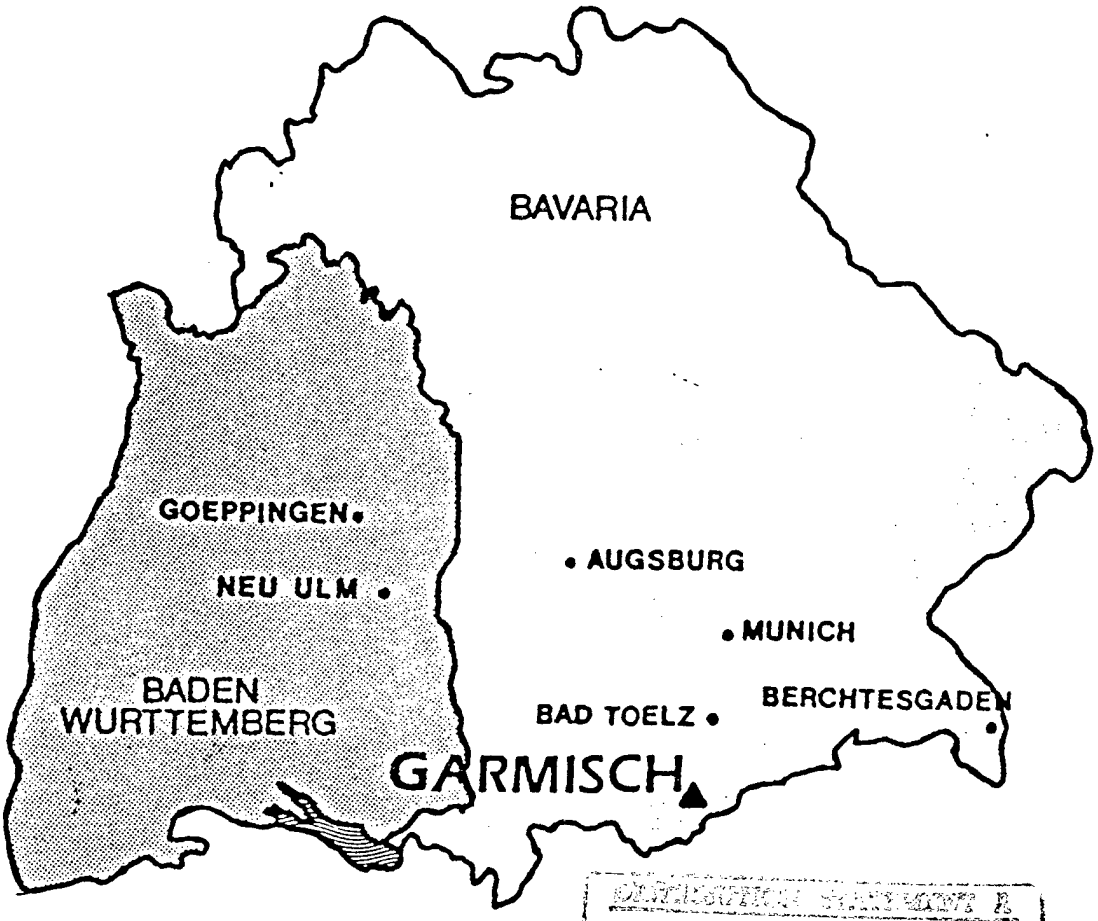
EEAP

PHASE III
EXECUTIVE SUMMARY



Garmisch Military Community
28 April 1986

VVKR | SUTER + SUTER

EXECUTIVE SUMMARY

I. PROJECT INTRODUCTION:

This document is the end result of the Energy Engineering Analysis Program (EEAP) at Garmisch Military Community in West Germany. This EEAP was authorized by the U.S. Department of the Army, European Division, Corps of Engineers, headquartered in Frankfurt, West Germany, under contract No. DACA-90-83-6-0023. The ultimate goal of this effort is the reduction of energy consumption in compliance with the objectives set forth in the U.S. Army Facilities Energy Plan.

The scope of services for this study defines the project in three phases of work. Phase I involves data collection for all buildings at Garmisch. The data collection phase includes utility data, determination and inspection of model buildings, assignment and review of similar buildings, and review of operating procedures. Phase II utilizes and relies heavily upon the information collected in Phase I. In this phase, energy conservation recommendations are developed to estimate related energy savings, as well as implementation costs for specific recommendations. Phase III of this project screened all energy conservation projects and provided programming documents for those projects which the community is requesting funding. By definition, any programmed project has a savings to investment ratio greater than one in compliance with the revised Energy Conservation Investment Program (ECIP) criteria dated June 1985. The three phases of work ended with no requests for funding. However, the first two phases of work compiled details of buildings and possible energy related modifications that can be used for future renovation activities.

II. PHASE I:

Phase I of the EEAP consisted of "data gathering and inspection of the facilities in the field." During this phase, several GY areas were reviewed at this military community. Complete details of the data collection including energy use data, and all building survey data can be found in the Phase I Data Report.

A. Buildings Surveyed:

At the Garmisch Military Community, the following GY areas were included under the contractual requirement for the EEAP:

GY 062 Artillery Kaserne: which consists primarily of storage buildings and shops.

GY 148 Garmisch Family Housing: which consists of housing units, schools, bachelor's quarters, and community support facilities.

GY 571 Sheridan Barracks: which consists of the headquarters facilities for the Garmisch Military Community and the Sheridan Plaza Hotel.

GY 247 General Abrams Hotel Dispensary: which includes medical clinics, dental clinics, a reconditioning center and the General Abrams Hotel.

GY 301 General Patton Hotel: which is a single building utilized as a recreational hotel.

GY 500 Garmisch Supply Area: which serves as a storage and distribution center for various materials.

GY 574 Garmisch Shopping Center: which includes various shopping facilities, exchanges, and a commissary as well as the Military Police, garage and repair shops.

