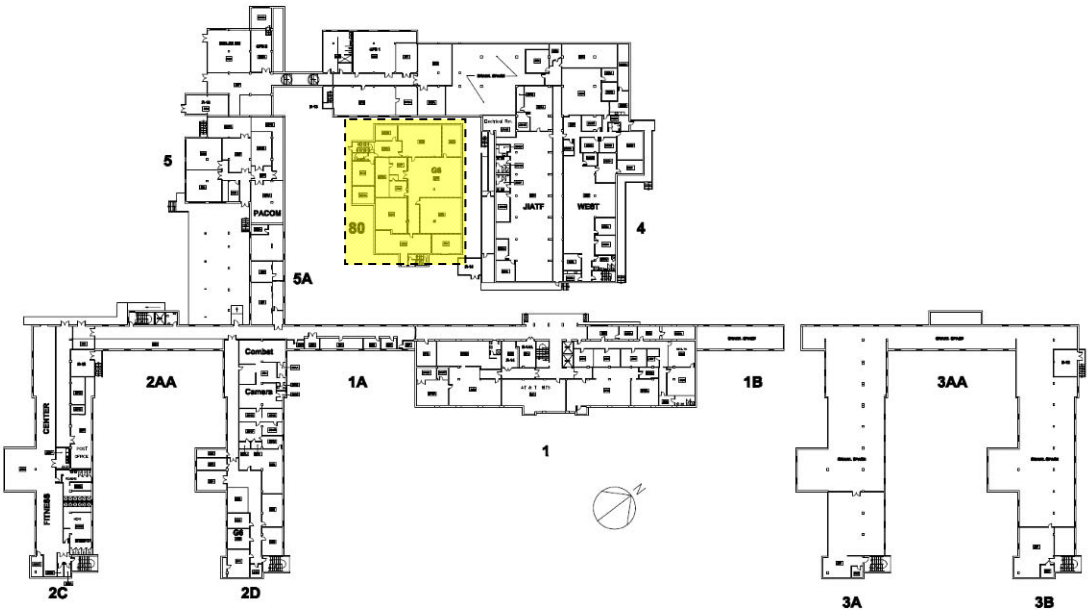


Figure D 24. Camp Smith "Old Hospital" Office Complex, Building 80

Space cooling is provided by two 40-ton air-cooled chillers and three DX units totaling 27 tons.

The predominant source of lighting in this building is 2x4 four-tube T8 fixtures. Various other fixtures exist for task lighting or other specialized lighting.

Service hot water is provided by propane boilers and the hot water loop in Building 5.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 2,474,735 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 2,583,350 kWh before retrofits and 2, 319,037 kWh after proposed retrofits are implemented. The energy use intensity goes from 237.2 MBtu/Ksf to 212.6 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_OldHosp_80
Old Hospital, Building 80, Admin/Control Room/Computers

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	2,583,350	69,258.7	236.4	452,409
post-retrofit	2,319,037	62,172.6	212.2	404,714
difference	-264,313	-7,086.1	-24.2	-47,696
% change	-10	-10	-10	-11
Central Hot Water - Bldg 5 SHW Loop (MBtu)				
existing	32	0.9	0.9	1,059
post-retrofit	16	0.4	0.4	519
difference	-16	-0.4	-0.4	-541
% change	-51	-51	-51	-51
Total (MBtu)				
existing	8,849	237.2	237.2	453,469
post-retrofit	7,930	212.6	212.6	405,233
difference	-918	-24.6	-24.6	-48,236
% change	-10	-10	-10	-11

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Large internal electrical loads dominate end uses consuming 4,529 MBtu/year, followed by space cooling with 2,518 MBtu/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_80
Old Hospital, Building 80, Admin/Control Room/Computers

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	737,633	401,495	117,202	1,327,020	0
post-retrofit	0	473,581	401,495	116,942	1,327,020	0
difference	0	-264,053	0	-260	0	0
% change	0	-36	0	0	0	0
Central Hot Water - Bldg 5 SHW Loop (MBtu)						
existing	0	0	0	0	0	32
post-retrofit	0	0	0	0	0	16
difference	0	0	0	0	0	-16
% change	0	0	0	0	0	-51
Total (MBtu)						
existing	0	2,518	1,370	400	4,529	32
post-retrofit	0	1,616	1,370	399	4,529	16
difference	0	-901	0	-1	0	-16
% change	0	-36	0	0	0	-51
Total (MBtu/1000ft2)						
existing	0	67	37	11	121	1
post-retrofit	0	43	37	11	121	0
difference	0	-24	0	0	0	0
% change	0	-36	0	0	0	-51

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_OldHosp_80
Old Hospital, Building 80, Admin/Control
Room/Computers

Sulfur Oxides (lb)	
existing	23,366
post-retrofit	20,970
difference	-2,396
% change	-10
Nitrogen Oxides (lb)	
existing	11,176
post-retrofit	10,026
difference	-1,150
% change	-10
Carbon Monoxide (lb)	
existing	19,231
post-retrofit	17,248
difference	-1,982
% change	-10
Carbon Dioxide (tons)	
existing	2,368
post-retrofit	2,124
difference	-244
% change	-10
Particulate Matter (lb)	
existing	462
post-retrofit	415
difference	-48
% change	-10
Hydrocarbons (lb)	
existing	7,956
post-retrofit	7,137
difference	-819
% change	-10

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_80: Old Hospital, Building 80	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	522	27,815	151,553	145,125	2.7
	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	378	20,206	95,081	114,048	3.1
	Service Hot Water: Wrap tank with insulation and install aerators.	16	541	244	11,500	48.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	242	1,402	2,801	3.0
	TOTAL	917	48,804	248,280	273,474	2.9

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_80: Old Hospital, Building 80	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and cooling tower.	522	27,815	151,553	15,766	1.1
	Replace existing air-cooled chiller with very-high efficiency water-cooled chiller and	378	20,206	95,081	26,477	1.3

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	cooling tower.					
	Replace existing central hot water heat exchanger with electric water heater with R-24 insulation, install aerators, and lower tank temperature (abandon loop).	20	383	10,261	(5,600)	N/A
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	265	1,402	217	1.2
	TOTAL	921	48,669	258,297	36,860	1.2

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model. A new central chiller plant for the entire "old hospital" complex was not considered during this assessment because the long-term plans call for these facilities to be replaced.

Photos

Because of security concerns, interior photos were not permitted during the assessment.

Figure D 25. Building 80 (right side) and Building 5 (left side)

Building 81 Telephone Exchange

Building 81 is a small building built in 1962 to handle the telephone services. It has 3,299 ft^2. Building 81 is the only building in FEDS building group: 10_OldHosp_81.

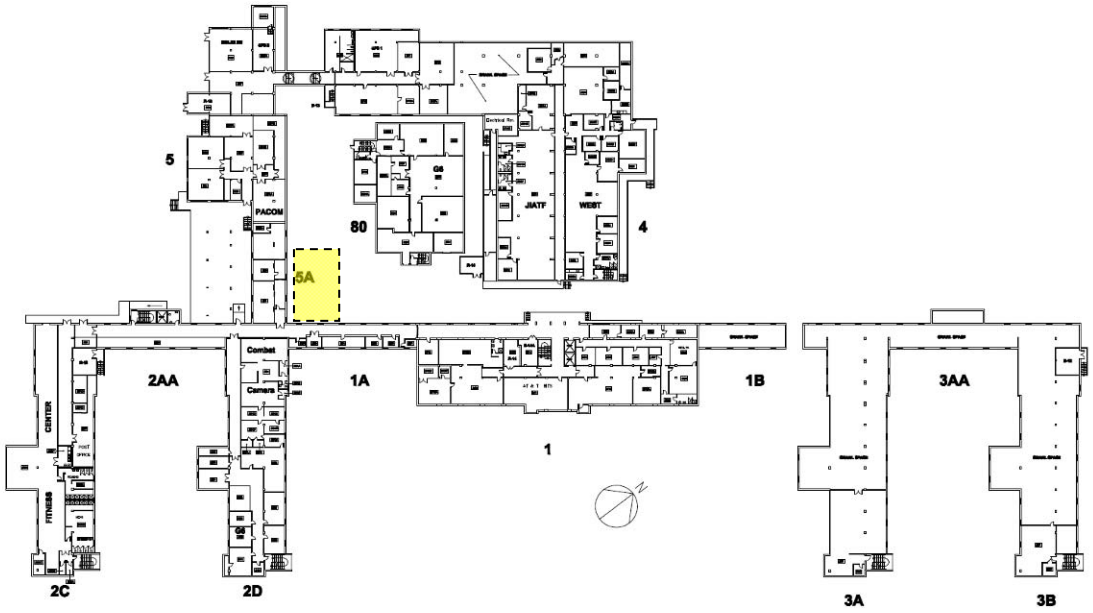


Figure D 26. Camp Smith "Old Hospital" Office Complex, Building 81(not shown)

Space cooling is provided by one 30-ton air-cooled chiller and several window air-conditioning units.

Lighting is provided by 2x4 four-tube T8 fixtures (80%) and 1x4 one-tube T8 lights.

