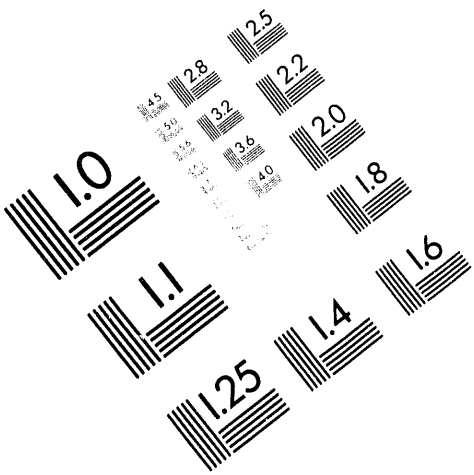

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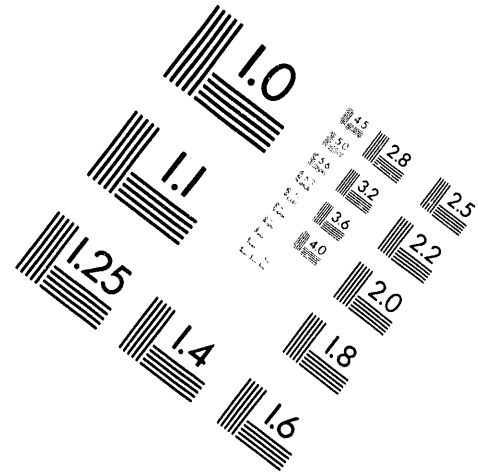

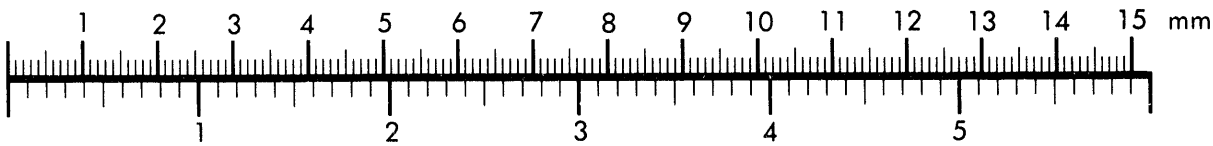

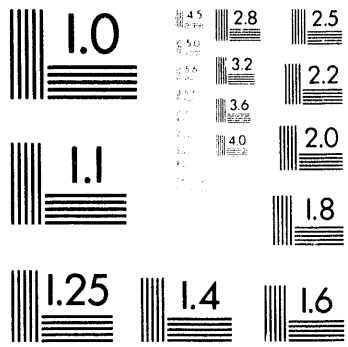

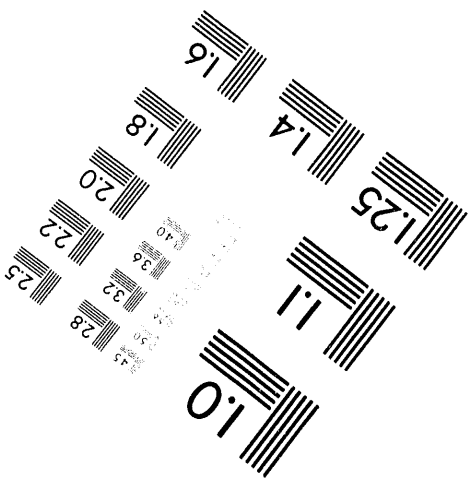

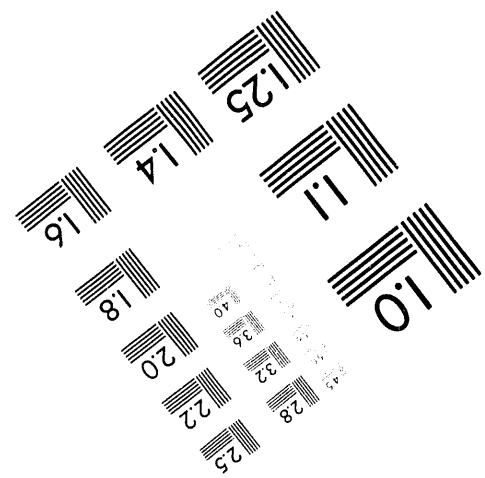

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PATRICK AIR FORCE BASE
INTEGRATED RESOURCE ASSESSMENT

VOLUME 1: EXECUTIVE SUMMARY

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ABSTRACT

Some of the most difficult problems encountered at federal sites in reducing energy consumption in a cost-effective manner revolve around understanding where energy is being used and what technologies can be employed to decrease energy use. Many large federal sites have one or two meters to track electric energy use for several thousand buildings and numerous industrial processes. Even where meters are available on individual buildings or family housing units, the meters are not consistently read. When the federal energy manager has been able to identify high energy users, the energy manager may not have the background, training, or resources to determine the most cost-effective options for reducing this energy use. This limitation can lead to selection of suboptimal projects that prevent the site from achieving full life-cycle cost savings.

The U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) has been tasked by the U.S. Air Force Space Command (SPACECOM) to identify, evaluate, and acquire all cost-effective energy projects at selected federal facilities. Pacific Northwest Laboratory (PNL)[a] is assisting FEMP in this effort. This is part of a model program that PNL has developed to provide a systematic approach to evaluating energy opportunities. The program 1) identifies the building groups and end uses using the most energy (not just having the greatest energy-use intensity) and 2) evaluates the numerous options for retrofit or installation of new technology that will result in the selection of the most cost-effective technologies. In essence, this model program provides the federal energy manager with a road map to significantly reduce energy use in a planned, rational, cost-effective fashion that is not biased by the constraints of the typical funding sources available to federal sites. The results from this assessment process can easily be turned into a 5- to 10-year energy management plan that identifies where to start and how to proceed to reach the mandated energy consumption targets.

(a) Pacific Northwest Laboratory is operated by Battelle Memorial Institute for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.

This report provides the results of the fossil fuel and electric energy resource opportunity (ERO) assessments performed by PNL at one of Florida Power & Light's primary federal facilities--the U.S. Air Force's Space Command (SPACECOM) facility, Patrick Air Force Base (AFB), located near Cocoa Beach, Florida. This is a companion report to Volume 2: Baseline Detail (Wahlstrom et al. 1993) and Volume 3: Resource Assessment (Sandusky et al. 1993).

SUMMARY

The federal government is the single largest energy consumer in the United States, with an annual consumption of 1.46 quads of energy during fiscal year (FY) 1991. Evidence suggests there is enormous energy and dollar savings potential within the federal sector. With the implementation of the most life-cycle cost-effective technologies, between 25% and 40% of the annual energy bill for buildings and facilities (about 30% of the total federal energy consumption) can be saved. On October 24, 1992, the Energy Policy Act of 1992 (EPAct 1992) was issued. The act directs federal agencies to reduce energy consumption by 20% from 1985 levels by the year 2000. To assist federal agencies in meeting this direction, the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) has been tasked by the U.S. Air Force Space Command (SPACECOM) to identify, evaluate, and acquire all cost-effective energy projects at selected federal facilities. Pacific Northwest Laboratory (PNL) is assisting FEMP in this effort.

