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CAPE CANAVERAL AIR FORCE STATION INTEGRATED RESOURCE ASSESSMENT

VOLUME 1: EXECUTIVE SUMMARY

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MASTER

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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 the 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. Air Force (USAF) Space Command (SPACECOM) has tasked the Pacific Northwest Laboratory (PNL)[a] in support of the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) to develop a model program that provides 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.

This report provides the results of the fossil fuel and electric energy resource opportunity (ERO) assessments performed by PNL at one of Florida

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Power & Light's (FPL's) primary federal facilities--the USAF SPACECOM facility, Cape Canaveral Air Force Station (AFS)--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. 1994).

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, Public Law 102-486) was issued. EPAct 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. Air Force (USAF) Space Command (SPACECOM) has tasked the Pacific Northwest Laboratory (PNL) in support of the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) to identify, evaluate, and acquire all cost-effective energy projects at selected federal facilities.

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 (FPL's) primary federal facilities--USAF's SPACECOM facility, Cape Canaveral Air Force Station (AFS)--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. 1994).

Cape Canaveral AFS is a 15,804-acre SPACECOM facility on a barrier island on the central east coast of Florida. The site is approximately 50 miles east of Orlando and approximately equal distance between Miami and Jacksonville. The site is bounded on the north by the Kennedy Space Center (KSC), on the west by the Banana River, on the south by Port Canaveral, and on the east by the Atlantic Ocean. The National Aeronautics and Space Administration (NASA) owns the KSC.

Currently, a total of 7,783 personnel are employed at Cape Canaveral AFS. The largest part of this total is civilian contractors (6,965). The remaining personnel are military personnel (439) and civilians employed as the

result of appropriated funds (379). There is no military family housing at Cape Canaveral AFS.

A total of 766 buildings with 4,411,172 ft^2 of floorspace were identified at the station.

Table S.1 shows a summation of the typical annual energy consumption for 1991 and 1992 and the energy cost for 1991 for all on-base facilities at Cape Canaveral AFS. For each energy type, the annual total is shown in units appropriate to the energy type and in a common unit (MBtu) as a basis of comparison.

Following life-cycle cost (LCC) guidelines required for all federal energy decisions (10 CFR 436), analysis results are presented in 11 common energy end-use categories (e.g., boilers and furnaces, service hot water, building lighting). By implementing all cost-effective EROs identified in this study, Cape Canaveral AFS will reduce annual energy use by 129,831 MBtu and reduce demand by 180,782 kW-mo. The single largest savings potential by end use is the roughly 24,000 MWh of electricity saved annually by increased lighting efficiency. As illustrated in Table S.2, the present

TABLE S.1. Typical Annual Energy Consumption and Energy Cost at Cape Canaveral AFS

	Annual Total			Annual Total (MBtu[a])			
Energy Type	1991	1992	Units	1991	1992	Percent of Total (1991)	Energy Cost (1991$ x 10^3)
Electricity	192,074.0	NA	MWh[b]	655,549[c]	NA	61.5	9,876
No. 2 Fuel Oil	924.1	NA	kgallon[d]	1 28,265[e]	NA	12.0	952
Diesel Fuel	1558.3	1705.7	kgallon[f]	218,162[g]	238,798	20.5	1,558
MOGAS	502.4	508.6	kgallon[f]	63,805[h]	64,592	6.0	619
Total				1,065,781		100.0	13,005

(a) 1 MBtu = 1,000,000 Btu
(b) FPL Billing Records (CY91)
(c) 3,413 Btu/kWh
(d) DEIS Records (CY91)
(e) 0.1388 MBtu/gal (CY91)
(f) Cape Canaveral AFS Personnel (CY91)
(g) 0.1400 MBtu/gal
(h) 0.1270 MBtu/gal

TABLE S.2. Total Savings, Cost, and Net Present Value (1993$) at Cape Canaveral AFS

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 Present Value of All Savings	Total Net Present Value
16,589,658	25,557,604	17,924,377	649,066	4,815,864	48,946,911	32,357,253

value (PV) of the installed cost of all EROs constituting the minimum LCC efficiency resource (i.e., cost-effective) at Cape Canaveral AFS is approximately $16.6 million in 1993 dollars (1993$). The PV of the savings associated with this investment is approximately $48.9 million, for an overall net present value (NPV) of $32.3 million.

Table S.3 provides a breakdown and summary of the cost-effective resource at Cape Canaveral AFS. Cost-sharing and rebate incentives from the utility would normally be factored into the analysis. Because the potential demand-side management (DSM) relationship with the electric utility, Florida Power and Light (FPL), is uncertain Cape Canaveral AFS project managers decided that this document would present an economic analysis from the government-funding-only perspective. Thus, if no cost-sharing with the utility can be arranged, the document will still be useful to the USAF when planning for implementation of various EROs. Once details of a cost-sharing agreement with the utility have been reached, the economic analysis can be redone at any time.

The operations and maintenance (O&M) savings are a reflection of the incremental cost difference between the cost of maintaining the existing equipment and that of maintaining new or retrofitted equipment. Because maintenance costs of new or retrofitted equipment are often the same as the costs to maintain the existing equipment, this incremental maintenance cost is often zero.

Table S.4 accompanies Table S.3, which presents a breakdown and summary of the energy and demand savings for the first year and full implementation of the cost-effective resource at Cape Canaveral AFS.