GY 730 General Von Steuben Hotel: which is also a single building utilized for recreational hotel.

GY 609 Sports Center: which includes a recreational area billeting office and sales store as well as a movie theater, bowling alley and tennis courts.

The other GY areas included in the Garmisch Master Planning area that were not a part of this Scope of Work are:

GY 306 Garmisch Golf Course
GY 525 Hohenpeissenberg Radio Relay Facility
GY 550 Linderhof Training Area
GY 580 Hausberg Ski Area
GY 750 Breitenau Skeet Range
ENG 76 Schneeferner Haus

These areas were excluded from the Scope of Services by the EUD Project Manager due to the nature and type of buildings located in these GY areas.

Ten buildings surveyed at Garmisch Military Community were designated "Annex A Buildings." These facilities were audited in great detail in order to complete a computerized analysis of current energy use, possible energy conservation opportunities and the performance of the existing heating and ventilating equipment. These Annex A Buildings surveyed at Garmisch were as follows:

GY 571 Sheridan Barracks:			
Bldg. No.	114	Shops/Office	107,000 SF
	119	Gymnasium	12,000 SF
	123	Sheridan Plaza Hotel	96,000 SF
	102	Offices/Billets	64,000 SF
GY 247 General Abrams Hotel Dispensary:			
Bldg. No.	308	Recreational Hotel	49,000 SF
	306	Dispensary/Billeting	50,600 SF
GY 301 General Patton Hotel:			
Bldg. No.	830	Recreational Hotel	73,640 SF
GY 574 Garmisch Shopping Center			
Bldg. No.	501	Shopping Center	109,590 SF
GY 730 General Von Steuben Hotel:			
Bldg. No.	840	Recreational Hotel	55,090 SF

GY 609 Sports Center
Bldg. No. 997 Restaurant 25,300 SF

All other heated buildings at Garmisch were surveyed in Phase I as "walk-through similar buildings." That is, they were surveyed to discern the differences between them and an Annex A Building that they were judged similar to. Due to the wide variety of building types at Garmisch, not all facilities could be made similar to one of the ten Annex A Buildings at Garmisch. Since this EEAP contract encompasses six military communities, there was a total of 51 Annex A Buildings, 41 of which were located at other communities. These facilities were judged by the EUD Project Manager to be representative of all facilities on all military communities under contract. As a result, some buildings at Garmisch were judged similar to Annex A Buildings at another military community in order to provide computer simulation.

The list of these buildings at other military communities follows:

Community	GY	BLDG	USE
Augsburg	280	220	Maintenance Shop
Augsburg	280	210	Mess Hall/Gym
Augsburg	187	704	Family Housing
Augsburg	187	743	Family Housing
Augsburg	572	178	Rug Cleaning/Upholstery Shop
Augsburg	572	134	Child Care Center
Bad Toelz	283	24	Family Housing
Bad Toelz	163	138	Family Housing
Berchtesgaden	600	211	Commissary
Berchtesgaden	820	407	Recreational Hotel

During the computer analysis of the energy consumption of each boiler plant, each Annex A Building was reviewed as if it existed at Garmisch, whether it did or not. That is, an Annex A Building from the Augsburg Military Community was analyzed with Garmisch weather data in order to make the similar building's analysis more accurate. Complete information on all of these buildings can be found in the Phase I Data Report.

At each building, whether reviewed as an Annex A Building or a walk-through similar building, an ECO checklist for the specific building under consideration was completed. This checklist noted over 110 Energy Conservation Opportunities (ECO) that were reviewed at the facility. Each ECO was noted as "Completed" or "Not Completed" and if not completed, as "Feasible" or "Not Feasible." Based on this checklist, all energy conservation calculations were performed after incorporating the Phase I comments from both EUD and the military community. All ECO's noted as "Not Completed," and "Feasible" were reviewed for implementation. This checklist was also verified against the current ECIP Project List and the Master Planning Documents at Bad Toelz so that their would be no duplication of effort for projects already recommended and slated for implementation.

B. Energy Consumption History:

As reviewed in the Phase I Data Report, the Garmisch Military Community has steadily reduced its energy consumption since the peak year of FY 1978. By FY 1983, the total reduction since 1975 has been 19%, thus nearly reaching the mandate established by the Department of the Army to reduce overall energy consumption by 20% from the FY 1975 levels. The energy consumption trends can be seen in the following chart from data provided by the VII Corps Headquarters in Stuttgart, West Germany:

Energy Consumption History (MIL BTU)

FY	Electricity	Heating Fuel	Total Fuels
1975	59,914	223,445	283,359
1976	59,670	220,698	280,368
1977	58,278	221,276	279,554
1978	59,299	225,205	284,504
1979	59,705	213,055	272,760
1980	60,053	197,382	257,435
1981	58,893	183,580	242,473
1982	62,373	174,616	236,989
1983	64,902	163,756	228,658

For complete data and information on the Energy Consumption History, refer to the Phase I Data Report.

C. Energy Conservation Efforts since FY 1975:

The reduction in the energy consumption at Garmisch has been due to a number of factors. Perhaps the most significant has been the establishment of a Community-wide Energy Conservation Program by the Director of Engineering and Housing. This program has included an educational effort to inform every individual and each family on the Garmisch Community of the importance of energy conservation. This program ultimately affects every aspect of life at Garmisch. In addition, there has been an Energy Conservation Awards Program to recognize those individuals and groups leading the energy conservation efforts.

Since FY 1975, substantial energy conservation actions have been put into effect. These include the following measures.

General: All heating plant operations reduced to minimum essential times. Heating temperatures reduced. Consolidated activities and closed buildings within installation. Replaced high wattage lamps with lower wattage lamps. Improved maintenance and control of boilers and heating systems. Replaced radiator valves with thermostatic valves. Installed heat reflectors behind radiators. Installed timers and day/night switches on lighting circuits. Replaced incandescent light fixtures with fluorescent lights.