This report provides the results of the fossil fuel and electric energy resource opportunity (ERO) assessments performed by PNL at one of Florida Power & Light's primary federal facilities--the U.S. Air Force's Space Command (SPACECOM), Patrick Air Force Base (AFB), located near Cocoa Beach, Florida. This is a companion report to Volume 2: Baseline Detail (Wahlstrom et al. 1993) and Volume 3: Resource Assessment (Sandusky et al. 1993).

Patrick AFB is a 2,108-acre SPACECOM facility containing military family housing units, base industrial facilities, an airfield, and related community facilities. In FY92, the number of people affecting energy consumption through their use of Patrick AFB facilities included 4,000 active duty military personnel and 2,000 civilian personnel. In addition, approximately 45,000 to 50,000 retired military personnel and their families, living on the east coast of Florida, were entitled to use these facilities; the extent of their energy consumption has not been determined.

A total of 1,188 buildings with 5,288,364 ft^2 of floorspace were identified at the base. Utilities include electricity, a central heating steam system, natural gas, water, and sewage.

Table S.1 shows a summation of the typical yearly energy consumption and cost for all on-base facilities and housing at Patrick AFB. For each energy type, the yearly total is shown in units appropriate to the energy type and in a common unit as a basis of comparison.

TABLE S.1. Typical Annual Energy Consumption and Cost at Patrick AFB

Energy Type	Annual Total	Annual Total (MBtu)[a]	Percent of Total	Energy Cost (1991$ x 10^3)
Electricity	108,676 MWh	370,803[b]	73.9	6,065
Gasoline	710.5 kgal	78,150[c]	15.6	874
Natural Gas	238 ktherm	23,819[d]	4.8	91
Diesel	141.9 kgal	19,161[e]	3.8	146
No.2 Fuel Oil	69.7 kgal	9,671[f]	1.9	72
Totals		501,604	100.0	7,248

(a) 1 MBtu = 1,000,000 Btu
(b) 3,413 Btu/kWh
(c) 0.1100 MBtu/gal
(d) 100,000 Btu/therm; 1,050 Btu/t^3
(e) 0.1350 MBtu/gal
(f) 0.1388 MBtu/gal

Following life-cycle cost (LCC) guidelines required for all federal energy decisions (10 CFR 436), PNL prioritized the various energy resource opportunities (EROs) by 10 end-use categories (e.g., lighting, hot water, motors). The net present value (NPV) of the installed cost of all cost-effective EROs at Patrick AFB is nearly $16.7 million (1993$). The NPV of the savings associated with this investment is approximately $34.2 million (1993$), for an overall NPV of roughly $17.5 million. By implementing all cost-effective EROs identified in this study, Patrick AFB will reduce annual energy use by 98,000 MBtu and reduce demand by 97,000 kW-mo (20.6%). Annual energy expenditures will decrease by nearly $1.5 million. The single largest savings potential by end use is the roughly 13,000 MWh of electricity (approximately $0.45 million) saved annually by increased lighting efficiency.

ACKNOWLEDGMENTS

The authors would like to extend their gratitude and acknowledge the assistance of key people who have been allied with the decision-making process for implementation of energy resource opportunities at Patrick AFB. These people provided PNL with detailed and timely information that increased the value and usefulness of our analysis. We would like to thank Lt. Mark Nelson and Lt. Mike Grubb of the 45th CES/CEOE (Patrick AFB, Florida); Craig Miller of the U.S. Air Force Space Command (Peterson AFB, Colorado); and Vince Juselis of the 45th CES/CECR (Cape Canaveral Air Force Station, Florida).

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ABBREVIATIONS AND ACRONYMS

AFB	Air Force Base
AFR	Air Force Regulation
AFS	Air Force Station
AFTAC	Air Force Technical Applications Center
Btu	British thermal unit
City Gas	City Gas of Florida
Corps	U.S. Army Corps of Engineers
CY	calendar year
DEIS	Defense Energy Information System
DHW	domestic hot water
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DSM	demand-side management
EPA	Environmental Protection Agency
EPAct	Energy Policy Act of 1992
ERO	energy resource opportunity
EUI	energy-use intensity
FEDS	Facility Energy Decision Screening
FEMP	Federal Energy Management Program
FPL	Florida Power & Light
FY	fiscal year
HPS	high-pressure sodium
kW	kilowatt
kWh	kilowatt-hour
LCC	life-cycle cost
LPS	low-pressure sodium
MBtu	million British thermal units
MEP	Mobile Electric Power
MWh	megawatt-hour
O&M	operations and maintenance
PNL	Pacific Northwest Laboratory
RECS	Residential Energy Consumption Survey
SERC	Southeastern Electric Reliability Council
SPACECOM	space command
T&D	transmission and distribution
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service

1.0 INTRODUCTION

Nearly 2.4% of all energy used in the United States is consumed by the federal government in buildings, facilities, and operations, making it the single largest energy consumer in the country. In fiscal year (FY) 1991, the federal government consumed nearly 1.46 quads[a] of energy annually at a cost of $11.26 billion. Of this, buildings and facilities consumed 0.41 quads at a cost of $3.75 billion (DOE 1992). Evaluations (completed and ongoing) by Pacific Northwest Laboratory (PNL) at over 50 federal installations indicate there is an enormous energy and dollar savings potential within the federal sector. Evidence suggests there is a potential to save 25% to 40% of the annual energy bill by implementing the most life-cycle cost-effective technologies (Currie 1992). Furthermore, a level of investment of $5 billion to $10 billion between now and the year 2000 has the potential of saving $2 billion annually in the federal sector (Currie 1992). This investment will be applied towards the retrofit and replacement of current lighting, motor, transformer, water heating, space cooling, space heating, process, and vehicle equipment with new and more efficient technologies.

In line with the Energy Policy Act of 1992 (EPAct 1992), federal agencies have set a goal of 20% reduction in federal facility energy use and industrial process efficiency improvement by the year 2000 (from 1985 levels). This Act requires the purchase of energy-consuming goods or products that are the most life-cycle cost-effective. Other legislation affecting energy conservation goals in the federal sector include the life-cycle cost (LCC) method and procedures of 10 CFR 436.

The 10 CFR 436 legislation mandates the use of LCC methods and procedures by all federal agencies for the design of new federal buildings and the application of energy conservation measures to existing buildings. EPAct addresses energy, environmental, and economic issues in a coordinated and comprehensive manner. It encourages investment in conservation and energy efficiency by gas and electric utilities by allowing utilities to recover the

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(a) One quad is equivalent to 1 quadrillion (10^{15}) Btu of energy.

cost of demand-side management (DSM) incentives through rate recovery. EPAct authorizes and encourages federal agencies to participate in utility incentive programs to increase energy efficiency and conserve water. It also establishes a Federal Energy Efficiency Fund to provide grants to agencies to assist them in meeting the energy reduction mandates with $10 million available in FY 1994 and $50 million available in FY 1995.