TABLE S.3. Summary of the Cost-Effective Energy Resource at Cape Canaveral AFS (1993$)

ERO Category	Present Value of Installed Cost	Present Value of Energy Savings	Present Value of Demand Savings	Present Value of O&M Savings	Present Value of Replac. Savings	Present Value of Total Savings	Net Present Value
Air Conditioning	5,631,801	-663,962	7,050,801	965,176	4,255,171	11,607,187	5,975,385
Boilers	924,950	1,931,863	2,032,477	-4,544	336,174	4,295,970	3,371,020
Envelope	158,018	365,095	47,326	0	0	412,421	254,403
Generators	373,236	-1,373,697	3,823,200	-798,261	0	1,651,242	1,278,006
Heat Pipes	2,631,580	11,439,374	0	0	0	11,439,374	8,807,794
Lighting	6,179,025	12,999,180	4,742,382	486,694	0	18,228,257	12,049,232
Motors	691,048	859,750	228,191	0	224,519	1,312,459	621,411
Totals	16,589,658	25,557,604	17,924,377	649,066	4,815,864	48,946,911	32,357,253

TABLE S.4. Summary of the Energy and Demand Savings at Cape Canaveral AFS

ERO Category	First-Year Energy Savings (MBtu)	Full Implement. Energy Savings (MBtu)	First-Year Demand Savings (kW-mo)	Full Implement. Demand Savings (kW-mo)
Air Conditioning	3,540	-10,615	1,142	71,565
Boilers	-1,520	-1,520	20,415	20,415
Envelope	2,279	2,279	475	475
Generators	-17,048	-17,048	38,400	38,400
Heat Pipes	68,913	68,913	0	0
Lighting	82,082	82,082	47,634	47,634
Motors	4,883	5,740	2,292	2,292
Totals	143,130	129,831	110,359	180,782

Table S.5 presents a breakdown and summary of the total fuel balance at Cape Canaveral AFS. Total existing fuel use is based on information developed for the Volume 2: Baseline Detail companion report to this document (Wahlstrom et al. 1993). Total fuel use after ERO implementation was determined, where possible, by subtracting the total fuel savings from the total existing fuel use.

TABLE S.5. Fuel Balance at Cape Canaveral AFS

Fuel Type	1991 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)
Diesel	218,162	NA	0	NA	24,887	NA	243,049	NA
Electricity	655,549	362,135	167,775	180,782	16,529	0	504,303	181,353
Fuel Oil	128,265	NA	63,618	NA	60,147	NA	124,794	NA
Totals	1,001,976	362,135	231,393	180,782	101,562	0	872,145	181,353

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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 Cape Canaveral AFS. These people provided Pacific Northwest Laboratory with detailed and timely information that increased the value and usefulness of our analysis. We would like to thank Craig Miller of the U.S. Air Force Space Command Headquarters (Peterson AFB, Colorado); Jim Czumak and Gus Diaz of Johnson Controls - World Services; Bill Gnan, former employee of Johnson Controls - World Services; and Kim Carter of Cape Canaveral AFS. Of particular importance to the completion of this study was the significant and conscientious assistance and leadership provided by Vince Juselis of Cape Canaveral AFS.

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ABBREVIATIONS AND ACRONYMS

ADMIN	administration (building type)
AFB	Air Force Base
AFS	Air Force Station
BRK/ADM	barracks, administration (building type)
Btu	British thermal unit
CFC	chlorofluorocarbon
COMCATN	communication facility (building type)
CY	calendar year
DEIS	Defense Energy Information System
DET-RR	detached restroom (building type)
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DSM	demand-side management
EMCS	energy management and control system
EPAct	Energy Policy Act of 1992
ERO	energy resource opportunity
FED	Facility Energy Decision Screening software
FEMP	Federal Energy Management Program
FPL	Florida Power & Light
FUELDSP	fuel building
FY	fiscal year
GSLDT-3	General Service Large Demand Time-of-Use
HCFC	hydrochlorofluorocarbon
IRP	integrated resource planning
KSC	Kennedy Space Center
kW	kilowatt
kWh	kilowatt-hour
kW-mo	kilowatt-month
LAB-MED	medical laboratory
LCC	life-cycle cost
MBtu	million British thermal units
MTRPOOL	maintenance shop-motorpool (building type)
MW	megawatt
MWh	megawatt-hour
MWR	morale, welfare, & recreation (building type)
NASA	National Aeronautics and Space Administration
NASLEAS	NASA - Leased
NASOWN	NASA - Owned
NIST	National Institute of Standards and Technology
NPV	net present value
O&M	operation and maintenance
PLT-BLD	heat/cool/plant (building type)
PLT-EQU	maintenance shop-equipment
PNL	Pacific Northwest Laboratory
PV	present value
R&D	research and development (building type)
RESTRNT	restaurant (building type)
SECURITY	Security Facility

SHOP	Miscellaneous maintenance shop
SHOP-ELC	maintenance shop-electrical (building type)
SHOP-WPN	maintenance shop-weapons (building type)
SIR	savings-to-investment ratio
SPACECOM	Space Command
STOR-UH	unheated storage (building type)
TRAING	training (building type)
USAF	U.S. Air Force
W	watt
WHS	warehouse (building type)

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, Public Law 102-486), 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 direction 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 cost of demand-side management (DSM) incentives through rate recovery. EPAct

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

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 FY94 and $50 million available in FY95.

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 direction of the EPAct, the U.S. Department of Energy (DOE) FEMP, supported by PNL, has been tasked by the U.S. Air Force (USAF) Space Command (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 Cape Canaveral Air Force Station (AFS), FEMP is designing a model program for federal customers served by the Florida Power & Light Company (FPL).