GY 500 Garmisch Supply Area: Repair and insulate roof at Bldg. #400. Replace single pane windows with thermopane windows, Bldg. #223 and #410.

GY 148 Family Housing: Insulate roof and walls, replace windows, Bldgs. #723, #724 and #725. Insulate roof, Bldgs. #700, #717, and #718. Consolidate and modernize heating plants, Bldgs. #716 and #725. Weatherize and insulate exterior walls, Bldgs. #700, #704-706. Replace single pane windows with thermopane windows Bldg. #700.

GY 571 Sheridan Barracks: Replace steam valves at all buildings. Repair and insulate roof, Bldgs. #101-104, 109, 110, 114, 116-119, 124, and 127. Repair heating system insulation, Bldg. #111. Replace single pane windows with thermopane Bldgs. #101, 102, 103, 109, 119, 124.

GY 301 General Patton Hotel: Replace LP steam boilers with hot water boilers. Replace all radiator valves with thermostatic control valves. Repair and insulate roof. Replace single pane windows with thermopane windows.

GY 247 General Abrams Hotel and Dispensary: Replace single pane windows with thermopane windows, Bldg. #302-312. Replace LP steam boilers, Bldg. #305. Repair radiator valves with thermostatic control valves Bldg. #304-314.

GY 730 General Von Steuben Hotel: Replace LP steam boilers with hot water boilers. Repair and insulate roof. Replace single pane windows with thermopane windows.

GY 062 Artillery Kaserne: Install heat pumps and heat recovery system, Bldg. #211. Replace space heaters with central heating system Bldg. #204B.

GY 574 Garmisch Shopping Center: Repair and insulate roof Bldgs. #501, 502, and 505. Replace LP steam boilers and radiator valves, Bldg. #501.

GY 609 Garmisch Sports Center: Replace boilers, install heat recovery system in exhaust systems, Bldg. 994-997. Repair and insulate roof Bldg. 994-997.

Refer to the Phase I Data Report for the current list of all ECIP projects presently ongoing, in design or under contract.

III. PHASE II

Phase II of EEAP consisted of "analysis of data (collected in Phase I), performance of feasibility and economic studies and the identification of proposed projects." More specifically, Phase II consisted of 1) verification of computer simulated buildings' energy consumption versus actual utility bills; 2) identification of proposed projects and calculation of savings, costs, and SIRs; and 3) deletion of projects, as requested by Garmisch Military Community and required under ECIP criteria.

A. Methodology:

The basis of the analysis phase of this EEAP at Garmisch is the computerized analysis of the Annex A Building at this military community and at several other communities which were judged similar to other buildings at Garmisch. As noted earlier, the calculated energy consumption of each building at Garmisch was based on the computer analysis of these facilities.

The computer program utilized for this analysis is entitled C-PARTS (Component Performance Analysis for Real Thermal Systems). This program was developed and copyrighted by VVKR Incorporated of Alexandria, Virginia and is designed to allow an accurate assessment of each energy sensitive element in an existing building. The program utilizes standard American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) heat transfer methodologies and thermal resistance values for building materials from the National Bureau of Standards (NBS) or ASHRAE. Since the program was specifically designed with the analysis of existing buildings in mind, it is based on an hour by hour analysis of a typical day each month, and provides outputs that can easily be compared with the actual utility consumption data of an existing facility.

In this manner, the C-PARTS analysis can be checked against a known factor, the utility consumption of the facility for accuracy. Any significant deviations between the C-PARTS output and the actual consumption point to a problem in the C-PARTS data input or analysis. As a result, the final C-PARTS outputs have been verified against real data rather than a simple estimate of energy consumption.

As reviewed earlier, the vast majority of buildings analyzed are walk-through similar buildings. Each of these facilities was made similar to an Annex A building, located either at this community or another. For each walk-through building, a variation checklist was provided to note the differences between that building and the Annex A building to which it was judged similar. For example, two buildings may be similar in respect to the basic construction and use, but one has 25% greater window area and 30% greater floor area than the other. These approximate variations have been noted for each walk-through building in respect to its associated Annex A building. All heat transfer coefficients, U-values, are assumed equal to those for the Annex A Building, unless noted otherwise.

After these analyses have been complete, each of the walk-through similar buildings at this community is analyzed by C-PARTS in relation to its associated Annex A building. The variations noted above are taken into account in the analysis process to derive an accurate estimation of the energy use at each individual walk-through facility.

B. Boiler Plant Verification Analyses:

The next procedure in the C-PARTS Analysis at this military community is the verification of the computed energy consumption against the actual energy consumption for the test year. There is no specific energy consumption data for each building. Rather, there is energy consumption data for central boiler plants which provide heat to a number of buildings, and for electrical substations, which provide power to a number of buildings.

After the energy consumption data has been calculated for all of the Annex A buildings and the walk-through similar buildings, the facilities are all grouped according to the central plants and substations or lowest metered source servicing them. The totals of these facility groupings are then verified against the historical energy consumption data.

There are several factors that can cause deviations between the ASHRAE computed loads of C-PARTS and actual consumption data. The major factors are as follows:

1. Distribution line losses and steam leaks.

2. Lack of heating system controls that cause building occupants to open windows for comfort and thus increase infiltration losses,

3. Doors that are left open for excessive time periods especially in repair and maintenance facilities.

4. Low boiler efficiencies, poor or non-existent controls, and low maintenance factors.

5. Non-scheduled or irregular use of a facility.

Whenever possible, corrections for these factors were introduced, based on additional data that was collected during the Phase I survey. This data includes the ambient air conditions on the day of the survey, the number of windows and doors found open, comments on leaking pipes, doors found open, poor heating system controls, building plans and blueprints and photographs of building conditions. With this additional information, and the ability of the C-PARTS program to rapidly re-evaluate the building loads, adjustments were made to account for the infiltration and other losses to verify the computer analysis with the actual energy consumption within reasonable limits.