The U.S. Department of Defense (DoD), with hundreds of installations worldwide, massive aviation fuel needs, and approximately 335,000 buildings, is the largest energy consumer within the federal government, consuming approximately 87.1% of the total. It controls 1.94 billion square feet of federal buildings (69.0% of the total federal real property) with a total real property cost of $79.9 billion (48.6% of the total real property cost) (GSA 1989). Model programs being developed by PNL for DSM at DoD installations can set the standard for energy efficiency for all DoD and federal installations. These DSM programs are being deployed at several DoD installations.

Some of the most difficult questions that a federal site has to address in reducing its energy consumption in a cost-effective manner include where the energy is being used and what technologies can be employed to decrease the energy use. Many large federal sites have one or two meters to track electric energy use for several thousand buildings and numerous industrial processes. Even where meters are available on individual buildings or family housing units, the meters are not consistently read. When the federal energy manager has been able to identify high energy users, the energy manager may not have the background, training, or resources to determine the most cost-effective options for reducing this energy use. This limitation can lead to selection of suboptimal projects that prevent the site from achieving the full LCC savings.

The model program developed by the Federal Energy Management Program (FEMP) constitutes a systematic approach to evaluating energy opportunities. The program 1) identifies the building groups and end uses using the most energy (not just having the greatest energy-use intensity), and 2) evaluates the numerous options for retrofit or installation of new technology that will result in the selection of the most cost-effective technologies. In essence,

this model program provides the federal energy manager with a road map to significantly reduce energy use in a planned, rational, cost-effective fashion that is not biased by the constraints of the typical funding sources available to federal sites. The results from this assessment process can easily be turned into a 5- to 10-year energy management plan that identifies where to start and how to proceed to reach the mandated energy consumption targets.

To assist federal agencies in meeting the conditions of the EPAct, FEMP, supported by PNL, has been tasked by SPACECOM to identify, evaluate, and acquire all cost-effective energy projects at selected federal facilities. FEMP's mission is to improve the efficiency and fuel flexibility of energy use in federal buildings, transportation, and operations; and to facilitate the transfer of energy management experience among federal agencies. At Patrick AFB, FEMP is designing a model program for federal customers served by the Florida Power & Light Company (FPL). This program will 1) identify and evaluate all electric and fossil fuel cost-effective energy projects; 2) develop a schedule for project acquisition considering project type, size, timing, and capital requirements, as well as energy and dollar savings; and 3) secure financing (through FPL) required to implement cost-effective electric energy efficiency projects and have FPL procure the necessary contractors to perform detailed audits and install the technologies.

This report provides a summary of the baseline of energy use information found in Volume 2: Baseline Detail (Wahlstrom et al. 1993) and of the energy resource opportunities (EROs) assessment found in Volume 3: Resource Assessment (Sandusky et al. 1993). In addition, this report summarizes a strategy for implementation of this conservation and fuel-switching potential.

The Patrick AFB installation is characterized in Section 2.0. A baseline of energy use is found in Section 3.0. The analytical approach for determining EROs is described in Section 4.0, with a summary of resource assessment results in Section 4.1. Section 5.0 describes a strategy for implementing of EROs, and the conclusions and recommendations resulting from the integrated resource assessment are found in Section 6.0. References are listed in Section 7.0, and the LCC methodology is provided in the Appendix.

2.0 SITE CHARACTERIZATION

Patrick Air Force Base (AFB) is a 2,108-acre space command (SPACECOM) facility consisting of two noncontiguous land parcels joined by a road easement approximately 1 mile south of the city of Cocoa Beach, on the east coast of the state of Florida. The base is approximately 130 miles south of Jacksonville, 205 miles north of Miami, and 115 miles east-northeast of Tampa. The main base is located on a barrier island, bounded on the east by the Atlantic Ocean and on the west by the Banana River. U.S. Route A1A, a major north-south highway on the Florida east coast, traverses the base. The main base consists of 1,791 acres and contains family housing units, base commercial and industrial facilities, and an airfield. The south housing area, located approximately 1 mile south of the base, consists of 317 acres for military family housing and related community facilities. The base's mission includes the responsibility of safety, planning, engineering, support services, scheduling test operations, launch and range operations, directing or supporting operations, test results evaluation, and providing similar support to other Department of Defense (DoD) and non-DoD programs (EDAW undated).

The base is the headquarters of the 45th Space Wing of the U.S. Air Force Space Command (USAF SPACECOM) and includes Cape Canaveral Air Force Station (AFS), Antigua Air Station, Ascension Auxiliary Airfield, and Florida mainland stations that provide tracking services.

In FY92, the number of personnel and their families affecting energy consumption at Patrick AFB included 4,000 active duty military personnel assigned to the base. Almost all of these people live in military housing. An additional 2,000 civilians are employed at the base. These personnel do not live in military housing. Approximately 45,000 to 50,000 retired military personnel and their families living on the east coast of Florida are

entitled to use these facilities, affecting energy consumption through their use of site facilities such as the Post Exchange, recreation centers, and medical facilities.

The base, along with Cape Canaveral AFS, hosts over 40 tenant organizations. These tenants depend upon the base for support services. Some of the major organizations located at Patrick AFB include

- 41st Air Rescue Squadron
- U.S. Air Force (USAF) Technical Applications Center
- Department of State Air Wing
- Florida Air National Guard
- U.S. Army Corps of Engineers
- USAF Judiciary/Area Defense Counsel
- Federal Aviation Administrator, Manager USAF Special Forecast Office (AFSFO)
- 21st Medical Service Squadron.

Land use at Patrick AFB is listed in Table 2.1. The largest land uses are for accompanied housing that comprises 414 acres and the airfield that comprises 387 acres. The administrative facilities at the base account for 58 acres that are concentrated in the portion identified as the "main base." Community commercial, community service, unaccompanied housing, and industrial facilities are also located in the main base north of the airfield. Another large administrative parcel, containing the USAF Technical Applications Center (AFTAC) building, is located in the southeastern quadrant of the base.

The main community center, including the commissary, main base exchange, and hospital, is located at the southern edge of the base. This allows retirees easy access to these facilities without having to travel into the main base area. Outdoor recreation areas include the golf course and marina in the southwest portion of the base, family camping and picnic areas along

TABLE 2.1. Existing Land Use at Patrick AFB

Land Use	Acres
Airfield	387
Runway/Taxiway/Apron	197
Aircraft Operation and Maintenance	29
Industrial	178
Administrative	58
Community Commercial	95
Community Service	15
Medical	15
Accompanied Housing	414
Unaccompanied Housing	20
Outdoor Recreation	274
Open Space	373
Water	44
Launch and Range Control	5
Total	2,108

the Banana River, and four designated recreation areas along the Atlantic Ocean. Family housing is divided into three distinct neighborhoods: north housing (North Wherry), central housing (South Wherry), and south housing (Capehart) areas. Of these three areas, the newest is Capehart, which was constructed in the late 1950s. A total of 1,556 units in 793 buildings are located in these three housing areas, and each unit is all-electric.