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 assessment of energy resource opportunities (EROs) found in Volume 3: Resource Assessment (Sandusky et al. 1994). In addition, this report summarizes a strategy for implementation of this conservation and fuel-switching potential.

The Cape Canaveral AFS 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 implementation of EROs, and the conclusions and recommendations 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

Cape Canaveral AFS is a 15,804-acre SPACECOM facility on a barrier island on the central east coast of Florida. The site is approximately 50 miles east of Orlando and approximately equal distance between Miami and Jacksonville. The site is bounded on the north by the Kennedy Space Center (KSC), on the west by the Banana River, on the south by Port Canaveral, and on the east by the Atlantic Ocean. The National Aeronautics and Space Administration (NASA) owns the KSC.

The nearest civilian community to Cape Canaveral AFS is the city of Cape Canaveral, which is located adjacent to the south side of Port Canaveral. South of Cape Canaveral is the city of Cocoa Beach. The nearest community to the west of the site is the city of Titusville, which is approximately 20 miles away.

The topography of Cape Canaveral AFS is flat and much of the site is covered with native vegetation. Cape Canaveral AFS is the home of several threatened and endangered wildlife species. The site also has been designated as a national seashore to protect the current habitat and nesting area of sea turtles.

Cape Canaveral AFS is the launch facility of the 45th Space Wing of the USAF SPACECOM that also includes Patrick Air Force Base (AFB), Antigua Air Station, Ascension Auxiliary Airfield, and other Florida mainland stations that provide tracking services. The focus of this document is Cape Canaveral AFS. A companion document has been prepared for Patrick AFB (Sandusky and Wahlstrom 1994).

The primary mission of Cape Canaveral AFS is to provide the launch site, facilities, hardware, and support required to assemble, process, checkout, test, and launch all types of space boosters, upper stages, satellites, and other payloads (EDAW undated). The site also provides the facilities, infrastructure, and ground support for launch base instrumental requirements that include radar, telemetry, optics, command and control, communications, and collection and real-time processing of data.

Cape Canaveral AFS provides logistical support to a variety of major organizations in support of their primary missions. Some of the organizations that are tenants at Cape Canaveral AFS are the U.S. Naval Ordinance Test Unit, NASA, U.S. Army, and various commercial organizations.

Currently a total of 7,783 personnel are employed at Cape Canaveral AFS. The largest part of this total is civilian contractors (6,965). The remaining personnel are military personnel (439) and civilians employed as the result of appropriated funds (379). There is no military family housing at Cape Canaveral AFS.

A total of 766 buildings with 4,411,172 ft^2 of floorspace were identified at the station.

Most support facilities at Cape Canaveral AFS are centrally located in what is known as the "Industrial Area." This area includes facilities for administration, launch and range support and control, community services, recreation, and other industrial land uses. Table 2.1 provides a listing of the existing land uses and proposed future land uses.

TABLE 2.1. Land-Use Information at Cape Canaveral AFS

Land Use	Existing (Acres)	Future (Acres)
Airfield	1,129	1,120
Runway/Taxiway/Apron	105	105
Industrial	522	753
Administrative	-	266
Outdoor Recreation	-	410
Open Space	193	1,446
Water	1,768	1,768
Launch Operations	4,912	3,292
Launch and Range Support	7,075	5,366
Launch and Range Control	-	288
Port Operations	100	981
Total	15,804	15,794

2.1 BUILDING CHARACTERIZATION

A total of 23 primary building categories were identified at Cape Canaveral AFS. These categories were based on identifiable function or uniqueness in terms of operation, construction, age, and energy use. A building categorization is provided in Table 2.2.

TABLE 2.2. Building Categorization at Cape Canaveral AFS

Building-Type	Description	Total Area (ft^2)	Average Area (ft^2)	Average Age	Number of Buildings	Percentage of Buildings
ADMIN	Adm Bldg	316,888	9,903	30	32	4.18
BRK/ADM	Barracks, Admin	1,854	1,854	32	1	0.13
COMCATN	Commun Fac	219,783	6,464	25	34	4.44
DET-RR	Detached Rstrm	1,585	528	25	3	0.39
FUELDSP	Fuel Bldg	2,399	1,200	20	2	0.26
HANGAR	Hangar	40,519	40,519	39	1	0.13
LAB-MED	Med Lab	12,064	12,064	35	1	0.13
MTRPOOL	Maint Shop	68,337	9,762	30	7	0.91
MWR	Morale, Rec	13,585	4,528	22	3	0.39
NASLEAS	NASA-Leased	732,416	8,419	27	87	11.36
NASOWN	NASA-Owned	745,470	3,241	34	230	30.03
OTHER	Other	9,580	2,395	22	4	0.52
PLT-BLD	Heat/Cool/Plant	34,950	1,456	28	24	3.14
PLT-EQU	Maint Shop-Equip	68,571	2,212	28	31	4.05
R&D	Research & Dev	1,236,903	18,741	31	66	8.62
RESTRNT	Restaurant	16,443	16,443	34	1	0.13
SECURTY	Security Fac	37,542	1,295	21	29	3.79
SHOP	Misc Maint Shop	219,099	8,115	27	27	3.52
SHOP-ELC	Maint Shops-Elec	77,132	11,019	31	7	0.91
SHOP-WPN	Main Shops-Weapons	5,150	5,150	36	1	0.13
STOR-UH	Unheated Storage	155,553	1,556	26	100	13.05
TRAING	Training Fac	5,548	2,774	32	2	0.26
WHS	Warehouse	389,801	5,340	27	73	9.53
Total		4,411,172			766	100.00

A mnemonic letter code identifies each building type. The facility category entitled "Other" was identified from the real property list and includes items such as utility vaults, waste treatment buildings, and other

unique facilities that have 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 the real property list.

