Basewide Energy Systems Plan for Fort Bragg

Womack Army Community Hospital

Executive Summary

Final Submittal

Energy Audit

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EXECUTIVE SUMMARY

The results of the energy engineering analysis performed at Womack Army Community Hospital, located in Fort Bragg, North Carolina, are summarized herein. That work was performed by JRB Associates (JRB) for the Army Corps of Engineers, Savannah District, under a modification to contract No. DACA21-80-C-0014. The project included a detailed audit of the hospital and energy support facilities, utility meter plan development, and investigation of many energy conservation measures. Emphasis was put on Energy Management and Control Systems (EMCS). Analysis was performed with the assistance of the Building Loads and System Thermodynamics (BLAST) computer program developed by the Army Construction Engineering Research Lab (CERL). Energy Conservation Investment Program (ECIP) documents were developed for recommended measures.

Womack Hospital is a 405,000 square foot, 500 bed, 9 story hospital. The hospital's major energy using systems are listed in Table 1 along with their

TABLE 1. WOMACK HOSPITAL CURRENT ESTIMATED ENERGY USE BY SYSTEM TYPE

	Raw Source Use			
	Electric		Natural Gas	
	MBtu/YR	% of Total	MBtu/YR	% of Total
HVAC System:				
Chilled Water Plant	49,100	41		
Central Boilers			55,500	75
Air Handling Units and Pumps	34,400	28	3,500*	5
Lighting	34,800	29		
Domestic Hot Water			13,500	18
Processes (cooking, medical, and miscellaneous	1,800	2	1,500	2

*humidifier energy

associated current energy use estimated by BLAST computer simulations. Historical energy use data is not available. The basic hospital building structure is masonry with double-pane, bronzed windows and a flat, built-up roof. The heating ventilating and air conditioning (HVAC) system consists of

22 individual built-up systems, supplied by a dedicated chilled water plant and a central heating plant. The heating plant also serves several facilities near the hospital. Over 90 percent of the interior lighting system is fluorescent, the remaining being incandescent. All but one exterior light is High Pressure Sodium (HPS) vapor. Domestic hot water, is heated by the heat exchangers off the main boilers. Kitchen hot water is boosted locally as necessary.

In order to identify actual energy use of Womack Hospital, a metering plan was submitted for approval and implementation. The following items, as shown in Figure 1, were included in this plan:

- Metering of electrical feeders number one and ten to identify kWh use and kW demand of the hospital;
- Metering of the two 600 kW emergency generators for kWh use;
- Metering of fuel oil use of the emergency generators; and
- Metering of steam flow into the hospital.

The plan has been approved for implementation and the meters should be installed in early 1984. Following a year of data collection, a report will be issued identifying actual hospital energy use.

An extensive list of potential energy conservation options (ECO's) was included in the Scope of Work. These were supplemented with other ECO's identified during the field survey, and the combined set of options were considered for application in the hospital. An initial screening of ECO's was made after analyzing initial survey data and a number (see Table 2) were chosen for more detailed consideration. Measures found not applicable are listed in Table 3 with a brief explanation of why. The detailed analysis of the applicable ECO's resulted in sixteen cost effective options. Eight of these were combined into three ECIP's and two were classified as Quick Return on Investment Projects (QRIP). The remaining six are Operation and Maintenance (O&M) projects. Table 4 summarizes the ECIP's; Table 5 summarizes QRIP and O&M projects.