A total of 33 primary building categories were identified at the base. These categories were based on identifiable function or uniqueness in terms of operation, construction, age, and energy use. A mnemonic letter code identifies each building type. Categorization is provided in Table 2.2, along with information on floorspace, average floorspace, average age, the number of buildings in each category, and their percentage of the total.

The "other" facility category was identified from the real property list (GSA 1989) and includes items such as utility vaults, kennels, water treatment buildings,

TABLE 2.2. Building Characterization at Patrick AFB

Bldg-type	Description	Floorspace (sq ft)	Avgflrsp (sq ft)	Avg Age (Years)	Number of Bldgs	Percent of Total
ADMIN	Administration Building	903,999	25,111	35	36	3.03
BRK/ADM	Barracks (Dormitory; enlisted & BOQ)	325,972	11,240	40	29	2.44
CHAPEL	Chapel	19,588	9,794	38	2	0.17
CLINIC	Medical/Dental Clinic	9,280	4,640	24	2	0.17
CLUB	Club (NCO, Officers, etc.)	23,391	2,924	21	8	0.67
COMCATN	Communications	87,123	5,808	26	15	1.26
DET-RR	Detached Restrooms, Latrines, Shower Houses, etc.	1,390	232	21	6	0.51
DGR	Dry Goods/Retail	150,862	21,552	21	7	0.59
DINING	Enlisted Dining Facility	82,537	27,512	42	3	0.25
FUELDSP	Fuel Dispensing Bldgs.	211	106	28	2	0.17
GROCERY	Commissary	84,797	84,797	11	1	0.08
HANGAR	Hangar	172,563	43,141	42	4	0.34
HOSPITL	Hospital	74,071	74,071	26	1	0.08
HOTEL	Hotel/Motel/Guesthouse	64,060	3,559	43	18	1.52
HSG-FAM	Family Housing	1,873,722	2,363	36	793	66.75
HUT	Misc. Small Bldgs. and Shelters (not security)	1,760	880	26	2	0.17
MTRPOOL	Maint. Shops for Cars, Trucks, Tanks	79,586	7,959	24	10	0.84
MWR	Morale, Welfare, & Recreation (Non-physical rec)	126,375	9,027	27	14	1.18
OTHER	Other (non ECO bldgs.)	13,792	511	34	27	2.27
PLT-BLD	Heat/Cool/Power Plant, Elec. Dist Bldgs	17,979	1,498	26	12	1.01
R&D	Research and Development Buildings	128,224	18,318	34	7	0.59
REC	Physical Recreation (gym, bowling alley, etc)	47,566	7,928	19	6	0.51
RESTRNT	Restaurant	3,641	1,214	10	3	0.25
SECURITY	Security Operations (police, fire)	45,490	4,549	23	10	0.84
SHOP	General Maint. Shops, Inc. DEH/Base Eng.	60,288	4,019	33	15	1.26
SHOP-AIR	Maint. Shops for Aircraft	2,738	1,369	42	2	0.17
SHOP-ELC	Maint. Shops for Electronics, Avionics, ECM, etc.	192,629	24,079	34	8	0.67
SHOP-WP	Maint. Shops for Weapons (all weapons)	2,397	479	15	5	0.42
STOR-UH	Unheated Storage	182,375	1,721	32	106	8.92
TERMINL	Airport, Bus, Train Terminal	87,168	87,168	47	1	0.08
TRAING	Training/Classrooms (not simulator)	39,402	19,701	23	2	0.17
WHS	Warehouse	374,821	12,925	33	29	2.44
WHS-CLD	Cold Storage Warehouse	8,567	4,284	38	2	0.17
Totals		5,288,364			1,188	100.00

and other unique facilities having very low energy use. Real property items such as fire protection and sprinkler systems, fire and security alarm systems, and outdoor facilities with no energy consumption were not included in our listing.

3.0 ENERGY USE BASELINE

This section describes characteristics of overall energy use at Patrick AFB. Table 3.1 shows the typical annual energy consumption for Patrick AFB. For each energy type, the yearly total is shown in appropriate units, and in common units as a basis of comparison. This typical year is based on the best available data gathered from 1991 consumption levels. As can be seen from Figure 3.1, electricity is by far the largest energy type at Patrick AFB.

TABLE 3.1. Typical Annual Energy Consumption and Cost at Patrick AFB

Energy Type	Annual Total	Annual Total (MBtu)[a]	Percent of Total	Energy Cost (1991$ x 10^3)
Electricity	108,676 MWh	370,803[b]	73.9	6,065
Gasoline	710.5 kgal	78,150[c]	15.6	874
Natural Gas	238 ktherm	23,819[d]	4.8	91
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(c) 0.1100 MBtu/gal
(d) 100,000 Btu/therm; 1,050 Btu/ft^3
(e) 0.1350 MBtu/gal
(f) 0.1388 MBtu/gal

3.1 ELECTRICITY SUPPLY SOURCE DESCRIPTION

Defense Energy Information System (DEIS) records for a typical year (CY91) indicate on-base industrial use of electricity at 66,808 MWh and family housing use at 41,868 MWh. Electricity is supplied by Florida Power & Light (FPL) and billed under a time-of-use rate structure designated by GSLDT-3. The on-peak period is from 6:00 a.m. to 10:00 a.m. and 6:00 p.m. to 10:00 p.m. for November 1 through March 31, and 12:00 noon to 9:00 p.m. from April 1 through October 31. The rate in effect in 1991 consisted of a monthly

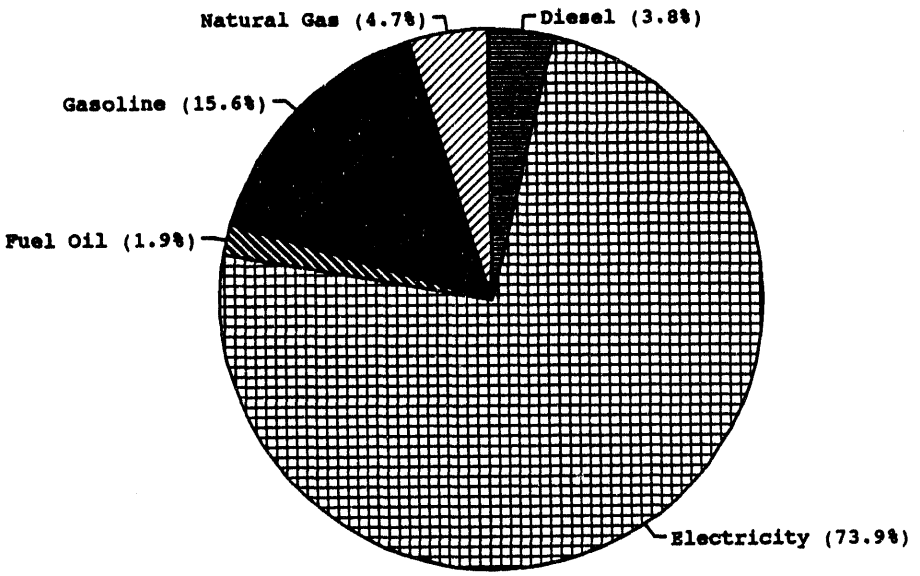

FIGURE 3.1. Energy Use by Fuel Type (MBtu)

customer charge of $400 and an on-peak demand charge of $6.25/kW. An on-peak energy and fuel charge of $0.01082/kWh and $0.02175/kWh, respectively, and an off-peak energy and fuel charge of $0.00949/kWh and $0.01975/kWh were charged. An oil backout charge of $0.0651/kWh and a conservation charge of $0.0135/kWh were also included in the electric bill. Housing areas were on the same rate as the main base. The average cost of electricity for on-base industrial and military family housing areas was $0.0532/kWh in 1991. Table 3.2 summarizes the electric rate information.

