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UNITED STATES ARMY

THE CHIEF OF STAFF

15 February 1978

SUBJECT: Management of Army Energy Resources

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1. The acute petroleum shortages experienced in 1973 have abated somewhat, but national dependence upon foreign sources for petroleum has increased. While national energy consumption continues to grow, the Army has reduced its consumption by over 27 percent since 1973. It is essential that we in the Army maintain this momentum, which has been achieved by greater efficiency in the management and consumption of energy resources.

2. The inclosed Army Energy Plan provides you the background, goals, strategies, objectives, and policy necessary to improve further the Army's use of energy. The plan anticipates the energy future and can accommodate new technologies and discoveries. Its purpose is to ensure that the Army can maintain a high state of readiness in an uncertain energy environment. Only through a total Army effort in implementing sound energy policies can we assure that our national security obligations will be met.

3. While the responsibility for coordinating the Army energy program lies with the Deputy Chief of Staff for Logistics, I challenge all commanders to do their part in meeting the goals and objectives outlined in this plan.

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as

BERNARD W. ROGERS
General, U.S. Army
Chief of Staff

SUBJECT: Management of Army Energy Resources

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ARMY ENERGY PLAN

Prepared for

Office of the Deputy Chief of Staff for Logistics
Directorate of Transportation, Energy, and Troop Support
The Army Energy Office
Headquarters, Department of the Army
Washington, D.C. 20310

Prepared by

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The Plan identifies the Army's organization, goals, objectives, and policies with respect to energy. It projects energy consumption and costs to the year 2000 and summarizes the programs required to support the long range goals. A summary of current and needed energy related legislation is included.

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FOREWARD

This Army Energy Plan has been prepared by Unified Industries Incorporated, 205 South Whiting Street, Alexandria, Virginia 22304, for the Army Energy Office. Assistance and guidance were provided by the Advisory Group on Energy and the Army Staff. It portrays the world, national, and Department of Defense energy environment within which the Army must operate. The Plan identifies current and long term objectives and goals of the Army. It summarizes those existing and new Army programs which will be necessary to accomplish those goals and objectives. To the extent possible, costs have been identified. Energy consumption and costs have been projected to the year 2000. Upon publication of this plan, it is expected that the major commands and the Army staff will develop the detailed implementation plans which can then be costed and included in the appropriate programing and budgetary documents. Further reproduction and distribution of this document is authorized and encouraged. Comments and/or recommendations concerning this report should be forwarded to the Army Energy Office, Headquarters, Department of the Army, Office of the Deputy Chief of Staff for Logistics, Attention: DALO-TSE, Washington, D.C. 20310.

SUMMARY

The Army Energy Plan describes the current and projected (to the year 2000) energy situation in which the Army must operate and summarizes those actions and programs which have been developed and/or are needed to cope with those conditions. It addresses the Army goals, objectives, policies, and programs for military activities. An energy plan applicable to the civil works activity of the Corps of Engineers will be developed separately.

BACKGROUND

World Situation

World industrial growth during the past century has been characterized and hastened by the widespread availability of inexpensive energy, primarily petroleum. The Arab oil embargo of 1973 served to drive home a number of points, key among them being that the world's principal oil consumers are not the major oil producers. The Middle East and Africa have an estimated 67 percent of the petroleum reserves while Western Europe and the Western Hemisphere have only 19 percent. By most estimates, these reserves are expected to be exhausted within the next 70 years. In the 1973 to 1974 time frame, prices for petroleum rose threefold, signaling the end of cheap oil. The distribution of alternate sources of recoverable oil, such as tar sands and oil shale, favor the Western Hemisphere, but economical recovery techniques have not been developed to date.

U.S. Situation

The United States, with only 6 percent of the world's population, consumes more than 30 percent of the world's energy. It uses more energy per dollar of gross national product (GNP) than any other industrialized nation. Petroleum is used primarily for transportation, coal is used principally for electric utilities and industry, and natural gas is preferred for residential heating and some industrial uses.

Petroleum production in the United States reached its peak in 1970 and is declining. As a result, in 1977 the United States imported approximately 50 percent of its requirements. Many analysts predict that U.S. petroleum reserves will be exhausted before the year 2000 thereby creating a significant potential problem for the Department of Defense (DOD). Coal constitutes 90 percent of the U.S. energy reserves but supplies only 18 percent of the energy consumed.

ENERGY OBJECTIVES, STRATEGIES, GOALS, AND ORGANIZATION

Objectives and Goals

The national energy strategy is reflected in the following objectives established by the President on 29 April 1977:

a. In the near term, to reduce dependence on foreign oil and to limit vulnerability to supply disruptions.

b. In the midterm, to keep U.S. oil imports sufficiently low to weather the eventual decline in the availability of world oil supplies caused by capacity limitations.

c. In the long term, to develop renewable and essentially inexhaustible sources of energy for sustained economic growth.

Some of the key specific national goals cited by the President, to be accomplished by 1985, are as follows: Reduce energy usage growth to 2 percent per year, reduce gasoline consumption by 10 percent, increase coal production by two-thirds, use solar energy in 2-1/2 million homes, and reduce energy consumption in Federal buildings by 20 percent in existing buildings and 45 percent in new buildings.

Organization

The Department of Energy Organization Act, approved 4 August 1977, established the Department of Energy (DOE) to become effective 1 October 1977. This act provides for the consolidation and coordination of energy and energy-related functions of the Federal Energy Administration (FEA), the Energy Research and Development Administration (ERDA), and other Federal agencies under the new department.

THE ARMY ENERGY SITUATION

Department of Defense

The Department of Defense (DOD) consumes 1.9 percent of the nation's energy but consumes over 3 percent of the total petroleum used by the United States. DOD established the following energy conservation goals:

FY74 - 7 percent savings over FY73

FY75 - 15 percent savings over FY73

FY76 - 0 percent growth over FY75

FY77 - 0 percent growth over FY75

All of these goals were achieved. The organization for energy within DOD consists of a Directorate for Energy under the Deputy Assistant Secretary for Energy, Environment, and Safety (DASD (EE & S)).

Army Goals and Objectives

The Army has been operating under the following energy management objectives:

a. Conserve energy while maintaining readiness.

b. Maintain zero growth based on FY75 total energy consumption.

c. Maintain a supportive and cooperative role with designated national energy authorities in the development of new energy sources.

After reviewing the entire energy situation looking to the year 2000 and in consideration of the Presidential goals, the Army Advisory Group on Energy (AGE) adopted on 1 December 1977, the following goals and objectives for the Army:

a. Reduce energy consumption by 45 percent by the year 2000.

(1) Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness.

(2) Reduce energy consumption in facilities operations by 25 percent by FY85 and 50 percent by the year 2000.

(3) Expand energy conservation education/information and incentive programs for all Army military and civilian personnel and their dependents.

b. Reduce dependence on nonrenewable and scarce fuels by the year 2000.

(1) Eliminate the use of natural gas and reduce the use of petroleum fuels in facilities operations by 75 percent by the year 2000.

(2) Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000.

(3) Increase efficiency of nonrenewable energy dependent mobility systems by 15 percent with no degradation to readiness.

c. Attain a position of leadership in the pursuit of national energy goals.

Organization for Energy

The key organizational elements within the Army for energy are a Special Assistant for Energy within the Office of the Assistant Secretary of the Army (Installations, Logistics, and Financial Management) (ASA(I,L&FM)), the Army Advisory Group on Energy composed of general officers or civilian equivalent representatives from Army Staff agencies and the Army Energy Office. The Army Energy Office is located within the Directorate for Transportation, Energy, and Troop Support of the Office of the Deputy Chief of Staff for Logistics (ODCSLOG) and is charged with overall responsibility for supervising and coordinating the Army Energy Program.

Requirements and Costs

The Army's share of DOD energy consumption is 18 percent. Of that amount, 84 percent is consumed in installation or facilities operations and 16 percent in mobility operations. Between FY73 and FY75 the Army reduced its consumption by 23.6 percent or a total of 83.7 trillion British thermal units (Btu), exceeding the DOD goal by 8.6 percent. In FY75 the Army consumed 270.9 trillion Btu of energy at a cost of $545 million. In FY76 and FY77, despite yearly reductions of approximately 5 percent in consumption compared with FY75, the costs exceeded $600 million. If the Army were to maintain the FY75 level of energy consumption to the year 2000, the cost of energy for that year would be expected to exceed $3.1 billion. On the other hand, if the Army meets its newly adopted goals of reducing overall energy consumption by 45 percent, the costs would be expected to be $1.8 billion in FY2000 resulting in a cost avoidance of $1.3 billion. The estimate for total cost avoidance for the 20-year period between FY80 and FY2000 would be in excess of $11 billion. It is proposed that the Army use this cost avoidance in support of the funds needed to develop the Army programs to meet its goals and objectives.

THE ARMY'S ENERGY PROGRAMS

The Army has operated an extensive energy conservation program with the overall objectives of conserving energy and maintaining zero growth. The program is concentrated in the areas of: installation operations, mobility operations, training, and research and development. The Army's activities in each of the above areas, to include changes required to meet the long range goals, are summarized below and are discussed in greater detail in the main body of this report.

Installation Operations

The Army is currently conserving energy in installation operations by such means as reducing heating temperatures to 65° F and cooling temperatures no lower than 78° F in working and living areas, increasing insulation, keeping windows and doors closed, reducing lighting levels, consolidating activities, reducing water temperature levels, and fine tuning equipment for better efficiency. In the near term (FY78-83), the Army will concentrate on its goal of reducing energy consumption by 25 percent by 1985. This goal goes beyond the Presidential energy consumption goals of 20 percent reduction in energy consumption in existing Federal buildings and 45 percent reduction in new Federal buildings by 1985. Energy Conservation Investment Program (ECIP) projects are expected to accomplish 12 of the 20 percent reduction goal with the remaining 8 percent to be achieved through improved energy management. The 45-percent Presidential goal is to be achieved through the use of energy efficient building and mechanical system design. In order to meet its long term goal of a 50-percent reduction in energy consumption in facilities operations, the Army will be conducting comprehensive basewide energy conservation studies, and testing alternate sources of energy such as solar and refuse-derived fuel. By the year 2000, it is expected that much of the Army's real property will be replaced with new buildings employing more energy efficient design. Programs for the period will be concerned with innovative construction methods, improved utility systems, and better management of energy. The Secretary of the Army will annually present awards to recognize the energy conservation achievements at an installation in each of the following categories: Active Army, Army National Guard, and Army Reserves.

Mobility Operations

In mobility operations, conservation of energy is achieved through adherence to the 55 mph speed limit and improved petroleum, traffic, and transportation management. Actions such as converting the sedan fleet to compact vehicles and moving heavy equipment on higher mile per gallon transports are expected to significantly reduce fuel consumption in order to meet the 10-percent reduction goal. As we move into the mid- and long range periods, the greatest challenge faced by Army mobility programs is to maximize fuel economy with no degradation in the state of readiness. Future programs will ensure that vehicle and other fuel consuming equipment under development have fuel economy as an evaluation factor included among established source selection criteria. In the long range the Army will move toward the utilization of electric powered vehicles to the maximum extent for administrative purposes and explore the use of synthetic fuels in order to achieve the Army goal to convert 20 percent of its mobility energy consumption to alternate or synthetic fuels by the year 2000.

Training

Measures which are being used by the Army to conserve energy in training include consolidating field and firing range training, incorporating conservation into individual and unit training, utilizing dismounted troop movement when feasible, and leaving equipment onsite while troops return to garrison by bus or truck. Another key program is increased use of simulators, simulations, and other training devices. These programs will continue to be pursued vigorously in the near term and at this time appear to offer the best opportunity for savings in training energy consumption in the long range period with no degradation in the state of readiness.

Research and Development

Research and development (R&D) efforts by the Army include cooperative programs with the DOE, the Navy, and the Air Force and the monitoring of commercial developments and demonstration projects in addition to Army initiated research and development.

In the mobility operations area, efforts are directed toward new or improved aircraft and ground propulsion systems and alternate energy fuel sources. New initiatives involve research into fuel savings through improvements in engines and transmissions as well as in fuels and lubricating oils. In order to meet the Army's long range goals of reduction in energy consumption and dependence on petroleum fuels, Army research and development will concentrate on new engines of improved efficiency capable of using synthetic and alternate fuels.

In the facilities or installation operations area, research and development efforts are directed toward providing technology on energy conservation, alternate energy sources and management of energy resources so as to minimize the impacts of the rising cost of energy and scarce fuels on the Army's readiness and training mission. On going research includes computer aided evaluation of building energy loads, energy carrier, storage and distribution system concepts. A data system is being developed to predict, report, and analyze energy consumption. Procurement specifications for solar energy systems for heating, cooling, and hot water are being developed. Other R&D efforts in alternate sources include waste derived fuel and coal conservation. Control systems will provide tools for basewide energy management. New construction techniques as well as improved energy and utility systems are needed to accomplish the President's goals for a 20-percent reduction in energy consumption in existing buildings and a 45-percent reduction in energy consumption in new construction. To meet the Army's long term objective of a 50-percent reduction in energy consumption in installation operations will require an extension into all aspects of energy systems research. Conversion technology will have to be closely examined to eliminate all natural gas and reduce the use of petroleum heating fuels 75 percent by the year 2000.

Public Affairs

The Office of the Chief of Public Affairs (OCPA) established a Command Information Mini Plan on Energy Conservation in CY1977. The objectives of the plan were to create awareness among all active and reserve Army, National Guard, civilian employees, retirees, and dependents of the importance of and their responsibilities for achieving energy conservation. A recent study established that there is a potential readership audience of 35,000,000 persons in these groups. In addition, a Public Affairs Plan has been prepared to support the Army Energy Plan and the implementation of Army energy programs and policies designed to meet the Army's near term and long range energy goals. This plan provides for the dissemination and circulation of informational materials and outlines the responsibilities of OCPA, Department of the Army (DA) Staff agencies, and the major commands.

FEDERAL ENERGY LEGISLATION

A summary is provided of the energy legislation, both proposed and enacted by the U.S. Congress, of the greatest interest to the Army. These have been selected from over 60 pieces of energy legislation which have been enacted by

Congress since the 1973 oil embargo. The major thrust of this legislation has been to encourage conservation and to reduce dependence on foreign sources. Legislation is needed in the following areas to assist in meeting the Army's goals:

a. A 4-day workweek could provide installation commanders an additional means of conserving energy.

b. Refuse-derived fuel usage at installations retrofitted at no cost to the Army would be possible if operation and maintenance funded contracts were authorized for extended periods of time.

c. Nuclear powerplant licensing and operating regulations need clarification or adjustment to make nuclear power a more practical option.

d. Additional incentives are needed to develop additional coal supplies to include alleviating environmental restrictions involved in strip mining and burning higher sulfur content coal.

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CHAPTER 1

BACKGROUND: WORLD AND UNITED STATES ENERGY SITUATIONS

1.1 WORLD ENERGY SITUATION

1.1.1 Historical Perspective. Global industrial and economic growth has been primarily driven by the unrestricted and expanding availability of energy. From a historical perspective, the harnessing of waterpower was the harbinger of the Industrial Revolution, but it has been energy in the form of fossil fuels used in steam and combustion engines that truly revolutionized our industrial capabilities. With seemingly endless supplies of wood, surface coal, yet untapped subsurface coal, and the discovery, starting in 1859, of underground "oceans" of crude oil, the global energy situation early in the 20th century could only be termed ideal.

Crude oil in the form of petroleum and its byproducts eventually proved to be the most efficient and cost-effective energy resource worldwide. Since 1918, the annual increase in world petroleum production has averaged 6.7 percent. It is important to note, however, that it was the industrialized world, represented primarily by Western Europe and the United States, that provided the impetus for increased petroleum production for nearly half of this century. Petroleum consumption increased as industrial and economic activity increased throughout the world. In fact, recent worldwide changes in gross national product (GNP) and petroleum consumption have a close correlation (figure 1-1).