FIGURE 1. WOMACK HOSPITAL METERING PLAN

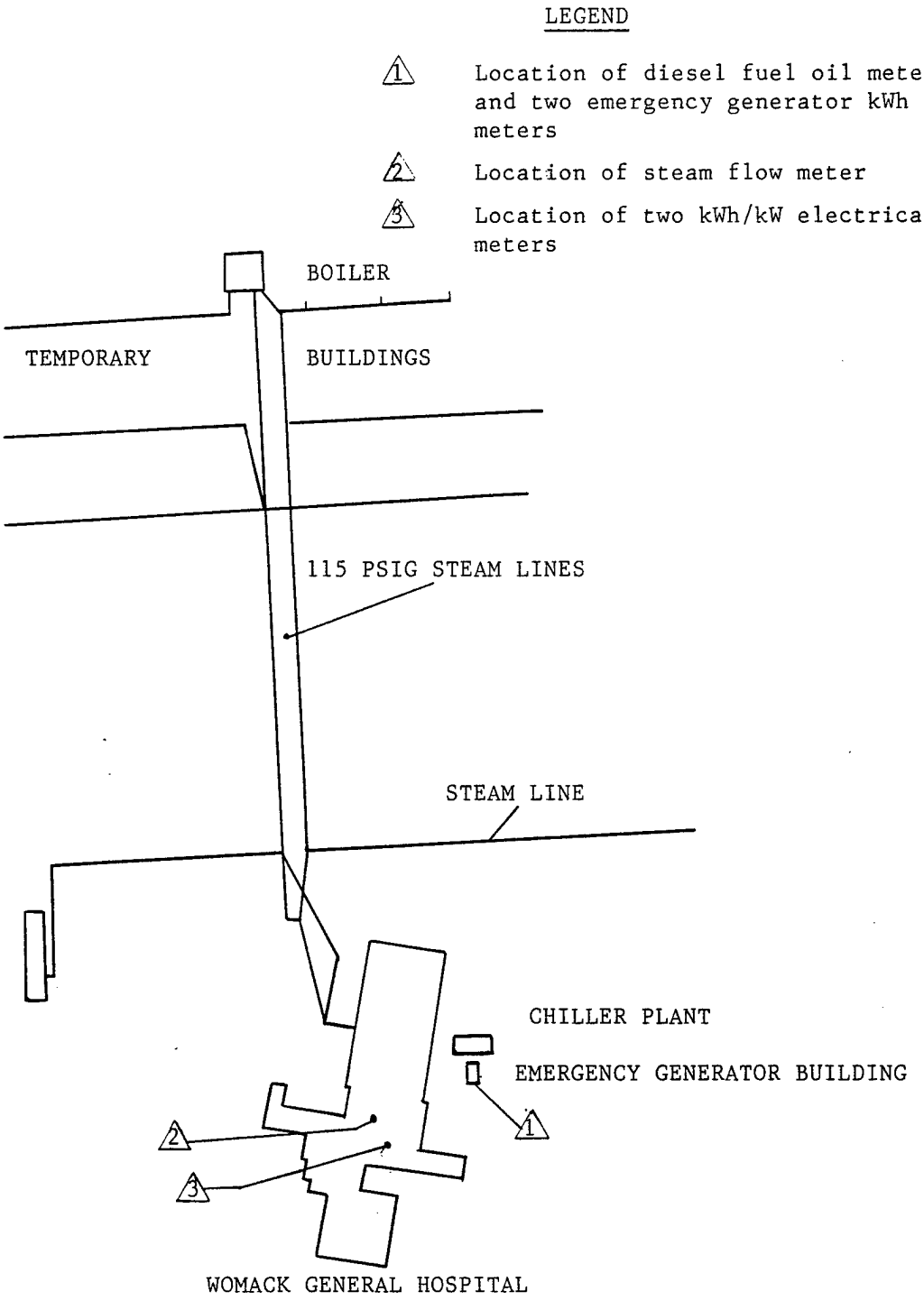


TABLE 2. LIST OF POTENTIAL ENERGY CONSERVATION OPPORTUNITIES, FORT BRAGG, NORTH CAROLINA

OPPORTUNITIES CATEGORY	DESCRIPTION	COMMENTS
HVAC	1. Shut down/set back HVAC units, cycle fans and pumps	Recommended for several systems and certain individual zones - See Subsection 4.2.3.6 (EMCS).
	2. Reduce total and outside air quantities	Current and required air quantities have been compared by zone and changes are recommended for four systems. (See QRIP's)
	3. Shut down recirculating pumps	Recommended for induction systems secondary circulating pump, see EMCS.
	4. Reduce humidification	The elimination of a humidifier is recommended for 10 systems, see EMCS.
	5. Condenser water reset	Capability has been provided with EMCS.
	6. Reset thermostats	Space temperatures should be reset to standard values (see Appendix B, Table B-3). Savings included with EMCS.
	7. Repair steam lines and steam traps	Insulation on the main steam line needs repair (see ORIP's)
	8. Reset hot and cold deck temperatures	See EMCS
	9. Reset chilled water temperature	See EMCS
	10. Revise outside air economizer control	See EMCS
	11. Reduce reheat or eliminate simultaneous heating and cooling	See EMCS
	12. Replace hand valves with automated controls	Actually applies to manual summer/ winter change-over switches. Automated change over included in EMCS.