Service hot water is provided by electric water heaters.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 244,910 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 243,761 kWh before retrofits and 230,756 kWh after proposed retrofits are implemented. The energy use intensity goes from 252.2 MBtu/Ksf to 238.7 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_OldHosp_81
Old Hospital, Building 81 phones

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	243,761	73,889.2	252.2	42,689
post-retrofit	230,756	69,947.4	238.7	40,271
difference	-13,004	-3,941.8	-13.5	-2,417
% change	-5	-5	-5	-6
Total (MBtu)				
existing	832	252.2	252.2	42,689
post-retrofit	788	238.7	238.7	40,271
difference	-44	-13.5	-13.5	-2,417
% change	-5	-5	-5	-6

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Large internal electrical loads dominate end uses consuming 401 MBtu/year, followed by space cooling with 228 MBtu/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_OldHosp_81
Old Hospital, Building 81 phones

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	66,889	38,392	20,188	117,368	922
post-retrofit	0	57,485	38,392	16,941	117,368	569
difference	0	-9,404	0	-3,247	0	-353
% change	0	-14	0	-16	0	-38
Total (MBtu)						
existing	0	228	131	69	401	3
post-retrofit	0	196	131	58	401	2
difference	0	-32	0	-11	0	-1
% change	0	-14	0	-16	0	-38
Total (MBtu/1000ft2)						
existing	0	69	40	21	121	1
post-retrofit	0	59	40	18	121	1
difference	0	-10	0	-3	0	0
% change	0	-14	0	-16	0	-38

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_OldHosp_81
Old Hospital, Building 81 phones

Sulfur Oxides (lb)	
existing	2,204
post-retrofit	2,086
difference	-118
% change	-5
Nitrogen Oxides (lb)	
existing	1,053
post-retrofit	997
difference	-56
% change	-5
Carbon Monoxide (lb)	
existing	1,811
post-retrofit	1,715
difference	-97
% change	-5
Carbon Dioxide (tons)	
existing	223
post-retrofit	211
difference	-12
% change	-5
Particulate Matter (lb)	
existing	44
post-retrofit	41
difference	-2
% change	-5
Hydrocarbons (lb)	
existing	750
post-retrofit	710
difference	-40
% change	-5

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_81: Old Hospital, Building 81	Replace existing package A/C with very high efficiency unit.	25	2,023	22,223	849	1.1
	Replace existing window air-conditioners with ultra high efficiency window units.	4	217	2,025	268	1.3
	Service Hot Water: Wrap tank with insulation, wrap pipes near tank, and install aerators.	1	61	126	280	7.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	162	935	1,888	3.0
	Replace existing 2x4 4-lamp T8 with 2x4 4-lamp 28-W super T8 with reflector.	13	636	8,101	2,897	1.4
	TOTAL	44	3,099	33,410	6,182	1.4

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_OldHosp_81: Old Hospital, Building 81	Service hot water: Install faucet aerators.	1	46	14	265	19.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	178	935	161	1.2

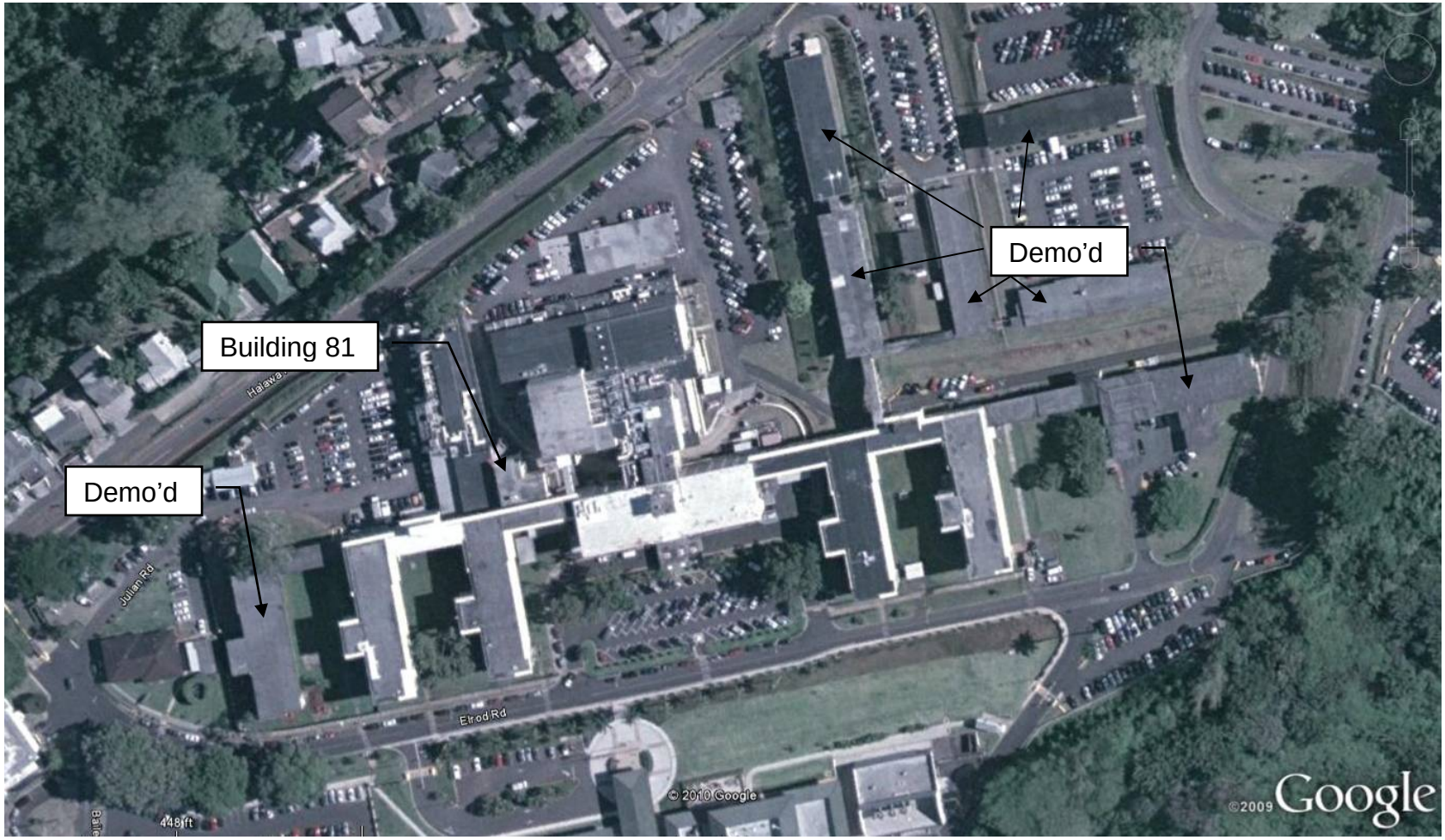
FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	TOTAL	2	224	949	426	1.5

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model.

Photos

Because of security concerns, building photos were not permitted during the audit. Publicly available satellite images show the location of Building 81.



Source: Google Earth

Figure D 27. Satellite image of "Old Hospital" complex

Building 20

Building 20 is a three-floor administrative building built in 1942. It has a total area of 75,585 ft^2. Building 20 is the only building in FEDS building group: 10a.

Space cooling is provided by a ground-mounted 135-ton air-cooled chiller and air-handling units in the building and on the roof. The roof-mounted ductwork has several rusted openings in the return duct introducing 100% outside air into the air-handling unit. Several window air-conditioners are present.

Building 20 has a mix of lighting technologies. The administration areas that have not been extensively remodeled primarily use 2x4 three-tube T12, with a few 2x4 two-tube U-tube T12. Where floors have been remodeled, the predominant fixture is 2x2 U-Tube T8, with fewer 2x4 two-tube T8. The computer room has ceiling fixtures with two incandescent bulbs (although many of these were off), in addition to 2x4 three-tube T12 fixtures.

Service hot water is provided by electric hot water heaters.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 2,656,974 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 2,642,279 kWh before retrofits and 1,976,400 kWh after proposed retrofits are implemented. The energy use intensity goes from 119.3 MBtu/Ksf to 89.2 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_a
Building 20, Admin

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	2,642,279	34,957.7	119.3	462,729
post-retrofit	1,976,400	26,148.0	89.2	344,917
difference	-665,880	-8,809.7	-30.1	-117,812
% change	-25	-25	-25	-25
Total (MBtu)				
existing	9,018	119.3	119.3	462,729
post-retrofit	6,745	89.2	89.2	344,917
difference	-2,273	-30.1	-30.1	-117,812
% change	-25	-25	-25	-25

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Motors and miscellaneous equipment constitute the largest loads consuming 909,037 kWh/year, followed by space cooling with 730,542 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_a
Building 20, Admin

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water *
Electricity (kWh)						
existing	0	730,542	389,969	605,572	909,037	7,159
post-retrofit	0	306,218	389,969	370,661	909,037	514
difference	0	-424,324	0	-234,910	0	-6,645
% change	0	-58	0	-39	0	-93
Total (MBtu)						
existing	0	2,493	1,331	2,067	3,103	24
post-retrofit	0	1,045	1,331	1,265	3,103	2
difference	0	-1,448	0	-802	0	-23
% change	0	-58	0	-39	0	-93
Total (MBtu/1000ft2)						
existing	0	33	18	27	41	0
post-retrofit	0	14	18	17	41	0
difference	0	-19	0	-11	0	0
% change	0	-58	0	-39	0	-93

* Energy consumption values for both distributed and central SHW are reported for Hot Water annual energy use.