1.1.2 The Global Energy Crisis. In October 1973, the world was subjected to a selective political denial of petroleum by the Arab oil embargo. This embargo on crude oil exports to Western Europe and the United States from the Organization of Arab Petroleum Exporting Countries (OAPEC), following the

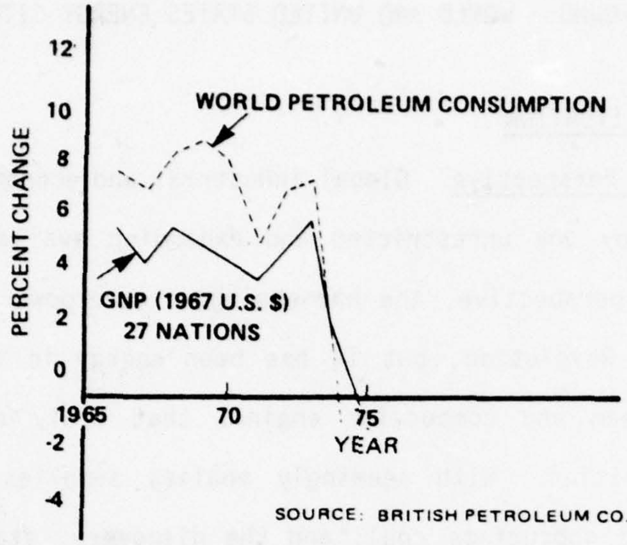
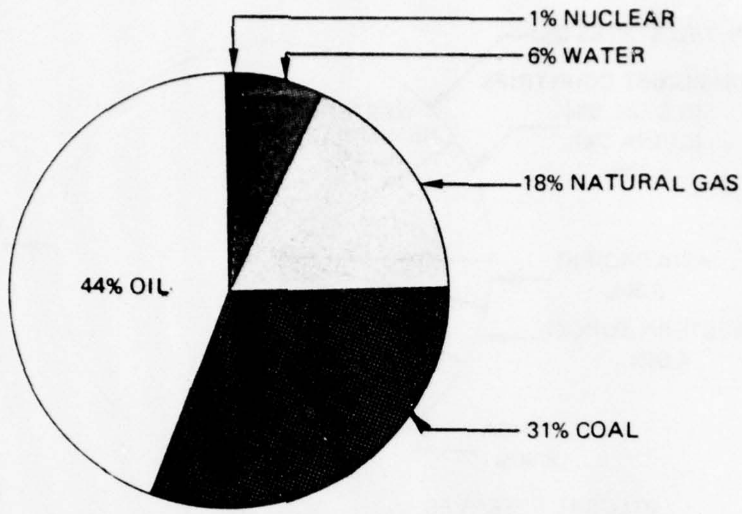


Figure 1-1. CHANGES IN ENERGY AND GNP APPROXIMATED FOR THE WORLD

Mideast conflict of late 1973, led to mandatory curtailment of activities and in turn to lower petroleum consumption throughout the Western World.

An immediate effect of the embargo was a threefold increase in the price of imported petroleum from 1973 to 1974. Oil constitutes about 44 percent of the world's primary energy consumption (figure 1-2). For the world's industrialized nations, therefore, energy problems are primarily oil problems when oil supplies are cut off. Due to this reliance on oil, the world's economic balance soon faltered. This manifested itself in a general slowdown in the tempo of international business and industrial production and attendant increases in the rates of unemployment and monetary inflation.

The economic crisis was somewhat abated by the lifting of the embargo in March 1974, but the world suddenly became aware of the harsh realities of a new era of energy supply and demand.



SOURCE: BRITISH PETROLEUM REVIEW OF THE OIL INDUSTRY, 1975

Figure 1-2. 1974 WORLD ENERGY SOURCES

1.1.3 The Global Energy Predicament. While the crisis of 1973 was politically motivated, the real issue with respect to the world's energy situation lies in the fact that the principal oil consumers are not the major oil producers. Geographical distribution of proved and probable crude oil reserves, estimated by the Central Intelligence Agency (CIA), places 67 percent of the world's oil in the Middle East and Africa. The combined reserves of the entire Western Hemisphere, along with Western Europe, make up only 19 percent of the world's total reserves. The United States has a mere 6 percent of that total. (See figure 1-3.) The long term energy predicament is that oil reserves are nonrenewable. Thus, alternative forms of energy will eventually become a necessity. This fact of practical exhaustion is also true for natural gas and coal.

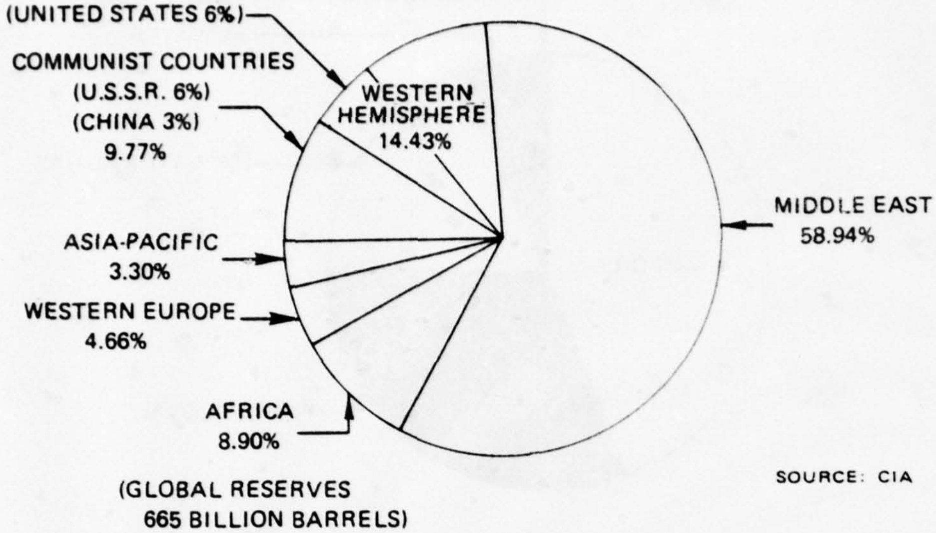


Figure 1-3. 1977 ESTIMATED, PROVED AND PROBABLE, WORLD PETROLEUM RESERVES

1.1.4 World Oil Depletion. The oil depletion date is the time when the available resources are below the amount necessary to maintain existing world consumption patterns. This constitutes a shortfall in supply. The exhaustion date is when the world has consumed the total of ultimately discovered, recoverable oil reserves. As oil reserves are depleted, production can be expected to decline. Theoretical exhaustion dates have been projected based on the length of time that varying levels of production and consumption rates could continue until oil supplies have been totally exhausted. The various estimates of future consumption or the remaining reserves available are no more than informed opinions. New extraction techniques, changing oil prices, conservation measures, and national growth and consumption rates are among the many parameters which, when varied, provide differing theoretical exhaustion dates. Estimates of proved reserves vary for the same reasons. Consequently, a broad range of estimates of both proved and theoretical reserves have been examined.

Four alternative oil consumption growth rates have been used to determine possible exhaustion dates (figure 1-4). The shaded area represents the Energy Research and Development Agency's (ERDA) 1976 estimated spread of total oil resources available. The ERDA upper limit represents the greatest amount of oil resources that are estimated to exist. The ERDA lower limit represents

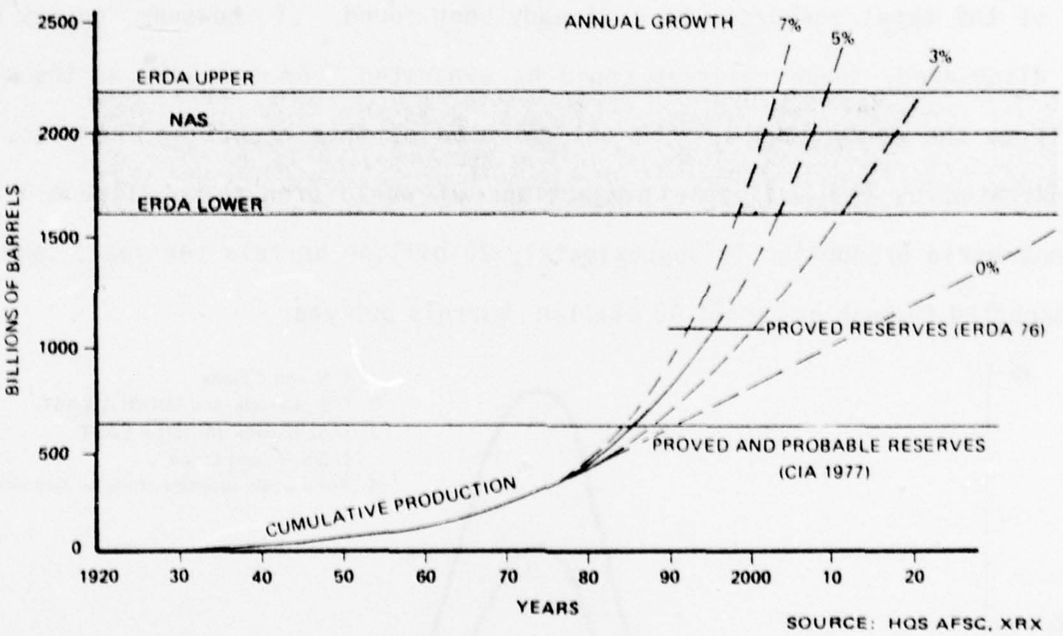


Figure 1-4. USE OF WORLD PETROLEUM RESOURCES

the least amount of petroleum reserves considered to exist. The dark line within the shaded band represents the 1975 estimate of the National Academy of Sciences (NAS).

It is significant to note that the exhaustion dates are relatively insensitive to reduced growth rates. The difference between exhausting the shaded upper and lower bounds of the ERDA prediction is about 4 to 8 years, depending upon the growth rate assumed. Reducing the historical growth (6.7 percent) to 5 percent would delay exhaustion by about 5 to 6 years, with exhaustion occurring between the years 2002 and 2007. Using a 3 percent growth rate, exhaustion would occur no later than 2020. By these extrapolations even if zero growth in consumption could be achieved, worldwide supplies would be totally exhausted by the middle of the next century.

Both the ERDA and the CIA estimates of proved reserves indicate that about half of the total resources have already been found. If, however, no new oil were discovered, these reserves could be exhausted from as early as the mid-1980's to the early 1990's. The unlikelihood of this occurring, however, is demonstrated by the available projections of world production (figure 1-5). Current world production is approximately 20 billion barrels per year, and it is expected to peak at about 40 billion barrels per year

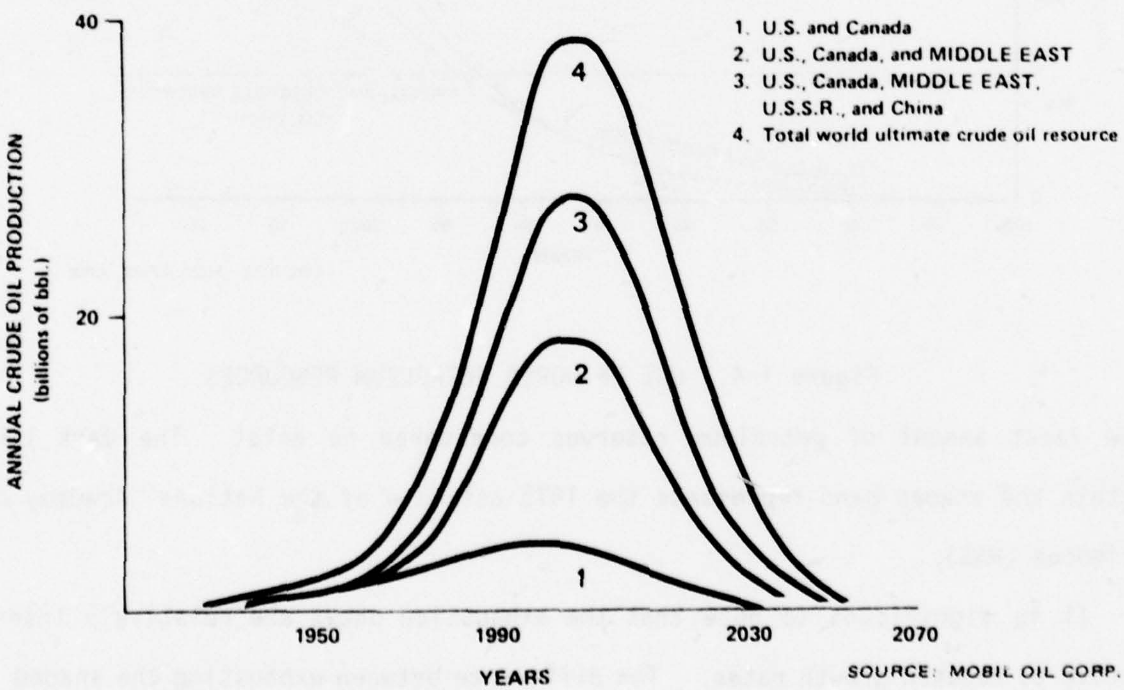


Figure 1-5. PRODUCTION OF PETROLEUM

in the 1990's. Thereafter, as total predicted reserves are depleted, production is expected to decrease.

1.1.5 Alternative Sources of Oil. Oil shale and bituminous tar sands both contain considerable amounts of recoverable oil. The world total oil recoverable from oil shale was estimated by the most recent World Energy Conference held in 1974 to be 1,462.5 billion barrels. Of this total, it is estimated that 72.7 percent can be found in the United States, 12.4 percent in Canada, with mainland China having the bulk of the remainder at 10.5 percent. Estimated oil deposits in oil shale nearly equals ERDA's conservative estimate of total recoverable world crude oil from conventional wells. Currently, extraction costs of oil from shale are not competitive with the extraction costs of crude oil from oil wells. Possible adverse environmental impacts of oil shale recovery further reduce its desirability as an alternative energy source. To illustrate this, it takes 1.88 million tons of shale excavation per day to produce 1.5 million barrels of oil. This equates to only 15 percent of the daily import of oil in 1977 and the excavation required is the equivalent of digging a new Panama Canal each week. Moreover, crushing and heating the shale to the necessary 1,100° F in a retort to boil off the oil locked in the rock turns the rock caustic and increases its bulk by 20 to 30 percent. Disposal of the leftover rock presents a problem, since it could introduce alkaline salts into water systems which could pose a threat to local agriculture. However, as conventional oil supplies are depleted and costs rise markedly, the oil shale alternative will become increasingly economically attractive and viable. Recovery of oil from tar sands has similar restrictions and problems attendant to oil shale recovery. Canada, with 38.5 percent, and South America, with

50.6 percent, have the bulk of the total estimated 956 billion barrels of oil equivalent available from tar sands as estimated by the 1974 World Energy Conference.

1.1.6 Natural Gas Resources. Natural gas is usually found in the geographic vicinity of oil bearing formations. Its geographical distribution is therefore similar to that of crude oil. The CIA estimates that total-proved, and probable, world natural gas reserves currently stand at 74.4 trillion cubic meters. (See figure 1-6.) This is the equivalent of 470 billion barrels of oil. Estimates of ultimately recoverable natural gas vary as widely as those for petroleum reserves. Expected exhaustion dates for natural gas follow a pattern similar to those for petroleum, with practical exhaustion expected, even under ideal circumstances, no later than the year 2070.

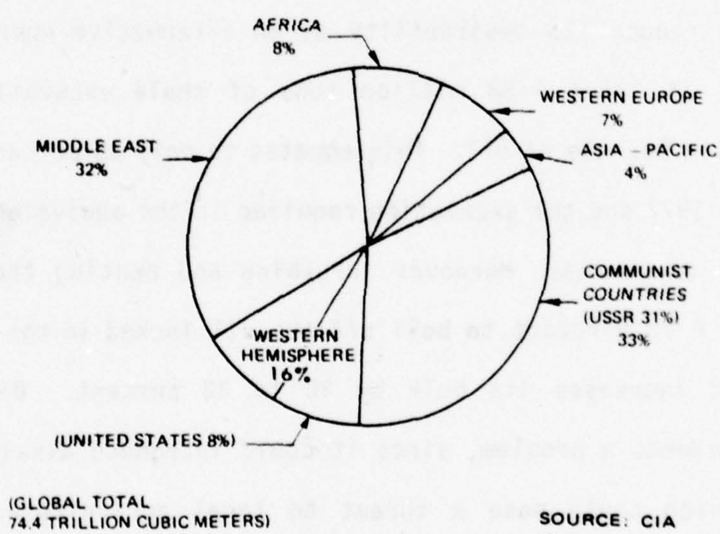


Figure 1-6. ESTIMATED, PROVED AND PROBABLE, WORLD NATURAL GAS RESERVES

It is noteworthy that while geographical distribution is generally similar to that for crude oil, the Soviet Union has a much larger percentage of estimated, world-proved, and probable, gas reserves (31 percent), than was shown for its share of oil reserves (6 percent). The United States has only 8 percent of proved, world gas reserves. Although the free world (non-communist) has 67 percent of total gas reserves, it is significant that natural gas is transported in bulk most efficiently by pipeline. Thus, the United States can rely less on both domestic and imported natural gas to supplement its future energy needs than can the Soviet Union which has large domestic gas reserves and can make extensive use of inland gas pipelines. The United States on the other hand must look to imported natural gas which would require the more expensive and more complicated process of gas liquification and tank storage necessary for its importation.

