**Robins Air Force Base
Integrated Resource Assessment**

Volume 1: Executive Summary

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Abstract

Some of the most difficult problems that a federal site has in reducing its energy consumption in a cost-effective manner revolve around understanding where the energy is being used, and what technologies could 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, he or she may not have the background, training, or resources to determine the most cost-effective options for reducing this energy use. This can lead to selection of suboptimal projects that prevent the site from achieving the full life-cycle cost savings.

The U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP), supported by the Pacific Northwest Laboratory (PNL),^(a) has developed a model program that provides a systematic approach to evaluating energy opportunities that 1) identifies the building groups and end uses that use the most energy (not just have 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 roadmap 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 five- to ten-year energy management plan that identifies where to start and how to proceed in order 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 the U.S. Air Force Materiel Command Robins Air Force Base facility, located near Macon, Georgia. It is a companion report to Volume 2, *Baseline Detail*, and Volume 3, *Resource Assessment*.

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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 that 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) could be saved. On October 24, 1992, the Energy Policy Act of 1992 (EPAct 1992) was issued. It directs federal agencies to reduce energy consumption by 20% from 1985 levels by the year 2000. In an effort to assist federal agencies in meeting this Act, the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP), supported by the Pacific Northwest Laboratory (PNL), has been tasked by the U.S. Air Force Materiel Command (AFMC) to identify, evaluate, and acquire all cost-effective energy projects at selected federal facilities.

Robins Air Force Base (AFB) is an 8,790-acre AFMC facility supporting the Warner Robins Logistics Center south of Macon Georgia. In FY 1991, the daytime population of the Base averaged 19,920 persons, with 5,329 military personnel and dependents full-time residents. To determine an energy consumption baseline the Base was divided into the following three major areas: commercial, family housing, and utility. Two of these areas had structures totaling 1,468 buildings and a total area of 13,476,203 ft². On-post utilities include the following: electricity, district steam heat, chilled water, water, fire protection, sewage, and outdoor lighting.

Total energy consumption at Robins AFB in FY 1991 was 1,935,629 MBtu, at a cost of \$15,359,000. Characteristic energy types included: electricity, natural gas, #2 fuel oil, and propane. While electricity and natural gas account for almost all of the energy consumption, roughly 50% each, electricity was nearly 80% of the total energy cost. End uses for electricity included: fans/pumps, lighting, heating, cooling, cooking, domestic hot water, refrigeration, and other. Lighting made up nearly one-quarter of the electric energy consumption. Fossil fuel and HTHW end uses included: space heating, hot water, cooking, generators, and other. The central plants made up nearly 80% of total fossil fuel consumption.

Following life-cycle cost (LCC) guidelines required for all federal energy decisions (10 CFR 436 1990), PNL prioritized the various energy resource opportunities (EROs) by 15 end-use categories (e.g., lighting, hot water, heating, etc.). The net present value (NPV) of the installed cost of all cost-effective EROs at Robins AFB is nearly \$13.6 million (1992\$). The NPV of the savings associated with this investment is approximately \$32.7 million (1992\$), for an overall NPV of \$19 million. By implementing all the cost-effective EROs identified in this study, Robins AFB will reduce annual energy use by 78,600 MBtu (4.0%), and annual energy expenditures will decrease by over \$1.9 million (12.2%).

A summary of the savings by major end-use category is provided in Table S.1.

Table S.1. Robins AFB ERO Summary by Major End Use

Energy Resource Opportunity Category	First Year Energy Savings (MBtu)	First Year Demand Savings (kW-mo)	Full Implement. Energy Savings (MBtu)	Full Implement. Demand Savings (kW-mo)	Present Value of Installed Cost (1993\$)	Net Present Value (1993\$)	Savings to Investment Ratio
Lighting	53,572	37,397	53,572	37,397	5,822,743	4,103,264	1.70
Pumps/Motors	31,260	21,525	33,481	23,891	1,938,078	3,233,420	2.67
Furnace & Birs.	17,258	98	17,545	98	559,794	1,210,495	3.16
DHW	15,851	3,579	15,851	3,579	1,017,444	1,242,359	2.22
Trans. & Dist.	7,397	4,407	7,397	4,407	39,610	1,716,095	44.32
Envelope	7,271	2,257	7,271	2,257	500,087	441,192	1.88
Radiant Heat	1,538	14	1,538	14	30,600	87,772	3.87
Cooling Twr. ^(a)	1,125	1,539	1,125	1,539	39,000	105,142	3.70
Transport.	0	0	3,610	0	709,909	978,115	2.38
AC ^(b)	(13,318)	17,331	(24,010)	22,317	2,681,638	2,035,715	1.76
Peak-Shave ^(c)	(38,746)	63,960	(38,746)	63,960	299,001	3,884,553	13.99
Totals	83,208	152,107	78,634	159,460	13,637,903	19,038,120	2.40
<p>(a) Cooling tower freeze protection ERO.</p> <p>(b) Includes both electric to electric and electric to natural gas AC options.</p> <p>(c) Energy savings for Peak-shaving EROs are calculated as generated electricity less #2 fuel oil consumed in generating.</p>							
<p>First year savings is all "replaced immediately" options; full implementation savings is "replaced immediately" and "replaced on failure" options.</p>							

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Abbreviations and Acronyms

AFB	Air Force Base
AFMC	Air Force Materiel Command
AGL	Atlanta Gas Light Company
BX	base exchange
CFR	Code of Federal Regulations
CNG	compressed natural gas
DoD	United States Department of Defense
DOE	United States Department of Energy
DSM	demand-side management
ECIP	Energy Conservation Investment Program
EMCS	energy management and control system
E.O.	Executive Order
EPAct	Energy Policy Act of 1992
ERO	energy resource opportunity
ESCO	energy service company
EUI	energy-use intensity
FEDS	Facility Energy Decision Screening
FEEF	Federal Energy Efficiency Fund
FEMP	Federal Energy Management Program
FY	fiscal year
Georgia Power	Georgia Power Company
GPC	Georgia Power Company
GPSC	Georgia Public Services Commission
HVAC	heating, ventilation, and air conditioning
IRP	Integrated Resource Plan
kW	kilowatt
kWh	kilowatt-hour
kW-mo	kilowatt-month
LCC	life-cycle cost
NPV	net present value
MBtu	million British thermal units
O&M	operations and maintenance
PNL	Pacific Northwest Laboratory
SEPCO	Savannah Electric Power Company
SES	shared energy savings
SIR	savings to investment ratio
USAF	United States Air Force

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, it 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 at over 50 federal installations indicate that there is an enormous energy and dollar savings potential within the federal sector. Evidence suggests that 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 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 would 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 includes the life-cycle cost (LCC) method and procedures set forth in 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 1992 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. It 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 could 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, he or she may not have the background, training, or resources to determine the most cost-effective options for reducing this

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

energy use. This can lead to selection of suboptimal projects that prevent the site from achieving the full life-cycle cost savings.

