

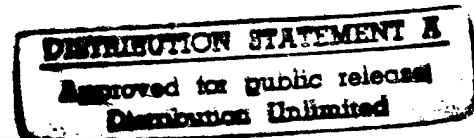


Executive Summary

FINAL REPORT

ENERGY ENGINEERING ANALYSIS (EEA) PROGRAM

for



**LONE STAR ARMY AMMUNITION PLANT
TEXAS**

Prepared for

**UNITED STATES ARMY DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS**

Under

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CONTRACT NO. DACA 63-79-C-0177

Prepared by

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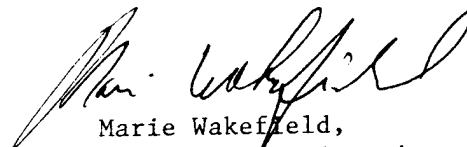


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EXECUTIVE SUMMARY

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DISTRIBUTION STATEMENT A

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INTRODUCTION

The objective of this Energy Engineering Analysis (EEA) for LSAAP is threefold:

- o Develop a systematic plan of projects which will result in reducing energy consumption.
- o Consider renewable energy sources with the objective of establishing an orderly procedure for reducing use of non-renewable energy sources.
- o Determine the feasibility of Total Energy (TE), Selective Energy (SE), and Central Heating Plant (CHP) concepts using alternative fuels.

In essence, an assessment of the entire energy picture at LSAAP was undertaken. This report is a summary of that effort.

LSAAP was originally built during 1941 and 1942 as a shell loading plant for the Army. After World War II, the facility was deactivated until 1951 when it was reactivated as a Government Owned, Contractor Operated (GOCO) facility. Day and Zimmerman was selected as the operator in 1951 and has been the operating contractor ever since. Located just west of Texarkana, Texas, LSAAP encompasses an area of approximately 15,546 acres. The primary mission of LSAAP is to load, assemble and pack ammunition and ammunition components for the Army.

DATA BASE FOR ANALYSIS

The study commenced with the collection of all the raw data and information required to determine the distribution and forms of present energy consumption. This raw data and information consists of building envelope characteristics, type and method of operating environmental and process energy systems, building population and occupancy schedules, historical energy usage, etc.. This data is then used as the basis for determining a detailed energy data base for the entire facility, which maps the form and quantity of energy consumption from the receiving point, through conversion processes, and on to the point of end use for heating, cooling, lighting, process, etc.. The energy data base provides a detailed picture of present energy consumption which is then used in the process of identifying energy conservation opportunities (ECOs) and to serve as a gauge against which energy savings calculations can be compared.

In this case, present energy consumption was considered to be the actual total energy consumption recorded for FY 1979, which was the most recent, complete year of data when the study was commenced. Thus, the energy data base used is a detailed breakdown of the actual total energy consumption for FY 1979. Table ES-1 on the following page shows the composite breakdown from an itemized building energy consumption assessment in five categories. A more detailed breakdown on a building by building basis may be found in Table 3.10 on page 3-37 in Volume I of the report.

TABLE ES-1
ENERGY DATA BASE (FY 1979)

	Fossil Fuel		Electricity	
	10 ⁶ Btu	% of Total	kWh	% of Total
Heating	157,785	23.8	607,955	3.6
Cooling	-	-	4,184,286	24.9
Lighting	-	-	1,693,085	10.0
Process*	365,527	58.0*	9,477,204	56.0
Other **	116,582	18.2**	914,700	5.4
	<u>639,894</u>	<u>100.0</u>	<u>16,915,000</u>	<u>100.0</u>

* Includes boiler plant conversion losses (35.4%).

** Includes distribution system losses (14.1%) and condensate losses (3.6%).

EVALUATION OF ENERGY CONSERVATION OPPORTUNITIES

Potential ECOs were identified in a number of areas during the initial energy analysis. Not only did typical building envelope ECOs exist, but also opportunities existed in process ventilation systems, outside air reductions, laundry plant improvements, boiler/steam/and condensate return system modifications, fuel systems, and a centralized Energy Monitoring and Control System (EMCS). All ECOs were evaluated to determine feasibility in accordance with the requirements of the Energy Conservation Investment Program (ECIP) guidelines.