3.0 ENERGY-USE BASELINE

This section describes characteristics of overall energy use at Cape Canaveral AFS. Table 3.1 shows the typical annual energy consumption for 1991 and 1992 and the energy cost for 1991 for all on-base facilities at the station. For each energy type, the annual total is shown in appropriate units and in a common unit (MBtu) 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 used at Cape Canaveral AFS.

TABLE 3.1. Typical Annual Energy Consumption and Energy Cost at Cape Canaveral AFS

Energy Type	Annual Total			Annual Total (MBtu[a])		Percent of Total (1991)	Energy Cost (1991$ x 10^3)
	1991	1992	Units	1991	1992		
Electricity	192,074.0	NA	MWh[b]	655,549[c]	NA	61.5	9,876
No. 2 Fuel Oil	924.1	NA	kgallon[d]	28,265[e]	NA	12.0	952
Diesel Fuel	1558.3	1705.7	kgallon[f]	218,162[g]	238,798	20.5	1,558
MOGAS	502.4	508.6	kgallon[f]	63,805[h]	64,592	6.0	619
Total				1,065,781		100.0	13,005

(a) 1 MBtu = 1,000,000 Btu
(b) FPL Billing Records (CY91)
(c) 3,413 Btu/kWh
(d) DEIS Records (CY91)
(e) 0.1388 MBtu/gal (CY91)
(f) Cape Canaveral AFS Personnel (CY91)
(g) 0.1400 MBtu/gal
(h) 0.1270 MBtu/gal

3.1 ELECTRIC SUPPLY SOURCE DESCRIPTION

Defense Energy Information System (DEIS) records for a typical year (FY91) indicate on-base industrial electricity consumption of 192,074 MWh, which includes USAF and all reimbursable accounts. Electricity is supplied by FPL and billed under a time-of-use rate structure designated by General Service Large Demand Time-of-Use (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

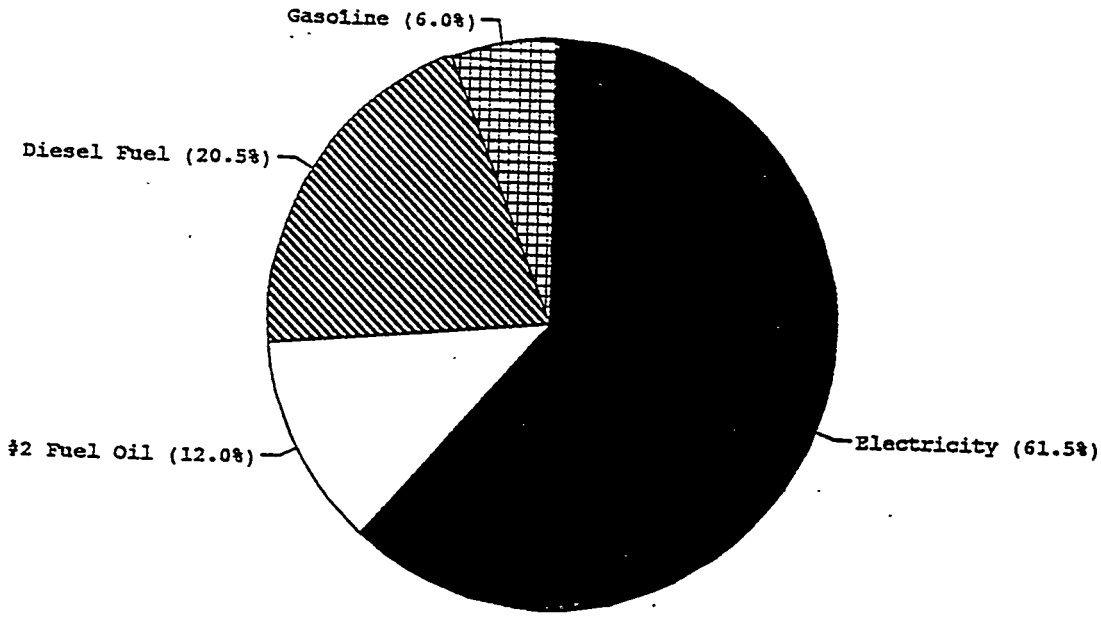

FIGURE 3.1. Energy Use by Fuel Type (MBtu)

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 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. Table 3.2 summarizes the electric rate structure.

3.2 NO. 2 FUEL OIL SUPPLY SOURCE DESCRIPTION

No. 2 fuel oil is used to power portable electric generators for standby power during launch periods at the station. No. 2 fuel oil is also used for limited space and water heating via oil-fired hot water or steam boilers. During summer months, reheat is used in some buildings as part of the air conditioning/dehumidification systems. In calendar year (CY) 1991, Cape Canaveral AFS purchased 22,002 barrels of No. 2 fuel oil (128,262 MBtu) at a price of

TABLE 3.2. Cape Canaveral AFS Electric Rate Structure Breakdown

Season	Rate Type	Hours of Day	Demand Charge ($/kWh)	Energy Charge (¢/kWh)	Fuel Charge (¢/kWh)	Oil Backout Charge (¢/kWh)	Conservation Charge (¢/kWh)	Total Energy Charge (¢/kWh)
Winter (Nov. 1 - March 31)	On-Peak	6:00am-10:00am	6.25	1.082	2.175	0.651	0.135	4.043
		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 (April 1 - Oct. 31)	On-Peak	12:00pm-12:00pm	6.25	1.082	2.175	0.651	0.135	4.043
	Off-Peak	9:00pm-12:00pm	0.00	0.949	1.975	0.651	0.135	3.71

$1.03/gal for a total cost of $951,806. Fuel oil use represents 20% of the total energy use at the station. This relatively large percentage is accounted for by the frequent use of portable generators.