The model program the Federal Energy Management Program (FEMP) has developed constitutes a systematic approach to evaluating energy opportunities which 1) identifies the building groups and end uses that use the most energy (not just have 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 roadmap 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 five- to ten-year energy management plan that identifies where to start and how to proceed in order to reach the mandated energy consumption targets.

In an effort to assist federal agencies in meeting the conditions of EPAct, DOE-FEMP (supported by PNL) has been tasked by the U.S. Air Force Materiel Command (AFMC) 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 Robins Air Force Base (Robins AFB), FEMP is designing a model program for

federal customers served by the Georgia Power Company (Georgia Power). 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 100% of the financing required to implement electric energy efficiency projects from Georgia Power and have Georgia Power 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* (Keller et al. 1993) and of the assessment of energy conservation potentials found in *Volume 3: Resource Assessment* (Sullivan et al. 1993).

The Robins AFB installation is characterized in Section 2. A baseline of energy use is found in Section 3. The analytical approach for determining energy resource opportunities (EROs) is described in Section 4, with a summary of resource assessment results in Section 4.1. Section 5 describes a strategy for implementation of EROs, and the conclusions and recommendations are found in Section 6. References are listed in Section 7. The Life-Cycle Cost Methodology is provided in Appendix A, and a Robins AFB Extended Energy Project Implementation Structure is provided in Appendix B.

2.0 Site Characterization

Robins AFB is an 8,790-acre Air Force Materiel Command (AFMC) facility in central Georgia. The Base is located just east of the town of Warner Robins, Georgia, at 32.38°N and 83.36°W and at an elevation (runway) of 294 feet.

The Base mission is to support the Warner Robins Air Logistics Center.

In fiscal year (FY) 1990, the daytime population on the Base averaged 19,920. Active military personnel assigned to the site numbered 4,175. The estimated number of military dependents was 5,674. 5,329 military personnel and dependents live on post, with the remainder living in nearby off-base towns. Due to the nature of the activities at Robins AFB, there are many civilian employees. Civilians employed full-time at the site, but not living in family housing, numbered 15,745 in FY90. Military personnel not assigned to the Base affect energy consumption to some extent by their use of site facilities such as the post exchange (PX) and recreation centers. There are some 23,729 military retirees (and dependents) in middle Georgia who are entitled to use the facilities, but the extent of this use has not been determined.

For energy consumption and billing purposes, the Base is divided into three major areas: commercial, family housing, and utility

(with utility including exterior lighting, pumping, and transmission and distribution losses).

Table 2.1 gives the number of buildings and total square feet for each of the areas.

There are 519 commercial, industrial, and command buildings at Robins AFB. These buildings have a total floor area of 11,860,201 ft².

There are 10 permanent on-post family housing areas containing a total of 1,416 family dwelling units in 822 buildings with a total floor area of 1,837,976 ft². Family housing areas are located at the southern end of the Base and across State Highway 247 in the city of Warner Robins. Natural gas is used for space heating and domestic hot water in the majority of the housing areas, with the exception of Chevron Village, which has electric hot water heaters.

A mobile home park provides space, electrical service, water and sewer service for 100 units.

Table 2.1. Robins AFB Building Characterization

Base Area	Number of Buildings	Total Floorspace (ft ²)	Percent of Total Floorspace
Commercial	519	11,860,201	86.6
Family Housing	822	1,837,976	13.4
Total	1,341	13,698,177	100.0

3.0 Energy Use Baseline

This section documents the baseline energy use at Robins AFB. The analysis characterizes electric, natural gas, #2 fuel oil, and propane for the federal fiscal year (FY) 1991. It provides a breakdown of energy-use for Robins AFB by fuel type, building type, and energy end use. A complete energy consumption reconciliation is presented that includes the accounting of all energy use among buildings, utilities, central systems, and applicable losses.

Table 3.1 shows a summation of the typical yearly energy consumption and cost for all facilities at Robins 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 for comparison. The total consumption values represent typical current yearly usage, from the best available data during 1990 and 1991. The annual energy consumption was 1,935,629 MBtu, at a cost of \$15,359,000.

Table 3.2 breaks down the energy consumption by fuel type and end use for the Base's three major areas. On the electric side, utility readings and various building meters were used to determine the total electric energy consumption by building type within each area. These meter data, along with estimates of energy-use intensities (EUIs), were used to reconcile the energy consumption by building type and end-use category (lighting, heating, cooling, etc.).

Energy consumption is described with the following four figures: Figure 3.1 describes the energy use by fuel type, Figure 3.2 describes the energy use by facility sector, Figure 3.3 describes the energy use by end use for all fuels, and Figure 3.4 describes the energy use by end use for electricity only.

Table 3.1. Typical Yearly Energy Consumption and Energy Cost at Robins AFB

Energy Type	Yearly Total (purchase units)	Yearly Total [MBtu ^(a)]	Percent of Total Energy Consumption	Energy Cost [1990\$ x 10 ³]	Percent of Total Cost
Electricity	269,085 MWh	918,386 ^(b)	47.20	12,200	79.40
Natural Gas	961,873 KCF	982,072 ^(c)	50.50	2,923	19.00
#2 Fuel Oil	249 kgal.	34,603 ^(d)	1.80	230	0.01
Propane	6,220 gal.	568 ^(e)	0.03	6	<0.01
Totals:		1,935,629	100.00	15,359	100.00
(a) 1 MBtu = 1,000,000 Btu. (b) 3,413 Btu/kWh. (c) 100,000 Btu/therm; 1,050 Btu/ft ³ of natural gas. (d) 0.1388 MBtu/gal of #2 fuel oil. (e) 0.0913 MBtu/gal of propane.					

Table 3.2. Energy Consumption by End Use (MBtu/yr)

	Base Area			
Fuel Type/End Use	Commercial	Family Housing	Utility	Total
Electric:				
Heating	1,688	0	0	1,688
Cooling	78,458	39,356	0	117,814
Vent./Fans	103,040	5,326	0	108,366
DHW	3,892	4,109	0	8,001
Cooking	7,092	6,843	0	13,935
Refrigeration	22,983	13,893	0	36,876
Interior Ltg.	205,650	22,085	0	227,736
Exterior Ltg.	10,828	2,454	0	13,281
Other Bldg. End Use	174,661	12,543	0	187,204
Street Ltg.	0	0	35,084	35,084
Trans. & Dist. Loss	0	0	46,064	46,064
Trailer Park	0	3,753	0	3,753
Central Plants	0	0	66,196	66,196
PAVE PAWS	50,841	0	0	50,841
Total	659,134	110,362	147,343	916,839
Percent of Total	71.9%	12.0%	16.1%	100.0%
Natural Gas:				
Heating	19,414	47,048	0	66,462
DHW	9,024	20,362	0	29,386
Cooking	4,366	0	0	4,366
Other Bldg. End Use	317	0	0	317
Central Plants	0	0	882,038	882,038
Total	33,121	67,410	882,038	982,569
Percent of Total	3.4%	6.9%	89.8%	100.0%

