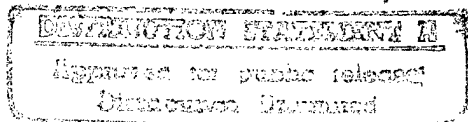


**Energy Savings Opportunity Survey
Energy Engineering Analysis Program (EEAP)
Fort Campbell, Kentucky**

Final Report - Phase I

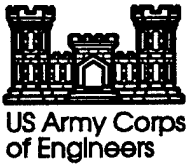
Executive Summary



**CONTRACT # DACA27-93-C-0096
SYSTEMS/CORP PROJECT # 93006
NOVEMBER 12, 1993**

SYSTEMS_{corp}

SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION






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PHASE I FINAL REPORT

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1 EXECUTIVE SUMMARY

1.1 SYNOPSIS

Systems Corp surveyed and completed energy analyses for 98 buildings, fifteen chiller plants, and roadway lighting. The energy conservation opportunities (ECOs) evaluated were lighting efficiency improvements, instantaneous water heaters, heat recovery from hot refrigerant gases, absorption chiller replacements, and ground water coupled heat pumps. Cost estimates were prepared using M-CACES. Life cycle cost analyses were performed using the Life Cycle Cost in Design (LCCID) computer program. Project development brochures (PDBs) and DD1391 forms were prepared for Energy Conservation Investment Program (ECIP) projects. The projects that were developed represent \$2,257,000 in annual savings with favorable simple paybacks and saving to investment ratios (SIRs).

1.2 INTRODUCTION

Systems Engineering and Management Corporation (Systems Corp) was contracted by the Louisville District of the United States Army Corps of Engineers in June 1993 to perform an energy savings opportunity survey (ESOS) for 98 buildings at Fort Campbell, Kentucky. In addition, the project includes an exterior lighting survey of 5 locations around the facility and a comprehensive survey of 15 chillers serving 57 buildings on the Post.

1.2.1 Scope of Work

1. Evaluated selected energy conservation opportunities (ECOs) to determine their energy savings potential and economic feasibility.
2. Conduct a limited site survey of selected buildings or areas to insure that any methods of energy conservation which are practical and have not been evaluated in any previous energy study have been considered and the results documented.
3. Determine efficiency of existing chillers. Determine the replacement option with the highest SIR.
4. Provide complete programming or implementation documentation for all recommended ECOs.

1 EXECUTIVE SUMMARY

5. Prepare a comprehensive report to document the work performed, the results, and the recommendations.

1.2.2 Organization of the Final Report

The submitted material for this report consists of the following:

Energy Savings Opportunity Survey
Energy Engineering Analysis Program (EEAP)
Fort Campbell, Kentucky

Volume 1: Sections 1 - 4
Volume 2: Section 4 (continued)
Volume 3: Sections 5 - 15

1.3 PRESENT AND HISTORICAL ENERGY CONSUMPTION

The baseline energy consumption and energy conservation opportunity energy consumption were determined using spreadsheets and manual calculating to model system energy consumption. These have been included in *Section 2* of this report.

1.3.1 Natural Gas Costs

The natural gas consumption and cost for the 12 months (July 1992-June 1993) at Fort Campbell are shown in *Table 1.3.1, Fort Campbell Natural Gas*. *Figure 1.3.1* is a bar graph of the monthly consumption and costs. The natural gas cost used for evaluating the ECOs is as follows:

COST/MCF = \$3.41/MCF
COST/MBTU = \$4.00/MBTU

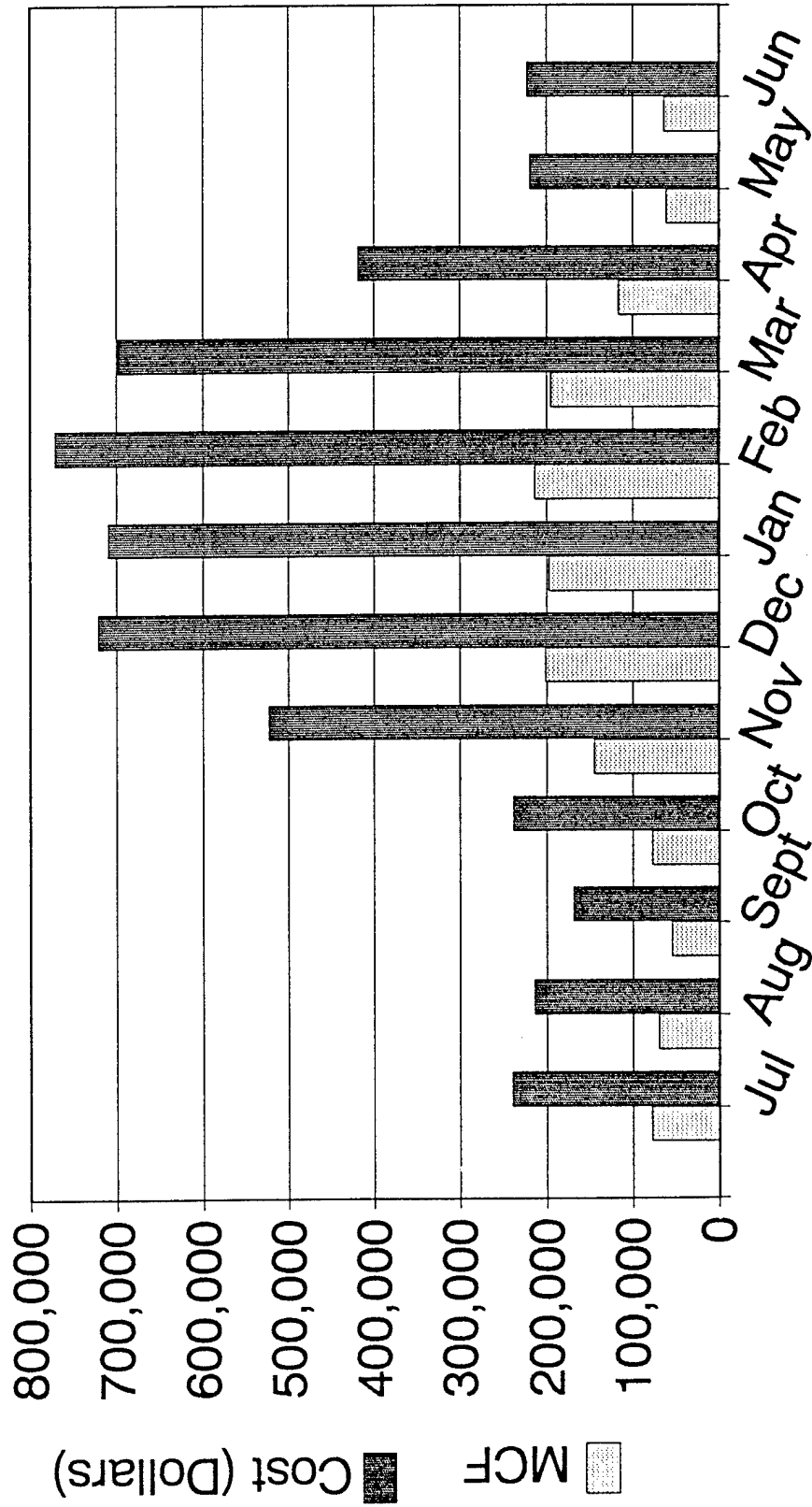
FORT CAMPBELL NATURAL GAS

July 92 - June 93

MONTH	MCF	COST	COST/MCF
Jul 92	77,701	\$239,700	3.08
Aug	69,605	214,724	3.08
Sept	54,771	168,963	3.08
Oct	77,298	238,456	3.08
Nov	145,408	522,621	3.59
Dec	201,521	722,174	3.58
Jan 93	196,833	710,486	3.61
Feb	213,900	771,339	3.61
Mar	195,479	699,147	3.58
Apr	116,968	419,168	3.58
May	60,884	219,255	3.60
Jun	64,113	222,479	3.47
TOTAL	1,474,481	\$5,148,485	3.49
Min	54,771	168,963	3.08
Max	213,900	771,339	3.61
Avg	122,873	429,040	3.41

FORT CAMPBELL ESOS

Natural Gas July 92 - June 93



1 EXECUTIVE SUMMARY

1.3.2 Electric Costs

The electric energy consumption, demand, and costs for the past 12 months (July 1992-June 1993) are shown in *Table 1.3.2 Fort Campbell Electric*. *Figure 1.3.2* is a bar graph of the monthly consumption and cost. The electric cost used to calculate the electric cost savings for the project is as follows:

COST/KWH	=	\$0.02114/KWH (No Demand)
COST/MBTU	=	\$6.19/MBTU (No Demand)
COST/KW	=	\$11.78/KW (Monthly Demand)