Since many ECOs are interrelated (i.e., the savings of one affect the savings of another), energy conservation analysis of a building with multiple ECOs identified was done in the following sequence in order to account for those interrelationships:

- o The building envelope was evaluated first to insure that it was as weathertight as is economically feasible under ECIP guidelines.
- o Next, the heating, ventilating, air conditioning and exhaust systems were evaluated, assuming the feasible building envelope ECOs were implemented. Also, internal process systems and functions were evaluated at the same time, if they did not affect the functional requirements being performed.
- o Centralized control of energy systems through use of an Energy Monitoring and Control System (EMCS) was evaluated.
- o Site electrical and steam distribution systems were evaluated.
- o Central steam plants were evaluated.

The results of the detailed analysis of ECOs based on ECIP criteria are summarized in Table ES-2 on the following page. ECO descriptions and identification of buildings to which they apply may be found in Volume I, Sections 4.0 and 5.0.

TABLE ES-2
FEASIBLE ECOs FOR LSAAP

<u>ECO Description</u>	<u>Energy Savings (Increase)</u>		<u>Estimated Implementation Cost (FY 1983)</u>	<u>E/C Ratio</u>
	<u>Fossil Fuel (10⁶ Btu/yr)</u>	<u>Electricity (kWh/yr)</u>		
Building envelope weatherization (weatherstripping, roof insulation and wall insulation)	29,831	421,122	\$516,811	67.2
Laundry plant improvements	989.5	(504)	23,870	41.2
No. 6 Fuel oil system insulation	15,818.5	-	26,804	590.2
Additional steam and condensate line insulation	29,348.5	-	580,954	50.5
Boiler blowdown heat recovery	4,000	-	56,180	71.2
Increased condensate return	20,375	(97,802)	690,000	27.9
De-stratification using ceiling fans	469	(8,640)	14,540	25.4
Economizer cycles	-	10,940	9,000	14.1
Variable air volume	5,15.1	146,483	29,400	238.6
Outside air flow reduction	3,520	38,030	70,400	56.3
Steam unit heater control modification (using EMCS)	721.4	-	34,000	21.2
Domestic hot water heater modifications	192.2	-	4,370	42.2
Boiler combustion control modifications	26,917	-	195,000	138.0
EMCS	<u>36,643</u> 173,537	<u>1,848,300</u> 2,357,929	<u>\$1,149,005</u> \$3,400,334	<u>50.1</u> 59.1

The feasible ECOs represent an energy savings of 27.1 percent in fossil fuel consumption and 13.9 percent in electrical energy use, when compared to the FY 1979 data base. This equates to a reduction in total source energy of 24 percent. Based on prior reductions in energy use, the composite savings of present practices plus these ECOs reduce the FY 1975 data base usage by 43.5 percent for fossil fuel, 23.3 percent for electricity, and 39 percent for total source energy.

The feasible ECOs, based on a E/C ratio of 14 or greater*, were developed into FY83 ECIP projects for funding. Form 1391s and Project Development Brochures (PDBs) were prepared. These documents are to be used as back-up for Energy Conservation and Management (ECAM) projects prepared by LSAAP. Identification of these projects are as follows:

<u>Project No.</u>	<u>Project Title</u>
LS/E-0100	Areas B, C, D, F, & G Building Weatherization
LS/E-0101	Areas I, J & K Building Weatherization
LS/E-0102	Areas M, O, P, Q, R & S Building Weatherization
LS/E-0103	Blowdown Heat Recovery System
LS/E-0104	Areas B, F, G, K, & Q Insulation of Horizontal Tanks, Piping and Fuel Oil Heaters
LS/E-0105	Building K-21 Hot Water Tank Insulation and Water Heat Recovery
LS/E-0106	Areas B, F, and G Increased Condensate Return
LS/E-0107	Area Q Increased Condensate Return
LS/E-0108	Building I-30 Destratification
LS/E-0109	Areas K and Q Additional Insulation on Steam and Condensate Lines
LS/E-0110	Areas B, F, and G additional Insulation on Steam and Condensate Lines
LS/E-0111	Unit Heater Shut Off Valve
LS/E-0112	Outside Air Flow Reduction
LS/E-0113	VAV Conversion
LS/E-0114	EMCS
LS/E-0115	Boiler Modifications