TABLE 2. LIST OF POTENTIAL ENERGY CONSERVATION OPPORTUNITIES, FORT BRAGG, NORTH CAROLINA (continued)

OPPORTUNITIES CATEGORY		DESCRIPTION	COMMENTS
	13.	Install Variable Air Volume systems	Recommended for clinic addition AHU.
	14.	Cycle fans and pumps	Continuous operation of all fans and pumps are necessary to maintain desired space conditions during occupied hours. Cycling during unoccupied hours is addressed under EMCS.
	15.	Recover heat	Heat recovery off the incinerator was recommended in a previous ECIP and is summarized in this report and included in new ECIP.
	16.	Install Condenser Brush Cleaners	Recommended in previous ECIP, summarized in this report, not recommended due to low SIR.
BOILER PLANT	1.	Reduce steam pressure	Can be done for a portion of the year. See write up.
	2.	Increase boiler efficiency	O_2 trim controls were investigated and found to be uneconomical, also see 4 and 5 below.
	3.	Repair condensate line	Recommended, see Section 4.3.2.
	4.	Install economizer	Recommended.
	5.	Install preheater	Economizer more cost effective.
LIGHTING	1.	Shut off lights, revise cleaning schedule	100% of the lights are left on during cleaning, and can be reduce, see recommended O&M.
	2.	Reduce lighting levels, delamp	Actual and required levels were compared, and no changes are recommended.
	3.	Install electronic ballasts	Electronic ballasts are recommended as replacements when existing ballasts burn out. See recommended O&M.

TABLE 2. LIST OF POTENTIAL ENERGY CONSERVATION OPPORTUNITIES, FORT BRAGG, NORTH CAROLINA (continued)

OPPORTUNITIES CATEGORY		DESCRIPTION	COMMENTS
	4.	Install self-powered exit lights	Not cost effective.
	5.	Adjust site lighting	Extremely low parking in areas with high lighting levels. Recommended adjustments in parking and lighting schedules are included under O&M.
	6.	Retrofit heat sensing switches	Not cost effective.
BUILDING ENVELOPE	1.	Install weather stripping	Exterior doors need new weather stripping, see recommended O&M.
	2.	Install vestibules	Not cost effective.
ELECTRIC EQUIPMENT	1.	Shut down elevators	Additional information indicated automatic shutdown has been implemented.
	2.	Balance transformer loads	Field readings show transformer line load variances of less than 5%, indicating balanced transformers.
	3.	Reduce transformer losses	While excess capacity leads to higher transformer losses redundancy is necessary for the hospital's mission and no changes are recommended.
	4.	High efficiency electric motors	These are recommended equipment at the time of replacement and are discussed in Section 3.3.3.
PLUMBING	1.	Install flow restrictors	Recommended for showers.

TABLE 2. LIST OF POTENTIAL ENERGY CONSERVATION OPPORTUNITIES, FORT BRAGG, NORTH CAROLINA (continued)

OPPORTUNITIES CATEGORY		DESCRIPTION	COMMENTS
KITCHEN	1.	Shut off kitchen exhaust	Current operating procedures.
	2.	Install heat recovery system	Recommended for dishwasher and pot and pan washer. The use use of small decentralized refrigeration units preclude this option for refrigeration equipment.
	3.	Install supply air for exhaust hood	Not economical.