1.4 ENERGY CONSERVATION OPPORTUNITIES INVESTIGATED

Systems Corp analyzed five energy conservation opportunities (ECOs) at Fort Campbell, Kentucky. The analysis was performed utilizing energy models developed by Systems Corp and data collected during the field survey of the facilities at Fort Campbell. Each ECO was evaluated to determine the potential energy savings, dollar savings, implementation costs, simple payback, life cycle cost, and savings to investment ratio (SIR). The five ECOs that were evaluated are as follows:

- ECO - 1 Instantaneous hot water heaters
- ECO - 2 Ground water coupled heat pumps
- ECO - 3 Refrigerant heat reclaim
- ECO - 4 Replace chillers with high efficiency chillers
- ECO - 5 Improve lighting efficiency

Systems Corp's energy analysis models were used to determine the savings achieved for implementing each ECO in the facilities that were evaluated. The U.S Army Corp of Engineers M-CACES software was used to estimate the implementation cost of each ECO in each facility evaluated. The U.S Army Corp of Engineers Life Cycle Cost in Design, Version 1.0, Level 72, software was used to perform life cycle cost analyses and determine the SIR of each ECO for each facility evaluated.

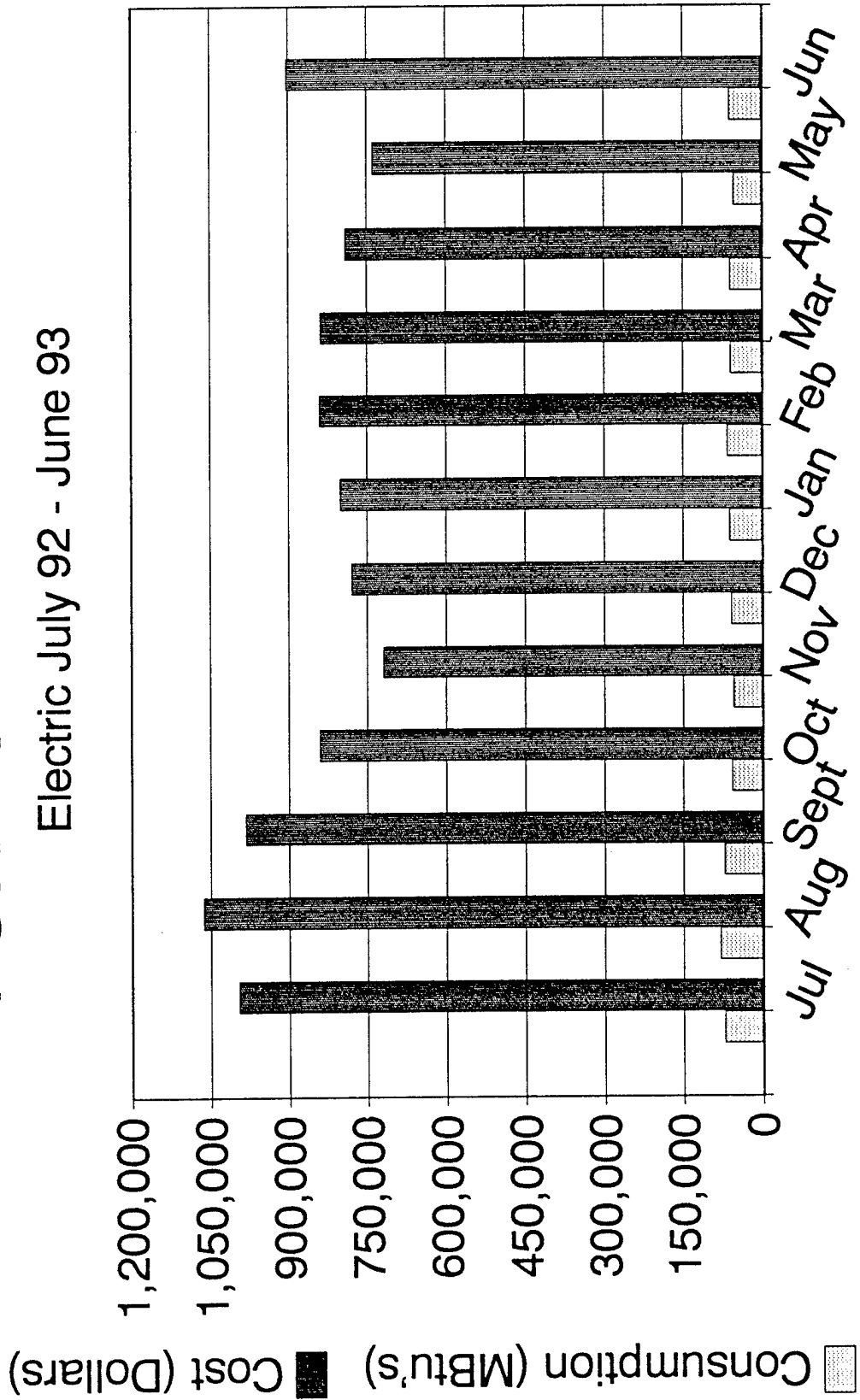
FORT CAMPBELL ELECTRIC

July 92 - June 93

MONTH	DEMAND KW	DEMAND COST	CONSUMPTION KWH	CONSUMPTION COST	COST DEM & CONS	COST/KWH
Jul 92	45,171	\$532,114	21,096,600	\$464,810	\$996,924	.047
Aug	45,927	541,020	23,818,200	523,607	1,064,627	.045
Sept	43,697	514,751	21,319,200	469,265	984,016	.046
Oct	39,425	464,427	17,047,800	376,277	840,704	.049
Nov	31,072	366,028	16,077,600	353,458	719,486	.045
Dec	34,020	400,756	17,287,200	380,190	780,946	.045
Jan 93	33,907	399,424	18,320,400	402,420	801,844	.044
Feb	35,381	416,788	19,307,400	424,019	840,807	.044
Mar	38,140	449,289	17,644,200	388,828	838,117	.048
Apr	33,944	399,860	17,808,000	391,392	791,252	.044
May	34,663	408,330	15,691,200	331,712	740,042	.047
Jun	43,697	514,751	18,429,600	389,601	904,352	.049
TOTAL	459,044	\$5,407,588	223,847,400	\$4,895,579	\$10,303,117	.046
Min	31,072	366,028	15,691,200	331,712	719,486	.044
Max	45,927	541,020	23,818,200	523,607	1,064,627	.049
Avg	38,254	450,628	18,653,950	407,965	858,593	.046

FORT CAMPBELL ESOS

Electric July 92 - June 93



1 EXECUTIVE SUMMARY

1.4.1 ECOs Recommended