In preparing the programming documents, economic computations and DD Form 1391s for each project, guidance** was received from the Fort Worth District, Corps of Engineers as follows:

- o Construction cost escalation factors, provided by AR415-17 and EIRS Bulletin, should be used to calculate construction cost in paragraph 1 of the ECIP Economic Analysis Summary and items 8 and 9 of DD Form 1391 (Project Cost and Cost Estimates).
- o Differential fuel escalation rates set forth in ECIP guidance should be used to calculate energy costs in paragraphs 2 and 3 of the ECIP Economic Analysis Summary.

* DAEN-MPO-U TWX dated 29 December 1980.

** 27 February 1981

This was done for each project, preparing each project for FY 1983 and adjusting economic justification to that year. Construction costs were escalated to Midpoint of Construction Date (MCD) per AR-415-17 and fuel costs were escalated per ECIP criteria.

Based on the ECIP criteria for the average E/C ratio for all ECIP projects in a given program year (32 for FY 1983; 30 for FY 1984), the recommended implementation program for these projects is as follows:

<u>Fiscal Year</u>	<u>Project Title</u>	<u>Energy Savings (10⁶ Btu/yr)</u>	<u>Project Cost (\$1000)</u>	<u>E/C Ratio</u>	<u>B/C Ratio</u>	<u>Payback Period (Yrs)</u>
1983	Building Weatherization (LS/E-0100, 0101, 0102)	34,716.0	\$ 650.1	53.4	5.8	3.4
	Fuel System Insulation (LS/E-0104)	15,818.5	34.7	455.9	37.1	0.5
	VAV Conversion (LS/E-0113)	7,014.3	37.0	189.6	9.5	1.3
	Boiler Modification (LS/E-0115)	26,917.0	226.0	119.1	9.0	1.4
	Blowdown Heat Recovery (LS/E-0103)	4,000.0	74.8	53.5	4.3	4.3
	TOTAL	88,465.8	\$1,022.6	86.5		
	Energy Monitoring and Control System (EMCS)* (LS/E-0114)	53,083	\$1,329.5	43.6	1.4	13.4
1984	No projects are listed for FY 1984. With EMCS included, FY 1983 program had an E/C ratio of 62.3. Also, if projects remaining were included in FY 1984 to meet E/C ratio of 32, no other projects would remain for inclusion in plans for future years.					
1985	Additional Steam and Condensate Line Insulation (LS/E-0109, 0110)	29,348.5	\$ 750.8	39.1	3.4	5.9
	Increased Condensate Return (LS/E-1016, 1017)	19,241	891.8	21.5	2.3	7.6
	TOTAL	48,589.5	\$1,642.6	29.5		

*The EMCS project is listed separately, because it is understood that a separate source of ECIP funding is specifically set aside for EMCS projects.

<u>Fiscal Year</u>	<u>Project Title</u>	<u>Energy Savings (10⁶ Btu/yr)</u>	<u>Project Cost (\$1000)</u>	<u>E/C Ratio</u>	<u>B/C Ratio</u>	<u>Payback Period (Yrs)</u>
1986	Outside Air Flow Reduction (LS/E-0112)	3,961.2	\$ 124.7	31.8	1.6	7.5
	K-21 (Laundry) Modifications (LS/E-0105)	983.7	30.0	32.8	2.7	7.1
	Unit Heater Shutoff Valves (LS/E-0111)	798.0	47.7	16.7	0.9	13.9
	I-30 Destratification (LS/E-0108)	368.8	18.8	19.6	1.1	10.9
	TOTAL	6,111.7	\$ 221.2	27.6		

As noted in Section 4.0, both domestic hot water heater modifications and K-14 economizer projects are not included since each has a capital cost of less than \$10,000 and can be implemented much sooner using other funding, such as O & M. Likewise, all projects listed for FY 1986 could also be accomplished in this same manner before 1986 with O & M funds. This approach should be considered by LSAAP personnel.