Table 3.2. (contd)

	Base Area			
Fuel Type/End Use	Commercial	Family Housing	Utility	Total
Fuel Oil:				
Heating	13,068	0	0	13,068
DHW	4,657	0	0	4,657
Central Plants	0	0	16,871	16,871
Total	17,725	0	16,871	34,596
Percent of Total	51%	0%	49%	100%
Total:	709,980	177,772	1,046,252	1,934,004
Percent of Total:	36.7%	9.2%	54.1%	100.0%

Figure 3.1. Energy Use by Fuel Type (MBtu)

Figure 3.2. Energy Use by Facility Sector (MBtu)

Figure 3.3. Energy Use by End Use for All Fuels (MBtu)

Figure 3.4. Energy Use by End Use for Electricity (MBtu)

4.0 Energy Resource Opportunities

The number of conceivable energy resource opportunities (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, *Volume 3: Resource Assessment*) 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 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 Appendix A.

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 *Volume 3: Resource Assessment*. Analysis results are presented in 15 common energy end-use categories (e.g., lighting, HVAC, refrigeration) and the three facility sectors representative of Robins AFB: commercial, family housing, and utilities. Savings are indicated by fuel type: fuel oil #2, natural gas, propane, steam, and electricity.

As illustrated in Table 4.1, the NPV of the installed cost of all cost-effective EROs at Robins AFB is nearly \$13.6 million (1992\$). The NPV of the savings associated with this investment is approximately \$32.7 million (1992\$), for an overall NPV of \$19 million. By implementing all the cost-effective EROs identified in this study, Robins AFB will reduce annual energy use by 78,600 MBtu (4.0%), and annual energy expenditures will decrease by over \$1.9 million (12.2%), as summarized in the following tables.

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 Present Value of All Savings	Total Net Present Value
13,637,903	12,437,369	17,186,141	819,917	2,232,596	32,676,023	19,038,120

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 Robins AFB is approximately \$13.6 million in 1993 dollars (1993\$). The PV of the savings associated with this investment is approximately \$32.7 million, for an overall NPV of \$19.0 million.

Table 4.2 provides a breakdown and summary of the cost-effective electricity resource at Robins AFB. 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, Georgia Power Company, is uncertain, Robins AFB project managers decided that this document would present an economic analysis from the government-funding-only perspective. That way if no cost-sharing with the utility could be arranged, the document would still be useful to the U.S. Air Force (USAF) in its 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.

To accompany Table 4.2 is Table 4.3, which presents a breakdown and summary of both the energy and demand savings for the first-year and full implementation of the cost-effective electricity resource at Robins AFB.

Table 4.4 provides a breakdown and summary of cost-effective fossil fuel resource opportunities at Robins AFB.

To accompany Table 4.4 is Table 4.5, which presents a breakdown and summary of both the energy and demand savings for the first-year and full implementation of the cost-effective fossil fuel resource at Robins AFB.

Tables 4.6 and 4.7 present a breakdown and summary of the cost-effective fuel-switching opportunities. Table 4.6 presents the breakdown by ERO category and summary in dollars (1993\$) and Table 4.7 presents the same information in energy and demand (MBtu and kW-mo).

Table 4.2. Summary of the Cost-Effective Electric Resource at Robins AFB (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	994,181	70,966	182,250	0	805,239	1,058,455	64,274
Cooling Towers	39,000	129,883	14,259	0	0	144,142	105,142
Hot Water	10,9922	211,266	97,344	0	2,910	311,520	300,528
Lighting	5,822,743	6,416,091	2,762,466	747,449	0	9,926,006	4,103,264
Pumps/Motors	1,938,078	3,576,221	1,098,806	(28,479)	524,949	5,171,498	3,233,420
Trans. & Dist.	39,610	937,404	818,417	(121)	5	1,755,705	1,716,095
Totals	8,844,603	11,341,831	4,973,543	718,850	133,102	18,367,326	9,522,723

Table 4.3. Summary of the Electric Energy and Demand Savings

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	4,509	4,509	3,182	3,182
Cooling Towers	1,125	1,125	1,539	1,539
Hot Water	1,502	1,502	603	603
Lighting	53,572	53,572	37,397	37,397
Pumps/Motor	31,260	33,481	21,525	23,891
Trans. & Dist.	7,397	7,397	4,407	4,407
Totals	99,365	101,586	68,652	71,019

Table 4.4. Summary of Cost-Effective Fossil Fuel Resource at Robins AFB (1992\$)

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 Replacement Savings	Present Value of Total Savings	Net Present Value
Furnace & Boilers	83,106	85,462	0	(5,468)	59,384	139,379	56,273
Hot Water	666,282	716,594	0	0	435,734	1,152,327	486,045
Totals	749,388	802,056	0	(5,468)	495,118	1,291,706	542,318

Table 4.5. Summary of the Fossil Fuel Energy and Demand Savings

ERO Category	First-Year Energy Savings (MBtu)	Full Implement. Energy Savings (MBtu)
Furnace & Boilers	1,348	1,547
Hot Water	14,140	14,140
Totals	15,488	15,687

Table 4.6. Summary of the Cost-Effective Fuel-Switching/Multiple Fuel Resource at Robins AFB (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 Replacement Savings	Present Value of Total Savings	Net Present Value
Air Conditioning	1,687,457	303,537	2,543,669	(264,537)	1,076,229	3,658,898	1,971,441
Furnace & Boiler	163,973	597,138	0	0	73,082	670,221	506,248
Heating ^(a)	343,315	1,061,547	7,403	0	10,111	1,079,061	735,746
Hot Water	340,170	270,368	460,122	(61,082)	126,547	795,955	455,785
Peak-Shave	299,001	(3,994,742)	8,836,711	(658,415)	0	4,183,554	3,884,553
Transport.	709,909	1,271,746	0	1,090,569	(674,291)	0	1,090,569
Weather. Pkg.	500,087	783,888	364,694	0	(207,303)	941,279	441,192
Total	4,041,912	293,482	12,212,598	106,535	404,375	11,328,967	9,085,534
(a) Natural gas-fired radiant heaters.							

Table 4.7. Summary of the Fuel-Switching/Multiple Fuel Energy and Demand Savings

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	(17,827)	(28,519)	14,149	19,136
Furnace & Boiler	509	597	0	0
Heating ^(a)	16,939	16,939	112	112
Hot Water	208	208	2,976	2,976
Peak-Shave	(38,746)	(38,746)	63,960	63,960
Transport.	0	3,610	0	0
Weather. Pkg.	7,271	7,271	2,257	2,257
Totals	(31,645)	(38,639)	83,455	88,441
(a) Natural gas-fired radiant heaters.				