3.3 MOTOR VEHICLE FUEL (MOGAS) SUPPLY SOURCE DESCRIPTION

Fuels for motor vehicles at Cape Canaveral AFS are supplied through Raytheon Services. In FY91, the base vehicles consumed 503,079 gal of unleaded regular gasoline at a cost of $1.23/gal for a total cost of $618,787. During the same period, 1,512,718 gal of diesel fuel were consumed at $1.03/gal, costing $1,558,099.

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 as follows:

- Preliminary Screening. Select promising EROs from a master list (see Table 1.1, in Sandusky et al. [1994]), 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.

- 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 an 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 several 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 RESULTS OF RESOURCE ASSESSMENT

Following LCC guidelines required for all federal energy decisions (10 CFR 436), analysis results are presented in 11 common energy end-use categories (e.g., boilers and furnaces, service hot water, building lighting). By implementing all cost-effective EROs identified in this study, Cape Canaveral AFS will reduce annual energy use by 129,831 MBtu and reduce demand by 180,782 kW-mo. The single largest savings potential by end use is the roughly 24,000 MWh of electricity saved annually by increased lighting efficiency. As

illustrated in Table 4.1, the present value (PV) of the installed cost of all EROs constituting the minimum LCC efficiency resource (i.e., cost-effective) at Cape Canaveral AFS is approximately $16.6 million in 1993 dollars (1993$). The PV of the savings associated with this investment is approximately $48.9 million, for an overall NPV of $32.3 million.

Table 4.2 provides a breakdown and summary of the cost-effective resource at Cape Canaveral AFS. Cost-sharing and rebate incentives from the utility would normally be factored into the analysis. Because the potential DSM relationship with the electric utility, FPL, is uncertain, Cape Canaveral AFS project managers decided that this document would present an economic analysis from the government-funding-only perspective. Thus, if no cost-sharing with the utility can be arranged, the document will still be useful to the USAF when planning for implementation of various EROs. Once details of a cost-sharing agreement with the utility have been reached, the economic analysis can be redone at any time.

The operations and maintenance (O&M) savings are a reflection of the incremental cost difference between the cost of maintaining the existing equipment and that of maintaining new or retrofitted equipment. Because maintenance costs of new or retrofitted equipment are often the same as the costs to maintain the existing equipment, this incremental maintenance cost is often zero.

Table 4.3 accompanies Table 4.2, which presents a breakdown and summary of the energy and demand savings for the first year and full implementation of the cost-effective resource at Cape Canaveral AFS.

TABLE 4.1. Total Savings, Cost, and Net Present Value (1993$) at Cape Canaveral AFS

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 Present Value of All Savings	Total Net Present Value
16,589,658	25,557,604	17,924,377	649,066	4,815,864	48,946,911	32,357,253

TABLE 4.2. Summary of the Cost-Effective Energy Resource at Cape Canaveral AFS (1993$)

ERO Category	Present Value of Installed Cost	Present Value of Energy Savings	Present Value of Demand Savings	Present Value of O&M Savings	Present Value of Replac. Savings	Present Value of Total Savings	Net Present Value
Air Conditioning	5,631,801	-663,962	7,050,801	965,176	4,255,171	11,607,187	5,975,385
Boilers	924,950	1,931,863	2,032,477	-4,544	336,174	4,295,970	3,371,020
Envelope	158,018	365,095	47,326	0	0	412,421	254,403
Generators	373,236	-1,373,697	3,823,200	-798,261	0	1,651,242	1,278,006
Heat Pipes	2,631,580	11,439,374	0	0	0	11,439,374	8,807,794
Lighting	6,179,025	12,999,180	4,742,382	486,694	0	18,228,257	12,049,232
Motors	691,048	859,750	228,191	0	224,519	1,312,459	621,411
Totals	16,589,658	25,557,604	17,924,377	649,066	4,815,864	48,946,911	32,357,253

TABLE 4.3. Summary of the Energy and Demand Savings at Cape Canaveral AFS

ERO Category	First-Year Energy Savings (MBtu)	Full Implement. Energy Savings (MBtu)	First-Year Demand Savings (kW-mo)	Full Implement. Demand Savings (kW-mo)
Air Conditioning	3,540	-10,615	1,142	71,565
Boilers	-1,520	-1,520	20,415	20,415
Envelope	2,279	2,279	475	475
Generators	-17,048	-17,048	38,400	38,400
Heat Pipes	68,913	68,913	0	0
Lighting	82,082	82,082	47,634	47,634
Motors	4,883	5,740	2,292	2,292
Totals	143,130	129,831	110,359	180,782

Table 4.4 presents a breakdown and summary of the total fuel balance at Cape Canaveral AFS. Total existing fuel use is based on information developed for the Volume 2: Baseline Detail companion report to this document (Wahlstrom et al. 1993). Total fuel use after ERO implementation was determined, where possible, by subtracting the total fuel savings from the total existing fuel use.