Other ECOs were evaluated in the process of determining feasible projects. Those ECOs which were evaluated but did not meet ECIP criteria for LSAAP were:

Window insulation
Storm windows
Suspended ceilings
Boiler economizers
Increased condensate return, K-20 distribution system
Drying oven insulation
Drying room insulation
ECOs in Melt pour area
Destratification (other than Bldg. I-30)
Outside air flow reduction for:

G-15 I-39
G-23 R-13
I-13

Variable-air-volume system, Bldg. G-11
Economizer cycle (other than K-14)

Steam unit heater control for:

A-22 K-15
K-21 K-19

Mechanical air curtains
Window air conditioner replacement, Bldg. I-5
Local window air conditioner time clock controls
Lighting reduction ECOs

SOLAR ENERGY

Following the ECO evaluations and ECIP project development, an evaluation of renewable energy sources was performed. Solar energy utilization at LSAAP is detailed in Volume I Section 7.0. The results of the solar energy analysis are summarized in Table ES-3 below:

TABLE ES-3
Solar Energy Analysis

	<u>Domestic Hot Water Systems</u>	<u>Process Solar Heating Systems</u>	<u>Passive Solar Energy Systems</u>	<u>Solar Assisted Heat Pump</u>
No of Bldgs. Meeting Criteria	14	3	2	1 (Q-36)
Total Capital Cost Estimate	\$104,680	\$116,935	\$56,030	\$282,840
Escalated Payback Periods (years)	10.7-19.1*	11.1-16.8*	18.2	14.2
Net Fuel Savings (10 ⁶ Btu/yr)	795	1000	439	2722

*The range of paybacks for all buildings evaluated; specific escalated payback period depends on the specific building. See Table 7.4 and 7.5 for details.

Although the criteria for selection and presentation of results associated with solar energy applications is met (ETL-1110-3-302), all but three of these solar projects (K-19, Q-34, & G-114N) have a negative present worth life cycle cost over the economic life of the analysis (25 years). Therefore, a sensitivity analysis was performed by varying the key economic parameters of: capital cost, energy savings, fuel escalation rate, economic life, and discount rate. This sensitivity analysis showed that if the differential fuel escalation rate were 10 percent versus 8 percent, or if the discount rate were 7 percent versus 10 percent, the net life cycle costs become positive.

Implementation of solar energy projects which meet the criteria of escalated payback periods less than 20 years would reduce FY 1975 source energy by less than one percent. Biomass sources on-base, although available, are owned and operated by the RRAD Forestry Management Group, and were evaluated in conjunction with TE, SE and CHP concepts.

TE, SE AND CENTRAL HEATING PLANT EVALUATION

The development and analysis of all TE, SE and CHP concepts was based on a common reference point: supplying the thermal and electrical energy needs of all buildings and systems at LSAAP, not just the presently active facilities in use. This common reference point is based on historical data and detailed analysis of energy usage during FY 1979, however, it has been modified to reflect two major adjustments:

- o The implementation of all ECIP projects on all applicable buildings (active, idle and layaway).
- o The increased requirements resulting from increased production activity, increased building use and increased mobilization of personnel.

The reference year for energy requirements can be described as follows:

- o All buildings at LSAAP are in use; i.e., no buildings are in an inactive status, either idle or layaway.
- o All buildings and facilities are operating on a single shift, 8 hours per day, 5 day-a-week level; no production or administrative area requires two or three shift levels of activity (other than central utility operations, and the fire and security operations typical of FY 1979 levels).
- o The level of mobilization of production personnel (exclusive of administrative support) approximates a number of personnel equal to about 20 percent of that known to have been employed during peak production levels (1968); or approximately 1670 equivalent employees for a full year. (NOTE: 1968 levels averaged 8334 equivalent employees per year (production personnel) and FY 1979 levels averaged 650 production employees during the year. Source: Day and Zimmermann.)