3.2 NATURAL GAS SUPPLY SOURCE DESCRIPTION

This section describes the distribution and use of gas at Patrick AFB. Patrick AFB purchases all of its natural gas from City Gas of Florida (City Gas). City Gas does not institute a demand charge. The total consumption for a representative year (June 1991 to May 1992) was 238,000 therms (23,819 MBtu) at an average cost of $0.03813/therm for a total cost of $90,749 (City Gas of Florida billing records). This is approximately 5% of the overall energy use at Patrick AFB. Table 3.3 shows a breakdown of gas use.

TABLE 3.2. Patrick AFB Electric Energy Rate Breakdown

Season	Rate type	Hours of Day	Demand Charge ($/kW)	Energy Charge (¢/kWh)	Fuel Charge (¢/kWh)	Oil Backout Charge (¢/kWh)	Conservation Charge (¢/kWh)	Total Energy (¢/kWh)
Winter	On-Peak	6:00am-10:00am	6.25	1.082	2.175	0.651	0.135	4.043
(Nov 1-Mar 31)		6:00pm-10:00pm	6.25	1.082	2.175	0.651	0.135	4.043
	Off-Peak	10:00am-6:00pm	0.00	0.949	1.975	0.651	0.135	3.71
		10:00pm-6:00am	0.00	0.949	1.975	0.651	0.135	3.71
Summer	On-Peak	Noon-9:00pm	6.25	1.082	2.175	0.651	0.135	4.043
(Apr 1-Oct 31)	Off-Peak	9:00pm-Noon	0.00	0.949	1.975	0.651	0.135	3.71

TABLE 3.3. Patrick AFB Natural Gas Use

Building Area	Annual Total (therm x 10^3)	Annual Total (MBtu)	Percent of Total
Tech Lab	93.85	9,385	39.4
Hospital	53.03	5,303	22.3
Officer's Club Boiler	51.65	5,165	21.7
Officer's Club Mess	14.20	1,420	6.0
Burger King	10.78	1,078	4.5
Steam Plant	9.39	939	3.9
Base Exchange	2.86	286	1.2
Dental Clinic	1.51	151	0.6
Elementary School	0.92	92	0.4
Totals	238.19	23,819	100.0

Patrick AFB uses natural gas as a fuel for boilers at various locations across the base. In commercial buildings, boilers produce steam used primarily for dehumidification reheat in the summer months and space heating in the winter months.

3.3 NO. 2 FUEL OIL SUPPLY SOURCE DESCRIPTION

No. 2 fuel oil is used primarily for space and water heating via small oil-fired hot water or steam boilers. In FY91, Patrick AFB purchased 1659 barrels of No. 2 fuel oil (9,671 MBtu) at a price of $1.03/gal for a total cost of $71,768. All fuel oil for the base is supplied by a contract with Raytheon Services. Fuel oil use represents roughly 2% of the total energy use at the base. Fuel oil stores are generally available for emergency fuel. Several boilers are dual-fuel (natural gas or fuel oil) but normally burn natural gas. Stores of fuel oil are burned off in the boilers once a year to keep the fuel oil supply in good condition, accounting for the majority of the total fuel oil use. It should be noted that the price of $1.03/gal for FY91 is significantly higher than the price in either FY90 ($0.56/gal) or FY92 ($0.69/gal). Most of the price increase for FY91 is probably the result of higher fuel prices as a result of Operation Desert Storm.

3.4 MOTOR VEHICLE FUEL (MOGAS) SUPPLY SOURCE DESCRIPTION

Fuels for motor vehicles at Patrick AFB are also supplied through Raytheon Services. In FY91, the base vehicles consumed 710,458 gal of unleaded regular gasoline at a cost of $1.23/gal, for a total cost of $873,863. During the same period, 141,936 gal of diesel fuel were consumed at a cost of $1.03/gal, for a total of $146,194.

4.0 ENERGY RESOURCE OPPORTUNITIES

The number of conceivable EROs, fuel-switching opportunities, and renewable energy projects at a federal site is very large. A three-step process has been developed by PNL to make ERO selection, evaluation, and prioritization manageable. The steps are the following:

- Preliminary Screening. Select promising EROs from a master list (see Table 1.1 in Sandusky et al. [1993]), considering the site's mission, building stock, end-use equipment characteristics, utility characteristics, climate, energy costs, other local conditions that affect ERO viability, and recommendations from site staff (Sandusky et al. 1993).

- Cost and Performance Analysis. Establish, with a reasonable degree of accuracy, the technical and economic feasibility of each ERO that passed the preliminary screening. An analysis is performed comparing the operating and economic performance of the existing equipment and the ERO. Where applicable, impacts on energy security and the environment are included in the analysis.

- Life-Cycle Cost Analysis and Prioritization. Perform a life-cycle cost (LCC) analysis and rank EROs by net present value (NPV), so that a package with the optimal return on investment can be defined. If any utility cost-sharing or rebate programs exist, they can be included within this evaluation step.

The third step, LCC analysis and prioritization of EROs, is required by federal law (10 CFR 436). All federal agencies are required to evaluate the LCC of potential energy investments. An LCC evaluation computes the total long-run costs of a number of potential actions and selects the action that minimizes the long-run costs and maximizes the NPV of the energy investment. These requirements are discussed in more detail in the Appendix.

4.1 RESOURCE ASSESSMENT

This section summarizes the results of the ERO analysis and aggregates the savings potential into major end-use categories. The specific EROs are described in detail in Sandusky et al. (1993). Analysis results are presented in 10 common energy end-use categories (e.g., lighting, HVAC, motors). Savings are indicated by fuel type: No. 2 fuel oil, natural gas, electricity, gasoline, and diesel.

As illustrated in Table 4.1, the NPV of the installed cost of all cost-effective EROs at Patrick AFB is nearly $16.7 million (1993$). The NPV of the savings associated with this investment is approximately $34.2 million (1993$), for an overall NPV of $17.5 million. By implementing all the cost-effective EROs identified in this study, Patrick AFB will reduce annual energy use by 98,000 MBtu and demand by 97,000 kW-mo, and annual energy expenditures will decrease by nearly $1.5 million (20.6%), as shown in Table 4.2.