1.1.7 Coal Resources. Over half of the world's recoverable fossil energy is in the form of coal. Coal consumption, however, accounted for less than one-third of world energy consumption in 1974. The majority of the world's coal deposits are in the industrialized Western nations. Currently, only the communist countries use coal as their predominant energy source. Conversion from oil to coal use in Western nations is expected to increase in the near future. Resolution of problems concerning environmental impacts of coal mining are currently being acted upon. One major environmental issue involved is the costly reclamation of landscape which has been strip- or surface-mined. Also, coal, with high sulfur content, poses considerable threat to air quality. Sulfur can be substantially eliminated from coal, but the process is costly. In addition, eliminating particulate matter released into the air by burning coal requires a special scrubbing process which is also expensive.

1.2 UNITED STATES ENERGY SITUATION

1.2.1 Roots of the United States Energy Problem. The energy problem in the United States stems from the Nation's dependence upon one of its least abundant energy resources to provide for most of its energy needs. Since the year 1900, the United States has switched from using coal for over 75 percent of its energy needs to depending on oil and gas for over 75 percent of its energy needs (figure 1-7). However, oil and gas account for only 7 percent of U.S. proved recoverable reserves (figure 1-8).

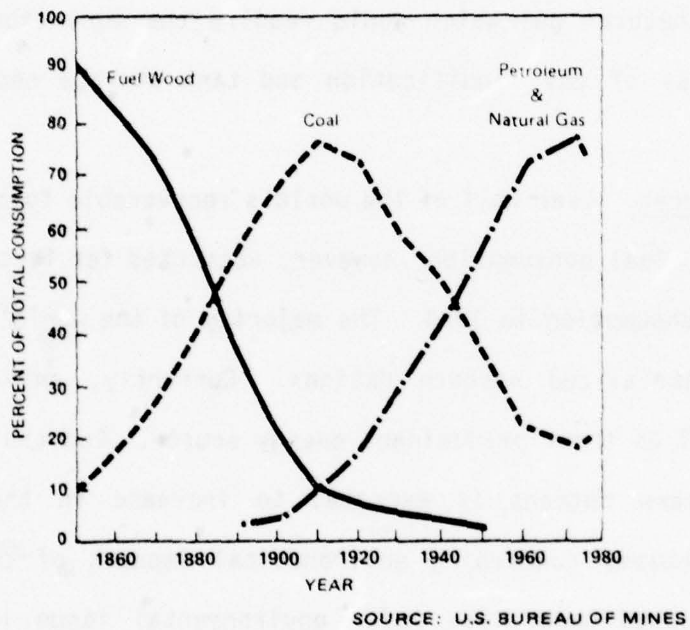


Figure 1-7. UNITED STATES SHIFT IN FUEL USE PATTERNS

From 1950 to 1970, energy costs decreased 28 percent. Inexpensive oil imports grew from 900,000 barrels per day, in 1950, to 3.4 million barrels per day in 1970. During this period, America's gross national product rose 102 percent and energy consumption virtually doubled. Because oil and gas were cheap and abundant, little concern was given to energy conservation. In fact,

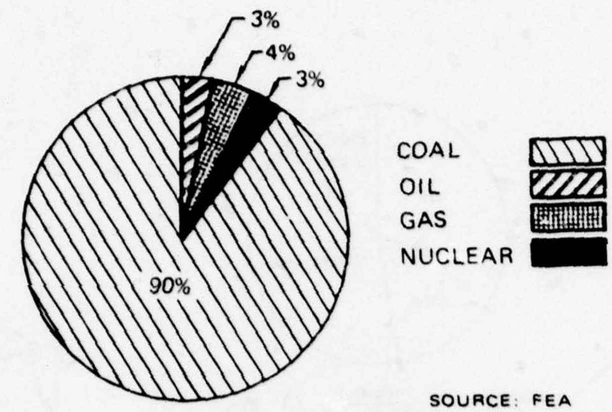


Figure 1-8. DISTRIBUTION OF RECOVERABLE NONRENEWABLE RESOURCES BY TYPE

higher energy consumption was, in many cases, stimulated by Government regulations. Our current American way of life has been shaped in large part by our increased energy consumption.

With less than 6 percent of the world's population, the United States consumes more than 30 percent of the world's energy. The United States uses more energy per dollar of gross national product than any other industrialized nation, more than doubling the consumption per capita of most western European nations.

1.2.2 <u>Current Energy Consumption Patterns and Trends</u>. United States energy consumption by end-use sector (industry, residential, and transportation) in 1976 (figure 1-9) indicates that oil is used heavily by all three sectors, but almost half of the total liquid petroleum is used in transportation. This is true because no economically feasible substitute fuel is currently available for the internal combustion engine. Coal is used principally by electric utilities and industry. Natural gas is a preferred fuel for residential and

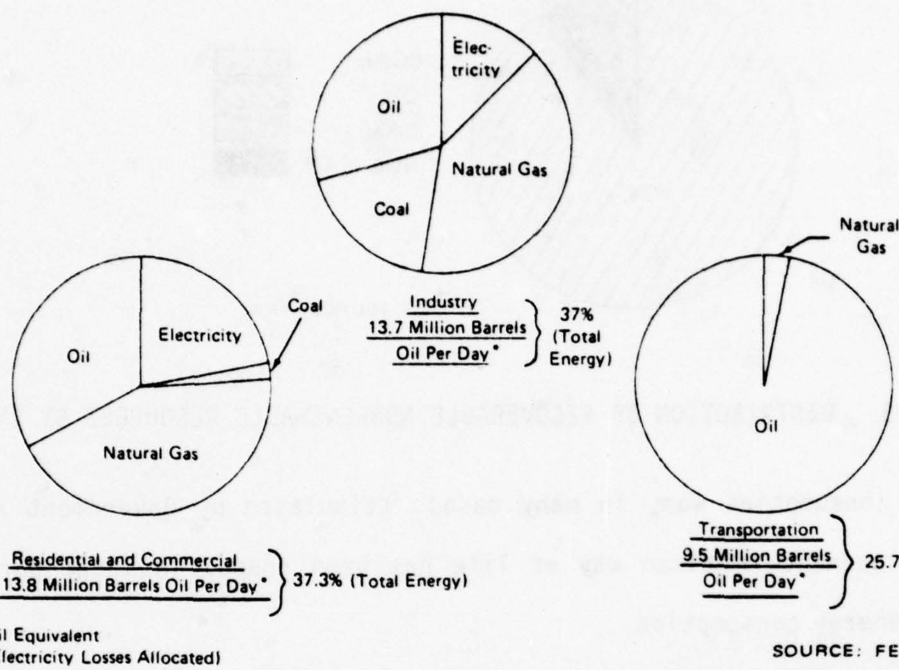


Figure 1-9. U.S. ENERGY CONSUMPTION BY SECTOR, CY1976

commercial use because it is a clean and efficient fuel for heating and it is also heavily used in industrial processes. Nuclear energy is used in generating electricity.

The consumption of electricity accounted for 28.8 percent of total domestic energy consumed in 1976. Oil and natural gas accounted for 15.7 percent and 14.5 percent, respectively, of total energy used in generating electricity. Coal used for electricity rose 1.8 percent from 1975 to the 1976 consumption level of 46.3 percent. Coal usage is expected to continue to increase as generating plants convert from natural gas and oil. The remainder of the generating sources were nuclear energy, 9.4 percent, hydroelectric power, 13.9 percent, and other sources, 0.2 percent.

It is important to note that conversion of energy from any fuel to generate or transmit electrical energy is a relatively inefficient process. Energy is lost each time a conversion takes place. Edison Electric Institute estimates that only approximately 30 percent of the energy contained in a fossil fuel is ultimately generated as electricity. As the electricity is converted by the end user to heating a coil or powering a motor, energy provided by the original source is further reduced. Thus, significant energy conservation opportunities exist in the generation, transmission, and utilization of electricity regardless of generating fuel source.

Oil consumption grew at an average annual rate of 4.4 percent from 1947 to 1973. The Arab oil embargo forced the price of oil to triple and also precipitated an immediate drop in consumption. Domestic demand for refined petroleum products dropped by 1 million barrels per day between 1973 and 1975. In 1976, however, the trend turned upward and oil consumption grew by 6.7 percent. Natural gas consumption, on the other hand, has decreased steadily from its all time peak percentage of total energy consumption of 33.2 percent in 1971 to 27.4 percent of total energy consumed in 1976.

Coal consumption has decreased steadily as a percentage of total energy consumption, from 1950, when coal constituted 38 percent of total energy consumed, until 1973, when the trend reversed because of its comparative price and increased restrictions on extraction methods and processes. In 1976, coal consumption constituted 18.4 percent of total energy consumed, as shown in figure 1-10.

Year	Total (quads)	Percent of Total				
		Petroleum[1]	Coal	Natural gas[2]	Hydroelectric power	Nuclear power
1950	34.0	39.7	38.0	18.1	4.2	--
1955	39.7	44.1	29.1	23.3	3.5	--
1960	44.6	45.0	22.8	28.5	3.7	(3)
1961	45.3	45.2	21.9	29.2	3.7	(3)
1962	47.4	44.8	21.5	29.8	3.9	(3)
1963	49.3	44.5	21.7	30.1	3.6	0.1
1964	51.2	43.7	22.0	30.5	3.7	0.1
1965	53.3	43.6	22.3	30.2	3.8	0.1
1966	56.4	43.2	22.2	30.8	3.7	0.1
1967	58.3	43.5	21.1	31.3	4.0	0.1
1968	61.8	43.8	20.5	31.7	3.8	0.2
1969	65.0	43.7	19.6	32.4	4.1	0.2
1970	67.1	44.0	18.9	32.8	4.0	0.3
1971	68.7	44.5	17.5	33.2	4.2	0.6
1972	71.9	45.8	17.3	32.0	4.1	0.8
1973	74.7	46.6	17.8	30.4	4.0	1.2
1974	73.0	45.8	17.9	30.2	4.5	1.6
1975	70.6	46.4	18.2	28.2	4.6	2.6
1976	74.2	47.3	18.4	27.4	4.1	2.8

[1] Includes natural gas liquids.

[2] Dry natural gas.

[3] Less than one-tenth of one percent.

SOURCES: BUREAU OF MINES, 1950 – 1975; FEA, 1976

Figure 1-10. DOMESTIC ENERGY CONSUMPTION BY TYPE OF FUEL

1.2.3 Oil Resources, Reserves, and Depletion. Increased consumption and lower domestic production of oil has led to increased dependence on the world oil market. This increases the the vulnerability of the United States to an interruption of import supplies critical to our energy requirements. In 1976, total imports averaged 7.3 million barrels of oil per day. This was 42 percent of U.S. consumption. By February 1977, oil imports increased to 9.6 million barrels per day. Of this, 84.1 percent of all crude oil imports came from the OPEC nations. Arab member nations supplied 46.7 percent of that total. This represents a 16-percent jump in import levels of September 1973, just prior to the Arab oil embargo, and further underscores the vulnerability of the United States to denial of imported oil supplies.

As the United States depletes its reserves, the trend towards importation will continue. Estimation of total U.S. reserves by the United States Geological Survey (USGS) has consistently been going down since 1963 when Duncan and McKelvey of the USGS predicted 658 billion barrels of total crude could be produced. It turns out that some very hopeful projections for new oil discoveries on- and offshore have thus far been disappointing. A 1974 report to the U.S. Senate stated that in 1945 it required 51 new-field wildcat wells to make one profitable discovery of oil. By 1965, it required 137 wildcat wells. Despite new technology, it is becoming harder and more expensive to find oil. Dr. M. King Hubbert, who was chief geology consultant to the Shell Oil Company and is an internationally renowned research geologist, predicted in 1956 that domestic crude oil production would peak between 1965 and 1970. He based this prediction on the thesis that total available domestic reserves were reaching a point of significant depletion, thereby sowing the seeds for a drop in production. Domestic production did indeed peak in 1970 (figure 1-11) and has declined steadily ever since. Dr. Hubbert's estimate of ultimate total crude oil production is 213 billion barrels. In June 1975, the USGS, after reexamining its earlier predictions and estimates, estimated that the ultimate total production of crude oil for the entire United States will be between 218.12 billion barrels (with a 95-percent probability) and 295.12 billion barrels (with a 5-percent probability). These lowered estimates closely correlate with Hubbert's original figures.

Estimates and projections of expected oil depletion dates depend upon assumed oil production and consumption rates. Annual growth rates in consump-

Year	Production (Millions of barrels per day)[1]
1950	5.4
1955	6.8
1960	7.0
1961	7.2
1962	7.3
1963	7.5
1964	7.6
1965	7.8
1966	8.3
1967	8.8
1968	9.0
1969	9.2
1970	9.6
1971	9.5
1972	9.4
1973	9.2
1974	8.8
1975	8.4
1976	8.1

[1]Does not include natural gas liquids, does include lease condensate.

SOURCE: FEA

Figure 1-11. DOMESTIC CRUDE OIL PRODUCTION

tion are subject to change, as conservation and other measures take hold. The Federal Energy Administration (FEA) projected that, with mandatory fuel efficiency standards and reductions in consumption due to higher oil prices, growth can be held to 3 percent annually. The projection developed in figure 1-12 depicts annual consumption growth rates from less than 1 percent to about 3 percent. The black strip represents ERDA's estimated range of future production, with expected, enhanced recovery methods and results taken into account. Taking the USGS statistical mean of total recoverable oil, and assuming that most of expected new discoveries will indeed occur, practical exhaustion can be delayed to between the late 1980's and mid-1990's. Also shown are current and projected possible levels of oil imports. Importing oil delays U.S. exhaustion dates. On the other hand, increased domestic production serves to advance the oil exhaustion date.

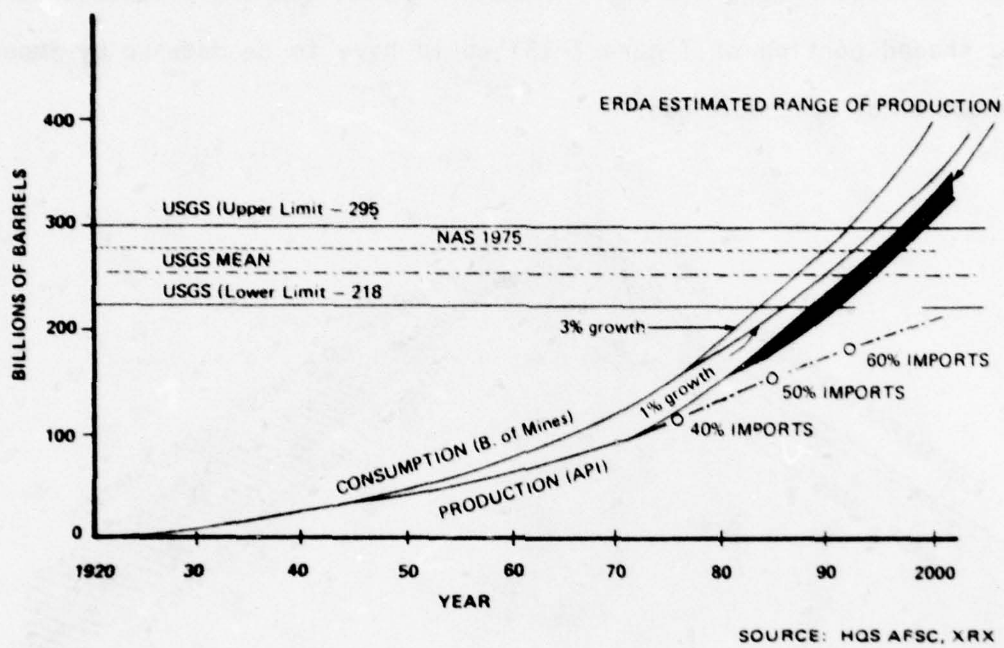


Figure 1-12. PREDICTED DOMESTIC OIL PRODUCTION, CONSUMPTION, AND EXHAUSTION

1.2.4 Natural Gas Resources, Reserves, and Depletion. Americans have been encouraged by Government and industry to consume natural gas because it is a clean, high efficiency fuel, and up to the present has been inexpensive.