C. Energy Conservation Opportunities:

The Energy Conservation Opportunities (ECOs) studies at this community was based on the Annex B requirements of the Scope of Services dated 20 January 1983. The ECO's noted in Annex B were those required by the Army for analysis. In addition to these, however, several additional ECO's were voluntarily added to the analysis procedure to provide a complete review of all feasible energy savings measures at this community. These additional ECO's also include some requested by various reviewing agencies after Phase I Data Report was submitted. Others requested were judged outside the requirements of this contract.

The ECO's proposed for review and analysis are divided into eight major groupings according to their building system. These groups are as follows:

		ABBREVIATION
1)	Building Envelope	(B)
2)	Cooling	(C)
3)	Heating	(H)
4)	Lighting	(L)
5)	Special Equipment	(S)
6)	Temperature Controls	(T)
7)	Ventilation	(V)
8)	Domestic Hot Water	(W)

Within these groupings, all ECO's under each Increment of study have been reviewed and analyzed. The analysis of each ECO was performed either by the C-PARTS program or by manual calculations, based on data derived from the C-PARTS analysis and Boiler Plant Verification Analysis.

Generally, the Building Envelope ECO's and Temperature Control ECO's were analyzed by re-running the C-PARTS load analysis for a specific building with revised inputs reflecting the ECO. For example, by analyzing the buiding first as existing, and then with additional roof insulation and comparing the two outputs, the energy savings associated with the roof insulation can be determined. These computer analyses were conducted on a full year's basis to obtain total savings in a year.

The manual calculations were based on data from the C-PARTS analysis of the facility or from the Boiler Plant Verification Analysis. All methods of the calculations were derived from ASHRAE or from several guidebooks provided by the U.S. Department of Energy.
The Master List of all Energy Conservation Opportunities that were reviewed at this community are as follows, though not all of these ECOs were applicable nor calculated.

BUILDING ENVELOPE

B-1 Insulation added to walls.

B-2.1 Insulation added to existing roof.

B-2.2 Insulation added with new roof.

B-3 Insulation added to basement ceiling.

B-4.1 Insulation added to attic floors.

B-4.2 Insulation added to usable attic.

B-5.5 Caulk and weatherstrip windows.

B-7.5 Caulk and weatherstrip doors.

B-8 Storm windows installed.

B-9 Storm doors installed.

B-10 Double pane windows installed.

B-11 Sun control screens or louvers added to windows.

B-12 Solar control film added to windows.

B-13.1 Glass area replaced with Spandrel panel

B-13.2 Glass area replaced with glass blocks

B-14 Automatic door closers installed.

B-15 Doors vestibuled.

B-16 Thermal barriers installed.

B-17.1 Double glaze skylights.

B-17.2 Remove existing skylights.

B-18 Loading dock doors sealed.

B-19 Air curtains installed.

B-20 Thermal/solar control shades installed.

COOLING SYSTEMS

C-1 Economizer systems provide free cooling during winter season.

C-2 Dual duct or multizone systems converted to single zone systems.

C-3 Cooling pipe lines and ductwork insulated.

C-4 Absorption cooling equipmment replaced.

C-5 Cooling equipment is serviced, cleaned and adjusted regularly.

C-6 Cooling of unoccupied areas is prevented.

C-7 Variable air volume systems installed.

C-8 Filters cleaned and inspected regularly.

C-9 Temperature of chilled water raised.

C-10 Solar assisted cooling equipment installed.

C-11 Reheat coils removed.

C-12 Heat recovered from refrigerant gas.

HEATING SYSTEMS

H-1 Combustion air to boiler preheated.

H-2 Fuel oil to boiler preheated.

H-3 Steam condensate returned to boilers.

H-4 Flue gas dampers installed.

H-5 Automatic ignition pilot lights installed.

H-6 Flue gas analysis and adjustment performed regularly.

H-7 Combustion is monitored and adjusted regularly.

H-8 Heating equipment converted from natural gas to oil or coal.

H-9 Steam, condensate and hot water piping insulated.

H-9.5 Insulate valves and fittings.

H-10 Unnecessary humidification removed.

H-11 Oxygen trim controls installed on boilers.

H-12 Heat recovery systems installed.

H-13 Solar energy heating system installed.

H-14 Reheat coils removed.

H-15 Temperature of hot water used for heating lowered.

H-16 Connected to district heating.

H-17 Turbulators installed in fire tube boilers.

H-18 Supply and return piping installed.

H-19 Spot heating installed.

H-20 Fluidized Bed Combustion System

H-21 Boiler Maintenance

LIGHTING SYSTEMS

L-1 Lighting fixtures removed.

L-2 Lamps and/or ballasts removed from fixtures.

L-3 Task lighting installed.

L-4 Lower wattage lamps installed.

L-5 Lamps and fixtures cleaned regularly.

L-6 Exterior lighting is reduced to minimum.

L-7 Lighting is off in unoccupied areas.

L-8 Photocell controls installed.

L-9 Automatic time clock controls installed.

L-10 Fixtures relamped on schedule.

L-11 Natural daylighting is utilized.

L-12 Incandescent fixtures replaced with fluorescent fixtures.

L-13 Exterior lighting replaced with low or high pressure sodium fixtures.

L-14 Mercury vapor fixtures replaced with high pressure sodium.

L-15 High efficiency ballasts installed.

L-16 Power reducers installed.

SPECIAL EQUIPMENT SYSTEMS

S-1 Time delay switches installed on elevator motors.

S-2 Motors and motor driven equipment are maintained and adjusted regularly.