Table 4.8 presents a breakdown and summary of the cost-effective resource determined within this ERO assessment.

To accompany Table 4.8 is Table 4.9, which presents a breakdown and summary of both the energy and demand savings for the first-year and full implementation for different fuel types at Robins AFB.

Table 4.10 presents a breakdown and summary of the total fuel balance at Robins AFB. Total existing fuel use is based on information developed for the Volume 2 Baseline Detail companion report to this document. Total fuel use after ERO implementation was determined, where possible,

by subtracting the total fuel savings from the total existing fuel use. In addition, percent savings of existing fuel use is presented, where possible.

Energy resource potential is described with the following four figures: Figure 4.1 describes the energy and demand savings potential in dollars, Figure 4.2 describes the energy resource potential in MBtu's by fuel type, Figure 4.3 describes the electric resource potential by ERO category, Figure 4.4 describes the fossil fuel resource potential by ERO category, and 4.5 describes the fuel-switch resource potential by ERO category. Figure 4.5 includes both energy and demand to fully explain the results.

Table 4.8. Summary of Cost-Effective Resource End Use (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 Replacement Savings	Present Value of Total Savings	Net Present Value
Air Conditioning	2,681,638	374,503	2,725,919	(264,537)	1,881,468	4,717,352	2,035,715
Cooling Tower	39,000	129,883	14,259	0	0	144,142	105,142
Furnace & Boiler	559,794	1,627,579	7,403	(5,468)	140,775	1,770,289	1,210,495
Heating ^(a)	30,600	116,569	0	0	1,803	118,372	87,772
Hot Water	1,017,444	1,198,228	557,466	(61,082)	565,191	2,259,803	1,242,359
Lighting	5,822,743	6,416,091	2,762,466	747,449	0	9,926,006	4,103,264
Peak-Shave	299,001	(3,994,742)	8,836,711	(658,415)	0	4,183,554	3,884,553
Pumps/Motor	1,938,078	3,576,221	1,098,806	(28,479)	524,949	5,171,498	3,233,420
Transport.	709,909	1,271,746	0	1,090,569	(674,291)	1,688,025	978,115
Trans. & Dist.	39,610	937,404	818,417	(121)	5	1,755,705	1,716,095
Weather. Pkg.	500,087	783,888	364,694	0	(207,303)	941,279	441,192
Totals	13,637	12,437,369	17,186,141	819,917	2,232,596	32,676,023	19,038,120

(a) Natural gas-fired radiant heaters.

Table 4.9. Summary of the Energy and Demand Savings by Fuel-Type

Fuel Type	First-Year Energy Savings (MBtu)	Full Implement. Energy Savings (MBtu)	First-Year Demand Savings (kW-mo)	Full Implement. Demand Savings (kW-mo)
Electricity	99,365	101,586 ^(a)	68,652	71,019
Fuel Oil	101	101	0	0
Fuel-Switch	(31,645)	(38,639) ^(b)	83,455	88,441
Natural Gas	15,387	15,586 ^(a)	0	0
Totals	83,208	78,634	152,107	159,460
<p>(a) Energy savings increases between first-year and full implementation because of additional implementation because of additional implementations of replace-on-failure (ROF) opportunities.</p> <p>(b) Energy saving decreases between first-year and full implementations because of additional ROF opportunities involving fuel-switching.</p>				

Table 4.10. Fuel Balance at Robins AFB

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)
Diesel	8,697	NA	3,814	NA	0	NA	4,883	NA
Electricity	918,386	545,781	152,337	159,460	0	0	766,049	386,321
Fuel Oil	34,603	NA	19,401	NA	56,563	NA	71,766	NA
Gasoline	22,167	NA	16,320	NA	0	NA	5,848	NA
Natural Gas	982,072	NA	36,300	NA	92,974	NA	1,038,746	NA
Totals	1,965,925	545,781	228,171	159,460	149,537	0	1,887,291	386,321

Figure 4.1. Present Value of Energy/Demand Savings

Figure 4.2. Energy Resource Potential in MBtu by Fuel Type

Figure 4.3. Electric Resource Potential by Resource Category

Figure 4.4. Fossil Fuel Resource Potential by Resource Category

Figure 4.5. Fuel Switch Resource Potential by Resource Category

5.0 Implementation Strategy

The purpose of the integrated resource planning (IRP) process is to develop an analytical and rational approach to reducing the energy consumption (and energy cost) at Robins AFB. The implementation step of this process reviews energy resource opportunities (EROs) identified in the integrated resource assessment and develops a framework for a multi-year energy management plan. When fully developed, this plan will discuss the types of projects, timing, sources of funding, and other considerations for Robins AFB. In addition, a strategy for negotiating with the electric utility (Georgia Power Company) and the gas utility (Atlanta Gas Light Company) needs to be part of this plan to fully take advantage of the utility incentives offered through promotional and demand-side management (DSM) programs.

Several implementation planning conferences were conducted with the Robins AFB energy manager during the latter part of fiscal year 1993. The objectives of the planning conferences were to demonstrate the methods by which projects can be selected from the *Volume 3 Integrated Resource Assessment* and to identify major project groups consistent with the Base Energy Plan. From these conferences with the energy manager, combined with findings and results from other Pacific Northwest Laboratory (PNL) projects at Robins AFB, an *Extended Energy Project Implementation Structure* was developed (Appendix B). Other PNL projects at Robins AFB include the "Relighting Demonstration Project" at the 162 building, and the operations and maintenance projects in the central plants and the 162 and 300 buildings.

The following criteria for project selection were established by PNL with the Robins AFB energy manager and include PNL experience from similar efforts at other DoD facilities:

- financial/cost-effectiveness
- technology selection (risk, order of implementation)
- mission considerations
- savings verification requirements
- operations and maintenance (O&M) considerations
- environmental impacts.

The energy resource opportunities (EROs) for electric and fossil fuels were reviewed, and categorized based on the selection criteria and Robins AFB priorities. These are listed in the "Efficient Technologies and Fuels" section of the *Extended Energy Project Implementation Structure* (Appendix B). EROs with significant Energy Conservation Investment Projects (ECIP) potential can be identified in this section for documenting and submission in accordance with ECIP program requirements.

Water conservation and renewable resources are included in the Energy Policy Act of 1992 (EPAct 92). EPAct 92 and several funding sources provide additional incentives and opportunities beyond energy-efficiency technologies. A water conservation opportunity and a discussion on renewable energy opportunities are identified separately in the "Water and Renewables" section of the *Extended Energy Project Implementation Structure*.