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_a
Building 20, Admin

Sulfur Oxides (lb)	
existing	23,886
post-retrofit	17,867
difference	-6,020
% change	-25
Nitrogen Oxides (lb)	
existing	11,414
post-retrofit	8,538
difference	-2,876
% change	-25
Carbon Monoxide (lb)	
existing	19,632
post-retrofit	14,685
difference	-4,948
% change	-25
Carbon Dioxide (tons)	
existing	2,418
post-retrofit	1,808
difference	-609
% change	-25
Particulate Matter (lb)	
existing	473
post-retrofit	353
difference	-119
% change	-25
Hydrocarbons (lb)	
existing	8,125
post-retrofit	6,078
difference	-2,048
% change	-25

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_a: Building 20	Replace existing air-cooled chiller with ultra-high efficiency water-cooled chiller and cooling tower.	1,110	62,639	207,657	682,402	4.4
	Replace existing water heater with heat pump water heater. Install aerators.	16	876	3,551	2,726	2.4
	Replace existing water heater with heat pump water heater. Install aerators.	7	327	447	1,495	7.2
	Replace existing 2, 75-W INC lamps with 2, 15-W CFL	248	15,223	13,012	250,896	20.3
	Replace existing 60-W INC flood light with 18-W CFL	5	403	97	6,872	72.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	417	2,440	4,811	3.0
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	349	20,200	86,293	263,560	4.1
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	239	13,872	60,144	180,133	4.0
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	86	4,408	9,768	66,576	7.8
	Replace existing 2x2 2-lamp U-tube T12 with 2x2 2-lamp U-tube T8.	36	2,979	9,807	41,877	5.3
	TOTAL	2,098	121,344	393,216	1,501,348	4.9

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_a: Building 20	Replace existing air-cooled chiller with ultra-high efficiency water-cooled chiller and cooling tower.	1,110	62,639	207,657	169,296	1.8
	Service hot water: Install faucet aerators and lower tank temperature.	8	462	124	2,661	22.5
	Replace existing water heater with heat pump water heater. Install aerators.	7	327	447	1,519	4.4
	Replace existing 2, 75-W INC lamps with 2, 15-W CFL	248	15,637	13,012	81,553	7.3
	Replace existing 60-W INC flood light with 18-W CFL	5	408	97	2,371	25.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	2	457	2,440	356	1.1
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	349	22,839	86,293	51,626	1.6
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	239	15,711	60,144	34,745	1.6
	Replace existing 2x4 3-lamp T12 with 2x4 2-lamp 28-W T5 with reflector.	86	4,641	9,768	18,222	2.9
	Replace existing 2x2 2-lamp U-tube T12 with 2x2 2-lamp U-tube T8.	36	3,428	9,807	11,007	2.1
	TOTAL	2,090	126,549	389,789	373,356	2.0

Additional Considerations

Building 20 would benefit from retrofit and/or recommissioning of building control systems. This effort is beyond the scope of the energy modeling task. In addition, one of the air-handling units on the roof had ductwork that had rusted to the point where 100% outdoor air was being pulled into the building. Significant energy savings would be realized by replacing deteriorating ductwork.

Photos

Because of security concerns, building photos were not permitted during the audit. Publicly available satellite images show the exterior of Building 20.

(Source: Google Earth)

Figure D 28. Building 20 Arial View

Building 21 Training Annex

Building 21 is a single-story admin-training building constructed in 1990. It has a total area of 2,520 ft^2. Building 21 is the only building in FEDS building group: 10b.

Space cooling is provided by nine window air-conditioners and one small residential size DX unit.

Lighting is typical T8 fluoresent.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 52,428 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 51,854 kWh before retrofits and 41,088 kWh after proposed retrofits are implemented. The energy use intensity goes from 32.1 MBtu/Ksf to 25.4 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10b
Building 20E, Admin/Training

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	51,854	9,397.3	32.1	9,081
post-retrofit	41,088	7,446.1	25.4	7,171
difference	-10,767	-1,951.2	-6.7	-1,910
% change	-21	-21	-21	-21
Total (MBtu)				
existing	177	32.1	32.1	9,081
post-retrofit	140	25.4	25.4	7,171
difference	-37	-6.7	-6.7	-1,910
% change	-21	-21	-21	-21

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Space cooling is the largest end use consuming 20,546 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10b
Building 20E, Admin/Training

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	20,546	5,731	15,056	6,658	3,863
post-retrofit	0	18,795	5,422	9,691	6,658	522
difference	0	-1,751	-309	-5,365	0	-3,341
% change	0	-9	-5	-36	0	-86
Total (MBtu)						
existing	0	70	20	51	23	13
post-retrofit	0	64	19	33	23	2
difference	0	-6	-1	-18	0	-11
% change	0	-9	-5	-36	0	-86
Total (MBtu/1000ft2)						
existing	0	13	4	9	4	2
post-retrofit	0	12	3	6	4	0
difference	0	-1	0	-3	0	-2
% change	0	-9	-5	-36	0	-86

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10b
Building 20E, Admin/Training

Sulfur Oxides (lb)	
existing	469
post-retrofit	371
difference	-97
% change	-21
Nitrogen Oxides (lb)	
existing	224
post-retrofit	177
difference	-47
% change	-21
Carbon Monoxide (lb)	
existing	385
post-retrofit	305
difference	-80
% change	-21
Carbon Dioxide (tons)	
existing	47
post-retrofit	38
difference	-10
% change	-21
Particulate Matter (lb)	
existing	9
post-retrofit	7
difference	-2
% change	-21
Hydrocarbons (lb)	
existing	159
post-retrofit	126
difference	-33
% change	-21

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10b: Building 20E	Replace existing water heater with heat pump water heater.	11	639	3,439	1,526	1.8
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	54	312	638	3.0
	Replace existing 2x4 2-lamp T12 with 2x4 2-lamp T8.	25	1,721	14,304	15,538	2.1
	TOTAL	36	2,414	18,055	17,702	2.1

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10b: Building 20E	Replace existing water heater with heat pump water heater.	11	639	3,439	403	1.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	59	312	53	1.2
	TOTAL	11	698	3,751	456	1.1

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model.

Photos

Because of security concerns, building photos were not permitted during the audit.

Building 700/701 PACOM Headquarters

Building 700 is the new PACOM headquarters building contstructed in 2003. The building has six floors and a total of 274,500 ft^2. The building is built into the hillside with the first two floors below ground level on one side and exposed on the other side. Entry to the building is on the 3rd floor, which is entirely above ground. The 3rd floor also has a small food court. The 4th floor has a smaller footprint that the lower floors, followed by the next two floors with an even smaller footprint.

Building 701 is a 9,458 ft^2 chiller plant that serves Building 701. Building 700 and its central plan (Building 701) are the only buildings in FEDS building group: 10_PACOM. The food service area was modeled separately as 10_PACOM_food and linked to building group 10_PACOM in the model.

Interior lighting is predominantly provided by T8 lighting using 2x4 two-tube fixtures (10%), 2x4 three-tube fixtures (60%), and 2x4 four-tube fixtures (30%). The building also has a variety of other specialized and task lighting including two-CFL fixtures.

Space cooling is provided by three water-cooled chillers located in Building 701. The plant has a total capacity of 1,977 tons. Building 701 uses a de-superheater to recover waste heat from the chillers for use in the hot water loop. Additionally, two propane boilers with a total capacity of 1.05 MMBtu/hr supplement the de-superheater to provide hot water to the building.

Central Plant & Thermal Loop Annual Energy and Cost Information

Plant ID: PACOM CEP 701
Description: chilled water
Type: Central Chilled Water

Plant Information:	Existing
Primary Equipment Consumption	
Electricity (kWh)	3,367,005
Auxiliary Equipment Consumption	
Electricity (kWh)	456,089
Total Energy Consumption (MBtu)	13,048
Annual Plant Output (ton-hr)	2,850,557
Annual O&M Cost ($)	29,660
Marginal Value of Output ($/ton-hr)	0.23
Average Value of Output ($/ton-hr)	0.24

Loop ID: PACOM Chilled W [DO NOT ABANDON]	Existing
Connected Loads	
10_PACOM (ton-hr)	2,632,079
10_PACOM_food (ton-hr)	66,675
Total Delivered Energy (ton-hr)	2,698,753
Loop Loss	
Thermal Loss (ton-hr)	7,460
Leakage Loss (ton-hr)	144,344
Total Loss (ton-hr)	151,803
Total Energy Input (ton-hr)	2,850,557
Loop Efficiency (%)	95
Annual O&M Cost ($)	1,818
Marginal Delivered Value ($/ton-hr)	0.23
Average Delivered Value ($/ton-hr)	0.26

Central Plant & Thermal Loop Annual Energy and Cost Information

Plant ID: PACOM Hot Water
Description: Domestic hot water
Type: Central Hot Water

Plant Information:	Existing
Primary Equipment Consumption	
Distillate Oil (gallons)	1,383
Other (MBtu)	1,677
Auxiliary Equipment Consumption	
Electricity (kWh)	3,511
Total Energy Consumption (MBtu)	1,881
Annual Plant Output (MBtu)	1,463
Annual O&M Cost ($)	1,148
Marginal Value of Output ($/MBtu)	26.55
Average Value of Output ($/MBtu)	27.23