Systems Corp recommended that the following ECOs be implemented due to favorable simple pay backs and savings investment ratios (SIRs).

- ECO - 2 Ground water coupled heat pumps
- ECO - 3 Refrigerant heat reclaim
- ECO - 4 Replace chillers with high efficiency chillers
- ECO - 5 Improve lighting efficiency

1.4.2 ECOs Rejected

ECO-1, Instantaneous Water Heaters, was rejected due to the fact that the potential energy savings was found to be quite small for each building that was evaluated. The implementation costs for each building evaluated did not represent a large investment, but when compared to the savings resulted in simple paybacks in excess of twenty years. Replacing the water heater systems did not yield an acceptable simple payback in any of the buildings evaluated.

1.4.3 ECIP Projects Developed

Systems Corp developed three ECIP projects. The projects include the replacement of 12 absorption chillers serving Korean war era barracks with natural gas engine driven screw chillers, the improvement of lighting efficiency in 38 buildings, and the installation of ground water coupled heat pumps in 770 military family housing units. The project information, including DD1391's, for each project are included in *Sections 3 (Chillers), 4 (Lighting), and 5 (GWCHP)*. The following table summarizes the savings and investment for each project.

TABLE 1.4.3
ECIP PROJECT SUMMARY

	<i>Ist Yr Savings</i>	<i>Investment</i>	<i>SIR</i>	<i>SPB (yrs)</i>
ECIP-1 Chillers	\$1,336,609	\$4,115,522	6.87	2.92
ECIP-2 Lighting	\$142,057	\$1,073,612	1.48	7.56
ECIP-3 GWCHP	\$674,606	\$4,837,740	1.15	7.17
TOTAL	\$2,153,272	\$10,026,874	3.53*	5.47*

Energy Savings
MBTU/yr
301,490
5,725
39,544
346,759

*These numbers are weighted averages to show representative values for a total life cycle cost analysis.

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1 EXECUTIVE SUMMARY

1.4.4 Non-ECIP Projects Developed

Systems Corp developed 2 projects that did not qualify for ECIP funding due to not meeting the \$300,000 investment criteria. The 2 projects are heat reclaim from hot refrigerant gases at the Commissary and improved lighting efficiency in non-appropriated fund facilities.

TABLE 1.4.4

	1ST YR SAVINGS	INVESTMENT	SIR	SPB
HEAT RECLAIM	\$2,233	\$19,240	1.86	8.62
NAF LIGHTING	12,493	87,822	1.59	7.03
TOTAL	\$14,726	\$107,062	1.63*	7.32*

*These numbers are weighted averages to show representative values for a total life cycle cost analysis.