Table 4.3 provides a breakdown and summary of the cost-effective energy resources at Patrick AFB. Table 4.4 provides a summary of the energy and demand savings at Patrick AFB. Table 4.5 shows the fuel balance at Patrick AFB for the existing condition, the amount of conservation, the new load added, the resulting fuel usage and finally, the net energy conservation.

The Lighting ERO category has the greatest energy conservation potential at Patrick AFB. Lighting EROs alone have a little over an $8 million NPV.

Energy resource potential is described with the following figures: Figure 4.1 describes the net present value, Figure 4.2 shows the full implementation annual energy savings for all EROs, and Figure 4.3 describes the energy resource potential in MBtus by the various fuel types.

TABLE 4.1. Total Savings, Cost, and NPV (1993$)

Total Present Value of Installed Cost	Total Present Value of Energy Savings	Total Present Value of Demand Savings	Total Present Value of O&M Savings	Total Present Value of Replacement Savings	Total Net Present Value
$16,693,883	$14,934,335	$8,429,275	$5,293,533	$5,498,735	$17,461,995

TABLE 4.2. Overall Resource Potential

	Existing	Resulting	% Reduction
Annual Energy Consumption (million MBtu/yr)	0.502	0.404	19.5
Annual Cost of Energy (million $/yr) Expenditures	7.25	5.75	20.6

TABLE 4.3. Summary of the Cost-Effective Energy Resources at Patrick AFB (1993$)

ERO Category	Present Value of Installed Cost (1993 $)	Present Value of Energy Savings (1993 $)	Present Value of Demand Savings (1993 $)	Present Value of O&M Savings (1993 $)	Present Value of Replacement Cost Savings (1993 $)	Present Value of Total Savings (1993 $)	Net Present Value (1993 $)
AC	6,210,400	(1,561,723)	6,067,747	824,808	2,594,756	7,925,589	1,715,189
Boilers	17,500	49,675	0	(7,811)	(4,631)	37,233	19,734
Controls	68,200	384,139	0	0	(10,196)	373,944	305,744
Envelope	1,386,934	5,122,174	0	0	0	5,122,174	3,735,240
HVAC	1,629,326	143,938	0	0	2,782,086	2,926,025	1,296,699
Lighting	3,551,476	7,008,373	2,193,583	2,634,927	0	11,836,883	8,285,407
Motors	528,155	624,774	142,949	0	207,203	974,926	446,771
Transportation	1,287,000	1,113,696	0	1,841,609	(413,570)	2,541,734	1,254,734
Trans & Dist	1,124,103	99,861	24,995	0	1,023,932	1,148,788	24,685
Wtr. Heating	890,790	1,949,428	0	0	(680,846)	1,268,582	377,792
Totals	16,693,883	14,934,335	8,429,275	5,293,533	5,498,735	34,155,878	17,461,995

Note: The ERO category AC applies to residential buildings, while HVAC applies to commercial buildings.

TABLE 4.4. Summary of the Energy and Demand Savings at Patrick AFB (1993$)

ERO Category	First Year Energy Savings (MBtu)	First Year Demand Savings (kW-mo)	Full Implement Energy Savings (MBtu)	Full Implement Demand Savings (kW-mo)	Annualized Energy Savings (1993$)	Annualized Demand Savings (1993$)
AC	(2,625)	72,387	(2,625)	72,387	(99,969)	388,408
Boilers	623	0	623	0	3,179	0
Controls	2,505	0	2,505	0	24,590	0
Envelope	30,267	0	30,267	0	327,880	0
HVAC	0	0	1,833	0	9,214	0
Lighting	44,266	22,032	44,266	22,032	448,620	140,416
Motors	3,148	1,436	4,318	1,436	39,993	9,150
Transportation	1,268	0	1,268	0	71,290	0
Trans&Dist	0	0	3,025	1,214	6,392	1,600
Wtr. Heating	12,283	0	12,283	0	124,787	0
Totals	91,735	95,855	97,763	97,069	955,976	539,574

TABLE 4.5. Fuel Balance at Patrick AFB

	Existing		Conservation		New Load		Resulting		Net Conservation	
Fuel Type	Existing Energy Use (MBtu)	Existing Demand (kW-mo)	Energy Use Reduction (MBtu)	Demand Reduction (kW-mo)	Increased Energy Use (MBtu)	Increased Demand (kW-mo)	Resulting Energy Use (MBtu)	Resulting Demand (kW-mo)	Net Energy Use Reduction (MBtu)	Net Demand Reduction (kW-mo)
Diesel	19,161	NA	2,923	NA	0	NA	16,238	NA	2,923	0
Electricity	370,803	247,196	95,782	97,069	0	0	275,021	150,127	95,782	97,069
Fuel Oil	9,671	NA	146	NA	0	NA	9,525	NA	146	0
Gasoline	78,150	NA	15,195	NA	0	NA	62,955	NA	15,195	0
Natural Gas	23,819	NA	5,174	NA	21,457	NA	40,102	NA	(16,283)	0
Totals	501,604	247,196	119,220	97,069	21,457	0	403,841	150,127	97,763	97,069