Marketed production and domestic consumption of natural gas both increased steadily from 1950 to the 1973 peak of approximately 22 trillion cubic feet. Figure 1-13 depicts data on natural gas production and consumption taken from 1950 to 1976. It also depicts projections of natural gas marketed production and domestic consumption (including imports) from 1976 to the year 2000. These projections were arrived at through a linear regression of natural gas production and consumption data and therefore represent a statistical technique and not necessarily a forecast. The regression was calculated from the last peaks in production and consumption which occurred in 1973 and 1972, respectively. Production is shown to drop off sharply and cease between 1995 and 2000. The statistical shortfall between consumption and production after 1978 (see shaded portion of figure 1-13) would have to be made up by imports or by production of synthetic gas.

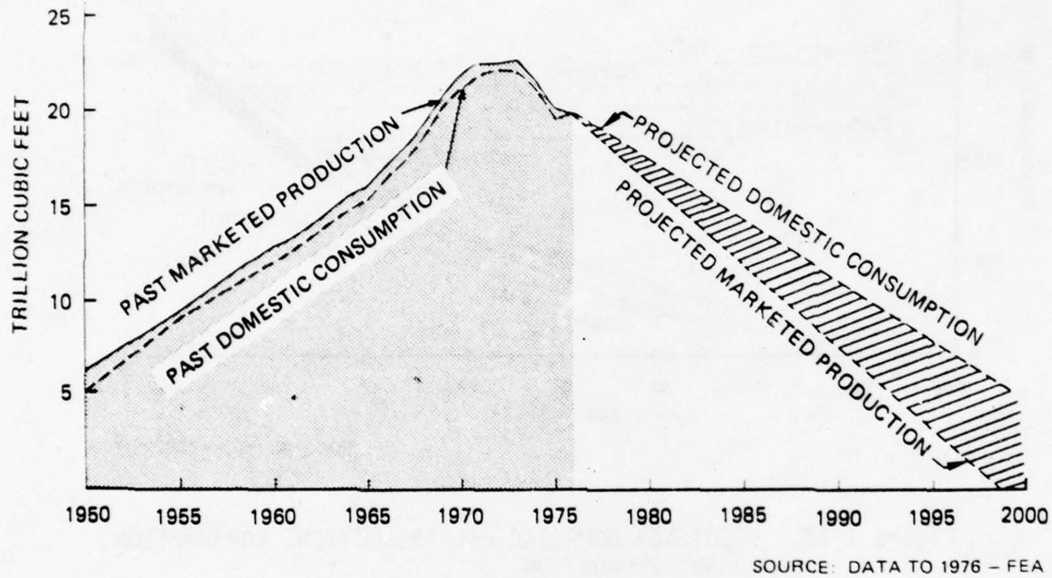


Figure 1-13. DOMESTIC NATURAL GAS PRODUCTION AND CONSUMPTION

The growth pattern of natural gas reserves is similar to production and consumption. Figure 1-14 depicts data on natural gas reserves taken from 1950 to 1976 which represents net totals of current reserves, newly discovered reserves, and depletion of reserves for a given year as opposed to a cummulative representation of reserves. The regression technique was also used here taking reserve data from 1967 (the highest peak in reserves) and projecting natural gas reserves to the year 2000. By 1973 gas reserves had dropped 15 percent to 250 trillion cubic feet. Subsequent years show approximately a 5-percent annual decrease in reserves. A steady depletion of reserves at the rates currently experienced will cause ultimate exhaustion of domestic natural gas to occur some time between the year 1990 and 2000. Apparently, while the technical ability to produce oil and the requirement to consume natural gas exist, that very production and consumption is outstripping the available natural gas reserves.

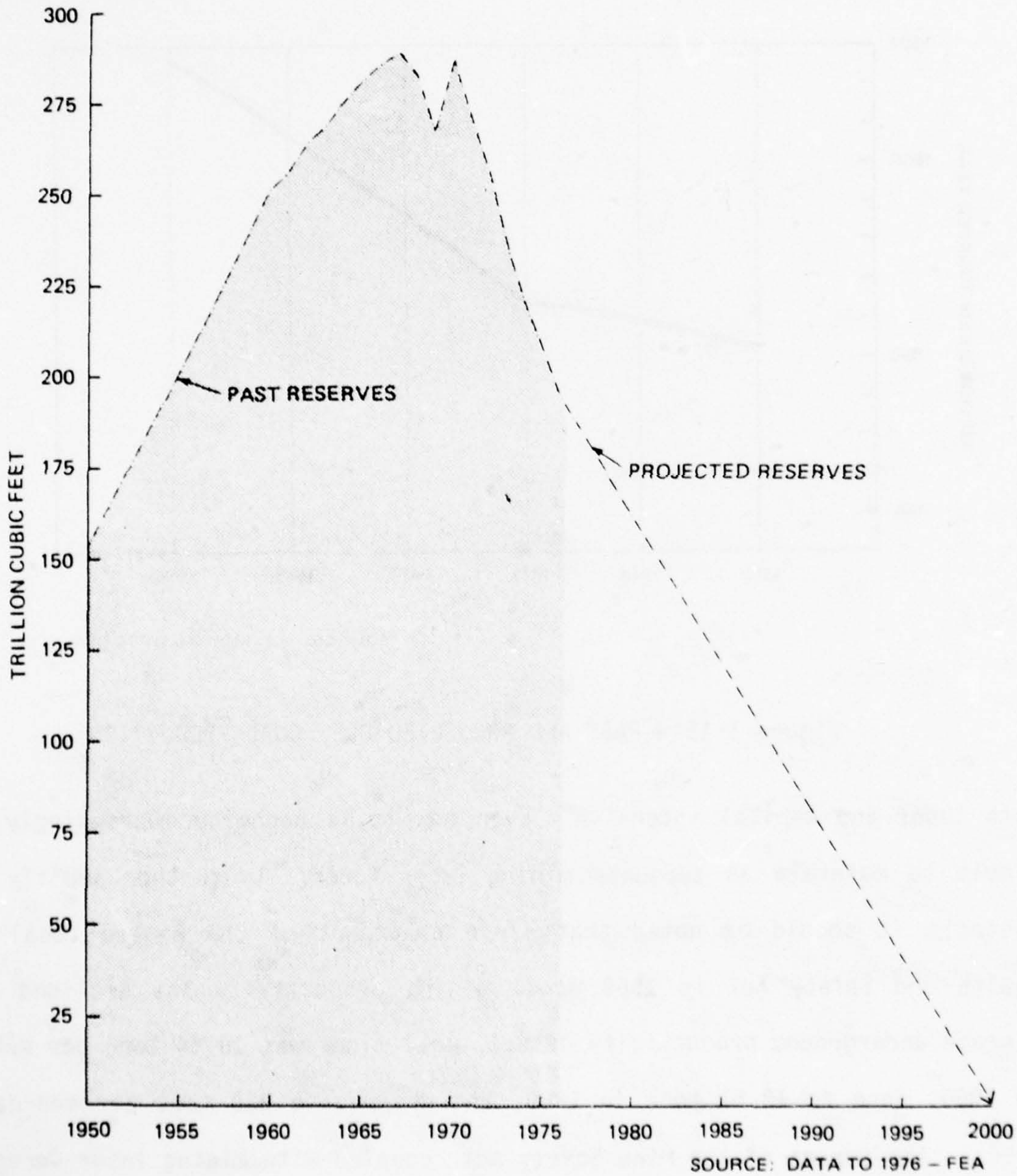


Figure 1-14. DOMESTIC NATURAL GAS RESERVES

1.2.5 <u>Coal Resources and Reserves</u>. Coal constitutes 90 percent of U.S. conventional energy reserves, but currently represents only 18 percent of energy use. While the coal industry presently has only a small amount of excess capacity, it is hoped that production can be significantly expanded in the near future (figure 1-15). However, expansion of mining capacity will be

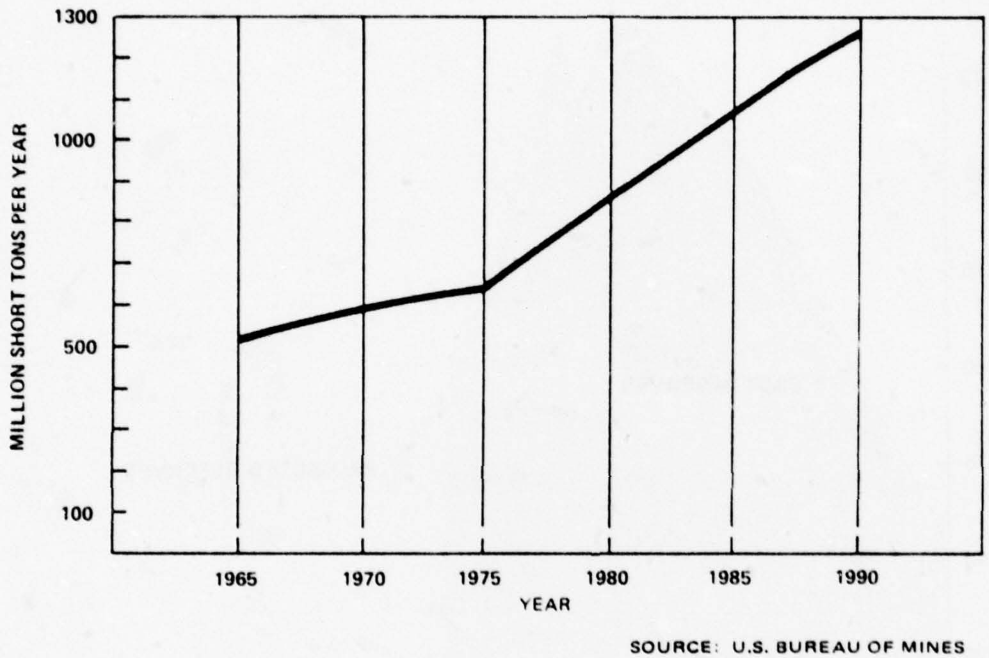


Figure 1-15. PAST AND PROJECTED U.S. COAL PRODUCTION

both labor and capital intensive. Even now it is becoming increasingly difficult to maintain an adequate mining labor force. To further amplify this obstacle it should be noted that since enactment of the Federal Coal Mine Health and Safety Act in 1969, coal mining productivity has declined. The average underground productivity of U.S. coal mines was 10.64 tons per man-day in 1960, rose to 15.61 tons in 1969, and dropped to 8.5 tons per man-day by 1976. The impact of the Mine Safety Act coupled with mining labor unrest has in part caused a 40-percent reduction of deep mine capacity during the period 1970 to 1976. This equates to an elimination of over 200 million tons per year of productive capacity. To compensate, 200 new mines with a capacity of 1 million tons per year might have to be initiated at a cost of $30 to $50 million per mine. While doubling coal production can be a partial energy solution, it also apparently provides serious new problems and challenges as well.

The United States has enough environmentally acceptable low sulfur coal reserves, located mainly in the Northern Rocky Mountain States, to last for the next few centuries at current rates. However, expansion of U.S. coal production also requires an associated expansion of the U.S. coal transportation system and coal handling and burning facilities. The one 273-mile slurry pipeline now operating in Arizona from the Black Mesa Coal Mines to the Mohave Generating Station handles about 5 million tons of coal per year. Currently considered or proposed pipelines could increase capacity to 100 million tons per year. In order to accommodate the doubling of our coal production, a major overhaul of the nation's rail network would be required in addition to providing new rolling stock. The National Academy of Engineers (NAE) estimates that an additional 8,000 railroad locomotives and 150,000 gondola and hopper cars would be required to effect a significant increase in usage of domestic coal reserves. NAE also indicates that at least 130 new rail-barge systems covering over 90,000 miles will need to be constructed to provide the United States with 1,300 million short tons per year. This increase in coal production could provide up to 40 percent of U.S. energy needs in 1990 based on current energy consumption levels.

1.2.6 Alternate Sources of Energy. The following outlines some of the more prominent and promising sources of fuels derived from either plentiful or inexhaustible resources.

1.2.6.1 Coal Gasification. Gas manufactured from coal was first produced in the late 18th century. The first U.S. company was chartered in Baltimore in 1816. The advent of electricity and availability of natural gas, in effect, caused the furtherance of coal gasification technology to be practically abandoned. Three coal gasification processes are currently under development.

Production of synthetic gas from coal is currently uneconomical in comparison with the regulated price of natural gas. As the supply of natural gas becomes critical, substitute fuels will be required.

1.2.6.2 Coal Liquification. The conversion technology required to use coal as a source of liquid fuels has existed for many years. During World War II, Germany built several synthetic fuel plants with a combined output of approximately 100,000 barrels per day. Availability of low priced crude oil in the United States has made this conversion technology uneconomical. However, for the past 20 years, the U.S. Office of Coal Research, Bureau of Mines, along with commercial interests has expended considerable research and development effort to improve the efficiency of conversion processes, lower the costs of facilities required, and generally make this alternative fuel source more competitive.

1.2.6.3 Nuclear. The restricted growth rate for nuclear power from fission is a function of the economic conditions of the utilities along with problems encountered stemming from environmental objections, safety considerations, complex licensing procedures, and construction and supply limitations, all of which result in delays. Moreover, the current most common reactor (lightwater) generates electricity from a uranium resource base of a finite size.

The ability to greatly expand nuclear generating capacity largely depends on the introduction of several new types of reactors which make better use of the available fissionable materials. Two alternatives are the liquid metal fast breeder reactor (LMFBR) and the high-temperature, gas cooled reactor (HTGR). Both reactors can greatly extend the resource base. The virtue of breeder reactors is that future models, which could be in operation late in this century, will produce more fuel than they consume. The United States has enough purified uranium-238 in storage which, if used in a breeder program, potentially could produce the electrical equivalent of more than five times all the oil possessed by all the oil exporting nations combined.

Nuclear fusion, the processing of combining the nuclei of light elements, has been successfully demonstrated in the laboratory for very short periods of time. Solution to the problem of containing the tremendous heat necessary to sustain the fusion reaction however is not near at hand. An important feature of the fusion process is that its fuel is derived from water which is one of the world's most plentiful resources.

1.2.6.4 Solar Energy. Harnessing radiant energy through various solar energy applications is an appealing concept because the technology emits almost no pollutants and does not compromise the environment or our health to the same extent as do other energy technologies. Some of the areas DOE is pursuing in this field are: heating and cooling; solar thermal conversion; photovoltaic conversion; and ocean thermal energy conversion. Of these, solar energy for space heating, cooling, and hot water are existing technologies.

The technical barriers to using solar energy are associated with the facts that the sun's rays are spread diffusely over the surface of the earth and are intermittent. To harness large amounts of radient energy, solar collectors must cover large areas, and the larger the facility, the higher the cost. Thus, the economic barriers to the use of solar energy stem from the fact that high initial costs are required for solar energy facilities, even though the operating costs are low.

1.2.6.5 Geothermal Energy. The heat inside the earth is a vast potential source of energy. The Geysers plant in California, for example, is currently producing electricity from geothermal energy. A probable course of development for geothermal energy in the near future will be construction of powerplants using hot water, brine, or steam separated from hot water or brine deposits, which occur in a few areas in the United States. Geothermal power is not expected to replace either fossil or nuclear fuels as the major source of electricity generation but will probably be exploited to whatever extent is practicable.

1.2.6.6 Hydrogen, Ammonia, Methanol, and Methane. These fuels have the common properties of being synthesized from abundant materials and of having products of combustion that are not noxious and that can be assimilated into the environment at the point of use. Hydrogen is the simplest and cleanest and has the highest heating value per pound of the fuels mentioned. Moreover, it is a basic ingredient for the other alternative fuels.

Today, hydrogen is most commonly produced by the steam reforming of volatile hydrocarbons. Some hydrogen is currently produced by the electrolytic decomposition of water. In the future, other possibilities for hydrogen production include bioconversion, use of ultraviolet light from a fusion torch, and use of municipal rubbish and plants as feedstock for chemical reforming using existing technology.