Loop ID: PACOM SHW Loop [DO NOT ABANDON]	Existing
Connected Loads	
10_PACOM (MBtu)	876
10_PACOM_food (MBtu)	12
Total Delivered Energy (MBtu)	888
Loop Loss	
Thermal Loss (MBtu)	54
Leakage Loss (MBtu)	521
Total Loss (MBtu)	575
Total Energy Input (MBtu)	1,463
Loop Efficiency (%)	61
Annual O&M Cost ($)	639
Marginal Delivered Value ($/MBtu)	26.55
Average Delivered Value ($/MBtu)	45.58

Energy Consumption by Fuel Type

The actual metered energy consumption for FY 2009 was 10,863,400 kWh. The modeled energy consumption for a typical year was 7,112,806 kWh (not counting central plant energy use) before retrofits and 6,627,598 kWh after proposed retrofits are implemented. The energy use intensity goes from 198.6 MBtu/Ksf to 185.5 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 10_PACOM
Bldg 700 PACOM Center

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	7,112,806	25,049	85.5	1,245,630
post-retrofit	6,627,598	23,340	79.6	1,156,635
difference	-485,208	(1,709)	(5.8)	(88,995)
% change	6.8	6.8	6.8	7.1
Central Hot Water - PACOM SHWBldg 5 SHW Loop (MBtu)				
existing	888	3	0.0	23,577
post-retrofit	825	3	0.0	21,921
difference	-63	(0)	(0.0)	(1,656)
% change	7.1	7.1	7.1	7.0
Central Chilled Water - PACOM				
existing	2,674,411	9,418	32.1	628,175
post-retrofit	2,503,360	8,816	30.1	587,998
difference	-171,051	(602)	(2.1)	(40,177)
% change	6.4	6.4	6.4	6.4
Total (MBtu)				
existing	56,380	198.6	198.6	1,897,382
post-retrofit	52,671	185.5	185.5	1,766,554
difference	-3,709	(13.1)	(13.1)	(130,828)
% change	6.6	6.6	6.6	6.9

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Space cooling is the largest end use consuming 32,095 MBtu/year, followed by motors and other miscellaneous loads with 11,793 MBtu/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 10_PACOM
Bldg 700 PACOM Center

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water *
Electricity (kWh)						
existing	0	0	1,009,917	2,647,633	3,455,256	-
post-retrofit	0	0	975,588	2,196,753	3,455,256	-
difference	0	-	(34,329)	(450,880)	-	-
% change	0.0	0.0	-3.4	-17.0	0.0	0.0
Central Hot Water -Bldg 5 SHW Loop (MBtu)						
existing	0	0	-	-	-	888
post-retrofit	0	0	-	-	-	825
difference	0	-	-	-	-	(63)
% change	0.0	0.0	0.0	0.0	0.0	-7.1
Other Fuels (MBtu)						
existing	0	2,674,411	-	-	-	-
post-retrofit	0	2,503,360	-	-	-	-
difference	0	(171,051)	-	-	-	-
% change	0.0	-6.4	0.0	0.0	0.0	0.0
Total (MBtu)						
existing	0	32,095	3,447	9,036	11,793	888
post-retrofit	0	30,042	3,330	7,497	11,793	825
difference	0	(2,053)	(117)	(1,539)	-	(63)
% change	0.0	-6.4	-3.4	-17.0	0.0	-7.1
Total (MBtu/1000ft2)						
existing	0	113.0	12.1	31.8	41.5	3.1
post-retrofit	0	105.8	11.7	26.4	41.5	2.9
difference	0	(7)	(0)	(5)	-	(0)
% change	0.0	-6.4	-3.4	-17.0	0.0	-7.1

* Energy consumption values for both distributed and central SHW are reported for Hot Water annual energy use.

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 10_PACOM

Sulfur Oxides (lb)	
existing	97,059
post-retrofit	90,576
difference	-6,483
% change	6.7
Nitrogen Oxides (lb)	
existing	46,626
post-retrofit	43,511
difference	-3,115
% change	6.7
Carbon Monoxide (lb)	
existing	80,384
post-retrofit	75,012
difference	-5,372
% change	6.7
Carbon Dioxide (tons)	
existing	9,889
post-retrofit	9,229
difference	-660
% change	6.7
Particulate Matter (lb)	
existing	1,926
post-retrofit	1,798
difference	-128
% change	6.6
Hydrocarbons (lb)	
existing	33,195
post-retrofit	30,977
difference	-2,218
% change	6.7

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_PACOM: Bldg 700 PACOM	Service Hot Water: Wrap tank with insulation.	62	1,633	982	41,786	43.6
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	7	867	4,768	10,289	3.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	153	841	1,818	3.2
	Replace existing 2x4 2-lamp T8 with 2x4 2-lamp 28-W super T8 with reflector.	237	9,330	127,209	34,428	1.3
	Replace existing 2x4 2-lamp T8 with 2x4 2-lamp 28-W super T8 with reflector.	42	1,657	22,449	6,268	1.3
	Replace existing 2x4 3-lamp T8 with 2x4 3-lamp 28-W super T8 with reflector.	1,498	61,025	539,121	518,280	2.0
	Replace existing 2x4 3-lamp T8 with 2x4 3-lamp 28-W super T8 with reflector.	267	10,835	95,139	92,605	2.0
	Replace existing 2x4 4-lamp T8 with 2x4 4-lamp 28-W super T8 with reflector.	949	35,402	296,363	316,799	2.1
	Replace existing 2x4 4-lamp T8 with 2x4 4-lamp 28-W super T8 with reflector.	169	6,285	52,299	56,559	2.1
	TOTAL	3,232	127,187	1,139,171	1,078,832	2.0
10_PACOM_food: Bldg 700 PACOM Food Service	Service Hot Water: Wrap tank with insulation.	1	23	54	545	11.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	57	312	673	3.2
	TOTAL	1	80	366	1,218	4.4

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
10_PACOM: Bldg 700 PACOM Center	Service Hot Water: Wrap tank with insulation.	62	1,633	982	12,484	13.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	7	945	4,768	1,002	1.2
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	166	841	176	1.2
	TOTAL	70	2,744	6,591	13,662	3.0
10_PACOM_food: Bldg 700 PACOM Food Service	Service Hot Water: Wrap tank with insulation.	1	23	54	135	3.5
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	61	312	65	1.2
	TOTAL	1	84	366	200	1.5

Additional Considerations

None.

Photos

Because of security concerns, building photos were not permitted during the audit.

Source: Google Earth

Figure D 29. Building 700 Arial Photo

Figure D 30. Rear side of Building 700

Figure D 31. Building 700 Food Court near Main Entrance

Building 402 Barracks

Building 402 is a three-floor barracks building with exterior walkways. The building, constructed in 1969, has a total area of 10,899 ft^2. It is identical to Buildings 401, 403, and 404. Building 401, 402, 403, and 404 constitue FEDS building group: 31_barracks.

Space cooling is provided entirely by window air-conditioning units. There are 36 per building, one per room.

Each room typically has CFL lights and 1x4 two-lamp T8 fixtures.

Service hot water is provided by a propane boiler located in Building 402. This boiler serves as a mini central plant for service hot water, providing hot water to all four barracks buildings.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 341,396 kWh for all four buildings. The modeled energy consumption for a typical year (using TMY weather data) was 332,824 kWh before retrofits and 359,637 kWh after proposed retrofits are implemented. The energy use intensity goes from 44.7 MBtu/Ksf to 28.2 MBtu/Ksf after retrofits. Note that electric use goes up because the model is recommending switching from propane boilers to electric heat pump water heaters.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 31_barracks
barracks complex (401-404)

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	332,824	7,634.3	26.1	58,286
post-retrofit	359,637	8,249.3	28.2	62,763
difference	26,813	615.0	2.1	4,477
% change	8	8	8	8
Central Hot Water - barracks loop (MBtu)				
existing	814	18.7	18.7	23,503
post-retrofit	0	0.0	0.0	0
difference	-814	-18.7	-18.7	-23,503
% change	-100	-100	-100	-100
Total (MBtu)				
existing	1,950	44.7	44.7	81,789
post-retrofit	1,227	28.2	28.2	62,763
difference	-723	-16.6	-16.6	-19,026
% change	-37	-37	-37	-23

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Space cooling is the major end use consuming 171,845 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 31_barracks
barracks complex (401-404)

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
EElectricity (kWh)						
existing	0	171,845	25,418	80,077	55,484	0
post-retrofit	0	171,515	25,418	79,036	55,484	28,184
difference	0	-330	0	-1,041	0	28,184
% change	0	0	0	-1	0	n/a
Central Hot Water - barracks loop (MBtu)						
existing	0	0	0	0	0	814
post-retrofit	0	0	0	0	0	0
difference	0	0	0	0	0	-814
% change	0	0	0	0	0	-100
Total (MBtu)						
existing	0	587	87	273	189	814
post-retrofit	0	585	87	270	189	96
difference	0	-1	0	-4	0	-718
% change	0	0	0	-1	0	-88
Total (MBtu/1000ft2)						
existing	0	13	2	6	4	19
post-retrofit	0	13	2	6	4	2
difference	0	0	0	0	0	-16
% change	0	0	0	-1	0	-88

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 31_barracks
barracks complex (401-404)

Sulfur Oxides (lb)	
existing	3,286
post-retrofit	3,251
difference	-35
% change	-1
Nitrogen Oxides (lb)	
existing	1,809
post-retrofit	1,554
difference	-256
% change	-14
Carbon Monoxide (lb)	
existing	3,276
post-retrofit	2,672
difference	-604
% change	-18
Carbon Dioxide (tons)	
existing	394
post-retrofit	329
difference	-65
% change	-17
Particulate Matter (lb)	
existing	70
post-retrofit	64
difference	-6
% change	-8
Hydrocarbons (lb)	
existing	1,289
post-retrofit	1,106
difference	-183
% change	-14

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
31_barracks: barracks complex (401-404)	Replace existing central hot water heat exchanger with heat pump water heater. Wrap tank with insullation and install LFSHs.	718	17,409	255,624	102,398	1.3
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	5	975	5,609	11,354	3.0
	TOTAL	723	18,384	261,233	113,752	1.3

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
31_barracks: barracks complex (401-404)	Service hot water: Wrap tank with insulation and install LFSHs.	37	1,068	1,061	7,743	8.3
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	5	1,067	5,609	921	1.2
	TOTAL	42	2,135	6,670	8,664	2.5

Additional Considerations

None.