Summarizing the data base load requirements, presented in Supplement A and Section 9.0, the reference year requirements incorporating these modifications are as follows:

	FY 1979 (DATA BASE)	FY 1979 (AFTER ECOs)	REFERENCE YEAR FOR ANALYSIS (INCLUDES ECOs AND MOBILIZATION EFFECTS)
<u>Electricity</u>			
Peak Demand (kW)	4,860	4,769	7,922
Energy (kWh)	16,915,000	14,692,200	25,711,200
<u>Steam</u>			
Heating (10 ⁶ lbs)	127,454	72,199	93,859
Distribution (10 ⁶ lbs)	113,732	91,263	101,414
Process (10 ⁶ lbs)	113,199	132,439	189,388
In-Plant Use (10 ⁶ lbs)	<u>48,943</u>	<u>25,147</u>	<u>30,326</u>
TOTAL (10 ⁶ lbs)	433,328	321,048	414,987

These annual energy requirements reflect a 13 percent reduction in electrical energy requirements and a 21 percent reduction in steam due to implementation of ECOs in both existing active facilities and other comparable buildings presently in an inactive status. Solar energy systems, if implemented, would show a net additional reduction of less than one percent in annual load requirements. The base case (existing central boiler plants and continued purchase of all electrical energy requirements) would require the following purchased energy requirements:

Electricity: 7922 kW peak demand, 25,711,200 kWh of electricity per year.
 Fossil Fuel: 590,242 kcf of natural gas, 249,919 gallons of No. 6 fuel oil per year (assuming that only curtailment of natural gas is the limitation placed on service by the FERC and not forced curtailment by ARKLA).

The amount of steam required to generate a given amount of electricity in a TE or SE cogeneration concept is directly related to the thermal/electric load ratio and individual turbine generator characteristics. Turbine generator characteristics vary with:

- o Inlet steam conditions (pressure & temperature).
- o Extraction point pressure & flow requirements at that point.
- o Exhaust pressure.
- o Turbine type and size.
- o Limits of theoretical design.

Turbine performance (of one turbine, or a combination of turbines), varies significantly depending upon the loads required to be met. A measure of performance which is more easily understood than others is that of heat rate (Btu/kWh) for the electricity being generated, since at a given level of thermal loads, the difference between one unit or plant performance would be the additional amount of energy needed to produce electricity.

Automatic extraction turbine generators are a cross between the full condensing (Utility type) and the backpressure (non-condensing) units. Control of the amount of power generated at any given moment can be controlled (within certain limits) independent of the amount of steam extracted for thermal loads. However, this is not done without some sacrifice in efficiency (heat rate) in the generation of electricity. In essence, an automatic extraction, condensing turbine generator is both a backpressure, non-condensing (high pressure section to the extraction pressure point) unit and a condensing (both the high and low pressure sections can be operated without any extraction flow) unit. Because of the low pressure section (between extraction point and condensing point) a certain minimum amount of steam is always required to be condensed. Therefore, the automatic extraction turbine generator unit has operating performance points between that of a back pressure unit and that of a condensing unit; this presents a wide band of possibilities. The thermal/electric load requirements will determine at which point within the possible range that the turbine generator will actually operate.

In order to determine not only the performance characteristics of a unit but the performance characteristics of multiple units and the entire TE plant, the computer program TESEP, previously developed by EMC, Inc., was used to aid in the selection of the major components of the system. TESEP accepts the time variant thermal/electric load requirements and, along with the input of operating parameters of specified units, computes the inlet throttle steam requirements of the turbine(s) necessary to meet those loads.