Ammonia is used extensively in the fertilizer industry, but it can also serve as a fuel. It can either be burned directly or be used as an input to a fuel cell.

Methanol is most commonly produced from synthetic gas obtained from coke, coal, or natural hydrocarbons. Methanol can also be produced by the destructive distillation of wood or municipal solid waste which also produces methane gas. Indeed, in mainland China and India small farms and villages have been using manure-fired methane generators for the past 20 years. Since manure is a relatively small resource in the United States other waste use such as crop residue, forestry leavings, and seaweed are being looked into. Four to eight billion tons a year of trees, sugarcane, and other crops could be grown on marginal land, not used for agriculture production, and be made into methanol and methane on a large scale. Both fuels are clean burning, efficient, and offer little or no environmental problems. A mixture of 10 percent methanol and gasoline or "gasohol" is already considered a viable means of stretching our use of petroleum distillates since it has already been used in unmodified automotive engines.

1.2.6.7 Wind Energy. Man has long recognized and utilized the energy in the wind. Windmills were known in China and Japan as early as 2000 B.C. and have been in common use for at least 700 years in parts of Europe. Wind energy systems were in wide use in the western United States until about 1950. Some are still to be found in remote regions, pumping water into stock tanks or generating electricity for individual farm houses. Wind is actually a universally distributed manifestation of the earth's solar energy. It requires a technology quite different from solar energy and therefore is mentioned separately here. DOE's general objective regarding wind power is to advance the technology and accelerate the development and utilization of reliable and economically viable wind energy systems to meet future energy requirements in the appropriate applications and regions.

CHAPTER 2

NATIONAL ENERGY OBJECTIVES, STRATEGIES, GOALS, AND ORGANIZATION

2.1 INTRODUCTION. The following reflects the nation's energy objectives, strategies, and goals as exerpted from the President's proposed National Energy Plan published 27 April 1977. Congress must fully ratify and incorporate the proposed plan into legislation before it can officially be considered national policy.

2.2 NATIONAL ENERGY PLANNING PRINCIPLES. The proposed plan contains 10 energy planning principles. They establish the context in which energy policy will be formulated, and provide the foundation for the National Energy Plan. The following are excerpts of those principles:

a. The energy problem can be effectively addressed if the Government accepts responsibility for dealing with it comprehensively, and if the public understands its seriousness and is ready to make necessary sacrifices.

b. Healthy economic growth must continue.

c. Environmental protection policies must be maintained.

d. The United States must reduce its vulnerability to potentially devastating supply interruptions.

e. The United States must solve its energy problems in a manner that is equitable to all regions, sectors, and income groups.

f. Growth of energy demand must be restrained through conservation and improved energy efficiency.

g. Energy prices should generally reflect the true replacement cost of energy.

h. Both energy producers and consumers are entitled to reasonable certainty as to Government policy.

i. Resources in plentiful supply must be used more widely, and the nation must moderate its use of those in short supply.

j. Use of nonconventional sources of energy must be vigorously expanded.

2.3 NATIONAL ENERGY OBJECTIVES. Three primary energy objectives have been proposed in the plan:

a. The United States must immediately reduce its dependence on foreign oil to limit its vulnerability to supply interruptions.

b. The United States must limit its oil imports to enable it to weather midterm stringency in world oil supplies caused by capacity limitations.

c. The United States must in the long term have renewable/inexhaustable sources of energy for sustained economic growth.

2.4 NATIONAL ENERGY STRATEGIES. The strategy of the proposed plan has three components to achieve national objectives.

a. Through conservation, rate reform, and pricing policy, the nation should reduce the annual rate of growth of demand to less than 2 percent.

b. Industries and utilities should convert to coal and other abundant fuels. This should reduce oil imports and make gas available for household use.

c. A vigorous energy research and development and demonstration program should be pursued to find viable energy alternatives.

2.5 NATIONAL ENERGY GOALS. The plan established the following goals to be achieved between now and 1985.

a. Reduce the rate of growth of energy comsumption to below 2 percent per year.

b. Reduce gasoline consumption by 10 percent below the 1975 level.

c. Reduce oil imports to less than 6 million barrels per day, about one-eighth of total energy consumption.

d. Establish a strategic petroleum reserve of 1 billion barrels.

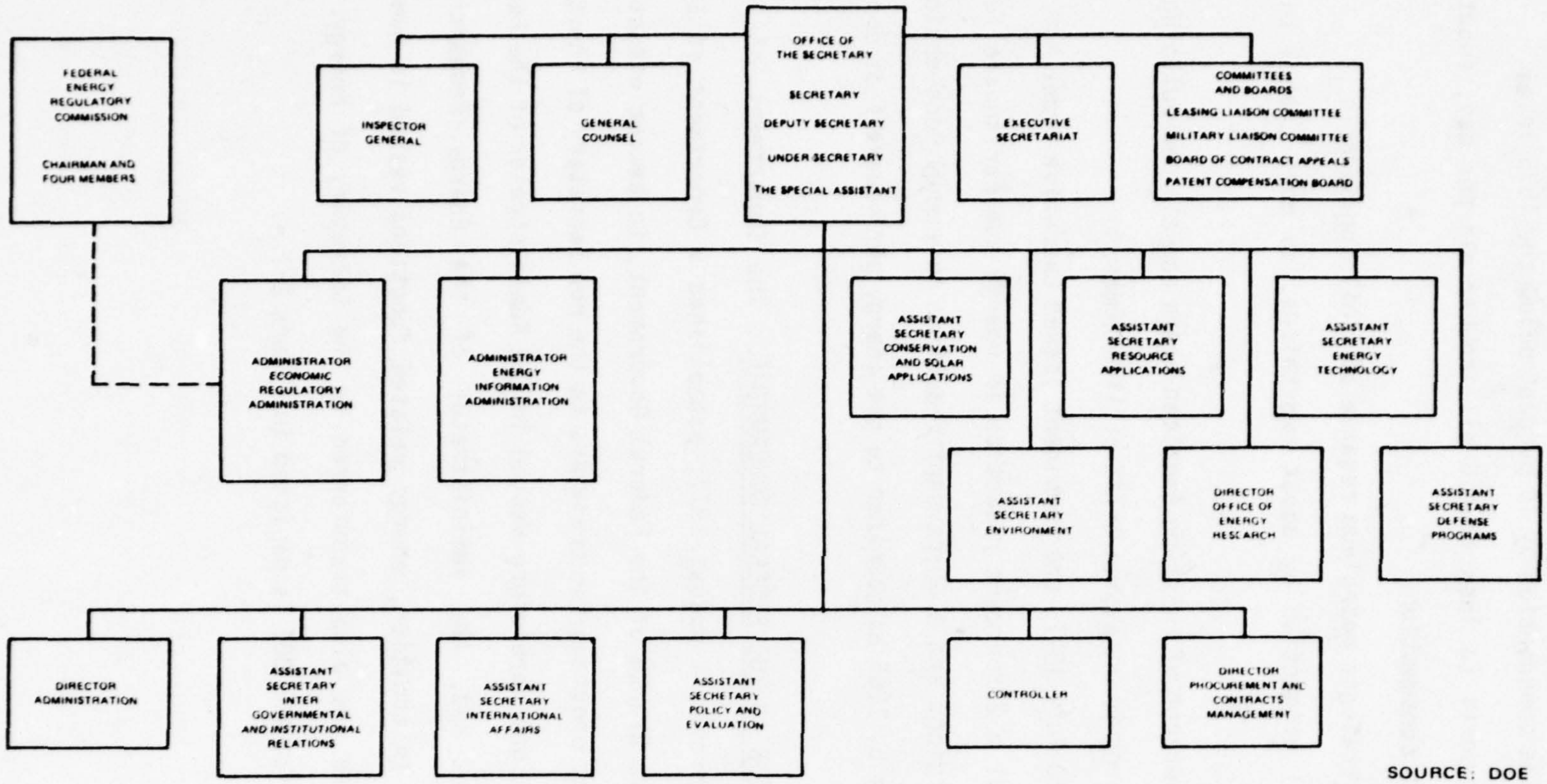
e. Increase coal production by about two-thirds, to more than 1 billion tons annually.

f. Insulate 90 percent of existing American homes and all new buildings.

g. Use solar energy in more than 2-1/2 million homes.

In addition, on 20 July 1977, the President issued Executive Order No. 12003 which has as its goal a 20-percent reduction in energy use per square foot in existing Federal buildings and a 45-percent reduction in energy consumption for new Federal buildings by 1985 as compared to the energy per square foot consumed in 1975.

2.6 <u>ENERGY ORGANIZATION IN THE FEDERAL GOVERNMENT</u>. The Department of Energy Organization Act, approved 4 August 1977, established a Department of Energy (DOE) in the Executive Branch of the Federal Government, to become effective 1 October 1977. The Act provides for transfers to the new Secretary of Energy all of these energy functions heretofore vested in the Administrator of the Federal Energy Administration and, the Administrator of the Energy Research and Development Agency. In addition, energy related functions vested in numerous other Federal agencies are also transferred to the Secretary of Energy. The general organization for the DOE is depicted in figure 2-1.



SOURCE: DOE

Figure 2-1. DEPARTMENT OF ENERGY ORGANIZATION AND FUNCTIONS

CHAPTER 3

THE ARMY ENERGY SITUATION

3.1 BACKGROUND. In order to address the Army energy situation, it is necessary to place it in perspective with the Department of Defense (DOD) energy environment as well as that of the nation and the world. DOD accounts for approximately 1.9 percent of the total national energy consumption (see figure 3-1) and 82.5 percent of the total Federal Government energy consumption.

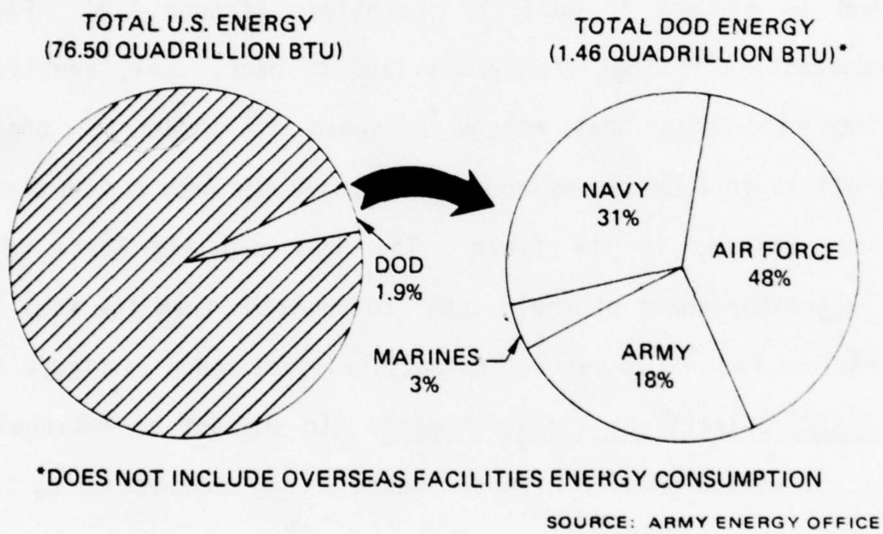


Figure 3-1. DISTRIBUTION OF DEFENSE ENERGY, FY77

While the overall DOD energy consumption is 1.9 percent of the total consumption, the percentage for petroleum consumption exceeds 3 percent. In terms of daily consumption, DOD consumes the equivalent of approximately 700,000 barrels of oil. Liquid petroleum requirements comprise 67 percent of that amount or nearly one half million barrels of oil, thereby underscoring the importance of petroleum to DOD operations. War, or the imminent threat of war, could cause these requirements to be doubled or tripled. The essentiality of petroleum to DOD operations, coupled with the fact that at present approximately half of the U.S. consumption is imported, make a reliable supply of petroleum of prime concern to DOD. Of the 1.46 quadrillion Btu of energy consumed by DOD in FY77, the Army consumed about 18 percent, the Navy 31 percent, the Air Force 48 percent, and the Marine Corps 3 percent, as shown in figure 3-1.

Of the Army's annual usage of energy, 84 percent is consumed in facilities operations and 16 percent in mobility operations (figure 3-2). Facilities operations consumption is that energy utilized to heat, cool, ventilate, and light buildings and also that energy consumed in industrial operations. Mobility operations include the energy used to move the Army and to conduct its operations and training in the field. The Navy and Air Force consume a proportionally greater share of their total consumption than the Army in their mobility operations, 40 and 70 percent respectively, as shown in figure 3-2.

3.1.1 DOD Goals, Objectives, and Strategies. In support of national objectives, DOD established a goal in FY74 to reduce energy consumption by 7 percent over FY73. In FY75, the goal was set at 15-percent savings using the FY73 consumption as the base figure. The goals for FY76 and FY77 were established at zero growth as compared with FY75. The DOD goals have been exceeded by a comfortable margin in each instance as shown in figure 3-3.

The DOD strategy has been to emphasize conservation through the DOD Energy Conservation Program. One of the cornerstones of that conservation program has been the Energy Conservation Investment Program (ECIP). This program is a military construction funded program for retrofitting existing DOD facilities

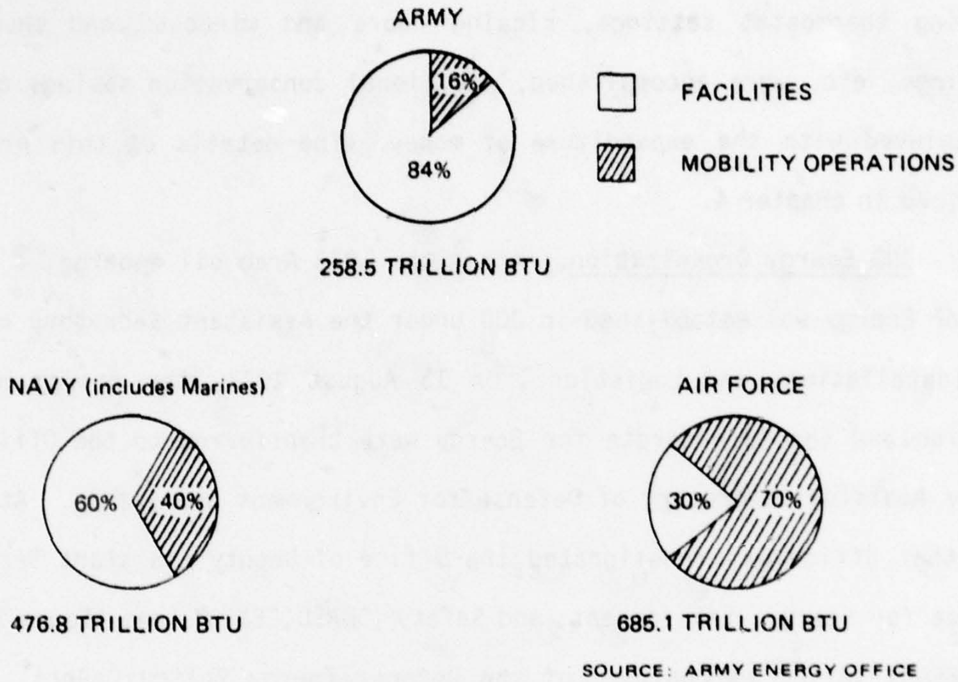


Figure 3-2. DISTRIBUTION OF ENERGY WITHIN SERVICES, FY77

FY	SAVINGS GOAL	RESULTS ACHIEVED
74	7% (base FY73)	25% savings
75	15% (base FY73)	26% savings
76	0 (base FY75)	7% savings
77	0 (base FY75)	3% savings

Figure 3-3. DOD ENERGY SAVINGS

to make them more energy-efficient while providing substantial savings in utility costs. DOD recognized early that once the "no-cost" actions such as reducing thermostat settings, closing doors and windows, and shutting off buildings, etc. were accomplished, additional conservation savings could only be achieved with the expenditure of money. The details of this program are contained in chapter 4.