TABLE 3. ENERGY CONSERVATION OPPORTUNITIES FOUND INAPPLICABLE FOR WOMACK HOSPITAL

OPPORTUNITIES CATEGORY		DESCRIPTION	COMMENTS
HVAC	1.	Shut off fan coil units	None in building.
	2.	Shut off stairwell heat	Already done.
	3.	Reduce water flows	This would only apply in two areas: 1. Room induction units - supply air temperature reset is a better option. 2. Chiller water - water temperature reset is a better option.
	4.	Shed loads during peak demands	No equipment identified that can be shed.
	5.	Install minimum motor size	No oversized motors (supported by measurements).
	6.	Install common header for chillers	Already done.
	7.	Insulate ducts and pipes	Already done.
	8.	Clean coils and tubes	Already in maintenance program.
	9.	Air filter maintenance	Already in maintenance program.
BOILER PLANT	1.	Shut steam off to laundry	No laundry.
	2.	Initiate boiler water treatment	Already done.
	3.	Clean boiler tubes	Already done.
	4.	Insulate boiler, piping, etc.	In most cases, adequate insulation already exists. (See repair steam lines in Section 4.3.2.)

TABLE 3. ENERGY CONSERVATION OPPORTUNITIES FOUND INAPPLICABLE FOR WOMACK HOSPITAL (continued)

OPPORTUNITIES CATEGORY		DESCRIPTION	COMMENTS
LIGHTING	1.	Convert to energy efficient systems	Energy conserving fluorescent lamps are being installed within the hospital. High Pressure Sodium are used outside.
	2.	Replace incandescent with fluorescent	All areas with any significant use already have fuorescent.
BUILDING ENVELOPE	1.	Caulk	New windows, good seals.
	2.	Install storm windows or double pane windows	Windows are already thermal pane.
	3.	Insulate roofs	Already done.
	4.	Install loading dock seals	Climate is extremely mild and docks are not in continuous use.
	5.	Install blinds or curtains	Already installed.
	6.	Solar shade	Windws are bronze tinted.
ELECTRIC EQUIPMENT	1.	Shut down pneumatic tubes	Already done.
	2.	Install capacitors for power factor correction	Electric rates do not include a power factor charge.
	3.	Use emergency generator to shave peaks	Already done.
	4.	Shed loads to reduce peak	No shedable loads identified.
PLUMBING	1.	Reduce domestic hot water temperatures	Temperatures at furthest points are 115°F. This is needed for showers.
	2.	Repair pipe insulation	Pipe insulation is adequate and in good condition.
	3.	Install automatic shutoff faucets	Flow restricters are a better option for hospitals.

TABLE 3. ENERGY CONSERVATION OPPORTUNITIES FOUND INAPPLICABLE FOR WOMACK HOSPITAL (continued)

OPPORTUNITIES CATEGORY		DESCRIPTION	COMMENTS
	4.	Decentralize hot water	Hot water needs are too widely distributed throughout the hospital.
	5.	Eliminate recirculating pump by heat taping pipe	Recirculating pumps necessary to supply water at reasonable pressures.
LAUNDRY			No laundry in hospital.
KITCHEN	1.	High efficiency steam valves	Existing valves operate satisfactorily.
	2.	Shut off equipment when possible	Already done.
	3.	Install automatic steam shutoff for equipment	No problems experienced with manual valves.
	4.	Turn off lights in coolers	Already done.

TABLE 4. WOMACK HOSPITAL ECIP PROJECTS PRIORITIZED BY SIR

ECIP Description	Construction Cost (October 1983 Estimate)	Programmed Cost (FY 87 Project)	SIOH	Savings Raw Source MBtu/yr		Annual* $ Savings	SIR
				Elec	Nat. Gas		
Hospital Modifications	301,000	370,000	17,000	9,790	9,150**	68,700	3.0
EMCS	1,201,000	1,543,000	66,000	23,860	22,430	134,600	1.6
Boiler Plant/Steam Distribution Modifications	434,000	546,000	24,000	--	9,540	39,400	1.4
TOTALS	1,936,000	2,459,000	107,000	33,650	41,120	242,700	N/A

*1983 dollars
**600 MBtu of this is LPG.