TESEP is programmed with logic to select the best turbine generator unit(s) within the concept to supply the load requirements for each thermal and electric load point stored (or input) and processes all points until all have been analyzed. The main objective of this procedure with the TESEP logic is to optimize the combined efficiencies of the units available for use and determine the best combination.

The selection process for TE concept development, using TESEP as a tool, involves:

- o Identifying the extremes in which the system must function.
- o Selecting units or combinations thereof, which could operate within these limits.
- o Performing analysis (TESEP) to determine the optimum combination.
- o Sizing auxiliary and support systems to the major system components selected.
- o Determining capital cost estimates associated with implementing the concept.
- o Determining the manpower and maintenance requirements associated with proper operation and reliability.

Once completed, an economic assessment for feasibility can be made.

The approach to selecting the optimum SE plant alternative is similar to that for the TE plant except for one major item: Purchased electricity. Selective energy, a concept where only a portion of the electrical energy requirements are generated on-site by the central plant, necessitates a detailed analysis in order to determine how much electricity optimizes, or minimizes, the overall cost of purchased energy. In addition to the thermal and electric load requirements to be satisfied by this selective energy plant, the local conditions of purchased electricity and the prevailing rate schedule determine the selective process and the amount of cogenerated electricity which should be produced. Therefore, SE plant concepts are evaluated based on two critical factors:

- o Thermal/electrical load ratios.
- o The electrical utility rate structure.

In the TE analysis, the complexity of the selection process relating to thermal/electrical load requirements was described. The same concerns also apply to SE plant concept evaluations. However, the selection process for optimizing the SE plant concept requires an extension of that process to include the cost of purchased electricity. Again, TESEP has been set up with a subroutine to specifically handle this additional analytical requirement.

When considering the generation of electricity on-site, the first determination is whether the prevailing plant operating mode should be peak shaving or base loading. Peak shaving refers to reducing the peak electrical energy purchased during periods of peak demand, while base loading refers to levelized loading of the SE plant. Base loading extends the operating time in the cogeneration mode.

The selection process for SE concept development using TESEP involves:

- o Selecting a mode of operation for the equipment being considered (peak shaving or base loading).
- o Evaluating the concept for the lowest life cycle energy costs for combined purchased coal (or steam use) and electricity for all sets of thermal/electric load pairs.
- o Summarizing and consolidating the data over the year of analysis.

This process is repeated for as many equipment combinations as necessary to arrive at a optimum arrangement and mode of operation which suits the thermal/electric loads at LSAAP.

The central heating plant (CHP) evaluation approach is similar to that for TE and SE analysis, however only the thermal load requirements are involved. The profiles for thermal loads which were required for both the TE and SE concept configurations apply to CHP concept evaluations and assessment. The base case, reference year loads, assume present operation with existing systems and the modified load base for full building utilization. This thermal load base consists of six (6) major load areas: B-15, F-29, G-29, K-20, Q-36 and I-11. For CHP concept considerations, these load areas have to be interconnected by additional steam transmission piping in order to facilitate centralized coal fired concepts. (This applies also to the thermal load requirement of TE and SE studies previously discussed.) Although each load area could be supplied individually with new coal fired plants, six separately operated coal handling facilities would be necessary. Costs, operation, and associated coal distribution problems would preclude such an approach.

Two concepts were assessed: one centralized plant for the entire facility, and a two plant concept - one for the west area and one for the east area. The difference between the two would be the interconnecting transmission piping between east and west, and smaller sized boilers suitable for the differences in load characteristics of the respective areas being served. Thermal load profiles of the respective areas to be served by each of these concepts were combined (with transmission losses added) to represent the CHP loads, and plant concepts then developed based on concurrent peak loads.