3.1.2 DOD Energy Organization. After the 1973 Arab oil embargo, a Directorate for Energy was established in DOD under the Assistant Secretary of Defense for Installations and Logistics. On 15 August 1977, the energy management function and the Directorate for Energy were transferred to the Office of the Deputy Assistant Secretary of Defense for Environment and Safety. At the same time that office was redesignated the Office of Deputy Assistant Secretary of Defense for Energy, Environment, and Safety [ODASD(EE&S)] (see figure 3-4). The DASD(EE&S) serves as chairman of the Defense Energy Policy Council which was established to serve as a forum for the development of broad energy policy. It is composed of representatives from the following agencies: OASD (MRA&L), Office of the Joint Chiefs of Staff (OJCS), Defense Logistics Agency (DLA), Army, Navy, and Air Force.

DOD established a Defense Energy Information System (DEIS) as an energy management tool to provide statistical data on consumption in each of the services. In addition, DOD has required that each armed service establish a centralized organization for energy comparable with and responsive to the DOD Directorate for Energy.

3.2 ARMY GOALS, OBJECTIVES, AND POLICIES

3.2.1 Current Goals. The following goals in support of national and DOD objectives were enunciated by the Army Energy Office (AEO) in 1977.

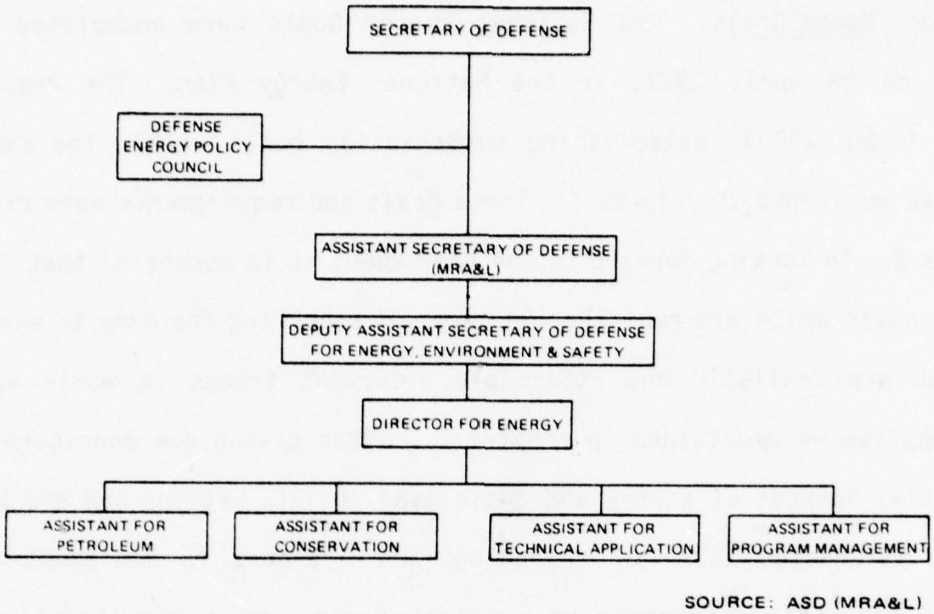


Figure 3-4. DOD ORGANIZATION FOR ENERGY

a. Conserve energy while maintaining readiness.

b. Maintain zero growth based upon FY75 total energy consumption.

c. Maintain a supportive and cooperative role with designated national energy authorities in the development of new energy sources.

The Army achieved a reduction in energy consumption of 5.4 percent in FY76 and 5.3 percent in FY77 thereby exceeding the DOD zero growth goals for each of those years. In FY75 the Army exceeded the DOD savings goal of 15 percent over FY73 consumption by a comfortable 8.6 percent. On 21 September 1977, the Secretary of the Army and the Chief of Staff in a joint document entitled "Total Army Goals" stated, "We will focus our efforts on: Energy systems (structure, power sources, and equipment) which make more efficient use of fuels, reduce dependence on nondomestic fossil fuels, and use less expensive and more plentiful resources."

3.2.2 Long Range Goals. The National Energy Goals were enunciated by the President on 29 April 1977, in the National Energy Plan. The President's Executive Order 12003, establishing conservation goals within the Executive Branch, was published 20 July 1977. These goals and requirements were discussed in chapter 2. In looking forward to the year 2000, it is essential that the Army establish goals which are ambitious in terms of requiring the Army to extend its reach, yet are realistic and attainable. Current trends in world and U.S. energy supplies were outlined in chapter 1. After giving due consideration to the potential sources of energy and their availability between now and the year 2000, the forecasted state of technology with respect to equipment and the Army's anticipated requirements, a new set of Army goals and objectives were developed. These goals and objectives were developed by the Army Staff through the medium of the Advisory Group on Energy (AGE) working group. The following goals and objectives for the Army were approved by the AGE on 1 December 1977.

a. Reduce energy consumption by 45 percent by the year 2000.

(1) Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness.

(2) Reduce energy consumption in facilities operations by 25 percent by FY85 and 50 percent by the year 2000.

(3) Expand energy conservation education/information and incentive programs for all Army military and civilian personnel and their dependents.

b. Reduce dependence on nonrenewable and scarce fuels by the year 2000.

(1) Eliminate the use of natural gas and reduce the use of petroleum fuels in facilities operations by 75 percent by the year 2000.

(2) Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000.

(3) Increase efficiency of nonrenewable energy dependent mobility systems by 15 percent with no degradation to readiness.

c. Attain a position of leadership in the pursuit of national energy goals.

In arriving at these goals many considerations were involved. A brief rationale of the basis upon which the goals were established and general direction the Army must proceed for their accomplishment is included here. A more detailed explanation of programs and alternatives for accomplishing the Army's goals is included in chapter 4.

In order to reduce dependence on foreign energy sources, particularly petroleum fuels, two general approaches are considered necessary: first, reduce overall consumption of energy and, second, substitute more readily available energy sources for the nonrenewable and scarce fossil fuels. The following basic assumptions were made.

- The Army will remain at essentially the same strength and be located in the same major locations (the planned relocation of forces from Korea has been considered).
- The Army's mission will be substantially unchanged.

The Army goal extends the Presidential goal of reducing gasoline consumption by 10 percent across the board to include diesel and aviation fuels. While the Army increases its mechanization and deploys new equipment such as the XM1 tank which is expected to be less energy efficient than the current M60 series tank, it must reduce its overall consumption through better energy management and achieve more energy efficiency in other equipment and in the use of simulators in training.

One of the 1977 Presidential goals requires the reduction in the annual growth rate of energy consumption to less than 2 percent, roughly half the current national rate. This rate could result in an increase exceeding 20 percent in the nations' energy consumption by 1985. In that same time frame, the Army is committing itself to reduce its consumption in the mobility operations area by 10 percent and in the facilities operations area by 25 percent, which equates to an approximate reduction of 22 percent, overall.

The replacement of a significant proportion of the Army's inventory of buildings with more energy efficient construction, improving energy efficiency of the remaining buildings, the use of selective and total energy systems, more efficient equipment, and better energy management are all expected to be combined to achieve the goal of 50 percent reduction in energy consumption in facilities operations by the year 2000.

Continuing in the facilities operations area, the anticipated exhaustion of domestic natural gas by the year 2000 dictates that the Army establish a goal of eliminating use of natural gas as a utility and establish programs which will accomplish that goal. If the Army is going to contribute to the reduction of oil imports and save petroleum fuels for its mobility operations in the face of gradual exhaustion of petroleum fuels, aggressive action will be required to reduce the use of petroleum fuels in facilities operations. Coal, either in gaseous or other processed states, solar and nuclear energy are prime alternate energy sources to accomplish these objectives.

Concurrently, actions in the mobility operations area to convert at least 20 percent of petroleum requirements to synthetic fuels or electricity are required. To these actions must be coupled efforts designed to obtain more efficient use of the remaining petroleum fuels.

In the pursuit and accomplishment of the aforementioned ambitious goals, the Army will be attaining a position of leadership in the pursuit of national energy goals.

3.2.3 Objectives. The overall objectives of the Army Energy Program are stated in AR 11-27 as follows:

a. Assure the availability and supply of energy to Army forces in accordance with mission and readiness priorities.

b. Participate in the national effort to conserve energy resources.

c. Attain, as a minimum, conservation goals established by DOD.

d. Participate in national research and development efforts toward new and improved energy sources.

e. Implement DOD energy-reporting requirements.

f. Promote Army-wide awareness of the essential need to conserve energy resources, and to foster a willingness to participate in conservation of these resources.

g. Recognize accomplishments of Army personnel in energy conservation.

3.2.4 Policies. In order to accomplish the Army's energy objectives, the following policies were established in AR 11-27 and will facilitate the accomplishment of the Army's long range energy goals:

a. Army energy resources will be intensively managed to assure their efficient and effective utilization in support of mission requirements.

b. Conservation of energy will be maximized consistent with mission, readiness, and health and safety requirements.

c. Energy conservation will be stressed in the design, development, production, procurement, and operation of equipment, weapons systems, and facilities. Energy consumption will be considered as a factor in the decision process during design, development, and construction of new equipment and facilities.

d. Energy requirements will be a mandatory agenda item at all in-process reviews (IPR).

e. Army-fixed facilities and mobile and transportable equipment will be operated and maintained to assure optimum performance and minimize energy consumption.

f. Close coordination will be maintained with other military services, the Defense Energy Directorate, DLA, ERDA, and FEA (the next revision of AR 11-27 will reflect the incorporation of ERDA and FEA into DOE), the Environmental Protection Agency (EPA), other Federal agencies, education and scientific institutions, and industry to assure a continuing exchange of information and ideas.

g. Department of the Army (DA) Staff elements and the major commands and their subordinate commands/agencies down to battalion level will establish a single point of contact (POC) to coordinate and expedite actions on energy matters and to disseminate essential information. For DA Staff agencies and major commands and agencies, the name, rank, agency, address (room for HQDA staff), and telephone number of the agency POC will be provided to HQDA (DALO-TSE). These items will be kept up to date.

h. Specific policy on petroleum fuels and coal is contained in AR 703-1.

i. Specific policy on utilities services is contained in the AR 420 series.

j. AGE (sec. I, chap. 7 of AR 11-27) and other existing DA boards, committees, and councils (e.g., the Select Committee, General Staff Council, and Army Policy Council) will serve as forums to discuss and resolve significant energy matters such as priorities, allocations, and budget restraints.

k. DA policy, plans, and activities will be assessed for their potential, adverse, or beneficial impact on energy.

l. Energy conservation will be incorporated into troop training and information programs.

m. Performance will be continually monitored against established energy conservation goals using the Defense Energy Information System (DEIS).

n. Natural gas will not be considered a reliable source of energy.

3.3 ORGANIZATION

3.3.1 Key Elements. The Department of the Army organization for energy consists of the following key elements: a Special Assistant for Energy, located in the Office of the Assistant Secretary of the Army (Installations, Logistics, and Financial Management), the AGE, and the AEO. These elements are backed up by the Army Staff through the staff agency POC's. An abbreviated organization chart is shown in figure 3-5. The Deputy Chief of Staff for Research, Development, and Acquisition (DCSRDA) and the Chief of Engineers (COE) are shown separately by virtue of their major separate responsibilities in the energy area which are summarized in paragraph 3.3.2.

3.3.1.1 Special Assistant for Energy. The Special Assistant for Energy was originally the Deputy Under Secretary of the Army for Operations Research. That responsibility was subsequently moved to the Office of the Assistant Secretary of the Army (Installations, Logistics, and Financial Management) [OASA(IL&M)]. The Deputy for Supply, Maintenance, and Transportation was appointed the Special Assistant for Energy, effective 19 July 1977.

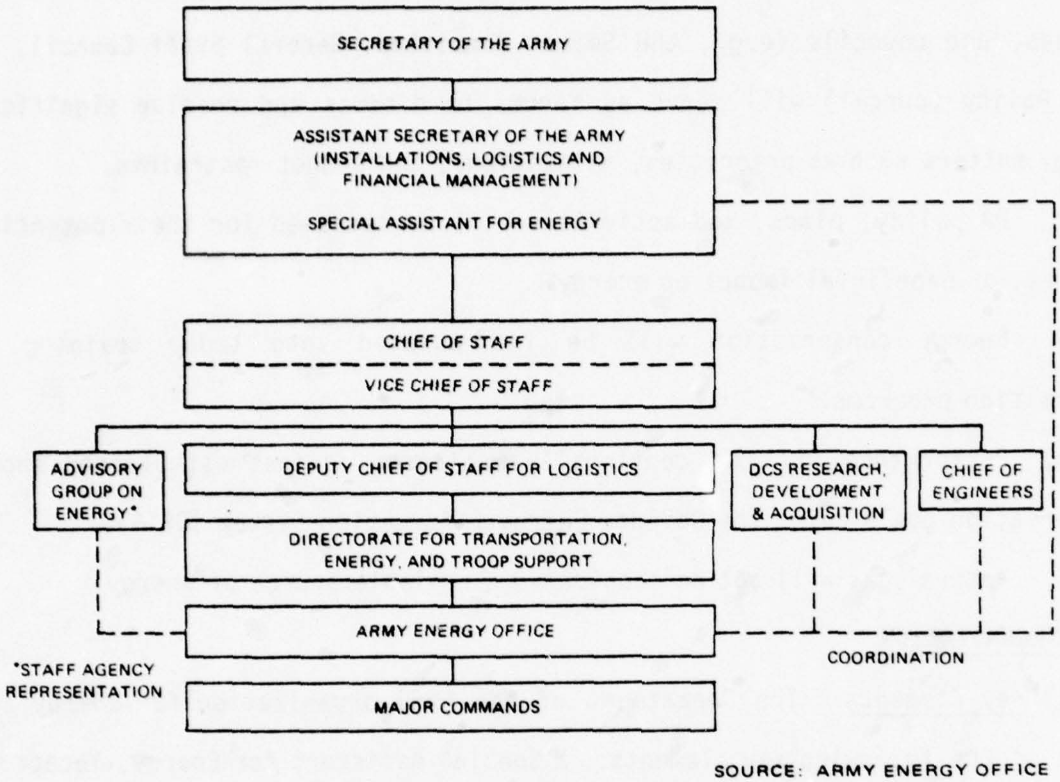


Figure 3-5. ARMY ENERGY ORGANIZATION

3.3.1.2 Advisory Group on Energy. The AGE was organized in April 1975 under the authority of AR 11-27 with a minimum required membership level of lieutenant colonel or civilian equivalent. As a result of the approval of the recommendations of an energy management study, the AGE was elevated to a general officer level body by Headquarters, Department of the Army (HQDA) Letter, file DALO-TSE (M), dated 5 July 1977, subject, "Army Energy Plan." The Director of Transportation, Energy, and Troop Support of the Office of the Deputy Chief of Staff for Logistics (ODCSLOG) chairs the AGE. It is composed of a principal in the grade of general officer or civilian equivalent designated from each of the following Army Staff elements:

Office of the Deputy Chief of Staff for Logistics (ODCSLOG), Chairman

Office of the Deputy Chief of Staff for Operations (ODCSOPS)

Office of the Deputy Chief of Staff for Research, Development, and Acquisition (ODCSRDA)

Office of the Deputy Chief of Staff for Personnel (ODCSPER)

Office of the Assistant Chief of Staff for Intelligence (OACSI)

Office of the Chief of Engineers (OCE)

Office of the Surgeon General (OTSG)

Office of the Comptroller (OCA)

Office of the Chief Army Reserve (OCAR)

Office of the Chief National Guard Bureau (OCNGB)

Office of the Director Program Analysis and Evaluation (PAED), Office of the Chief of Staff, Army

Office of the Chief of Public Affairs (OCPA)

The Secretary of the AGE is the Chief, AEO. The AGE has the following functions:

a. Continually review Army policies, programs, and procedures for their impact on energy and recommend corrective action when necessary.

b. Provide a forum for the exchange of information and ideas and determine actions required to attain Presidential or DOD-established goals for energy conservation and energy self-sufficiency.

c. Develop and provide recommendations on urgent energy matters.

The AGE is supported by a working group with action officer representation from the same staff elements as the AGE and chaired by the Chief, AEO.

3.3.1.3 Army Energy Office. The AEO was established in ODCSLOG by Chief of Staff Memorandum 73-10-133 dated 23 November 1973. Initially, the AEO was located within the Directorate for Supply and Maintenance. Subsequently, it was relocated to the Directorate of Transportation and Services which was redesignated the Directorate for Transportation, Energy, and Troop Support on 1 June 1976. AR 11-27 assigned to DCSLOG the Army General Staff responsibility for the following energy related functions:

a. Supervising and coordinating the Army Energy Program.

b. Formulating and recommending coordinated DA policy for the allocation, supply, and use of energy resources within the Army.

c. Developing and executing a comprehensive energy conservation program.

d. Providing principal Army staff advisors and contact on energy related matters to the Office of the Secretary of Defense (OSD), Office of Management and Budget, the Congress, and other military and Government departments and the civilian sector.

e. Participating in the budgetary process for the Army Energy Program within overall guidance and policies developed by the Director of the Army staff and the Comptroller of the Army.