Additional projects, which are not part of the PNL assessment, are suggested in the section titled "Institutional Energy Plans." Some suggested projects take advantage of on-going energy activities at Robins AFB, some involve special technologies, and others encourage regular reviews of institutional programs. The institutional projects primarily serve to ensure persistency of installed energy-efficient technologies, ensure efficient technology replacement of failed equipment, and ensure the

most beneficial utility rates. With the exception of institutional programs, to determine the cost-effectiveness of these additional projects, and to be consistent with the PNL assessment, special technologies and projects need to be evaluated using the federally mandated life-cycle cost (LCC) methodology.

From the result of the integrated resource assessment, nearly 1,900 EROs were divided into more than 22 projects to be successively implemented over the next several years. These EROs are the "winners," that is, possessing the largest net present value compared with similar technologies using the same and alternate fuels. Examples of major projects available to be initiated immediately include:

- A building envelope energy-efficiency improvement project, including both residential and non-residential buildings, that upgrades or installs insulation, weatherization, and window technologies. Included in the project is to acquire all DSM incentives available through the GPC integrated resource plans approved in 1993.
- Replacing standard efficiency motors with high-efficiency or variable-speed-drive motors will result in significant energy reduction. The project includes analyzing and determining if the motor is oversized for its application, which will result in additional energy savings.
- Immediate transmission and distribution energy-efficiency opportunities exist in two areas, power factor correction and conservation voltage reduction. Both of these opportunities are particularly attractive because of their low investment cost and immediate energy savings.
- Install thermostatically controlled heat elements in the cooling tower catch basins to avoid the continuous operation of the circulating pumps.

Other projects to be subsequently implemented include:

- water conservation measures with particular emphasis on programs contained in the Energy Policy Act of 1992,
- residential and non-residential domestic hot water system replacements,
- adding timers, photo sensors, and similar controls to outdoor recreational and physical training lighting systems.

Many of these projects will require several years to design, procure, and fully implement. Verification of the energy savings will continue for the life of the equipment.

5.1 Utility Partnership Status

The passage of Georgia House Bill 280 required that Georgia Power Company (GPC) file an Integrated Resource Plan (IRP) that establishes supply-side and demand-side management resources. The utility will require significant load (kW) in the near future to meet the system needs. GPC filed an IRP on January 10, 1992, in which new DSM programs were introduced for approval by the Georgia Public Service Commission (GPSC). The estimated avoided cost for baseload in the IRP is 2 cents/kWh and \$350/kW. Therefore, DSM program incentives were designed based on the avoided cost of capacity.

The GPSC ruled on the GPC and the Savannah Electric and Power Company (SEPCO) IRPs on July 8, 1992. PNL, with co-funding from the Army, FEMP and the Air Force, analyzed both the IRP filing by GPC and the GPSC ruling on the adequacy of the IRP filing.^(a) PNL provided this review to the Air Force, FEMP and the Army for

(a) Letter Report: "Critical Review of Georgia Power Company Integrated Resource Plans and the Georgia Public Service Commission Ruling on Georgia Power Company and Savannah Electric and Power Company Integrated Resource Plans." Pacific Northwest Laboratory, Richland, Washington. August 1992.

comment. The GPSC found significant shortcomings in the IRPs, particularly with the number and level of incentives offered for DSM programs. Based on the GPSC ruling, GPC and SEPCO filed additional and more-aggressive DSM programs.

In late 1992, GPC withdrew and refiled its commercial/industrial and its custom DSM programs, subsequently refiling a modified commercial/industrial program only. The custom program, which is generally the most viable to large federal installations, was not refiled.

On January 5, 1993, the GPSC ruled on the *Application of Georgia Power Company for Certification of Demand-Side Programs*. The ruling granted in part GPC's residential DSM programs. The applicability of the residential program to a federal installation such as Robins AFB was subject to debate. GPC eventually wrote a letter^(a) declaring as its position, "... the approved residential program is fully applicable to all military family housing units located at DoD installations serviced by Georgia Power throughout the State of Georgia." The letter was reviewed for opinion by staff of the Regulatory Law Office, Office of the Judge Advocate General, Department of the Army, the official federal intervener in the State of Georgia. The opinion expressed was that the letter justified considering the residential DSM programs offered by GPC.

The Application of Georgia Power Company for Certification of Commercial and Industrial

(a) Georgia Power Company letter, to Major General Paul E. Blackwell, Commanding General Fort Stewart, from W. Paul Bowers, Vice President, Retail Sales & Service, dated May 18, 1993.

Demand-Side Programs was ruled on by the GPSC on August 5, 1993. The GPSC's order grants, with modifications, GPC's commercial and industrial programs, which include a Small Business Rebate Program, a Custom Financing Program for New Construction, a Custom Lighting Program, and an Energy Analysis Service.

Neither the residential nor the commercial/industrial DSM programs approved by the GPSC are particularly attractive to Robins AFB, but they are not without merit, either. The two programs lack attractiveness because they apply to only a few of the myriad of efficient technology opportunities available and the incentives are trivial. Nevertheless, some efficient technology's capital costs can be reduced by the GPC DSM program and where applicable and life-cycle cost effective, Robins AFB should take advantage of the savings.

Atlanta Gas Light (AGL) Company submitted its integrated resource plan to the GPSC in December 1992. Subsequently, the Commission rejected the IRP in its entirety for reasons outside of the scope of this discussion. Because of the rejection, AGL does not have an approved DSM program at this time.

During the next two years (and beyond), Robins AFB can expect new and revised integrated resource plans from both GPC and AGL. Proposed new and revised DSM programs should not detain Robins AFB from acquiring all possible efficient technologies in the most expedient manner available, but staying appraised of proposed programs can be beneficial. Occasionally, limited resources force deferring some desirable efficient technology opportunities. In this case, familiarity with proposed programs can help make the selection of which technologies to defer.

6.0 Conclusions and Recommendations

The integrated resource assessment at Robins AFB systematically analyzed the entire base for the most life-cycle cost-effective energy resource opportunities. A summary of the savings by major end use is provided in Table 6.1.

The significant conclusions and lessons learned from this work include:

- This systematic approach to identifying energy resource opportunities (EROs) provides a framework for long-range energy planning that includes a means to achieve the mandated energy-reduction goals. The projects
- identified from this analysis can be implemented over a period of several years as funding is available.
- The integrated resource assessment provides accurate, complete and detailed results that can be used as the basis for prioritizing energy efficiency decisions.
- Substantial energy reduction and cost savings are available at Robins AFB even with the exceptionally low cost of energy for electricity and natural gas.