Date of Analysis - October, 1983

TABLE 5. WOMACK HOSPITAL OPERATION AND MAINTENANCE (O&M) AND QUICK RETURN ON INVESTMENT PROJECTS (QRIP)

Project Classification	Description	Project Costs*** Initial $	Initial Man Hrs	Annual $	Annual Man Hrs	Const. Time	Annual Savings Raw Source MBTU Elec.	Nat. Gas	Energy Savings*** $/yr	Man Hours	SIR
QRIP	Repair of Steam Line Insulation	8600	70	N/A	N/A	2 wks	--	3600	16,800	N/A	28
	Reduction of Air Quantities	16300	520	N/A	N/A	13 wks	1450	750	12,725	N/A	10
O&M	Steam Trap Repair	N/A	N/A	$2030 plus $100-300/ trap	64 plus 1 hr/ trap	N/A	--	460/trap	2150/trap	(increase*)	1 to 8
	High Efficiency Motors	500-2900/ motor	2/ motor	N/A	N/A	N/A	1160**	--	8900**	N/A	1 to 5
	Weatherstripping	6800	100	N/A	N/A	3 wks	35	80	120	N/A	1
	Electronic Ballasts	32/ Bal-last	.5/ Ballast	N/A	N/A	N/A	5900**	--	21,500**	N/A	1
	Revised Cleaning and Light Sched.	N/A	N/A	N/A	N/A	N/A	1825	--	5000	N/A	N/A
	Revised Site Lighting	N/A	N/A	N/A	N/A	N/A	230	--	900	N/A	N/A

*See Project Costs
**These are recommended replacements at time of failure. This total savings will not be realized until all items are replaced.
***1983 dollars

Analysis Date - October, 1983

While the QRIP and O&M projects are self-explanatory, the ECIP projects warrant additional discussion. The Hospital Modifications ECIP is a combination of projects including Variable Air Volume (VAV) air conditioning system for the clinic addition, flow restrictors for showers, heat recovery for the kitchen (dishwashers and pot and pan washer) and heat recovery for the ninth floor incinerator. The EMCS, which as a single option, is large anough to be a ECIP project, includes the following energy conservation control measures applied to the hospital:

- Enthalpy economizer control;
- Night setback/shutdown;
- Early morning warm up/cool down cycle;
- Equipment start/stop;
- Hot and cold deck reset;
- Monitoring and control of space temperatures and relative humidities; and
- Equipment monitoring and alarm.

The Boiler Plant/Steam Distribution Modifications ECIP combines boiler economizers, condensate line repair, and steam pressure reduction projects.

The total potential savings of hospital energy use, taking into consideration the interaction of all cost effective energy conservation options analysis, are:

- 40,500 MBtu/year raw source electric; and
- 27,000 MBtu/year natural gas.