The Army Energy Office performs these functions for the DCSLOG.

3.3.2 Army Staff Responsibilities. Summaries of specific responsibilities assigned to other Army Staff agencies are as follows:

DCSOPS - Establish priorities, ensure energy considerations are introduced into unit training and exercises and materiel requirements.

DCSRDA - Initiate research and development actions to conserve energy, consider energy conservation in the development, acquisition, manufacture, operation, and use of Army materiel.

DCSPER - Ensure energy conservation is incorporated in the curriculum of schools and individual training programs, emphasize energy conservation in the incentive awards program and other personnel related programs.

COA - Assist Army Staff in development of energy related budgeting actions.

COE - Develop and manage the installations and utilities element of of the Army Energy Program including construction and serve as principal Army Staff advisor on utilities services.

TSG - Ensure health and preventive medicine aspects of Army energy program and plan are adequate.

CPA - Develop and execute command and public information support for the Army Energy Program and Plan.

All staff agencies - Ensure energy considerations are included in agency functional responsibilities, coordinate energy matters with the Army Energy Office, and establish a single point of contact for energy matters.

3.3.3 Command Responsibilities. Commanders at all levels down to and including installation commanders are encouraged to establish and use command energy councils or committees. Commanders are responsible for:

a. Developing and maintaining an active command energy program to include a comprehensive energy plan. Commanders of major commands will provide copies of their plans to AEO and will provide annual updates of those plans.

b. Designating an activity with the responsibility of coordinating all energy matters. The use of full-time personnel is encouraged, whenever feasible.

c. Maintaining liaison and cooperation with appropriate Federal, state, and local energy offices.

3.3.4 Long Range Organizational Considerations. It is anticipated that the reduced availability of fossil energy sources and the higher cost of energy will demand increased attention from the Army's management as the year 2000 approaches. Accordingly, as the need for intensive management increases, it will require the use of more full-time personnel who are dedicated to energy matters. It will also require and justify a more extensive management information system in support of this intensive management effort. No major changes in the organizational structure for the management of energy at DA level are considered necessary or required.

3.4 REQUIREMENTS AND COSTS

3.4.1 Requirements

3.4.1.1 Current Requirements. The Army's energy consumption in FY77 was 258.5 trillion Btu. This represents a leveling off of the downward trend begun after the Arab oil embargo of 1973 as shown in figure 3-6.

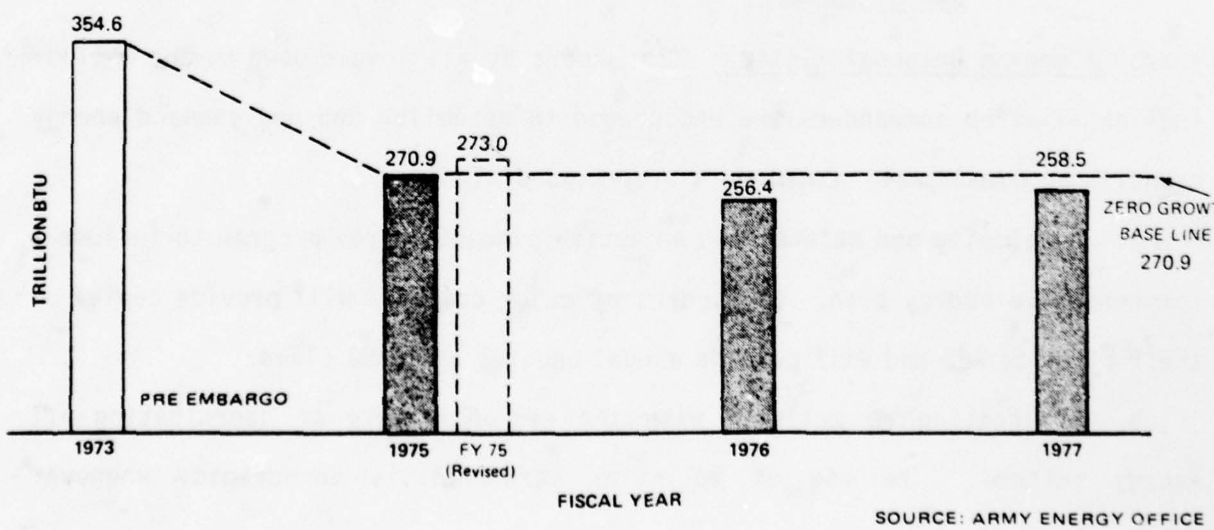


Figure 3-6. ARMY ENERGY CONSUMPTION

The Army met the DOD and Army zero growth objective in FY76 and again in FY77 by reductions of 5.4 and 5.3 percent respectively compared to FY75 despite the record setting low temperatures that occurred during the winter of 1976-1977.

The FY75 data base was revised in January 1977 by deleting the consumption data for the first quarter (July through September 1974) of FY75 and adding the consumption data for the comparable first quarter of FY76 (July through September 1975). This was done to enable more valid comparisons to be made with the new fiscal year adopted in FY77. The new consumption total for FY75 is 273 trillion Btu which represents a 0.8-percent increase over the former data base of 270.9 trillion Btu. This in turn resulted in a slightly larger percentage reduction in FY77 energy consumption when compared to FY75; i.e., 5.3 percent versus 4.6 percent using the former data base. Prior reports are not being changed but reports for FY77 and later years will reflect the revised FY75 data base.

Consumption of energy by major command is shown in figure 3-7. It divides into five approximately equal segments, i.e., DARCOM, FORSCOM, TRADOC, USAREUR, and all others.

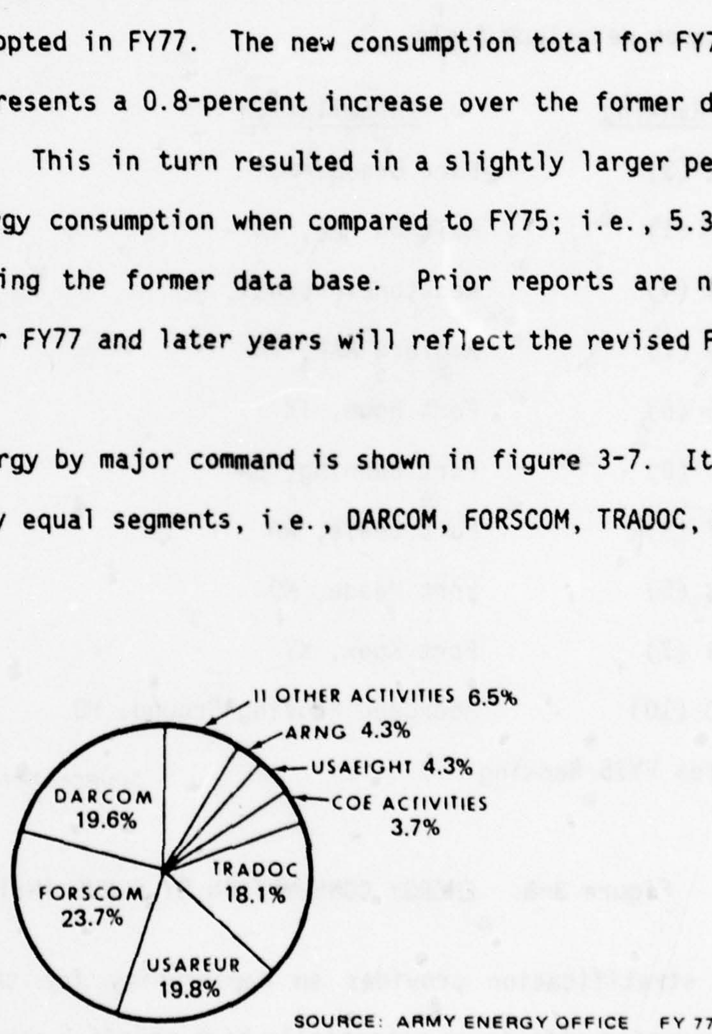


Figure 3-7. ENERGY CONSUMPTION BY MAJOR ACTIVITY, FY77

In looking at CONUS installations, 7 installations consume 25 percent, 22 installations account for 50 percent, and 79 installations account for 75 percent of the total energy consumed in installation operations. Three of the top 4 and 4 of the top 10 consumers are DARCOM installations (figure 3-8); FORSCOM accounts for another 4 and TRADOC the final 2. Fort Lewis, Washington, number seven on the list, derives a major portion of its energy from hydroelectric power, thereby furthering the Army and national goal of reducing dependence on petroleum fuels.

FY76 Ranking	Installation	Consumption (MBtu)
1 (3)	Fort Bragg, NC	5,454,489
2 (1)	Holston AAP, TN	5,217,011
3 (4)	Redstone Arsenal, AL	5,178,920
4 (2)	Radford AAP, VA	4,182,193
5 (6)	Fort Hood, TX	4,180,358
6 (8)	Fort Benning, GA	4,118,100
7 (9)	Fort Lewis, WA	4,052,222
8 (5)	Fort Meade, MD	3,931,432
9 (7)	Fort Knox, KY	3,800,443
10 (10)	Aberdeen Proving Ground, MD	3,557,310

( ) Denotes FY75 Ranking

SOURCE: OFFICE OF CHIEF OF ENGINEERS

Figure 3-8. ENERGY CONSUMPTION BY CONUS INSTALLATION, FY76

This stratification provides an opportunity for the Army to concentrate its conservation efforts on potentially high payoff installations.

Energy consumption by energy resource is shown in figure 3-9. Petroleum fuels represent the largest single energy source and are the principal energy resources used in mobility operations. The breakout of petroleum fuels in figure 3-9 shows that nearly 60 percent are consumed as heating fuels. Petroleum heating fuels when coupled with natural gas, purchased electricity, coal, liquid petroleum gas (LPG), and purchased steam account for the 84 percent of total Army energy consumed in facilities operations.

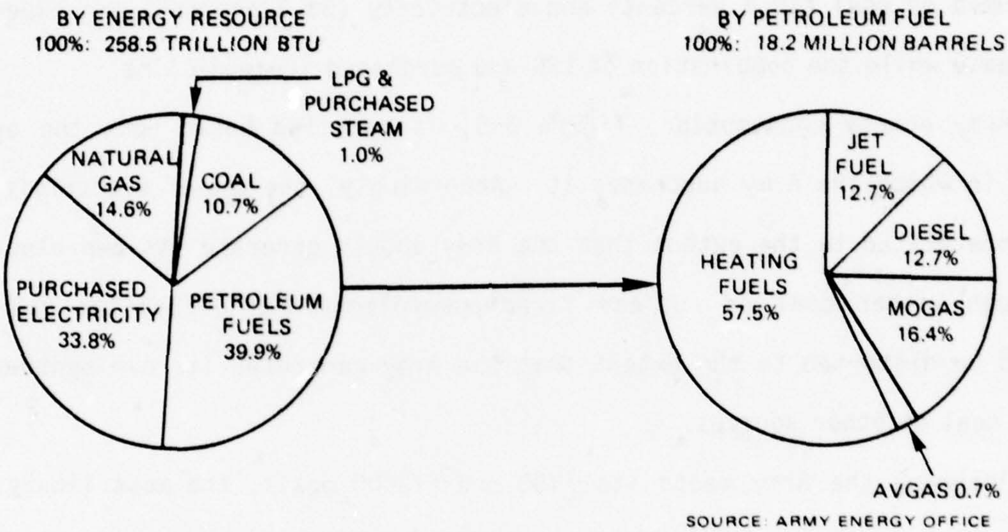


Figure 3-9. ENERGY CONSUMPTION BY RESOURCE, FY77

A reduction of 10 percent in energy consumption in the facilities area would have a greater impact on the Army's total energy consumption than a reduction of 50 percent in energy consumption in mobility operations. This fact, when coupled with the number of available alternative energy sources, makes the facilities operations area the most lucrative target for conservation and research and development efforts on the part of the Army.

3.4.1.2 Long Range Considerations. In order to meet the Army goals for the year 2000, several changes will be required in the energy consumption by resource pattern which is displayed for FY77 in figure 3-9. Natural gas must be replaced. The most promising candidates appear to be coal and synthetic gas from coal, refuse, or other sources. Where natural gas is replaced by a synthetic gas, it increases the possibility of making full utilization of existing distribution and combustion equipment. Likewise to the extent that petroleum fuels are replaced with shale oil derivatives or synthetic liquid fuels such as alcohol, existing distribution systems and engines with or without modification may continue to be utilized. The percentages of total energy consumed as coal (10.7 percent) and electricity (33.8 percent) are expected to increase while the combination of LPG and purchased steam decline.

Army energy consumption, figure 3-9, is compiled based upon the original form in which the Army purchases it. Accordingly, the use of electricity could be understated to the extent that the Army should generate its own electricity through either coal or nuclear fired powerplants. Likewise, the use of gas could be distorted to the extent that the Army generated its own synthetic gas from coal or other sources.

Assuming the Army meets its FY85 and FY2000 goals, the most likely mix of energy consumption is shown in figure 3-10. Gas as referred to in figure 3-10 includes synthetic gas and envisions total replacement of natural gas with synthetic gas by the year 2000. Petroleum includes synthetic fuels, 75 percent in the case of facility operations and 20 percent in the case of mobility operations.

3.4.2 <u>Costs</u>

3.4.2.1 <u>Current Costs</u>. The total bill for energy consumed by the Army in 1975 totaled $545 million. Costs incurred for energy consumed by the total Army exceeded $600 million in FY76 and FY77 despite reductions of 5.4 and 5.3 percent, respectively, in the actual energy consumed when compared to the base

	FY75	FY85	FY2000
Facility Operations			
Gas	47.3	24.8	12.9
Petroleum	34.2	25.6	19.7
Coal	58.9	47.2	32.5
Purchased Electricity	84.5	68.1	47.2
Purchased Steam	0.6	1.3	1.0
	225.5	170.0	113.3
Mobility Operations			
Petroleum	45.4	40.9	40.9
	270.9	210.9	154.2

Figure 3-10. PROJECTED ARMY CONSUMPTION (TRILLION BTU)

year of FY75. Since 50 percent of the nations' petroleum supply is being imported, the United States has limited influence on the price of petroleum. The costs of competing forms of energy have tended to follow each other in the upward spiral.

3.4.2.2 Long Range Prospects. Using the best available information, energy unit costs have been projected by the Office, Chief of Engineers to the year 2000 in 5-year increments in figure 3-11. These projections have been prepared based upon meeting the Army's long range goals. Under these conditions, costs would increase over 300 percent to $1,799 million by FY2000 despite a decrease approaching 45 percent in the total energy consumption. The cost in FY2000, if the Army held its energy consumption constant when compared to FY75, would be expected to exceed $3,189 million. The cost per million Btu in 1973 averaged $0.89, in 1975 it had risen to $2.01, and it is expected to increase to $4.61 by 1985 and to $11.67 by the year 2000. A comparison of costs under these two scenarios is shown in figure 3-12. Case I assumes

FACILITIES OPERATIONS		FY75	FY80	FY85	FY90	FY95	FY2000
Gas (Includes LPG)	Btu x 10^9	47,300	36,100	27,800	22,200	15,500	12,900
	Unit Cost $/MBtu	1.08	2.58	4.35	5.55	7.09	9.04
	Cost $000	51,084	93,138	120,930	123,210	109,985	116,616
Coal	Btu x 10^9	34,200	28,800	25,600	24,500	22,400	19,700
	Unit Cost $/MBtu	2.19	2.88	3.68	4.70	5.99	7.65
	Cost $000	74,898	82,944	94,208	115,150	134,176	150,705
Petroleum	Btu x 10^9	58,900	53,200	47,200	42,800	38,000	32,500
	Unit Cost $/MBtu	2.36	3.18	4.05	5.17	6.60	8.42
	Cost $000	139,004	169,176	191,160	221,276	250,800	273.650
Purchased Steam	Btu x 10^9	600	1,450	1,250	1,000	1,000	1,000
	Unit Cost $/MBtu	3.11	3.99	5.73	7.32	9.33	11.91
	Cost $000	1,866	5,786	7,163	7,320	9,330	11,910
Purchased Electricity	Btu x 10^9	84,500	77,700	68,100	61,000	54,400	47,200
	Unit Cost $/MBtu	2.03	3.57	5.76	9.28	13.31	19.11
	Cost $000	171,535	277,389	392,256	566,080	724,064	901,992
Subtotal	Btu x 10^9	225,500	197,250	169,950	151,500	131,300	113,300
	Cost $000	438,387	628,433	805,717	1,033,036	1,228,355	1,454,873
MOBILITY OPERATIONS		FY75	FY80	FY85	FY90	FY95	FY2000
Petroleum	Btu x 10^9	45,400	41,800	40,900	40,900	40,900	40,900
	Unit Cost $/MBtu	2.35	3.18	4.05	5.17	6.60	8.42
	Cost $000	106,613	132,924	165,645	211,453	269,940	344,378
Total Army	Btu x 10^9	270,900	239,050	210,850	192,400	172,200	154,200
	Unit Cost $/MBtu	2.01	3.18	4.61	6.47	8.70	11.67
	Cost $000	545,000	761,357	971,362	1,244,489	1,498,295	1,799,251

SOURCE: OCE AND ARMY ENERGY OFFICE

Figure 3-11. PROJECTED ENERGY CONSUMPTION AND COSTS (MBTU AND $000) constant energy consumption from the FY75 base year. Case II assumes the Army's goals of a 25-percent reduction in energy consumption in facilities operations and a 10-percent reduction in mobility operations by 1985 and a 50-percent reduction in mobility operations by FY2000 equating to a 45 percent overall reduction in energy consumption by FY2000.