Photos

Figure D 32. Front of Barracks 402

Figure D 33. Rear of Barracks 402

Building 600 Shops/Maintenance

Building 600 is a one-story maintenance facility. The building, built in 1983, has total area of 20,900 ft^2. There are several maintenance bays in addition to mixed office space.

Building 600 is the only building in FEDS building group: 40_Maint.

Space cooling is provided by 10 package cooling units of various sizes.

Lighting consists of 2x4 two-tube and 2x4 four-tube T8 lighting in the administrative areas and high pressure sodium lighting in the high bay areas.

Service hot water is provides by electric water heaters.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 146,186 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 145,253 kWh before retrofits and 144,978 kWh after proposed retrofits are implemented. The energy use intensity remains relatively unchanged at 23.7 MBtu/Ksf.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 40_Maint
Maintenance B600

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	145,253	6,949.9	23.7	25,437
post-retrofit	144,978	6,936.7	23.7	25,301
difference	-275	-13.2	0.0	-136
% change	0	0	0	-1
Total (MBtu)				
existing	496	23.7	23.7	25,437
post-retrofit	495	23.7	23.7	25,301
difference	-1	0.0	0.0	-136
% change	0	0	0	-1

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

The motors and other miscellaneous loads are estimated to consume 42,734 kWh/year, while cooling is the second largest consumer with over 30,581 MBtu/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 40_Maint
Maintenance B600

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water *
Electricity (kWh)						
existing	0	30,581	14,202	54,950	42,734	2,786
post-retrofit	0	30,565	14,195	54,834	42,734	2,650
difference	0	-15	-8	-116	0	-137
% change	0	0	0	0	0	-5
Total (MBtu)						
existing	0	104	48	188	146	10
post-retrofit	0	104	48	187	146	9
difference	0	0	0	0	0	0
% change	0	0	0	0	0	-5
Total (MBtu/1000ft2)						
existing	0	5	2	9	7	0
post-retrofit	0	5	2	9	7	0
difference	0	0	0	0	0	0
% change	0	0	0	0	0	-5

* Energy consumption values for both distributed and central SHW are reported for Hot Water annual energy use.

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 40_Maint
Maintenance B600

Sulfur Oxides (lb)	
existing	1,313
post-retrofit	1,311
difference	-2
% change	0
Nitrogen Oxides (lb)	
existing	627
post-retrofit	626
difference	-1
% change	0
Carbon Monoxide (lb)	
existing	1,079
post-retrofit	1,077
difference	-2
% change	0
Carbon Dioxide (tons)	
existing	133
post-retrofit	133
difference	0
% change	0
Particulate Matter (lb)	
existing	26
post-retrofit	26
difference	0
% change	0
Hydrocarbons (lb)	
existing	447
post-retrofit	446
difference	-1
% change	0

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
40_Maint: Maintenance B600	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	42	249	487	3.0
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	63	374	730	3.0
	TOTAL	<1	105	623	1,217	3.0

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
40_Maint: Maintenance B600	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	46	249	35	1.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	69	374	52	1.1
	TOTAL	<1	115	623	87	1.1

Additional Considerations

None.

Photos

Figure D 34. Building 600

Figure D 35. Building 600 End View

Building 602 UPS Building

Building 602 is a very small concrete block structure that houses an uninteruptalbe power suppy (UPS) center. The building, built in 2004, contains 604 ft^2. While small in footprint, this facilities has a large electrical load in powering the UPS. Likewise, a significant amount of cooling is employed to keep the sensitive equipment operating. The building has two rooftop package air-conditioning units, totalling approximately 15 tons of cooling.

Building 602 and Building 20C are both UPS buildings that constitute FEDS Group: 50_UPS.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 2,801,568 kWh for both buildings. The modeled energy consumption for a typical year (using TMY weather data) was 2,800,413 kWh before retrofits and 2,800,298 kWh after proposed retrofits are implemented. The energy use intensity goes from 4,376 MBtu/Ksf to 4,376 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 50_UPS
UPS Building 602

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	2,800,413	1,282,240.5	4,376.3	489,310
post-retrofit	2,800,298	1,282,187.5	4,376.1	490,581
difference	-116	-53.0	-0.2	1,271
% change	0	0	0	0
Total (MBtu)				
existing	9,558	4,376.3	4,376.3	489,310
post-retrofit	9,557	4,376.1	4,376.1	490,581
difference	0	-0.2	-0.2	1,271
% change	0	0	0	0

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

The UPS system and associated equipment consume a substantial amount of energy, using an estimated 2,304,124 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 50_UPS
UPS Building 602

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	240,625	254,041	1,623	2,304,124	0
post-retrofit	0	240,625	254,041	1,507	2,304,124	0
difference	0	0	0	-116	0	0
% change	0	0	0	-7	0	0
Total (MBtu)						
existing	0	821	867	6	7,864	0
post-retrofit	0	821	867	5	7,864	0
difference	0	0	0	0	0	0
% change	0	0	0	-7	0	0
Total (MBtu/1000ft2)						
existing	0	376	397	3	3,601	0
post-retrofit	0	376	397	2	3,601	0
difference	0	0	0	0	0	0
% change	0	0	0	-7	0	0

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 50_UPS
UPS Building 602

Sulfur Oxides (lb)	
existing	25,316
post-retrofit	25,315
difference	-1
% change	0
Nitrogen Oxides (lb)	
existing	12,097
post-retrofit	12,097
difference	-1
% change	0
Carbon Monoxide (lb)	
existing	20,807
post-retrofit	20,806
difference	-1
% change	0
Carbon Dioxide (tons)	
existing	2,562
post-retrofit	2,562
difference	0
% change	0
Particulate Matter (lb)	
existing	501
post-retrofit	501
difference	0
% change	0
Hydrocarbons (lb)	
existing	8,612
post-retrofit	8,611
difference	0
% change	0

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
50_UPS: UPS Building 602	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	102	623	1,155	2.9
	TOTAL	<1	102	623	1,155	2.9

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
50_UPS: UPS Building 602	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	113	623	65	1.1
	TOTAL	<1	113	623	65	1.1

Additional Considerations

None.

Photos

Because of security concerns, building photos were not permitted during the audit.

Figure D 36. Building 602

Building 366 Thrift Shop

Building 366 is a metal panel building constructed in 1994. It has a total of 1,764 ft^2.

Building 366 is in FEDS building group: 80_Misc. In addition, Buildings 6, 17, 50, 52, 56, 366, 367, 452, 453, and 611 are in this group.

Space cooling is provided by a mix of small split systems and window air-conditioning units.

Lighting varies by building.

Service hot water is provided by electric water heaters.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 143,351 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 140,028 kWh before retrofits and 117,610 kWh after proposed retrofits are implemented. The energy use intensity goes from 37.1 MBtu/Ksf to 31.1 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 80_Misc
Everything else

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	140,028	10,865.8	37.1	24,467
post-retrofit	117,610	9,126.3	31.1	20,604
difference	-22,418	-1,739.6	-5.9	-3,863
% change	-16	-16	-16	-16
Total (MBtu)				
existing	478	37.1	37.1	24,467
post-retrofit	401	31.1	31.1	20,604
difference	-77	-5.9	-5.9	-3,863
% change	-16	-16	-16	-16

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Space cooling is the largest end use in this group of buildings, consuming an estimated 104,627 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 80_Misc
Everything else

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	104,627	19,787	15,614	0	0
post-retrofit	0	86,459	16,115	15,036	0	0
difference	0	-18,168	-3,672	-578	0	0
% change	0	-17	-19	-4	0	0
Total (MBtu)						
existing	0	357	68	53	0	0
post-retrofit	0	295	55	51	0	0
difference	0	-62	-13	-2	0	0
% change	0	-17	-19	-4	0	0
Total (MBtu/1000ft2)						
existing	0	28	5	4	0	0
post-retrofit	0	23	4	4	0	0
difference	0	-5	-1	0	0	0
% change	0	-17	-19	-4	0	0

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 80_Misc
Everything else

Sulfur Oxides (lb)	
existing	1,266
post-retrofit	1,063
difference	-203
% change	-16
Nitrogen Oxides (lb)	
existing	605
post-retrofit	508
difference	-97
% change	-16
Carbon Monoxide (lb)	
existing	1,040
post-retrofit	874
difference	-167
% change	-16
Carbon Dioxide (tons)	
existing	128
post-retrofit	108
difference	-21
% change	-16
Particulate Matter (lb)	
existing	25
post-retrofit	21
difference	-4
% change	-16
Hydrocarbons (lb)	
existing	431
post-retrofit	362
difference	-69
% change	-16

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_Misc:	Insulate perimeter slab on grade by R-15.	15	1,010	15,335	2,146	1.1
	Add 4" fiberglass insulation to interior surface of metal roof.	60	4,101	44,081	26,929	1.6
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	543	3,116	6,322	3.0
	TOTAL	78	5,654	62,532	35,397	1.5

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_Misc:	Replace existing LED exit signs with electroluminescent panel retrofit kit.	3	587	3,116	480	1.2
	TOTAL	3	587	3,116	480	1.2

Additional Considerations

None.