The lighting ERO category has the greatest energy conservation potential at Cape Canaveral AFS. Lighting EROs alone have a little over a $12 million

TABLE 4.4. Fuel Balance at Cape Canaveral AFS

Fuel Type	1991 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)
Diesel	218,162	NA	0	NA	24,887	NA	243,049	NA
Electricity	655,549	362,135	167,775	180,782	16,529	0	504,303	181,353
Fuel Oil	128,265	NA	63,618	NA	60,147	NA	124,794	NA
Totals	1,001,976	362,135	231,393	180,782	101,562	0	872,145	181,353

NPV. Energy resource potential is described in the following figures: Figure 4.1 shows the NPV of the electric EROs, Figure 4.2 shows the full implementation annual energy savings for energy EROs, and Figure 4.3 shows the full implementation annual demand savings for energy EROs. Certain end uses, such as generators, actually use more energy, but the demand savings more than make up the difference; thus, they still show a positive NPV. Figure 4.4 shows the energy resource potential (in million British thermal units [MBtu] by the various fuel types.)

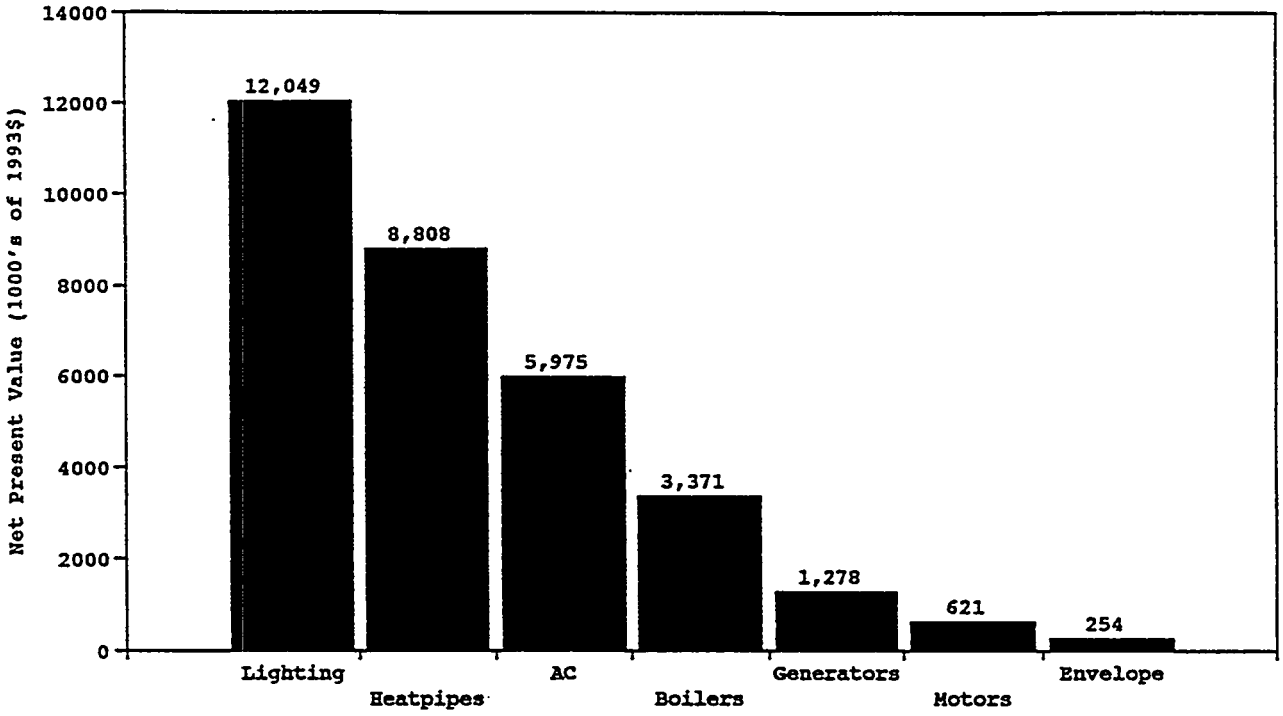

FIGURE 4.1. Net Present Value - Energy EROs

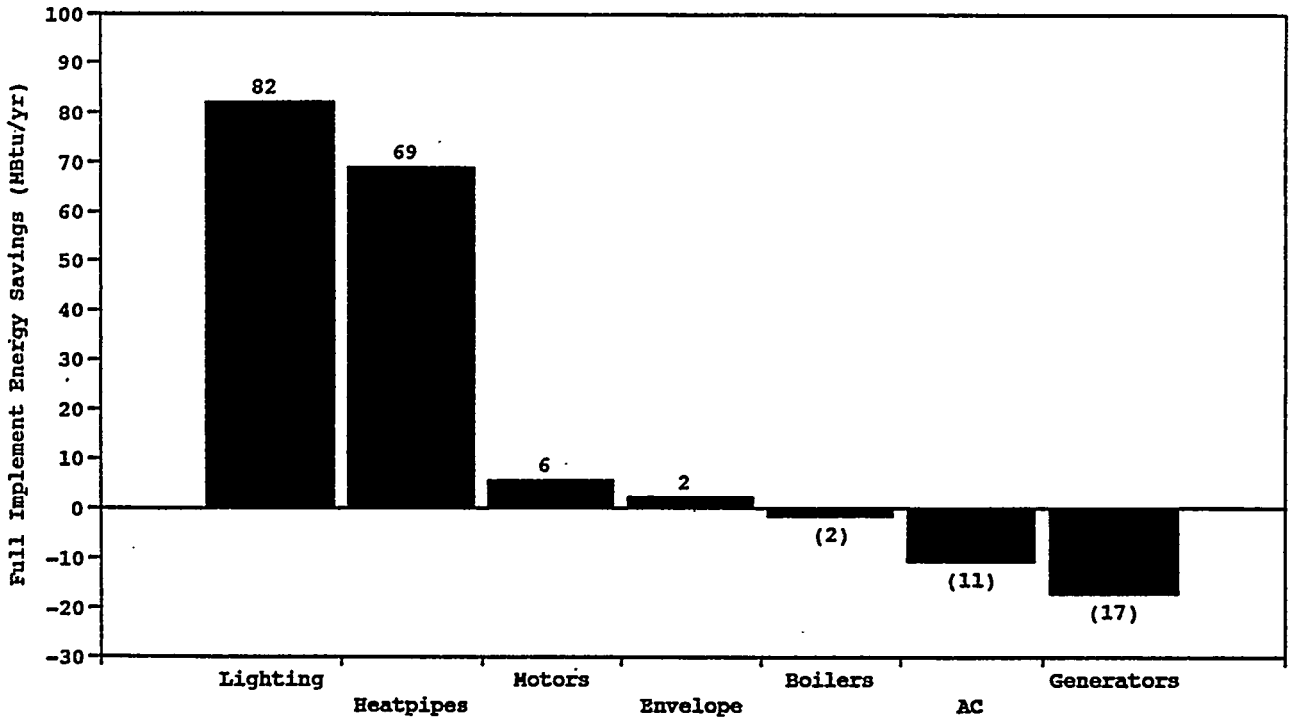

FIGURE 4.2. Full Implementation Annual Energy Savings

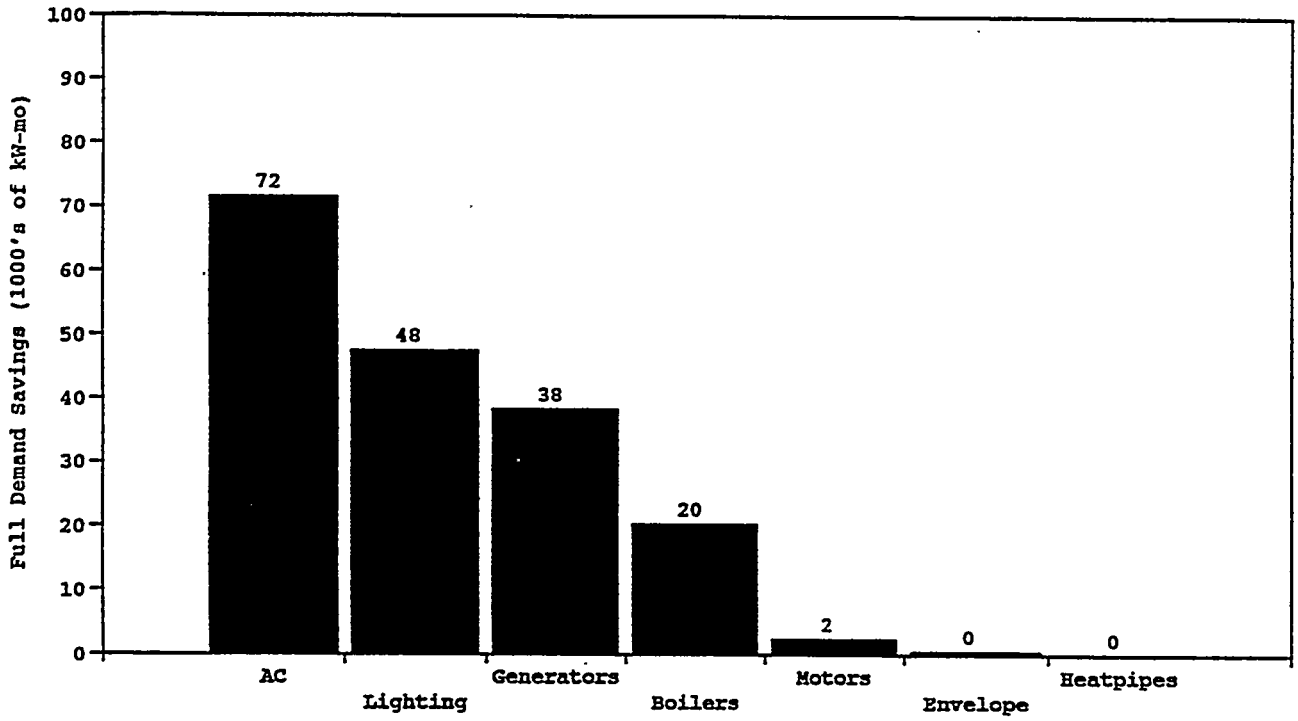

FIGURE 4.3. Full Implementation Annual Demand Savings - Electric EROs

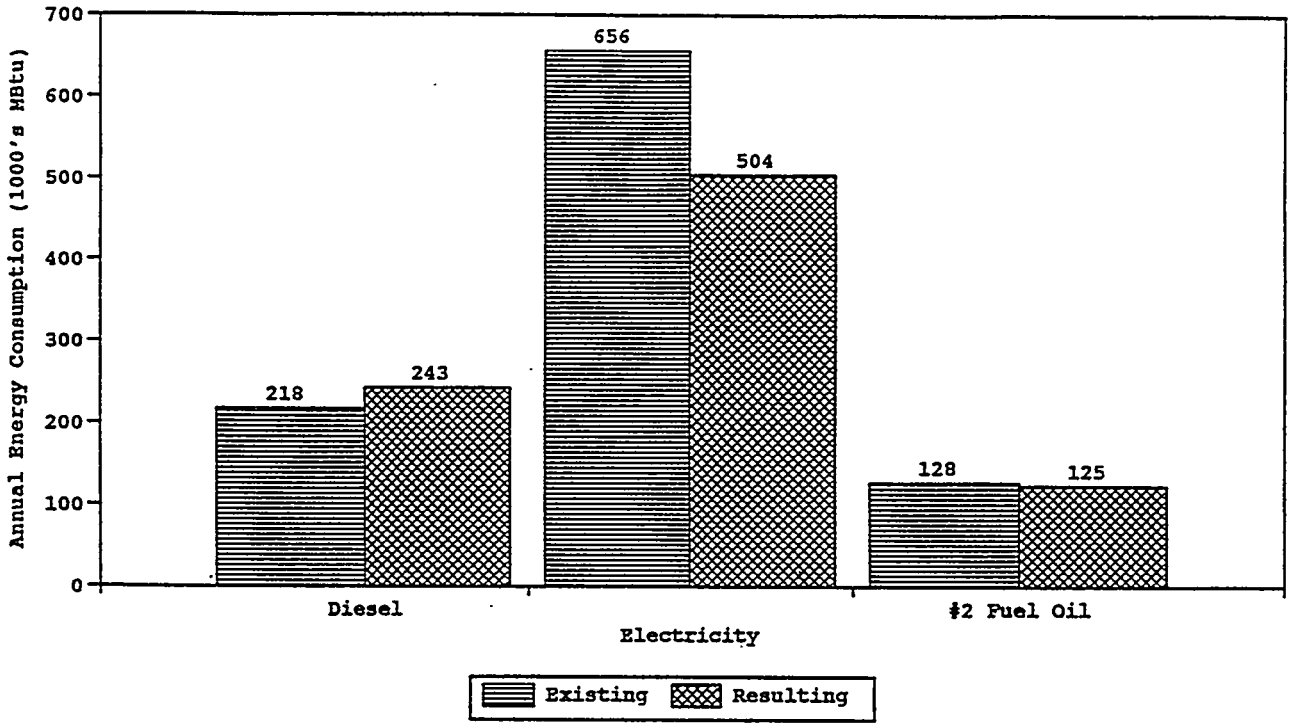

FIGURE 4.4. Energy Resource Potential (MBtu) by Fuel Type

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 Cape Canaveral AFS. The implementation step of this process reviews EROs 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 Cape Canaveral AFS. In addition, the plan needs to identify a strategy for a long-term working relationship with both the electric utility (FPL) and the gas utility (City Gas of Florida) to take full advantage of the utility incentives offered through promotional and 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 O&M activities, or implementation of special technologies in normal activities that are part of the overall mission of Cape Canaveral AFS. Projects involving special technologies need to be evaluated using the federally mandated LCC methodology.