One of the key factors associated with evaluating the feasibility of coal fired facilities is the specific coal to be used. For this analysis, a low sulfur, sub-bituminous Wyoming coal was used, since it was the coal used in the "Final Design Analysis - Replacement Boilers, LI84, FY80 MCA, RRAD" program. The specific key items in the proximate and ultimate analysis are:

Sulfur content: 0.56 percent
 Heating value: 9947 Btu/lb

The specifications for this project required the boilers to have the capability of using coal with a heating value ranging from 9747 to 14,000 Btu/lb; no sulfur range was given. Therefore, the analysis for LSAAP used the lower value (9747 Btu/lb) in order to be conservative. 0.56 percent sulfur coal, at 9747 Btu/lb, is classified as "compliance coal", in that for an installed boiler system with less than 250 million Btu/lb input fuel capacity, environment emission limits can be met without SO₂ pollution abatement equipment.

A summary of the life cycle analysis for TE, SE and CHP concepts are as follows:

	<u>TE</u>	<u>SE</u>	<u>CHP</u>	
			<u>Single</u>	<u>Dual</u>
Capital Cost	\$35,509,090	\$28,759,340	\$19,590,550	\$20,542,650
Total O & M and energy life cycle costs	\$52,412,830	\$47,533,000	\$43,267,420	\$42,911,990
Total life cycle costs	\$87,921,920	\$76,292,340	\$62,857,970	\$63,454,640

The base case, present plants operating under the full building utilization concept, has a life cycle cost of \$64,767,075. Therefore, the most cost effective long range alternative is a single CHP serving all production areas and the administrative area.

Applying the feasibility of biomass as an integral part of the long range picture, the biomass resource in the RRAD/LSAAP forests was evaluated for the single CHP concept to determine if economics is improved. A 70 percent coal/30 percent wood (by heating value) was substituted for the 100 percent coal source for the single CHP concept. The results showed that the life cycle costs utilizing biomass were \$61,983,110, a reduction of \$874,860 in the CHP life cycle cost. Therefore, a 150,000 lb/hr central heating plant, using both low sulfur coal and wood as the fuel source, is cost effective.

However, a sensitivity analysis was performed assuming that the sulfur content could be 1.5% by weight, which would not be a "compliance coal". This sensitivity analysis was performed because the actual coal which would be used would be procured through the Defense Fuel Supply Command (DFSC) and would not necessarily be low sulfur coal. Because the emissions from a coal which is not considered compliance coal (plant input fuel capacity less than 250 million Btu/hr), would be greater than 1.2 lbs/million Btu, 90 percent sulfur removal is required in the state of Texas, regardless of sulfur content. Therefore, the single CHP concept would have to be equipped with SO₂ scrubbers. The sensitivity analysis of this showed that the single CHP would no longer be economically feasible, if this is required. Therefore, in order for any coal fired CHP concept to be economically feasible, a compliance coal source must be used at LSAAP.

RECOMMENDATIONS

Sixteen (16) ECIP projects were identified, evaluated, and documented in this study. If all of these projects are implemented, the total source energy reduction since the base year, FY 1975, would be 58 percent. Thus, the Army Facilities Energy Plan goal of a 25 percent reduction in energy by FY 1985 can be achieved. The FY 2000 goal of a 50 percent reduction can also be achieved. It is recommended that all sixteen (16) ECIP projects be implemented as soon as funding will permit.

Several solar energy projects were identified and evaluated in this study. Except for 3 systems, these projects cannot be recommended on an economic basis, because, while they satisfy the requirements of ETL 1110-3-302, they do not result in a net savings life cycle costs. If all of the solar projects were implemented, the Army Facilities Energy Plan goal of satisfying 1 percent of the FY 1975 energy consumption will not be achieved.

One TE, one SE, and three CHP concepts were evaluated in this study. The TE and SE concepts did not prove to be cost effective; however, all three CHP concepts are cost effective assuming a 0.56 percent low sulfur coal fuel source. The most cost effective of these is a single CHP utilizing coal and wood as the fuel source. This concept is recommended for implementation as soon as funding will permit, providing low sulfur (compliance) coal is the input fuel. If implemented, the Army Facilities Energy Plan long range goals of eliminating natural gas usage, except for minor usage, and reducing petroleum usage by 75 percent can be achieved.