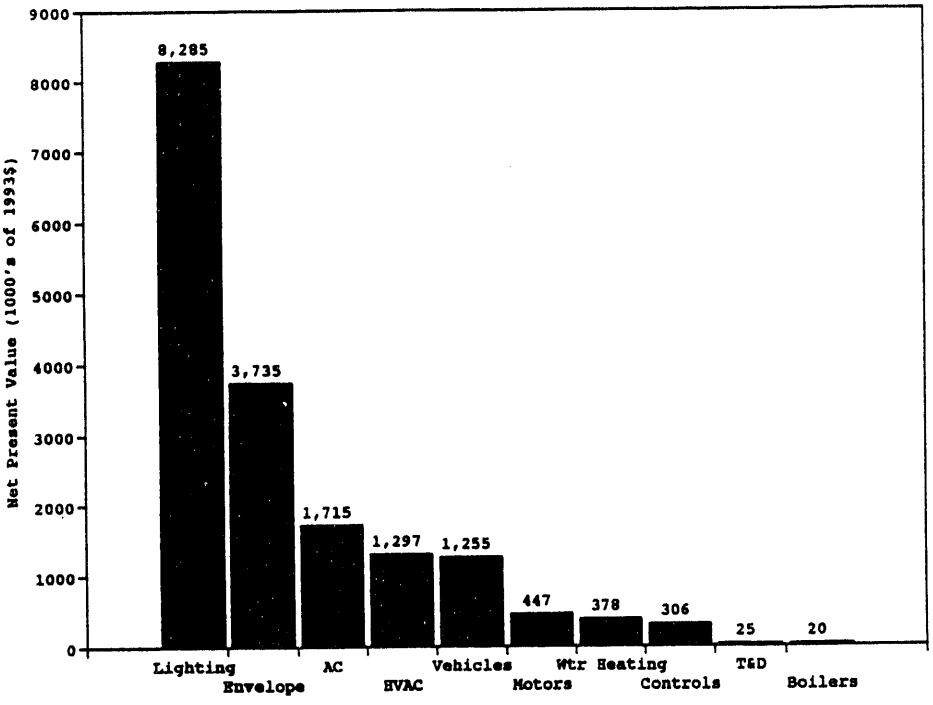

FIGURE 4.1. Net Present Value

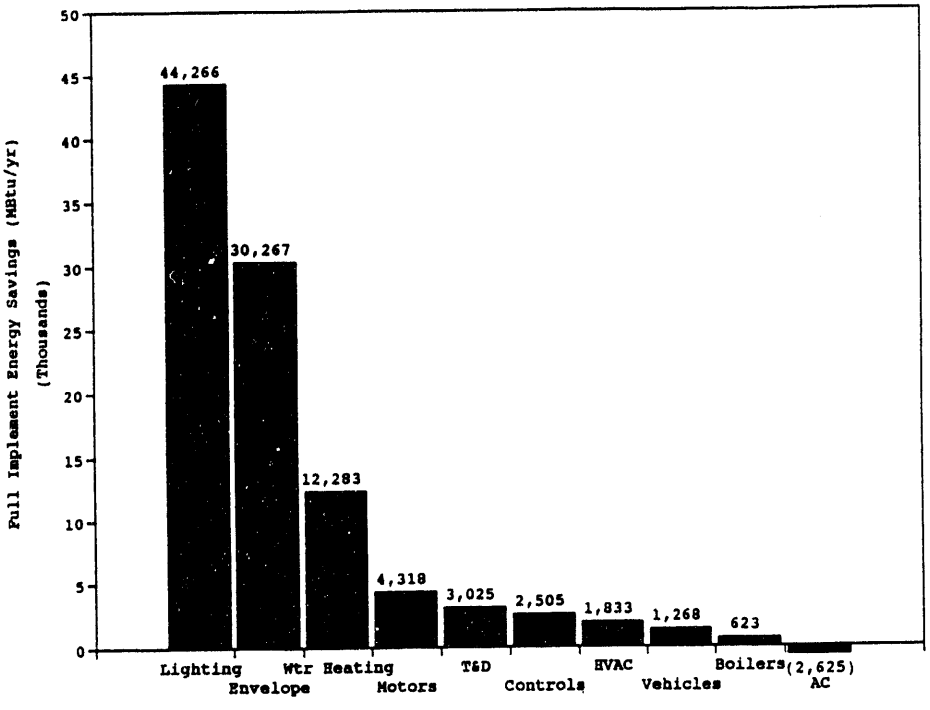

FIGURE 4.2. Full Implementation Annual Energy Savings - All EROs

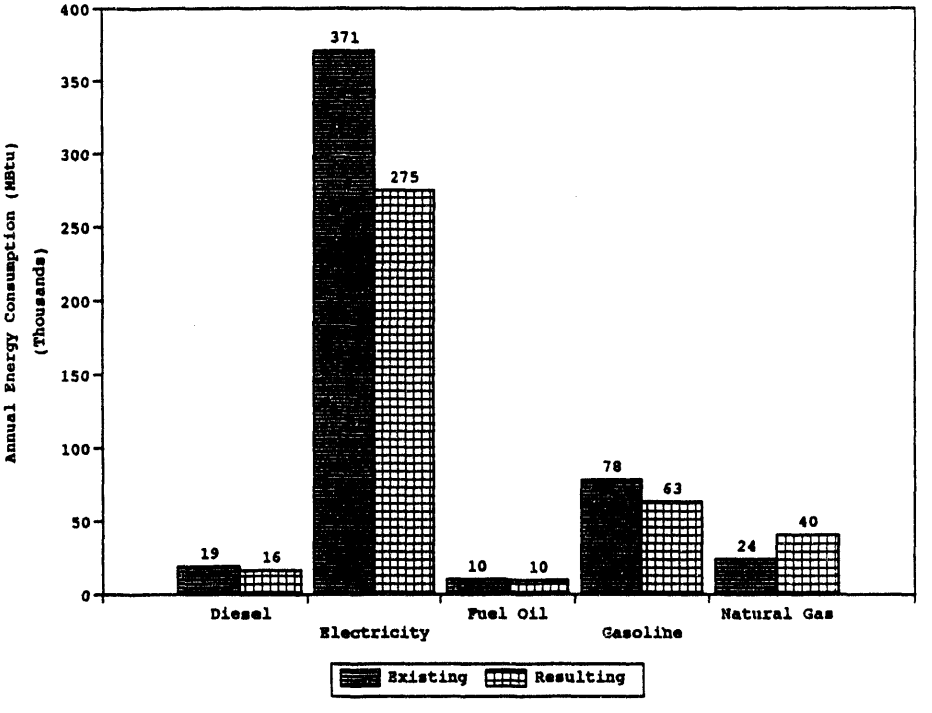

FIGURE 4.3. Energy Resource Potential (MBtu) by Fuel Type

5.0 IMPLEMENTATION STRATEGY

The purpose of the integrated resource planning (IRP) process is to develop an analytical and rational approach to reducing energy consumption (and energy cost) at Patrick AFB. The implementation step of this process reviews FROs identified in the integrated resource assessment and develops a framework for a long-term energy management plan. When fully developed, this plan will discuss the types of projects, timing, sources of funding, and other considerations for Patrick AFB. In addition, the plan needs to identify a strategy for a long-term working relationship with both the electric utility (Florida Power & Light) and the gas utility (City Gas of Florida) to take full advantage of the utility incentives offered through promotional and demand-side management (DSM) programs.

Current activities have focused on taking advantage of limited programs offered through the utilities. While this is a step in the right direction, failure to develop an overall plan will result in a piece-meal approach in the IRP process and could result in missed opportunities to combine or coordinate several programs to maximize both energy and overall cost savings.

The types of projects that should be considered will deal either with regular reviews of institutional programs, such as operations and maintenance activities, or implementation of special technologies in normal activities that are part of the overall mission of Patrick AFB. Projects involving special technologies need to be evaluated using the federally mandated life-cycle cost methodology.

Evaluation of potential energy resource opportunities that would result in projects for Patrick AFB are identified in Volume 3 of this report. Examples of major projects that are cost-effective and that could be initiated immediately at Patrick AFB are listed below.

- Ensure that replacement housing for the North and South Wherry housing areas include envelope energy efficiency improvements such as adequate insulation, current weatherization technologies, current window technologies, and installation of efficiency lighting technologies. The use of natural gas as a fuel source should be examined to evaluate the

potential of acquiring a lower-cost fuel and participating in the utility appliance leasing program.

- Develop a comprehensive lighting retrofit program for all current facilities. This should be done in concert with evaluation of the potential for installation of higher-efficiency chiller systems to maximize the potential of downsizing the capacity of the current systems.