Photos

Figure D 37. Building 366 Thrift Shop

Building 601 Security Office

Building 601 is a one-story concrete block building constructed in 1987. The building has a total of 3,888 ft^2.

Building 601 is the only building in FEDS building group: 80_police.

Space cooling is provided by nine window air-conditioners and a small split system.

Lighting is provided by 1x4 two-tube T8 and a few 13W CFLs.

There is no hot water in the building.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 93,005 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 91,838 kWh before retrofits and 91,694 kWh after proposed retrofits are implemented. The energy use intensity goes from 80.6 MBtu/Ksf to 80.5 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 80_Police
B601 Police Station

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	91,838	23,620.9	80.6	16,047
post-retrofit	91,694	23,583.8	80.5	16,064
difference	-144	-37.1	-0.1	17
% change	0	0	0	0
Total (MBtu)				
existing	313	80.6	80.6	16,047
post-retrofit	313	80.5	80.5	16,064
difference	0	-0.1	-0.1	17
% change	0	0	0	0

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

The motors and other miscellaneous loads are estimated to consume 29,289 kWh/year, while cooling is the second largest consumer with over 26,068 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 80_Police
B601 Police Station

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	26,068	23,786	12,694	29,289	0
post-retrofit	0	26,054	23,771	12,579	29,289	0
difference	0	-14	-15	-116	0	0
% change	0	0	0	-1	0	0
Total (MBtu)						
existing	0	89	81	43	100	0
post-retrofit	0	89	81	43	100	0
difference	0	0	0	0	0	0
% change	0	0	0	-1	0	0
Total (MBtu/1000ft2)						
existing	0	23	21	11	26	0
post-retrofit	0	23	21	11	26	0
difference	0	0	0	0	0	0
% change	0	0	0	-1	0	0

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 80_Police
B601 Police Station

Sulfur Oxides (lb)	
existing	830
post-retrofit	829
difference	-1
% change	0
Nitrogen Oxides (lb)	
existing	397
post-retrofit	396
difference	-1
% change	0
Carbon Monoxide (lb)	
existing	682
post-retrofit	681
difference	-1
% change	0
Carbon Dioxide (tons)	
existing	84
post-retrofit	84
difference	0
% change	0
Particulate Matter (lb)	
existing	16
post-retrofit	16
difference	0
% change	0
Hydrocarbons (lb)	
existing	282
post-retrofit	282
difference	0
% change	0

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_Police	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	106	623	1,225	3.0
TOTAL	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	106	623	1,225	3.0

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_Police	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	117	623	90	1.1
TOTAL	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	117	623	90	1.1

Additional Considerations

None.

Photos

Because of security concerns, building photos were not permitted during the audit.

Figure D 38. Building 601

Building 500 NCO Club

Building 500 is the NCO Club. This building was constructed in 1969. The building has 7,020 ft^2.

Building 500 is the only building in FEDS building group: 80_NCO.

Space cooling is provided by a small split system and a couple of window air-conditioning units.

Lighting is provided by a handful of 2x2 U-tube T8 lights, CFL fixtures, a few halogen fixtures, 60-W INC lamps in ceiling fans, and a couple dozen 25-W INC lamps in the bar area.

Service hot water is provided by a propane hot water heater.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 174,932 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 160,362 kWh before retrofits and 147,195 kWh after proposed retrofits are implemented. The energy use intensity goes from 98.0 MBtu/Ksf to 90.3 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 80_NCO
NCO Club, B500

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	160,362	22,843.5	78.0	28,083
post-retrofit	147,195	20,968.0	71.6	25,688
difference	-13,166	-1,875.5	-6.4	-2,395
% change	-8	-8	-8	-9
Other Fuels (MBtu)				
existing	140	20.0	20.0	3,124
post-retrofit	132	18.7	18.7	2,926
difference	-9	-1.3	-1.3	-198
% change	-6	-6	-6	-6
Total (MBtu)				
existing	688	98.0	98.0	31,207
post-retrofit	634	90.3	90.3	28,614
difference	-54	-7.7	-7.7	-2,593
% change	-8	-8	-8	-8

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Space cooling is the largest end use consuming 295 MBtu/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 80_NCO
NCO Club, B500

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	86,489	19,095	16,198	38,579	0
post-retrofit	0	80,439	17,500	10,677	38,579	0
difference	0	-6,050	-1,595	-5,521	0	0
% change	0	-7	-8	-34	0	0
Other Fuels (MBtu)						
existing	0	0	0	0	0	140
post-retrofit	0	0	0	0	0	132
difference	0	0	0	0	0	-9
% change	0	0	0	0	0	-6
Total (MBtu)						
existing	0	295	65	55	132	140
post-retrofit	0	275	60	36	132	132
difference	0	-21	-5	-19	0	-9
% change	0	-7	-8	-34	0	-6
Total (MBtu/1000ft2)						
existing	0	42	9	8	19	20
post-retrofit	0	39	9	5	19	19
difference	0	-3	-1	-3	0	-1
% change	0	-7	-8	-34	0	-6

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 80_NCO
NCO Club, B500

Sulfur Oxides (lb)	
existing	1,485
post-retrofit	1,364
difference	-121
% change	-8
Nitrogen Oxides (lb)	
existing	742
post-retrofit	682
difference	-60
% change	-8
Carbon Monoxide (lb)	
existing	1,298
post-retrofit	1,194
difference	-105
% change	-8
Carbon Dioxide (tons)	
existing	159
post-retrofit	146
difference	-13
% change	-8
Particulate Matter (lb)	
existing	30
post-retrofit	28
difference	-2
% change	-8
Hydrocarbons (lb)	
existing	528
post-retrofit	486
difference	-43
% change	-8

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_NCO: NCO Club, B500	Service hot water: Wrap tank with insulation.	9	198	124	4,182	34.8
	Replace existing 25-W INC lamp with 9-W CFL	7	326	2,084	3,606	2.7
	Replace existing 60-W INC lamp with 13-W CFL	21	1,263	232	21,833	95.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	57	312	668	3.1
	Replace existing metal frame, single-pane window with aluminum double-pane super Low-e window.	17	999	13,809	3,496	1.3
	TOTAL	54	2,843	16,561	33,785	3.3

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_NCO: NCO Club, B500	Service hot water: Wrap tank with insulation.	9	198	124	1,511	13.2
	Replace existing 25-W INC lamp with 9-W CFL	7	432	2,084	529	1.3

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
	Replace existing 60-W INC lamp with 13-W CFL	21	1,245	232	7,349	32.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	61	312	62	1.2
	TOTAL	37	1,936	2,752	9,451	4.9

Additional Considerations

FEDS recommends replacing incandescent lighting with more efficient technologies. This may not be possible because of aesthetic reasons in the lounge and entertainment spaces. This may be an opportunity to look at a detailed lighting design with advanced lighting technologies, including LED, dimmable CFL, dimmable fluorescent lighting. These are beyond the scope of this assessment.

Photos

Figure D 39. Building 500, Front View

Figure D 40. Building 500, Rear View

Building 501 Rec Center

Building 501 is a recreational center located near the barracks complex. This building contains common space, computers, a game room, and TV room. The building was constructed in 1986 and covers 5,518 ft^2.

Building 501 is the only building in FEDS building group: 80_RecCntr.

Space cooling is provided by eight small split systems with a total of 18 tons of cooling.

Lighting is provided by standard CFL fixtures, nine large CFL fixtures, T8 fluoresent, and a handful of incandescent lighting.