S-3 Time clocks installed to turn off vending machines and drinking fountains overnight and during weekends.

S-4 Kitchen equipment and laundry equipment maintained and cleaned regularly.

S-5 Co-generation equipment installed.

S-6 Laundry waste air/water heat recovered.

S-7 Kitchen waste air/water heat recovered.

S-8 Individual metering of family housing installed.

S-9 Peak demand load controlled.

S-10 Electrical Load Replacement

TEMPERATURE CONTROL

T-1 Heating and cooling reduced to unoccupied areas.

T-2 Time clocks added to heating and cooling systems.

T-3 Tamperproof thermostats installed.

T-4 Thermostats set at 78° for cooling, 65° for heating.

T-5 Thermostats relocated from outside walls and from areas subject to drafts or direct sunlight.

T-6 Economizer controls added to heating and cooling system.

T-7 Temperature control system adjusted and recalibrated seasonally.

T-8 Automatic energy management systems installed.

T-9 Zone control implemented.

T-10 Thermostatic radiator control valves installed.

T-11 Night setback controls installed.

T-12 Outside air reset installed.

T-13 Duty cycling controls installed.

T-14 Heating monitoring devices installed.

VENTILATION SYSTEMS

V-1 Outside air reduced to minimum levels.

V-2 Exhaust systems balanced with the outside air intake systems.

V-3 Time clocks installed to shut down exhaust systems overnight and during weekends.

V-4 Outside air dampers sealed and adjusted to operate properly.

V-5 Exhaust hoods are equipped with make-up air systems.

V-6 Toilet exhaust fans wired to operate only when lights are turned on.

V-7 Heat recovery systems installed between exhaust air and outside air.

V-8 Maintenance Shop Exhaust system installed.

DOMESTIC HOT WATER SYSTEMS

W-1 Temperature of domestic hot water reduced.

W-2 Hot water piping insulated.

W-3 Storage tanks insulated.

W-4.1 Eliminate hot water use.

W-4.2 Time clocks installed to shut off water heaters overnight and during weekends.

W-5 Flow restrictors installed in faucets and shower heads.

W-6 Time clocks installed to shut off circulating water pumps overnight and during weekends.

W-7 System equipment is serviced, cleaned and adjusted regularly.

W-8 Solar hot water system installed.

W-9 Systems decentralized.

W-10 Hot water production supplemented by heat pump.

D. Projects Requested for Funding:

Of the complete list of ECOs reviewed, 66 were analyzed in detail, with calculations estimating energy savings and implementation costs. Of the 66 ECOs analyzed, no projects were requested for funding by the Milcom.