- Replace standard-efficiency motors with high-efficiency or variable-speed-drive motors to reduce energy consumption. This would include motors associated with air ventilation and pumping and irrigation of water and sewage. This effort should include analyzing and determining if the current motor was oversized for its application, so additional energy savings can be obtained.

- Make broader use of the current EMCS system as a method for reducing the load associated with lighting and air conditioning. Any reduction should not be instituted if it would create an adverse impact on mission requirements.

Other projects that could be subsequently implemented included

- solar water heating systems to meet the water heating load in the Airman dormitories

- potential installation of a central thermal energy storage (TES) system to support the overall electrical loads in the main commissary, hospital, base exchange area

- implementation of compressed natural gas vehicles into the base motor pool to reduce mobility energy cost.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The integrated resource assessment at Patrick AFB was a major effort to identify various ways to meet the goals established under Executive Order 12759 (56 FR 16257). The significant conclusions and lessons learned from this work included the following:

- The systematic approach was used to identify energy resource opportunities that provide an overall framework for long-range energy planning to meet the mandated energy reduction goals. The projects identified from this analysis can be implemented over a period of several years as funding is available. Specific requests for funding from federal sources may require that the analysis performed in this study be updated to include the latest information regarding building characteristics, mission requirements, and energy uses.

- Substantial energy reduction and cost savings are available at Patrick AFB even with the exceptionally low cost of energy for electricity and natural gas. The EROs analyzed in this study provide a savings of 19.5% of the annual energy consumption and 20.6% of the annual energy cost.

- In most cases, the analysis did not include the value of any rebates that could be obtained from either the electric or gas utility. However, the electric utility has offered to establish an overall DSM program for Patrick AFB. Mutually agreeable projects would be financed through the utility with the cost being applied to the monthly billing. In this fashion, Patrick AFB would not be required to seek up-front funds to implement various energy projects. Other funding sources should also be explored to support implementation of the overall energy management plan.

- The overall energy plan and associated implementation process, although directed predominately toward acquiring energy-efficient technology, also must consider and integrate other issues that have potential to affect energy consumption. Examples of other issues included regular reviews of utility rate schedules, energy standards for retrofit and new construction, and institutional procedures that ensure energy-efficient technologies are installed when replace-on-failure occurs.

- The Energy Policy Act of 1992 provides Patrick AFB new and expanded opportunities in other energy-related technologies such as water, solar, and other renewables. Further evaluation of these opportunities should occur following the same life-cycle cost methodology (10 CFR 436) as all other EROs evaluated in this assessment.

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APPENDIX

LIFE-CYCLE COST METHODOLOGY

APPENDIX

LIFE-CYCLE COST METHODOLOGY

According to the provisions of 10 CFR 436, federal agencies are required to analyze all potential energy investments using a life-cycle cost (LCC) methodology developed by the National Bureau of Standards (NBS 1987). The LCC methodology calculates all relevant costs of a project and discounts them to a common basis in present dollars. The method then subtracts the LCC of the project from a similarly constructed LCC of the baseline. (The baseline is represented by the current conditions or technology.) This difference is called the net present value (NPV) of the action being considered. Actions are cost-effective if the NPV is positive and optimal if the NPV is greater than the NPV of alternative actions. Following this methodology results in minimizing the LCC of energy services at a site.

This economic analysis is central to the Federal Energy Management Program (FEMP) model approach for federal energy efficiency using the Facility Energy Decision Screening (FEDS) software system (Dirks 1993) to develop a fuel-neutral assessment of facilities to identify and quantify energy efficiency resources, supply alternatives, and fuel-switching opportunities.

All energy resource opportunities (EROs) identified by the FEDS assessment and described in Sandusky et al. (1993) are therefore subjected to the LCC economic analysis to determine their cost-effectiveness. The purpose of the FEDS assessment is to identify the facility energy efficiency resource alternatives available to decision makers; the economic analysis provides an estimate of the installed cost and energy savings of the cost-effective resource available at a facility using the most current and realistic assumptions possible. Individual projects and actions considered for implementation should be examined and analyzed more thoroughly at a project level prior to design and implementation.

Under the NIST methodology, energy prices are escalated and costs and benefits are discounted using factors taken from the current edition of Energy Prices and Discount Factors for Life-Cycle Cost Analysis (NIST 1992). Costs

and benefits are analyzed over a 25-year period, reflecting the average expected remaining life of a typical building. Other key assumptions in the methodology are:

- Prices for all goods and services (e.g., installed cost of a technology) will vary at the same rate as the inflation rate; therefore the "real" rate of inflation is zero.
- Energy or fuel prices vary at a rate different than that of the inflation rate. NIST reports the value by which the energy prices vary from the real rate of inflation (the escalation rate).
- All costs and benefits are discounted using the current federal discount rate (4.0% real for CY 1993).
- All EROs are analyzed for a 25-year period. This does not mean that a 25-year life is assumed for all installed equipment: actual estimates of equipment life are used, and the costs of replacing worn out equipment over a 25-year period are incorporated. The 25-year analysis period also does not mean that all streams of savings from EROs are assumed to endure 25 years: many are assumed to disappear as the existing equipment is replaced with more efficient equipment as part of the baseline.
- The analysis assumes that upfront unconstrained federal financing (at the federal discount rate) is available for all potential energy efficiency improvements and actions.

The last assumption, unconstrained (unlimited) federal financing, is incorporated into the LCC analysis to determine the total cost-effective energy efficiency resource at a site. Therefore, the analysis (under the unconstrained funding assumption) results in a menu of all identified energy project opportunities whose benefits exceed their costs.

In the presence of constraints on the funding available to implement these projects, some method of prioritizing the projects is needed. It is for this reason that a savings-to-investment ratio (SIR) is calculated to rank order projects starting with the project with the highest SIR. This ranking allows available capital to be allocated to those cost-effective projects in an order that results in the greatest savings per dollar of investment.

For most agencies or facilities, the entire list of cost-effective projects from the LCC analysis is significant and cannot be financed from a single source. Rather, all available funding sources need to be determined. Funding

sources include federal funds (MILCON, ECIP, Federal Energy Efficiency Fund); utility financing including utility offered rebates or other financial assistance; and energy services industry-financed projects. Each of these funding sources has its own requirements and its own costs, and therefore the cost-effectiveness of individual projects needs to be evaluated using the LCC analysis adjusted for each potential funding source's costs and constraints.

Many assumptions in addition to those listed above are required in the course of a FEDS assessment. In every case, the analysis team attempts to make the most realistic and defensible assumption. Where uncertainty exists, the team attempts to err on the side of conservatism. Therefore, the resulting estimate of the total cost-effective energy efficiency resource is a minimum estimate of the total potential resource, given the above assumptions. A more exact estimate and the development and design of projects generally requires a detailed facility audit. Such a detailed audit is beyond the scope of, but will benefit from the guidance provided by, a FEDS assessment.

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