Table 6.1. Robins AFB ERO Summary by Major End Use

Energy Resource Opportunity Category	First Year Energy Savings (MBtu)	First Year Demand Savings (kW-mo)	Full Implement. Energy Savings (MBtu)	Full Implement. Demand Savings (kW-mo)	Present Value of Installed Cost (1993 \$)	Net Present Value (1993 \$)	Savings to Investment Ratio
Lighting	53,572	37,397	53,572	37,397	5,822,743	4,103,264	1.70
Pumps/Motors	31,260	21,525	33,481	23,891	1,938,078	3,233,420	2.67
Furnace & Blrs.	17,258	98	17,545	98	559,794	1,210,495	3.16
DHW	15,851	3,579	15,851	3,579	1,017,444	1,242,359	2.22
Trans. & Dist.	7,397	4,407	7,397	4,407	39,610	1,716,095	44.32
Envelope	7,271	2,257	7,271	2,257	500,087	441,192	1.88
Radiant Heat	1,538	14	1,538	14	30,600	87,772	3.87
Cooling Twr. ^(a)	1,125	1,539	1,125	1,539	39,000	105,142	3.70
Transport.	0	0	3,610	0	709,909	978,115	2.38
AC ^(b)	(13,318)	17,331	(24,010)	22,317	2,681,638	2,035,715	1.76
Peak-Shave ^(c)	(38,746)	63,960	(38,746)	63,960	299,001	3,884,553	13.99
Totals	83,208	152,107	78,634	159,460	13,637,903	19,038,120	2.40
(a) Cooling tower freeze protection ERO.							
(b) Includes both electric to electric and electric to natural gas AC options.							
(c) Energy savings for Peak-shaving EROs are calculated as generated electricity less #2 fuel oil consumed in generating.							
First year savings is all "replaced immediately" options; full implementation savings is "replaced immediately" and "replaced on failure" options.							

- DSM funding through Georgia Power Company appears limited to the differential costs of a limited number of efficient technologies. DSM funding is not available from Atlanta Gas Light Company and other energy suppliers, but GPC, AGL, and other suppliers of energy to Robins AFB can be expected to have new, more-extensive programs in the future. Other funding sources should be explored for other electric, non-electric, and fuel-switching projects. Other funding sources include (but are not limited to) the Energy Conservation Investment Programs (ECIP), Shared Energy Savings (SES), and the Federal Energy Efficiency Fund when funded as part of EPAct 1992.
- The implementation process, although predominately directed towards 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.
- The Energy Policy Act of 1992 provides Robins 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, part 436) as all other EROs evaluated in this assessment.

The major recommendations of this assessment include:

- Command at Robins AFB anticipates continued growth beyond the year 2000 and an

expanded mission. These changes will affect the life-cycle cost (LCC) effectiveness of the remaining EROs and may result in the addition of more EROs. Some of the changes that can affect the results include new construction, building demolition and decommissioning, utility rate changes, and ERO implementation. Evaluate these changes during the planning process, not after installation.

- Significant savings in energy and dollars are available to Robins AFB through the installation of energy efficient technology. In spite of the ERO savings opportunities available, significantly more savings are available, perhaps as much as four times, through improved operations and maintenance. When funding is available, weigh carefully the energy savings opportunity when investing in efficient technology as compared with investing in maintenance.
- The PNL-developed Facility Energy Decision Screening Level 2 (FEDS-2) software was recently released and is available for use by the Robins AFB energy manager. The FEDS-2 software is a tool that provides capabilities beyond analyzing the LCC effectiveness of EROs. The FEDS-2 software can be used to quickly and methodically examine many types of proposals (such as shared energy savings and alternative funding), and new energy savings suggestions ('what if' ideas.) Use of the FEDS-2 software provides consistency and auditable results in accordance with federal regulations. Use the data collected for the integrated resource assessment and create a functional FEDS-2 software for Robins AFB.

7.0 References

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Appendix A

Life-Cycle Cost Methodology

Appendix A

Life-Cycle Cost Methodology

According to the provisions of 10 CFR Part 436,¹ 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).² The NIST LCC methodology calculates all relevant costs of a project and discounts them to result in present dollars, and then subtracts that sum from a similarly constructed LCC of baseline, 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 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 FEDS (Facility Energy Decision Screening) system 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 Volume 3 Resource Assessment report (Sullivan 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."³ 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/or the development and design of projects may require a detailed facility audit which is beyond the scope of a FEDS assessment.

References

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Appendix B

Extended Energy Project Implementation Structure

Appendix B

Extended Energy Project Implementation Structure

Efficient Technologies and Fuels

Cooling Tower Freeze Protection

To provide cooling when required during winter months, and to avoid freezing the cooling tower water supply, many cooling tower circulating pumps on Base are operated continuously during cold weather. The project proposes installing thermostatically controlled heat elements in the cooling tower catch basins to avoid the continuous operation of the circulating pumps.

	Totals:
First Year Energy Savings (MBtu)	1,125
Annualized Net Energy Savings (93\$)	9,227
First Cost of Project (93\$)	39,000
First Year O&M Savings (93\$)	0
Present Value of Project (93\$)	105,142

Building Envelope (Residential)

Typical environmentally controlled residential building envelope considerations for energy use reduction include added insulation to wall and/or attic, weather stripping, attic ventilation (forced or natural), window replacement upgrade (higher efficiency), and exterior surface finish (roof and/or walls).

	Totals:
First Year Energy Savings (MBtu)	7,594
First Year Billable Demand Savings (kW/mo)	2,002
First Cost of Project (93\$)	491,000
First Year O&M Savings (93\$)	0
Present Value of Project (93\$)	422,808

Outdoor Recreation Area Lighting

This project consists of adding timer controls to existing ballfield/physical training and similar outdoor lighting systems. The controls allow for a predetermined amount of time to elapse before turning off the lights. The controls do allow for a manual override as well as timed reset if necessary.

High Efficiency Motors

I. Replace Existing with High Efficiency

Replace existing single-speed standard-efficiency motors with high-efficiency motors. These motors are typically used for fan and pump applications. High-efficiency motors are typically not considered for motors below 1 horsepower. A standard operating procedure for replacement on failure of all existing motors with high-efficiency motors is to be developed.

II. Variable-Speed-Drive Motors

Many motors, particularly for fan and pump applications, are either oversized or sized to meet the maximum load. A variable-speed-drive (VSD) adjusts motor speed to meet only the required load, greatly reducing unnecessary energy consumption. VSDs are not typically considered for motors below 1 horsepower.

	RI	ROF
First Year Energy Savings (MBtu)	30,392	8,081
First Year Billable Demand Savings (kW/mo)	21,644	2,438
First Cost of Project (93\$)	1,396,035	531,391
First Year O&M Savings (93\$)	-1,830	0
NPV of Project (93\$)	3,074,675	200,754
RI = replace immediate ROF = replace on failure		

III. Procedure to Ensure High-Efficiency Motor Replacement

Develop a standard operating procedure for replacement on failure of all existing motors with high-efficiency motors. The procedure is necessary to ensure that high-efficiency motors replace standard/low efficiency motors.

Power Factor Correction

Power factor correction reduces losses in the transmission system and reduces or eliminates excess reactive load charges that the installation incurs each month. A poor power factor can be corrected by installing capacitors, typically at the site substation.