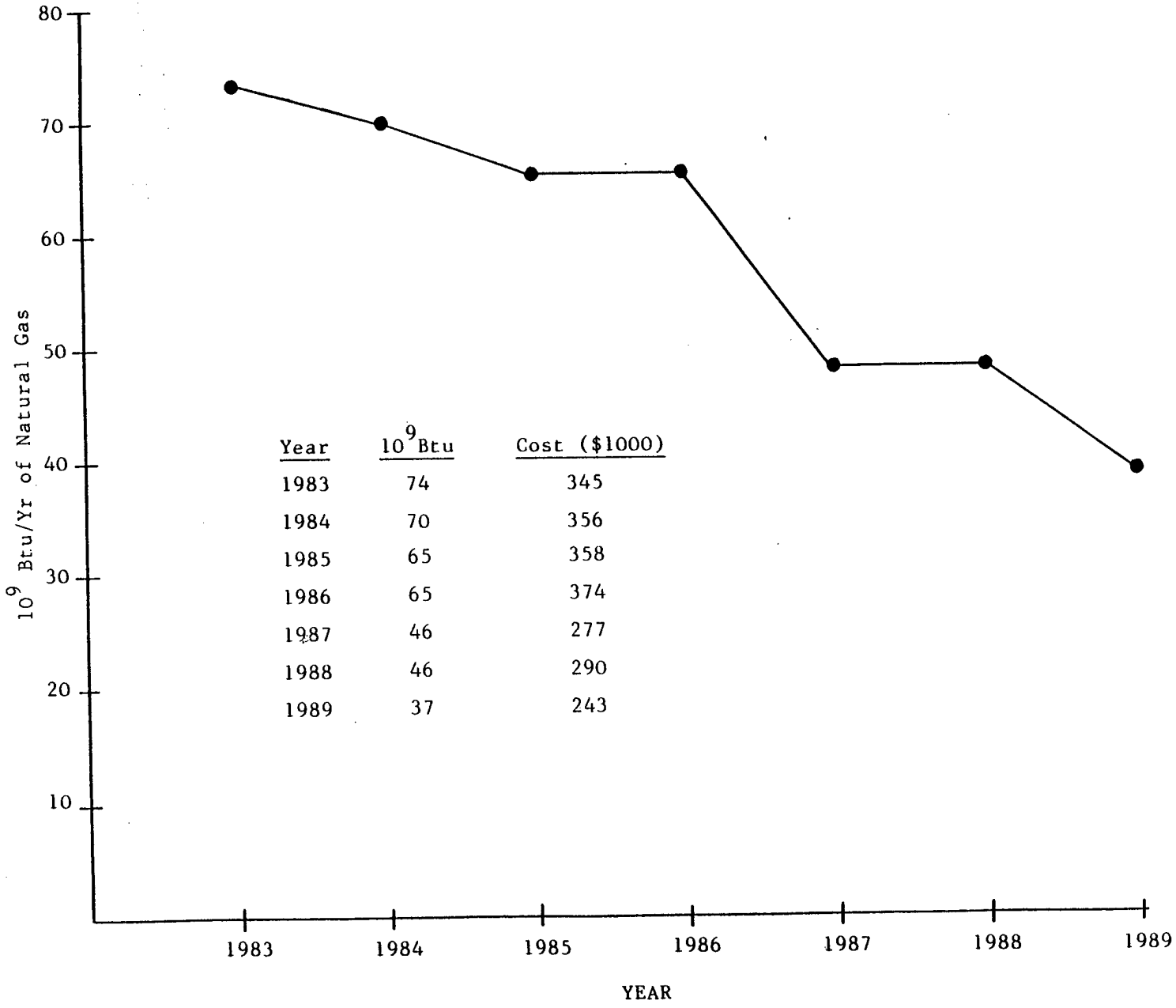
This represents a 34 and 37 percent decrease in electricity and natural gas use, respectively. An additional 9,800 MBtu of natural gas savings is identified in the Boiler Plant/Steam Distribution modification ECIP and the incinerator heat recovery project. These savings are not reported in the above total as the existing condition baseline energy use of the hospital does not include energy use of those systems.

Figures 1 and 2 show the estimated energy use and cost for the next 6 years. The 1983 values are use and cost before implementation of any ECO's identified in this report. In estimating future energy use it is assumed that high efficiency ballasts and motor replacements will be uniformly distributed from the present time through 1989, and all other O&M projects will be completed in 1984. QRIP projects will be completed in 1985. Boiler Plant/Steam Distribution and Hospital Modification ECIPs will be completed in 1987. The EMCS ECIP will be completed in 1989. Current energy use and energy consumption after all recommendations are made, are presented in Table 6. All values are based on raw source energy equivalents.

TABLE 6. CURRENT AND FUTURE RAW SOURCE ENERGY BUDGET
WOMACK HOPSITAL, FT. BRAGG, NC

	Raw Source Energy Use MBtu/year		Total Raw Source Btu/SF-year	Total Btu/SF-yr (using 3,413 Btu/kWh)
	Electricity	Natural Gas		
Current (1983)	120,100	73,900	479,000	271,000
After ECO implementation	79,600	46,900	312,000	174,000
Energy Budget for Hospital/Clinic Building	---	---	---	156,000*