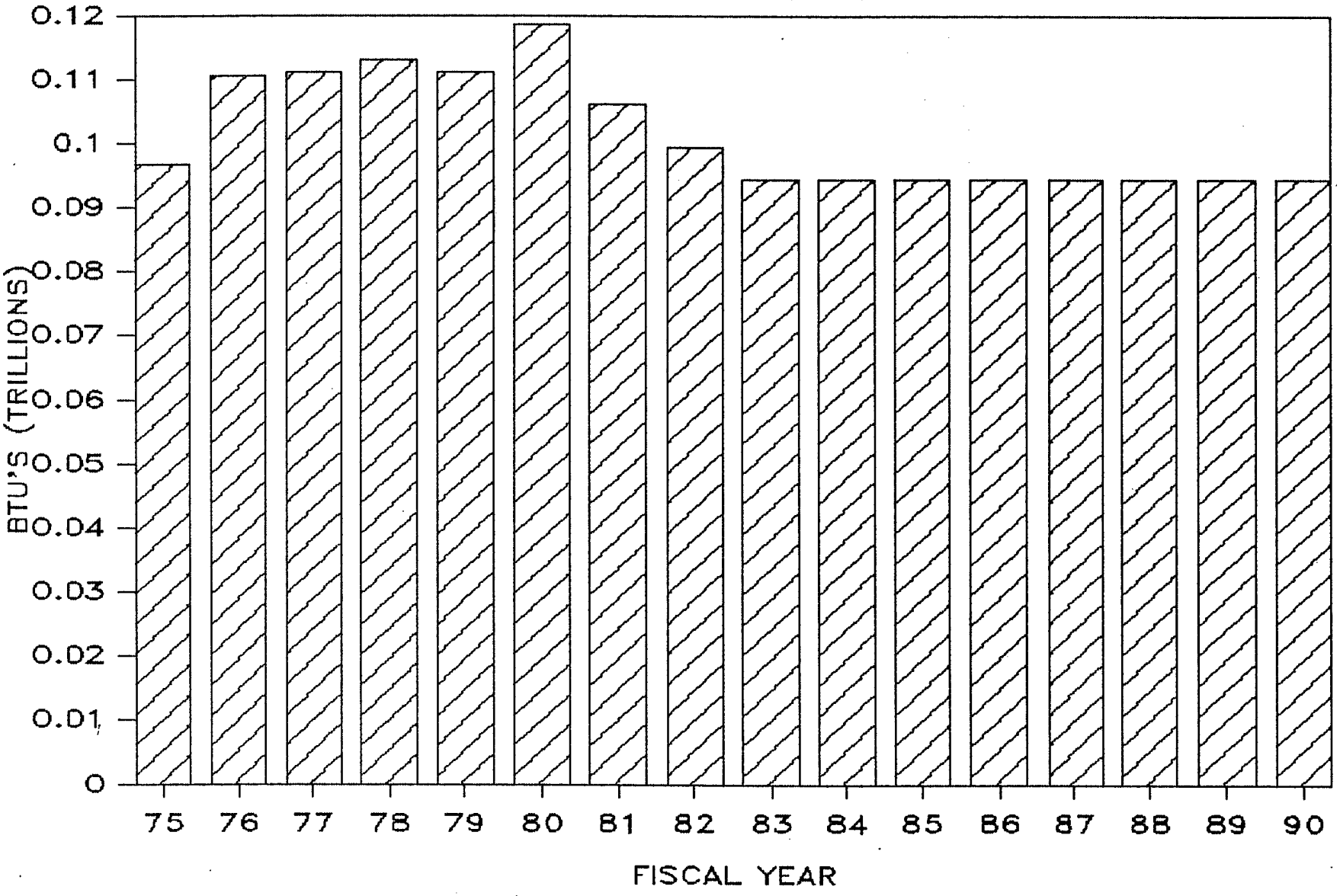
IV. PHASE III

Phase III of this study consists of preparing required programming documents, and preparing the Executive Summary. However, since Garmisch Milcom did not request funding for any of the ECO's analysed, only the Executive Summary has been prepared. The findings of the Phase II Energy Report can be used as guidelines for future energy conservation renovations. It contains much useful information for determining impact on basewide energy use for different energy related modifications to buildings.

The following graphs tract the energy consumption for the different energy sources being used at Garmisch Milcom. For years 1975-1983 actual consumption figures, provided by VII Corps, were used. For years 1983-1990 straight line projections from the 1983 consumptions were used. The last graph depicts the cost of different energy sources. Actual costs were utilized for 1983. However, for years 1984-1990 the fuel costs were modified based upon the most recent trends and projections.