Service hot water is provided by electric hot water heater.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 154,649 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 153,090 kWh before retrofits and 142,248 kWh after proposed retrofits are implemented. The energy use intensity goes from 94.7 MBtu/Ksf to 88.0 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 80_RecCntr
Bldg 501 Rec center

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	153,090	27,743.7	94.7	26,810
post-retrofit	142,248	25,778.9	88.0	24,825
difference	-10,842	-1,964.8	-6.7	-1,985
% change	-7	-7	-7	-7
Total (MBtu)				
existing	522	94.7	94.7	26,810
post-retrofit	485	88.0	88.0	24,825
difference	-37	-6.7	-6.7	-1,985
% change	-7	-7	-7	-7

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Cooling is the largest end use consuming 60,336 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 80_RecCntr
Bldg 501 Rec center

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	60,336	17,063	18,778	53,101	3,812
post-retrofit	0	55,529	15,793	17,310	53,101	515
difference	0	-4,807	-1,270	-1,467	0	-3,297
% change	0	-8	-7	-8	0	-86
Total (MBtu)						
existing	0	206	58	64	181	13
post-retrofit	0	190	54	59	181	2
difference	0	-16	-4	-5	0	-11
% change	0	-8	-7	-8	0	-86
Total (MBtu/1000ft2)						
existing	0	37	11	12	33	2
post-retrofit	0	34	10	11	33	0
difference	0	-3	-1	-1	0	-2
% change	0	-8	-7	-8	0	-86

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 80_RecCntr
Bldg 501 Rec center

Sulfur Oxides (lb)	
existing	1,384
post-retrofit	1,286
difference	-98
% change	-7
Nitrogen Oxides (lb)	
existing	661
post-retrofit	614
difference	-47
% change	-7
Carbon Monoxide (lb)	
existing	1,137
post-retrofit	1,057
difference	-81
% change	-7
Carbon Dioxide (tons)	
existing	140
post-retrofit	130
difference	-10
% change	-7
Particulate Matter (lb)	
existing	27
post-retrofit	25
difference	-2
% change	-7
Hydrocarbons (lb)	
existing	471
post-retrofit	437
difference	-33
% change	-7

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_RecCntr: Bldg 501 Rec center	Increase insulation above suspended ceiling by R-19.	10	763	9,514	3,708	1.4
	Replace existing water heater with heat pump water heater.	11	549	2,020	1,865	2.7
	Replace existing 75-W INC lamp with 23-W CFL	2	161	48	2,688	56.6
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	56	312	654	3.1
	Replace existing 2x4 3-lamp T8 with 2x4 3-lamp 28-W super T8 with reflector.	4	246	3,574	706	1.2
	Replace existing metal frame, single-pane window with aluminum double-pane super Low-e window.	10	610	9,227	1,349	1.1
	TOTAL	37	2,385	24,695	10,970	1.4

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_RecCntr: Bldg 501	Replace existing water heater with heat pump water heater.	11	549	2,020	1,331	1.7

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
Rec center	Replace existing 75-W INC lamp with 23-W CFL	2	162	48	915	19.9
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	<1	60	312	57	1.2
	TOTAL	13	771	2,380	2,303	2.0

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model.

Photos

Figure D 41. Building 501.

Building 612 Fire Station

Building 612 is the new fire station constructed in 2008. The building has a total of 7,126 ft^2.

Building 612 is the only building in FEDS building group: 80_Fire.

Space cooling is provided by two split systems with a total of 15 tons of cooling.

Lighting is provided through a mix of T8 fluoresent and CFL lighting fixtures.

Service hot water is provided by an electric water heater, a roof-mounted solar hot water system, and a de-superheater recovering waste heat from the cooling system.

Energy Consumption by Fuel Type

Actual metered data for this building was not available. FEDS calculated the energy use based on FY 2009 weather data to be 110,880 kWh. The modeled energy consumption for a typical year (using TMY weather data) was 109,966 kWh before retrofits and 109,678 kWh after proposed retrofits are implemented. The energy use intensity goes from 52.7 MBtu/Ksf to 52.5 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 80_Fire
Fire Station B612

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	109,966	15,431.7	52.7	19,258
post-retrofit	109,678	15,391.2	52.5	19,141
difference	-289	-40.5	-0.1	-117
% change	0	0	0	-1
Total (MBtu)				
existing	375	52.7	52.7	19,258
post-retrofit	374	52.5	52.5	19,141
difference	-1	-0.1	-0.1	-117
% change	0	0	0	-1

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

The motors and other miscellaneous loads are estimated to consume 40,119 kWh/year, while cooling is the second largest consumer with over 32,573 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 80_Fire
Fire Station B612

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	32,573	13,857	21,883	40,119	1,535
post-retrofit	0	32,537	13,847	21,767	40,119	1,407
difference	0	-36	-9	-116	0	-128
% change	0	0	0	-1	0	-8
Total (MBtu)						
existing	0	111	47	75	137	5
post-retrofit	0	111	47	74	137	5
difference	0	0	0	0	0	0
% change	0	0	0	-1	0	-8
Total (MBtu/1000ft2)						
existing	0	16	7	10	19	1
post-retrofit	0	16	7	10	19	1
difference	0	0	0	0	0	0
% change	0	0	0	-1	0	-8

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 80_Fire
Fire Station B612

Sulfur Oxides (lb)	
existing	994
post-retrofit	991
difference	-3
% change	0
Nitrogen Oxides (lb)	
existing	475
post-retrofit	474
difference	-1
% change	0
Carbon Monoxide (lb)	
existing	817
post-retrofit	815
difference	-2
% change	0
Carbon Dioxide (tons)	
existing	101
post-retrofit	100
difference	0
% change	0
Particulate Matter (lb)	
existing	20
post-retrofit	20
difference	0
% change	0
Hydrocarbons (lb)	
existing	338
post-retrofit	337
difference	-1
% change	0

Energy Conservation Measures (ECMs)

The FEDS model generated the following retrofits when funded through appropriated funding:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_Fire: Fire Station B612	Service hot water: Wrap tank with insulation and insulate pipes.	<1	21	112	76	1.7
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	110	623	1,281	3.1
	TOTAL	1	131	735	1,357	2.9

The FEDS model generated the following retrofits when funded through alternative finacing mechanisms:

FEDS Category	Technology Change	Energy Savings (MMBtu/yr)	1st Year Savings ($/yr)	Installed Cost ($)	Net Present Value ($)	SIR
80_Fire: Fire Station B612	Service hot water: Wrap tank with insulation and insulate pipes.	<1	21	112	13	1.1
	Replace existing LED exit signs with electroluminescent panel retrofit kit.	1	121	623	109	1.2
	TOTAL	1	142	735	122	1.2

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model.

Photos

Figure D 42. Building 612

Figure D 43. Building 612 with Solar Hot Water System on Roof.

Building 450/451 Racquetball Courts

Building 450 is a 1,600 ft^2 racquetball court built in 1977. Building 451 is a 1,722 ft^2 raquetball court built in 1985. The buildings have rooftop ventilation, but no active cooling.

Building 450 and 451 are the only buildings in FEDS building group: 80_RB.

Energy Consumption by Fuel Type

Actual metered data for these buildings was not available. FEDS calculated the energy use based on FY 2009 weather data to be 16,530 kWh for the two buildings. The modeled energy consumption for a typical year (using TMY weather data) was 16,557 kWh before retrofits and 13,848 kWh after proposed retrofits are implemented. The energy use intensity goes from 17.0 MBtu/Ksf to 14.2 MBtu/Ksf after retrofits.

Annual Energy Use by Building Set and Fuel Type
Building Set ... 80_RB
Indoor racquetball/handball courts (450 & 451)

Fuel	Energy	Energy Intensity (user units/1000ft2)	Energy Intensity (MBtu/1000ft2)	Dollars (2009)*
Electricity (kWh)				
existing	16,557	4,984.1	17.0	2,893
post-retrofit	13,848	4,168.6	14.2	2,426
difference	-2,709	-815.5	-2.8	-467
% change	-16	-16	-16	-16
Total (MBtu)				
existing	57	17.0	17.0	2,893
post-retrofit	47	14.2	14.2	2,426
difference	-9	-2.8	-2.8	-467
% change	-16	-16	-16	-16

* Dollar values for electricity include both energy and demand components.

Energy Consumption by End Uses

Lighting is the largest load consuming 12,923 kWh/year.

Annual Energy Use by Building Set, Fuel Type, and End Use
Building Set ... 80_RB
Indoor racquetball/handball courts (450 & 451)

Fuel	Heating	Cooling	Vent	Lights	Motors and Misc Equip	Hot Water
Electricity (kWh)						
existing	0	0	3,634	12,923	0	0
post-retrofit	0	0	3,617	10,232	0	0
difference	0	0	-18	-2,691	0	0
% change	0	0	0	-21	0	0
Total (MBtu)						
existing	0	0	12	44	0	0
post-retrofit	0	0	12	35	0	0
difference	0	0	0	-9	0	0
% change	0	0	0	-21	0	0
Total (MBtu/1000ft2)						
existing	0	0	4	13	0	0
post-retrofit	0	0	4	11	0	0
difference	0	0	0	-3	0	0
% change	0	0	0	-21	0	0

Emission Reduction

The emission reductions from implemented the proposed retrofits are as follows:

Annual Emissions by Building Set and Pollutant Type
Building Set... 80_RB
Indoor racquetball/handball courts (450 & 451)

Sulfur Oxides (lb)	
existing	150
post-retrofit	125
difference	-24
% change	-16
Nitrogen Oxides (lb)	
existing	72
post-retrofit	60
difference	-12
% change	-16
Carbon Monoxide (lb)	
existing	123
post-retrofit	103
difference	-20
% change	-16
Carbon Dioxide (tons)	
existing	15
post-retrofit	13
difference	-2
% change	-16
Particulate Matter (lb)	
existing	3
post-retrofit	2
difference	0
% change	-16
Hydrocarbons (lb)	
existing	51
post-retrofit	43
difference	-8
% change	-16

Energy Conservation Measures (ECMs)

No energy conservation measures were identified for this building group.

Additional Considerations

The storage areas should be evaluated for zone-based occupancy sensors to control existing lighting. Specific implementation of controls and zoning are not automatically included in the FEDS energy model.