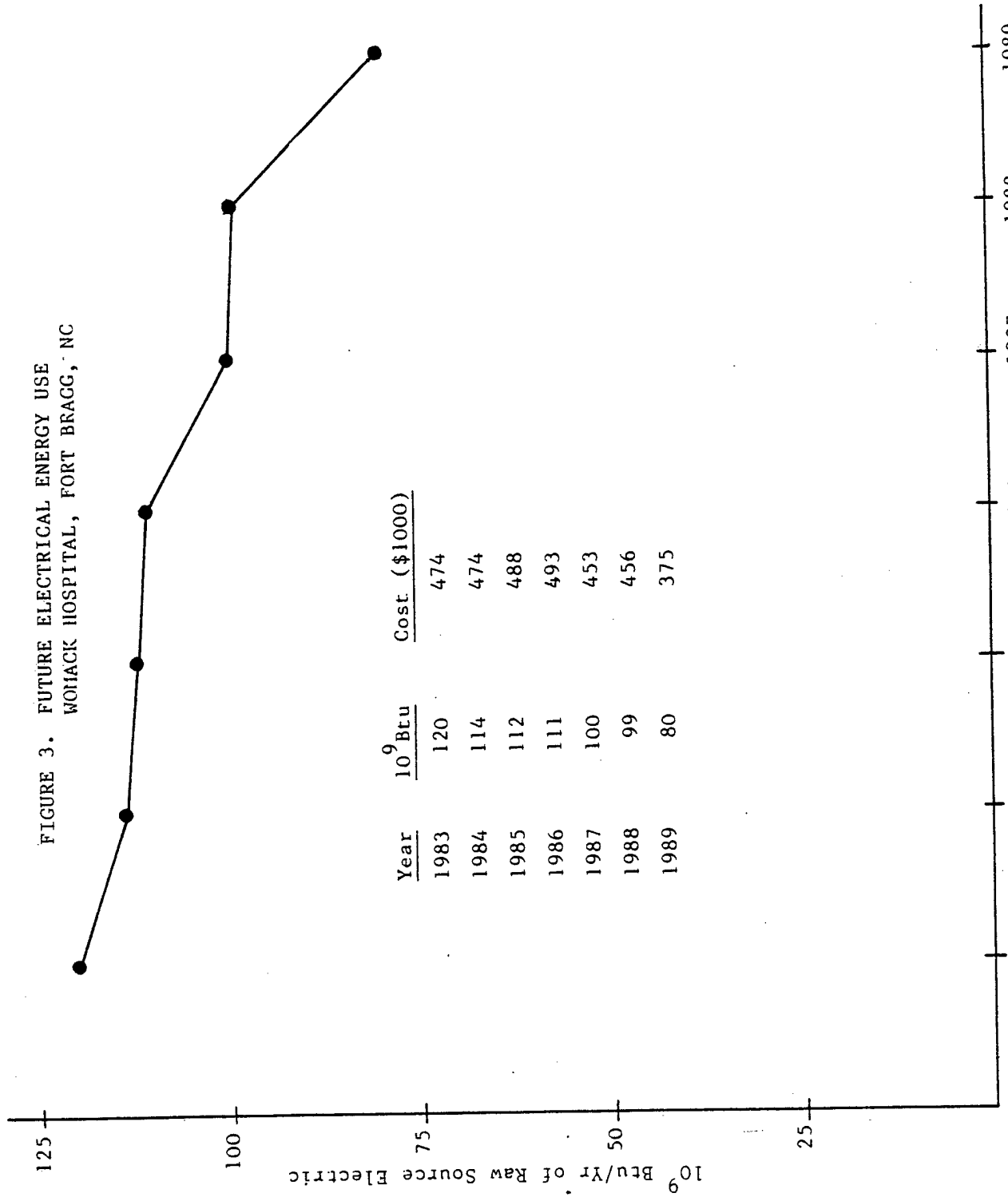
*Value provided by R. Cundiff, Savannah District Corps of Engineers
(Steam distribution system modifications not included).



Year	10^9 Btu	Cost ($1000)
1983	74	345
1984	70	356
1985	65	358
1986	65	374
1987	46	277
1988	46	290
1989	37	243

FIGURE 2. FUTURE NATURAL GAS ENERGY USE, WOMACK HOSPITAL
FORT BRAGG, NC (INCLUDES STEAM DISTRIBUTION SYSTEM IMPROVEMENTS)

FIGURE 3. FUTURE ELECTRICAL ENERGY USE
WOMACK HOSPITAL, FORT BRAGG, NC



Year	10^9 Btu	Cost ($1000)
1983	120	474
1984	114	474
1985	112	488
1986	111	493
1987	100	453
1988	99	456
1989	80	375