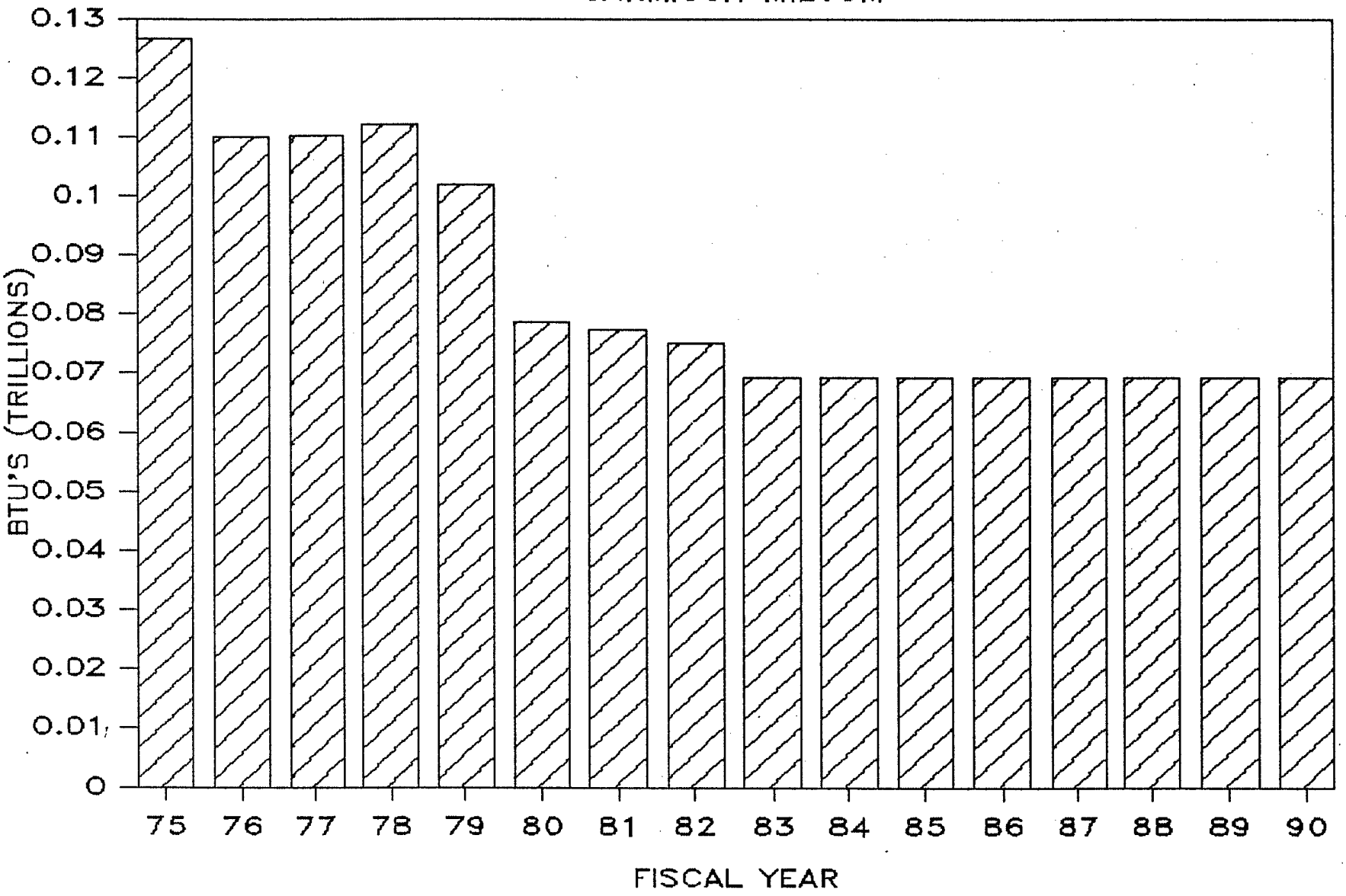
COAL CONSUMPTION

GARMISCH MILCOM



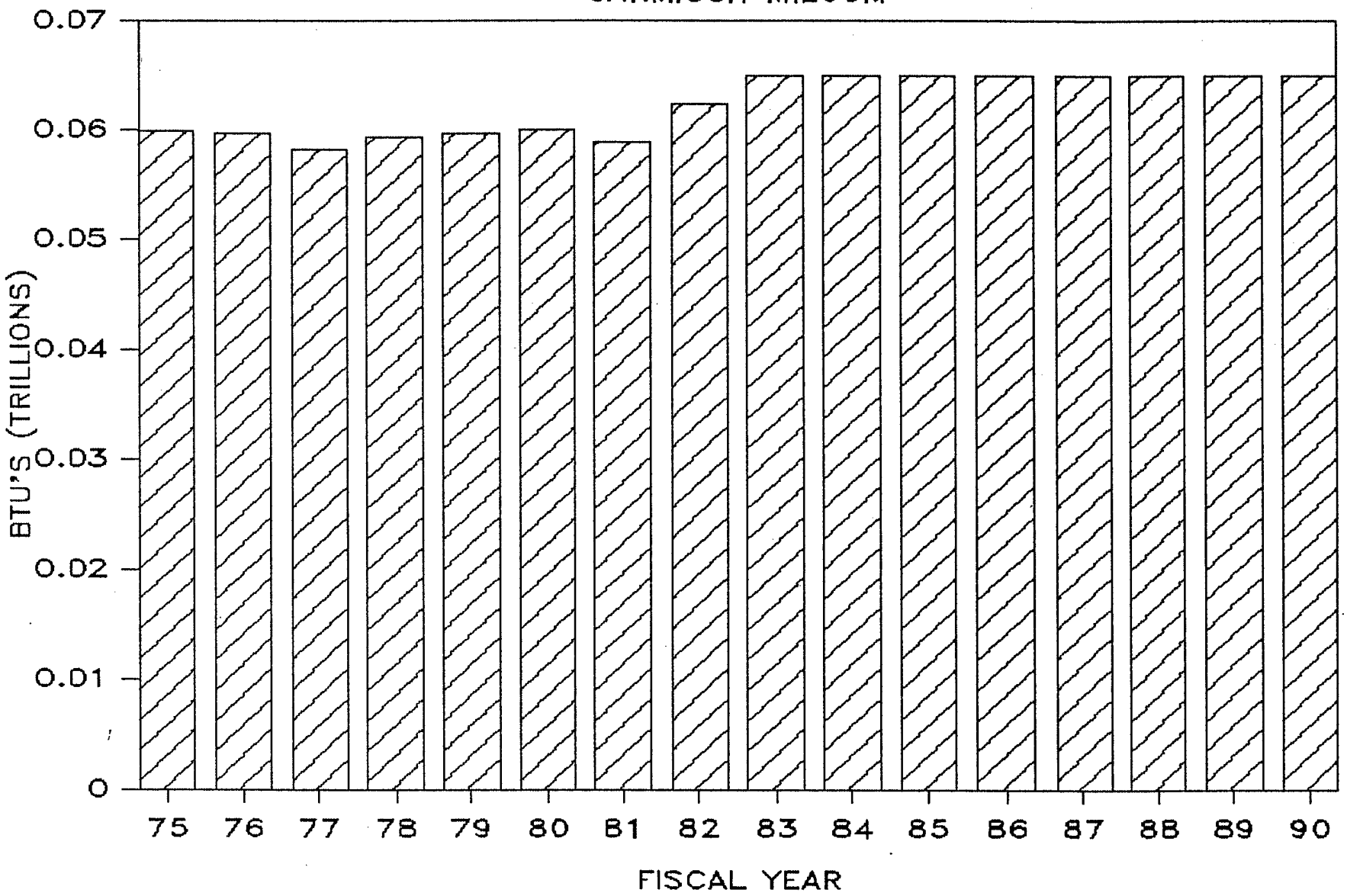
FUEL OIL CONSUMPTION

GARMISCH MILCOM



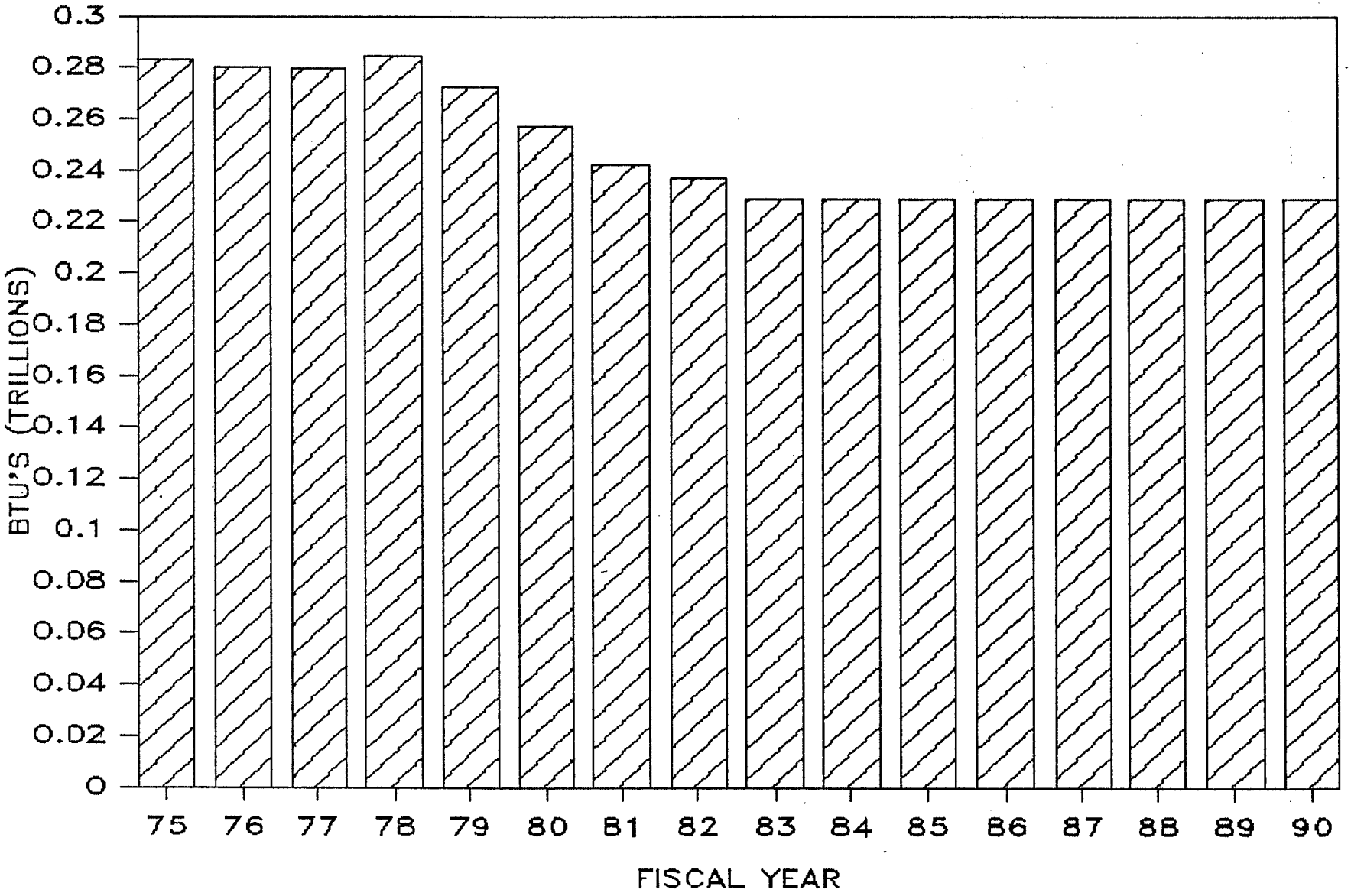