Photos

Figure D 44. Building 450

Appendix E

Conversion to Water-Cooled Chillers for Building Space Cooling

Appendix E
Conversion to Water-Cooled Chillers for Building Space Cooling

Water-cooled condensing of cooling equipment refrigerant results in a significant improvement in efficiency compared to air-cooled condensing. This advantage stems from two factors. Condenser water from an evaporative cooling tower is generally cooler than ambient air (except when the relative humidity is very high) and water is a more effective heat transfer fluid than air. The two factors work together to lower the refrigerant condensing temperature, hence improving both theoretical and actual refrigeration cycle efficiency. Combining cooling loads met by multiple smaller cooling units into fewer central units allows additional efficiency gains by using centrifugal compressors, a more efficient technology than alternative compressor types commonly used in smaller cooling equipment. These advantages do come at a price, however. Condensing refrigerant with water requires additional costs associated with a cooling tower, condenser water pumps and piping, and a shell to enclose the water as it passes by the condenser tubing. The condenser pump also represents an additional power consuming device that an air-cooled unit does not have. Finally, the distribution of centrally chilled water incurs pumping and piping costs and pumping energy not required by distributed direct expansion coolers (e.g., window air conditioner [AC] and packaged rooftop AC).

For the reasons noted above, water-cooled chillers offer significant performance advantages over air-cooled equipment that must be weighed against their additional capital costs. During the last few decades, space cooling has become much more common in Hawaiian military facilities because internal heating loads (e.g., personal computers and other office equipment) have increased, building designs have become less suitable for natural ventilation, and occupants expect a more comfortable working environment. The paragraphs that follow document the expected costs and energy savings associated with example conversions to water-cooled chillers at Hickam, Pearl, and Smith. Many other similar conversions are possible at these three facilities, but additional analysis was not possible with the assessment resources available. The installations are encouraged to consider additional opportunities for using water-cooled chillers where the economics are justified.

Hickam AFB
Buildings 2130, 2131, and 2133 are currently served by a small central cooling plant comprised of two air-cooled chillers. The proposed retrofit would replace the existing air-cooled chillers with two water-cooled chillers, a cooling tower, and condenser water pumps and piping. The existing chilled water pumps and piping would not change and the electrical service to the central plant should be adequate for the retrofit.

The peak and annual building cooling loads were estimated with the FEDS model, and the performance of the existing chillers was estimated from manufacturer's specifications for the two units. From this information, the annual kWh and peak kW electrical loads

were calculated and then combined with Hickam's electricity rates to calculate the current annual electricity costs. The existing system performance and electricity cost figures are presented in Table E1.

Although the FEDS model estimates a peak of only 61 tons for the three buildings, two 40-ton water-cooled chillers were assumed for the retrofit to match the existing nameplate capacity of the two air-cooled chillers. In this size range, the water-cooled chillers were assumed to use a rotary screw compressor rated at 0.73 kW/ton. In addition, the condenser water pump and cooling tower fan would be expected to consume 0.12 kW/ton for a total cooling plant performance of 0.85 kW/ton. The annual electricity bill for the water-cooled system was calculated to be $35,360 based on these assumptions, resulting in an annual savings of about $15,000 and a peak electric load reduction of 22 kW.

Table E 1. Hickam Buildings 2130, 2131, 2133 Existing System Performance and Electricity Cost

Building	Peak Load, Tons	Annual Load, Ton-hours	Annual Capacity Factor	Existing Air Cooled kW/ton	Existing Annual Electricity kWh	Existing Peak Electricity kW	Existing Annual Electricity Cost
2130	18.1	73,335	0.46	1.204	88,296	21.8	
2131	10.3	40,647	0.45	1.204	48,939	12.4	
2133	32.7	100,092	0.35	1.204	120,511	39.3	
Totals	**61.0**	**214,074**	**0.40**	**1.204**	**257,745**	**73.5**	**$50,087**

The two new 40-ton water-cooled chillers were estimated to cost $88,200 and the cooling tower, condenser pump, and piping an additional $26,100. These figures include all direct construction costs, but do not include any allowance for design or SIOH costs. Based on the direct cost, the payback period is 8 years. With an additional 16% for design and SIOH, the payback period rises to 9 years.

Pearl Harbor

Building 631, the Navy Exchange and Commissary, is currently served by a collection of packaged rooftop direct expansion (DX) AC units. The proposed retrofit would replace the existing DX units with a new chilled water coil (in the existing air-handler units [AHU]), two water-cooled chillers, a cooling tower, condenser water pumps and piping, and chilled water pumps and piping. The new chiller plant was assumed to be sited on the ground on the southeast side of the building, next to the Commissary.

The peak and annual building cooling loads were estimated with the FEDS model and the performance of the existing packaged DX units was estimated from the vintage of the existing equipment. From this information, the annual kWh and peak kW electrical loads were calculated and then combined with Pearl's electricity rates to calculate the current annual electricity costs. The existing system performance and electricity cost figures are presented in Table E2.

Table E 2. Pearl Building 631 Existing System Performance and Electricity Cost

Building	Peak Load, Tons	Annual Load, Ton-hours	Annual Capacity Factor	Existing Air Cooled kW/ton	Existing Annual Electricity kWh	Existing Peak Electricity kW	Existing Annual Electricity Cost
Navy Exchange (NEX)	275.1	918,580	0.38	1.2859	1,181,180	354	
NEX Food Court	125.0	342,737	0.31	1.2859	440,717	161	
Commissary	194.4	716,633	0.42	1.2859	921,501	250	
Totals	594.5	1,977,950	0.38	1.2859	2,543,446	764	$493,300

In this size range, the water-cooled chillers were assumed to use a centrifugal compressor rated at 0.51 kW/ton. In addition, the chilled water pumps, condenser water pumps, and cooling tower fan would be expected to consume 0.18 kW/ton for a total cooling plant performance of 0.69 kW/ton. The annual electricity bill for the water-cooled system was calculated to be $264,700 based on these assumptions, resulting in an annual savings of $228,600 and a peak electric load reduction of 354 kW.

A new 600-ton water-cooled chiller plant (chillers, cooling tower, pumps, plant piping, electrical, controls, and structure) was estimated to cost $656,000. Chilled water piping running to and from the ground to every rooftop air-handling unit was estimated to cost $225,000. The cost of the new chilled water coils was estimated to be $180,000. These figures include all direct construction costs, but do not include any allowance for design or SIOH costs. Based on the direct cost, the payback period is 4 years. With an additional 16% for design and SIOH, the payback period rises to 4.5 years.

Camp Smith

Buildings 401, 402, 403, and 404 are currently served by window DX AC units. The proposed retrofit would replace the window units with room fan coil units, external chilled water supply and return piping and a central water-cooled chiller plant serving all four buildings. The same plant would also serve Building 20, which already has air-cooled chillers, hence chilled water piping within the building, but will need chilled water supply and return piping from the new central plant to Building 20. The new chiller plant was assumed to be sited on the West side of Bailey Road, opposite Building 401.
The peak and annual building cooling loads were estimated with the FEDS model and the performance of the existing window DX AC units and air-cooled chillers were estimated from manufacturer's specifications for the two types of units. From this information, the annual kWh and peak kW electrical loads were calculated and then combined with Smith's electricity rates to calculate the current annual electricity costs. The existing system performance and electricity cost figures are presented in Table E3.

Table E 3. Smith Buildings 401-404, and 20 Existing System Performance and Electricity Cost

Building	Peak Load, Tons	Annual Load, Ton-hours	Annual Capacity Factor	Existing Air Cooled kW/ton	Existing Annual Electricity kWh	Existing Peak Electricity kW	Existing Annual Electricity Cost
401	65.7	147,804	0.26	1.16	171,515	76.2	
402	65.7	147,804	0.26	1.16	171,515	76.2	
403	65.7	147,804	0.26	1.16	171,515	76.2	
404	65.7	147,804	0.26	1.16	171,515	76.2	
20	142.8	419,327	0.34	1.44	603,203	205.3	
Totals	405.5	1,010,544	0.28	1.26	1,289,263	510	$275,500

In this size range, the water-cooled chillers were assumed to use a centrifugal compressor rated at 0.57 kW/ton. In addition, the chilled water pumps, condenser water pumps, and cooling tower fan would be expected to consume 0.18 kW/ton for a total cooling plant performance of 0.75 kW/ton. The annual electricity bill for the water-cooled system was calculated to be $164,200 based on these assumptions, resulting in an annual savings of $111,300 and a peak electric load reduction of 206 kW.

A new 400-ton water-cooled chiller plant (chillers, cooling tower, pumps, plant piping, electrical, controls, and structure) was estimated to cost $520,000. Chilled water piping that would be mounted on the exterior of Buildings 401-404 was estimated to cost $85,000. Chilled water piping running to and from the new central plant to Buildings 401-404 and 20 was estimated to cost $189,000. The cost of the new chilled water coils for Buildings 401-404 was estimated to be $75,000. These figures include all direct construction costs, but do not include any allowance for design or SIOH costs. Based on the direct cost, the payback period is 8 years. With an additional 16% for design and SIOH, the payback period rises to 9 years.

Before implementing this project, Camp Smith should consider other possible means of serving these five buildings with water-cooled chillers. An expansion of the chilled water plant serving Building 700 may offer some economies over the new plant proposed here, but the chilled water distribution piping would be longer. Integration with a new chilled water plant serving the eventual replacement of the Old Hospital Complex would probably be ideal if the Complex is going to be replaced relatively soon.

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