	Totals:
First Year Energy Savings (MBtu)	93
First Year Billable Demand Savings (kW/mo)	42
Reactive Demand Savings (KVAR-mo)	108,102
First Cost of Project (93\$)	38,610
First Year O&M Savings (93\$)	-8
Present Value of Project (93\$)	528,320

Conservation Voltage Reduction

Conservation voltage reduction can save energy by reducing the distribution voltage on the site by a small amount. The magnitude of the reduction is constrained by the requirement that load voltage must be maintained above the standard minimum of 5% below nominal.

	Totals:
First Year Energy Savings (MBtu)	7,304
First Year Billable Demand Savings (kW/mo)	4,365
First Cost of Project (93\$)	1,000
First Year O&M Savings (93\$)	0
Present Value of Project (93\$)	1,187,775

Transmission and Distribution System

The purpose of this project is twofold. First, the project examined the existing transmission and distribution (T&D) system for implementing life-cycle cost-effective energy efficiency upgrades. Second, the project recommends establishing a plan to ensure that T&D equipment replaced on failure, or for environmental reasons, is the most cost-effective based on life-cycle cost analyses. The T&D system was examined for immediate and replace-on-failure energy efficiency opportunities.

Residential Cooling

Replace old, low-efficiency central air cooling equipment with new high-efficiency models in family housing.

458 FH units on Flint Rates:	Totals:
First Year Energy Savings (MBtu)	3,702
First Year Billable Demand Savings (kW/mo)	NA
First Cost of Project (93\$)	876,154
First Year O&M Savings (93\$)	0
Present Value of Project (93\$)	60,022

Hot water - Residential

Replace existing gas and electrical water heaters with new efficient models in the family housing areas. This project also considers potential fuel switches to or from gas or electricity in all residential buildings with these fuels available.

	Totals:
First Year Energy Savings (MBtu)	10,794
First Year Billable Demand Savings (kW/mo)	NA
First Cost of Project (93\$)	1,400,140
First Year O&M Savings (93\$)	-7820
Present Value of Project (93\$)	1,086,311

Hot Water - Non-Residential

Replace existing gas and electric water heaters with new efficient models for non-residential buildings. This project also considers potential fuel switches to or from gas or electricity in all non-residential buildings.

Gas-Driven Heat Pumps

Replace current residential heating and cooling systems with natural gas-driven heat pumps and reduce higher-cost energy consumption.

Heating - Residential Furnaces

Residential furnace replacement was analyzed for older inefficient furnaces and evaluates upgrading them to high-efficiency models.

Ground-Coupled Heat Pumps

Ground-coupled heat pumps use the ground's relatively constant source temperature to achieve a significantly higher operating efficiency. This project, considered for residential housing, will replace existing gas furnace/central air-conditioning systems or existing air-to-air heat pumps.

Window Film

This project proposes installing reflective window film on the east and west windows of family housing units. Window films will reduce the solar heat gain to the dwelling units and therefore reduce cooling load. The slight increase in heating energy is offset by the cost difference between natural gas and electricity.

	Totals:
First Year Energy Savings (MBtu)	-323
Annualized Net Energy Savings (93\$)	5,842
First Cost of Project (93\$)	9,087
First Year O&M Savings (93\$)	0
Present Value of Project (93\$)	18,383

Radiant Heaters

Provide space heating by overhead infrared heating systems to provide comfort with lower air temperature and corresponding lower envelope conduction and infiltration loss; also reduces energy used to power fans and pumps. Radiant heaters are proposed for aircraft hangers, maintenance shops, and other high bay facilities. Some buildings require fuel switching from electricity, central plant steam, or fuel oil to natural gas.

	Totals:
First Year Energy Savings (MBtu)	16,729,382
Annualized Net Energy Savings (93\$)	68,426
First Cost of Project (93\$)	343,315
First Year O&M Savings (93\$)	0
Present Value of Project (93\$)	735,746

Building 83 Fuel Switch to Natural Gas

Building 83 (boiler plant on the north side of the airfield) currently burns fuel oil to provide heat and hot water to a number of surrounding buildings. A natural gas line has recently been extended into the area. This project proposes to extend the line to building 83, convert the boilers to gas, tune-up the boilers and add automatic electric vent dampers.

	Fuel Switch	Operating Improvements
First Year Energy Savings (MBtu)	0	455
Annualized Net Energy Savings (93\$)	12,208	2,431
First Cost of Project (93\$)	20,000	21,757
First Year O&M Savings (93\$)	0	0
Present Value of Project (93\$)	174,927	20,811

Heating - Non-Residential Boilers and Furnaces

Boiler and furnace replacement was evaluated for older inefficient systems and upgrades to higher efficiency models were evaluated. This project also considered potential fuel switches to or from gas or oil in all non-residential buildings with these fuels available, boiler tune-ups, and vent dampers.

Boilers:	RI	ROF
First Year Energy Savings (MBtu)	597	273
First Cost of Project (93\$)	98,264	141,283
First Year O&M Savings (93\$)	0	0
Present Value of Project (93\$)	315,883	18,095

Furnaces:	RI	ROF
First Year Energy Savings (MBtu)	1,010	119
First Cost of Project (93\$)	23,739	10,555
First Year O&M Savings (93\$)	0	0
Present Value of Project (93\$)	48,704	22,649

High Temperature Hot Water (HTHW) and Chilled Water Distribution

Excess capacity exists in the HTHW and chilled water distribution systems. Where practical, additional buildings will be added to the basewide HTHW distribution network and the basewide chilled water distribution network.

Exterior Lighting

Electrical savings can be realized by replacing exterior lighting (streetlights, security lights, residential lights, etc.) with more-efficient fixtures, and in the case of streetlights, removing some lamps from service and configuring other lamps to be turned off during periods of low traffic. A study of base exterior lighting will determine which is cost-effective and meets base safety, security and mission requirements.

Chiller Replacement

Due to CFC regulations, many existing chillers will have to be retrofitted to utilize alternate refrigerants. Robins AFB is already pursuing an aggressive CFC removal program from the environmental side. The replacement of CFC chillers also has the opportunity for energy savings. Life-cycle cost analyses performed determined the most cost-effective alternative system considering retrofit of the existing units, new standard refrigeration units of higher efficiency, new gas engine-driven units, gas-fired absorption units, and ground-coupled heat pumps. The following tables reflect all A/C EROs, residential and commercial, chillers and package units.

Elec. A/C:	RI
First Year Energy Savings (MBtu)	1,820
First Cost of Project (93\$)	292,999
First Year O&M Savings (93\$)	0
Present Value of Project (93\$)	7,073

Nat. Gas Engine A/C:	RI	ROF
First Year Energy Savings (MBtu)	-11,245	-16,790
Annualized Energy Savings (93\$)	67,784	98,151
First Cost of Project (93\$)	725,250	1,071,550
First Year O&M Savings (93\$)	-8,203	7,535
Present Value of Project (93\$)	489,756	1,323,761
RI = replace immediate ROF = replace on failure		

Peak Shaving - Post-Wide Evaluation

Perform a post-wide evaluation of the installation's electric utility rates to determine if peak shaving opportunities are available consistent with Robins AFB's mission requirements. The following table reflects an analysis by PNL to peak shave using back-up generators connected by feeders to the 9th Street substation. Two options were investigated: 1) using generators currently available, and 2) using one of the PAVE PAWS generators.