ELECTRICAL CONSUMPTION

GARMISCH MILCOM



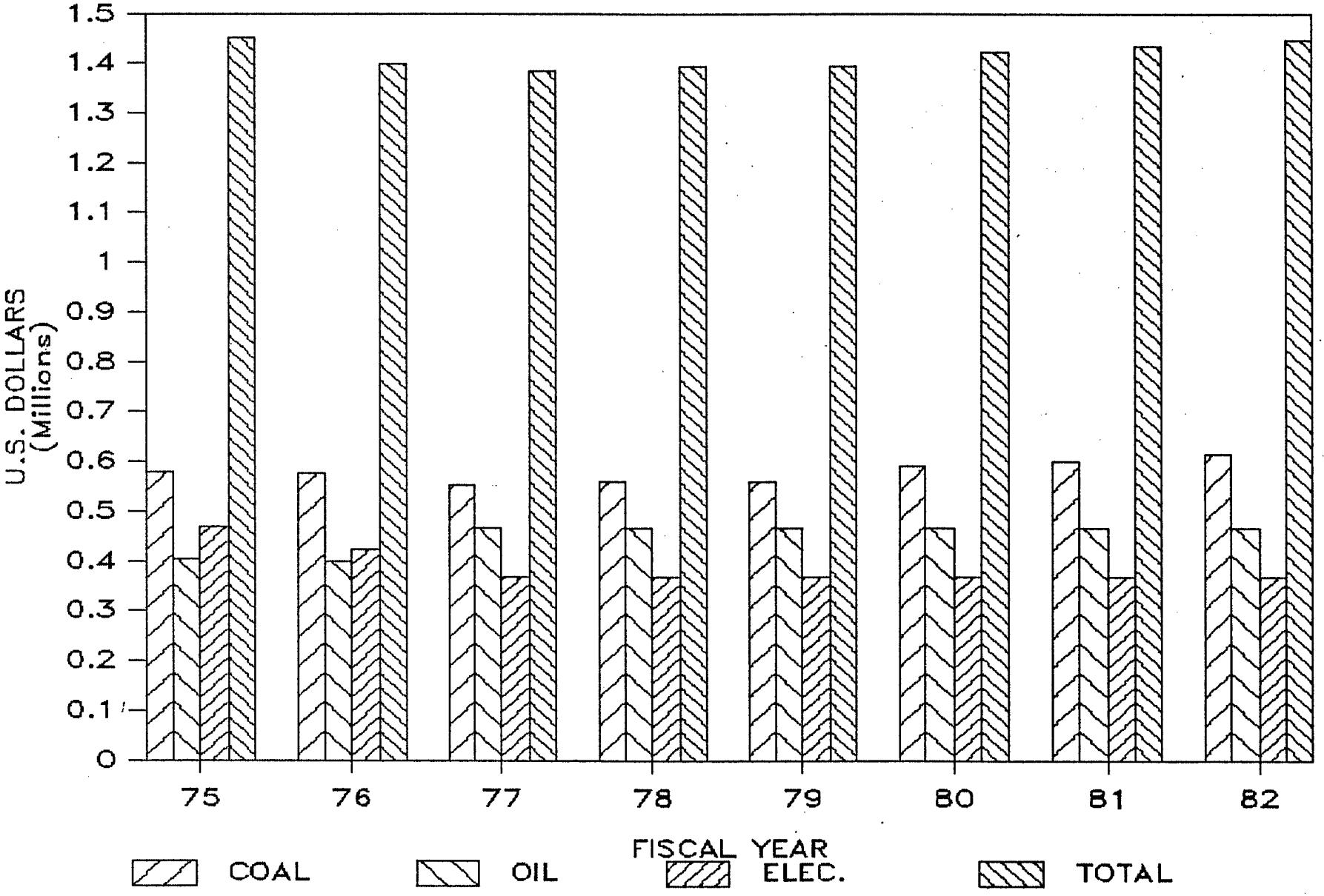
TOTAL ENERGY CONSUMPTION

GARMISCH MILCOM



TOTAL ENERGY COSTS

GARMISCH MILCOM



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