Evaluation of potential EROs that would result in projects for Cape Canaveral AFS are identified in Volume 3: Resource Assessment (Sandusky et al. 1994). Examples of major projects that are cost-effective and can be initiated immediately at Cape Canaveral AFS include the following:

- Install heat pipes to reduce the amount of energy required to maintain humidity levels in critical facilities.
- Develop a comprehensive lighting retrofit program for all current facilities. This program development should be done in concert with an evaluation of the potential for installing 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 effort would include all motors associated with air ventilation as well as motors used to pump water for industrial activities and sewage. This effort should also include analyzing and determining if the current motor is oversized for its application so additional energy savings can be obtained.

- Install a workable energy management and control system (EMCS) as a method of reducing the load associated with lighting and air conditioning during periods when facilities are not occupied. Any load reduction should not be instituted if it will create an adverse impact on mission requirements.

Other projects that can be subsequently implemented include the following:

- Installing generation stations to reduce peak demand and provide power during launch activities.

- Replace chillers with more efficient chillers. This strategy can be integrated with current efforts to manage chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs).

- Replace existing single-pane windows with double-pane windows that have a reflective film contained in the glass. At the same time, seal openings around doors and windows and other openings in buildings to reduce the amount of infiltration.

- Implement compressed natural gas vehicles into the motor pool to reduce mobility energy cost.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The integrated resource assessment at Cape Canaveral AFS 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 include the following:

- The systematic approach used to identify EROs provides 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 the analysis performed in this study be updated to include the latest information regarding building characteristics, mission requirements, and current energy uses.

- Substantial energy reduction and cost savings are available at Cape Canaveral AFS, even with the exceptionally low cost of energy for electricity and natural gas. The EROs analyzed in this study provide a savings of 13.0% of the annual energy consumption and 26.6% of the annual energy cost.

- In most cases, the analysis did not include the value of any rebates that can be obtained from either the electric or gas utility. However, the electric utility is in the process of establishing an overall DSM program for Cape Canaveral AFS. Mutually agreeable projects would be financed through the utility with the cost being applied to the monthly billing. In this fashion, Cape Canaveral AFS 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 predominately directed toward acquiring energy-efficient technology, also must consider and integrate other issues that have potential to affect energy consumption. Examples of other issues include 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.

- EPAct (Public Law 102-486) provides Cape Canaveral AFS 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 LCC 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 Institute of Standards and Technology (NIST 1992). The NIST 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 and Wrench 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 the Cape Canaveral Air Force Station Integrated Resource Assessment report (Sandusky et al. 1994) 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 as follows:

- 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 CY93).
- 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. For this reason, a savings-to-investment ratio (SIR) is calculated to rank the order of 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 require 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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