	Option 1	Option 2
Annual Energy Savings (MBtu)	-10,475	-28,271
Annual Demand Savings (kW-mo)	24,360	39,600
Annualized Energy Savings (93\$)	-68,759	-186,952
Annualized Demand Savings (93\$)	215,437	350,218
First Cost of Project (93\$)	216,401	82,600
First Year O&M Savings (93\$)	-14,801	-27,345
Present Value of Project (93\$)	1,843,784	2,040,768

Interior Lighting

The efficiency of building lighting can be improved up to 50% by retrofitting the existing fluorescent and incandescent fixtures with high-efficiency fluorescent tubes and electronic ballasts. A survey of buildings determined the potential for savings.

	Residential	Commercial
First Year Energy Savings (MBtu)	4,459	49,114
Annualized Net Energy Savings (93\$)	69,916	517,622
First Cost of Project (93\$)	344,274	5,477,969
First Year O&M Savings (93\$)	-10,521	58,367
Present Value of Project (93\$)	583,601	3,519,662

Water and Renewables

Water Conservation

Replace existing shower heads with high-efficiency, low-consumption shower heads. Replace existing water closets with high-efficiency, low water consumption water closets such as tank pressurization type. Energy savings are realized from reduced water heating, pumping, and water treatment. This project qualifies for special ECIP funding considerations under EAct 1992.

Low Flow Shower Heads Only:	Totals:
First Year Energy Savings (MBtu)	7,148
First Year Billable Demand Savings (kW/mo)	NA
First Cost of Project (93\$)	55,224
First Year O&M Savings (93\$)	0
Present Value of Project (93\$)	731,029

Renewable Energy Opportunity

Energy opportunities exist in utilization of landfill methane and solar technologies. Methane can be used as a fuel source to power generators for production of electricity. Solar power will be evaluated for possible water heating, and a solar wall could be used for space heating of aircraft hangars.

Institutional Energy Plans

Metering

Robins AFB made an initial commitment for installation of Enerlink. Continued use of this system should be examined closely in light of functions that can be transferred to UCS functions such as cost allocation and recovery, bill estimation, and verification, "what if" analysis of different rates to the same consumption, etc. Evaluate all available systems that achieve the same objectives. Initiate 6 months after installation of Enerlink and complete well before renewal date for lease of software.

Energy Standards for New Construction

This project involves developing installation-wide standards to ensure that any new construction is as energy efficient as practical. The standards will utilize the latest guidelines/standards from the Department of Energy (DOE), the Department of Defense (DoD), the Corps of Engineers (COE), and other sources.

Energy Rates and Structure Evaluation

Every two years (minimum recommended) evaluate the base's utility rates, both gas and electricity, to determine if they are best suited to satisfy mission requirements. The electrical rates will include time of day kWh charges and peak load charges. Future evaluations should include the possibility of "wheeling" of energy. (Wheeling is the buying of energy from another utility and using the local utility's distribution system to transport the energy to the base.)

Fuel Switch or More Efficient Equipment

Every two years, evaluate the various sources of fuel to determine if better choices exist. Fuel switching as well as upgrading to more energy-efficient equipment will be considered. This effort is consistent with growth associated with Robins AFB.

Open Dialogue with Suppliers of Natural Gas

Continue coordination with gas suppliers to stay abreast of existing and future incentives with regard to natural gas. This effort includes upgrading equipment to more efficient models, fuel switching, and extending distributions systems to new areas.

Electrical Distribution System Privatization

Privatization of the electrical distribution system has been proposed by Georgia Power Company (GPC). Preliminary discussions have taken place between Robins AFB and GPC. GPC is to propose the level of service and cost of the proposed plan. An independent life-cycle cost analysis must be performed.

Competitively Purchased Electricity (Wheeling)

Investigate the opportunities available to minimize the cost of purchased electricity in accordance with anticipated federal legislation requiring open access (often referred to as "wheeling") to suppliers of electrical energy. Open access to suppliers of electrical energy could occur as early as FY 96. Open access to gas suppliers currently exists under FERC 636. At this time, project activity involves monitoring federal legislative activities associated with open access to suppliers of electrical energy.

Privatization - Gas, Sewer, and Water

Investigate the economic feasibility of privatizing sewer, water, and natural gas distribution systems. An Independent Government Estimate (IGE) must be prepared to determine the costs/benefits.

Transmission and Distribution

The potential for growth will mean new and expanded transmission and distribution (T&D) systems. This project will evaluate the T&D systems for energy savings opportunities, including consolidation of substations, voltage reductions, and system redistribution.

Appliance Replacement

An economic analysis will be conducted to determine the most life-cycle cost-effective appliance for family housing replacements. High-efficiency refrigerators will be installed and one type to be investigated will be gas-fired refrigerators. Clothes dryer connections will be installed that utilize the most efficient fuel with electricity and natural gas investigated as a minimum. High-efficiency dishwashers will be installed. Gas-fired ranges will be evaluated for life-cycle cost.

Propane Plant Addition/Expansion

Evaluate propane-air plant to provide backup for natural gas supply and the interruptable fuel rates that apply to Robins AFB. If needed, determine additional capacity needed for LPG storage and for propane-air mixing. An expansion may be needed to accommodate mission and population growth. Funding is to be determined.

Additional Generation and Cogeneration Capacity

Assess adequacy of electric power supply and feasibility of cogeneration. In FY 99, additional information on these items will be available. Growth plans for the new decade will be better known and quantified and economics will be different. Initiate this evaluation in October 1998 for completion in six months. Funding is to be determined.

Operations and Maintenance

Central Plants - Operating Efficiency

Coordinate with Robins AFB plant managers to determine areas within the plant that offer potential for improved efficiencies and energy conservation.

Decision Support to Operations and Maintenance (DSOM)

DSOM has the potential to save operations, maintenance, and fuel costs for the Central Energy Plant. In addition, DSOM can significantly enhance safety and provide the capability to meet existing and future environmental requirements. This project will evaluate the Central Energy Plant to determine the extent of the economic savings available in operations, maintenance, and fuel costs from DSOM, and will provide an installation-specific conceptual design.

Utility Control System (SCADA) Addition

This project consists of utilizing the SCADA for items such as connecting existing emergency generators to the system to be utilized to expand peak shaving ability. Also, the system will be utilized to shed electrical loads during peak electrical demand hours, to activate/deactivate equipment on time schedules, and to perform other energy conservation functions.

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