	FY75	FY85	FY2000
I BASE CASE			
Facilities	438,387	1,060,314	2,807,101
Mobility	106,613	183,870	382,268
Total	545,000	1,244,184	3,189,369
II ARMY GOALS ACHIEVED			
Facilities		805,717	1,454,873
Mobility		165,645	344,378
Total		971,362	1,799,251
Cost avoidance under Case II		272,822	1,390,118

Figure 3-12. ENERGY COST COMPARISON ($000)

From a cost avoidance standpoint, $273 million would be freed up in FY85 and $1,390 million in FY2000. The figures are based upon a comparison of FY75 energy consumption and projected cost and consumption data from figure 3-11 shown in millions of dollars.

By averaging the cost avoidance data for the beginning and ending year for each 5-year period, from figure 3-11, it is possible to estimate an average annual cost avoidance for the 5-year interval. The shaded portion of figure 3-13 pictorially represents the cost avoidance to be realized as the Army achieves its FY2000 goals. Using this method the cumulative cost avoidance for the 20-year period between FY80 and FY2000 would exceed $11 billion. The Army should strive to obtain credit for this cost avoidance which would be

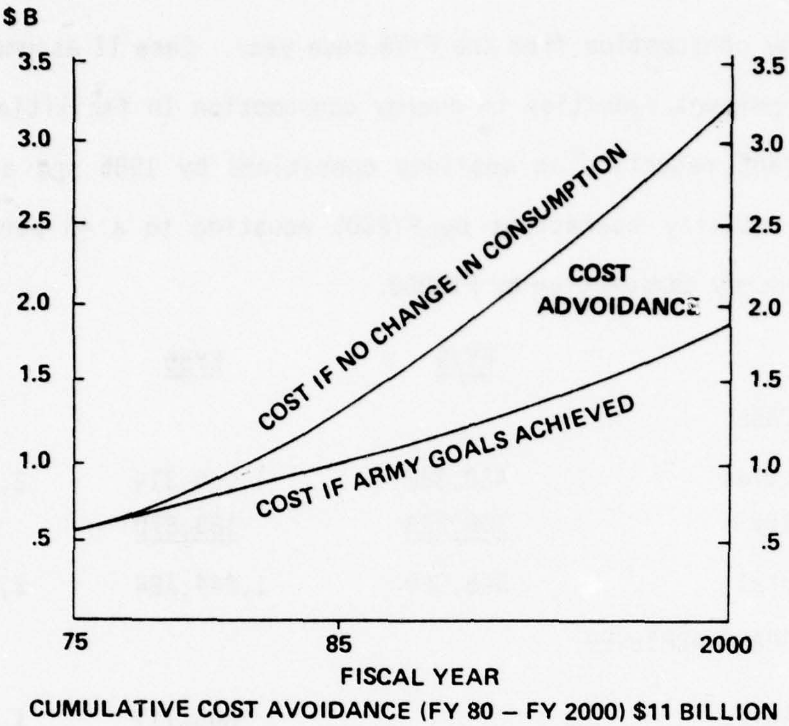


Figure 3-13. CUMULATIVE COST AVOIDANCE

used to assist in justifying funds for other related energy costs, e.g., construction to include the ECIP and to develop and procure more energy efficient equipment.

3.5.2.3 Related Energy Costs. The price paid for energy is the principal but not the only cost involved in a comprehensive energy program. Retrofit of existing buildings and new construction of buildings to make them more efficient, the energy audits and studies, research and development into new energy sources and systems, and the additional expense for labor intensive systems and energy training will all add to the annual energy cost.

It is anticipated that by the year 2000 many of these energy related costs will be absorbed into new standards and specifications for construction of new facilities and such programs as ECIP will no longer be required. Individual programs are discussed in greater detail in chapter 4.

CHAPTER 4

ARMY ENERGY PROGRAMS

4.1 SUMMARY

4.1.1 Introduction. In compliance with Executive Order 12003, dated 20 July 1977, which directs the Federal Government to set the example for the nation in energy conservation, the Army Energy Program was reviewed to determine what revisions were necessary to comply with Presidential guidance and what the revised program would cost. Outlined below are brief summaries of the Army's programs, which are covered in greater detail in later sections of this chapter. The funding required for these programs in the near term, FY79 to FY83, totals $733 million (figure 4-1).

APPROPRIATION	PROJ DESCRIPTION	FY 79	FY 80	FY 81	FY 82	FY 83	TOTAL
MILCOM	ECIP	68.4	77.4	82.9	86.7	93.0	408.4
OMA	EQUIPMENT-ECIP	(.3)	(5.0)	(5.0)	(5.0)	(5.0)	(20.3)
	TOTAL OMA	0.3	5.0	5.0	5.0	5.0	20.3
RDT&E	ENERGY MOTIVATED	(4.4)	(12.0)	(12.1)	(12.2)	(12.3)	(53.0)
	ENERGY RELATED	(35.7)	(46.3)	(47.6)	(50.9)	(50.8)	(231.3)
	TOTAL RDT&E	40.1	58.3	59.7	63.1	63.1	284.3
PROC	EQUIPMENT-ECIP	-	(5.0)	(5.0)	(5.0)	(5.0)	(20.0)
	TOTAL PROC	-	5.0	5.0	5.0	5.0	20.0
	TOTAL FUNDED	108.8	145.7	152.6	159.8	166.1	733.0

Figure 4-1. PROGRAM FUNDED REQUIREMENTS (FY79-83 POM) ($M)

4.1.2 Ongoing Programs

4.1.2.1 Energy Conservation Programs. The Army's energy conservation goal for FY76, 77, and 78 has been to maintain zero growth in energy consumption over that consumed in FY75. The Army achieved this goal with a total energy consumption in FY76 and FY77 of over 5 percent less than that of FY75 and 27.1 percent below that of FY73. These energy savings were achieved through the combination of energy savings techniques in the facility and mobility operations areas, such as installation of storm windows, insulation, temperature controls, electronic energy monitoring and control systems, heat recovery equipment, adherence to 55 mph speed limit, improved motor vehicle management, combining operational and administrative flying requirements, and using flight simulators.

In comparing energy conservation with reduced operations in the Army for FY73-76, the following items were considered: Total Army Strength, Total Army Budget, Total Energy Consumption, and Major Installation Closures (CONUS). All areas considered showed a downward trend from FY73 to FY76 with energy consumption showing the largest percent reduction. An analysis of this trend is shown below.

PERCENT REDUCTION BY CATEGORY - FY73-FY76

Army Consumption	27.9%
Army Strength	1.8%
Army Budget	16.5%
Major Army Installations (CONUS)	8.1%

Analysis of figures show that although there has been a reduction in each category presented, the reduction in energy consumption exceeds total percent reduction in every other case. Although there are many things that have an influence on energy consumption that have not been considered, it is felt that these indicators are representative of the level of operation of the Army and that a large part of the reduction in energy consumption can be attributed to energy conservation measures taken in the Army since 1973.

Army contractors are being motivated to develop and submit Value Engineering Changes which will reduce overall energy costs to the Army. Value Engineering Clauses outlined in the Armed Services Procurement Regulation provide incentives for contractors to reduce operating costs including energy savings on equipment and newly constructed facilities. The Army's effort to make contractors, procurement, and technical personnel more aware of this potential should greatly increase these cost and energy savings benefits.

Another Army program designed to conserve energy and reduce costs is the Quick Return on Investment Program (QRIP). The program provides a centralized source of funds for timely financing of "Quick Return" investments. The guidelines for proposing a project under the program are:

a. Project must be for at least $1,000 but cannot exceed $100,000.

b. Project must be self-amortizing within 2 years.

c. Project must be off-the-shelf equipment requiring minimum modification.

d. Project must produce hard dollar savings which can be reflected by reductions in the benefiting appropriations.

4.1.2.2 Training and Operations. The Army's policy is to conserve the maximum amount of energy consistent with allocating and utilizing those resources necessary to maintain the required state of readiness. The post-Vietnam phasedown, with its accompanying reduction in force and reduced operational and training activities, has helped reduce the Army's consumption of energy.

Another assist in achieving energy savings while attaining the Army's readiness objective has been and continues to be increasing the usage of training simulators and simulations. Advance planning to leave equipment on site, use of small wheeled vehicles to represent large, tracked, tactical vehicles, and improved petroleum (POL) handling techniques are some of the additional means being used to accomplish energy savings in the training environment.

4.1.2.3 Administrative Automobiles. By 1980, the Army will have reduced the size of sedans in its inventory as is discussed later. Further action is intended to adjust procurement of administrative vehicles in conformance with Presidential guidance on gasoline consumption goals for the nation's automobiles.

4.1.2.4 Basewide Energy Systems Studies. These studies are a systems approach to facility energy conservation. These studies will develop energy conservation project requirements at major Army installations that, when constructed, will integrate energy conservation, energy use, and energy control systems basewide and result in optimum utilization of energy resources.

4.1.2.5 The Energy Conservation Investment Program (ECIP). The objective of ECIP is energy reduction through retrofit of existing facilities. The early phases of ECIP, which started in FY76, included the most easily accomplished energy saving installation operations projects. The follow-on programs are more sophisticated. They include such projects as electronic energy monitoring and control, and heat recovery equipment. Recently approved criteria for justifying and prioritizing ECIP projects, effective with FY79, will be energy saved per dollar invested.

4.1.2.6 Equipment Energy Conservation Investment Program (EQ-ECIP). This program is oriented toward energy saving equipment modification for mobility oriented equipment such as aircraft, vehicles, missiles, mobile ground equipment, and other energy-consuming systems not included in the facilities ECIP. As noted in figure 4-1, projects are funded in the three areas of Operations and Maintenance, Army (OMA); Procurement; and R&D.

4.1.2.7 Alternate Sources of Energy. Although high cost estimates have restricted progress on solar energy projects, the Army has urged the Office of the Secretary of Defense to seek expanded DOE support for demonstration projects. The Army has planned for and is starting solar energy projects in family housing and selected buildings at Army installations, Army Reserve Centers, and National Guard Armories for space heating and cooling, hot water, and electrical power generation. The Army is moving ahead on those projects that can be reasonably justified. In response to Congressional language in the FY78 MCA Program Act, Public Law 95-83, 1 August 1977, which encourages the utilization of solar energy for MCA projects authorized by the act, a number of FY78 (6) and FY79 (14) projects are being designed with the optional use of solar energy systems for facility heating, cooling, and domestic hot water. The final choice of the use of solar energy will depend upon the bid costs and the economic feasibility.

The Army considers that the state-of-the-art for Refuse-Derived Fuel (RDF) systems is not sufficiently advanced to be ready for wide spread application in the near future. Fuel derived from processed waste has not yet proven to be technologically developed to the point of helping fulfill Army steam production requirements. A 3- to 5-year field test and evaluation of those systems having potential Army scale application is required. Although certain systems for the combustion of unprocessed solid waste are recommended, they too require further evaluation from the economic standpoint for Army-scale usage.

4.1.2.8 Research and Development. Energy conservation research and development continues to grow as increased opportunities for such conservation are brought to light by developments in the commercial sector. Adaptation of commercial developments assists the Army to make the most efficient use of energy in Army materiel and facilities, the two principal areas of Army's Research and Development Program. The materiel R&D program consists primarily of energy related projects in which the emphasis is on materiel development wherein energy savings represent at least 10 percent but less than 50 percent of their expected benefits. Examples of energy related projects are aircraft propulsion, ground vehicle engines (including fuel cells), power trains, and lubricants. The facilities R&D program consists primarily of energy motivated projects which are directly related to the reduction of energy consumption wherein energy savings represent 50 percent or more of the expected benefits. Ongoing research and development will provide computer aided evaluation of building energy loads and performance of total energy, selective energy, and heat pumps. Concepts for efficient central energy plants and energy storage and distribution systems are being developed. Criteria to convert to coal in existing central steam boilers will be provided. A reliable control automated energy monitoring and control system using microprocessor technology will provide a tool for the management of energy resources. Although the greater proportion of funds is directed toward energy related projects, the energy benefits derived will be as a spinoff from the improvements derived from those projects. The energy motivated element of the funding is considerably smaller than the energy related element, but should produce greater energy savings.

4.1.3 Long Range Programs (FY84-2000).

4.1.3.1 Installation Operations. The Army makes the assumption that by the year 2000 much of its real property will have been replaced. The vast bulk of the remainder will require retrofit. A broad range of new innovative techniques will be applied to new construction. Facilities will be better protected from ambient weather extremes, and underground construction will increase, particularly for non-living facilities. Requirements for energy studies, audits, monitoring, and metering are expected to increase to an annual average of $10 million by FY85, depending on the extent of utility metering of individual buildings.

4.1.3.2 Mobility Operations. Readiness is the big factor in determining what sacrifices, if any, can be made in mobility operations to offset the decreasing availability and the increasing costs of current sources of energy. The Army is headed for increased mechanization of its force structure which will mean increased fuel consumption. In order to compensate for this trend, the Army long range mobility operations programs are considering lighter weight vehicles, improved engine performance, utilization of synthetic and alternate fuels, and the storage and delivery means for these fuels with no decrease in readiness as the primary factor for adoption.

4.1.3.3 Training. Readiness is of equal concern in determining the extent of training programs as it is in mobility operations. Training concerns the readiness of the individual or unit to do the job, and mobility operations concerns the readiness of the tools required to do the job. Training is a major consumer of energy whose energy consumption can be reduced through two programs which prevail now and will continue to prevail in the future. They are: (a) the constant search for ways and means of reducing unnecessary movement of troops and equipment, and increasing efficiency in use of existing equipment and facilities through training, and (b) the greater use of simulators and simulations as training devices. The Army will continue vigorous pursuit of both programs in the long range period.

4.1.3.4 Research and Development. Long range Army energy R&D programs will seek effective energy conservation measures, alternative energy sources, and improved energy management techniques for military facilities. In mobility operations, the Army R&D projects will concentrate on areas that will contribute toward meeting the Army's goals to reduce energy consumption and dependence on petroleum based fuels.

4.2 INSTALLATION OPERATIONS

4.2.1 General. The Army is vigorously pursuing a multifaceted energy reduction program. Thus far, all the broad program objectives have been met. It has been previously pointed out in figure 3-2 that installations operations or facilities consume 84 percent of the Army's total energy, with mobility operations consuming the balance of 16 percent. It is quite apparent from these figures that the Army's greatest potential for energy reduction exists in installation operations.

In installation operations, the Army has appreciably reduced its consumption in both heating energy and purchased electricity, but at the same time significant increases in cost have occurred due to higher prices. If the Army had continued to use energy at the same rate as 1973, it would have cost $108 million more than the actual cost in 1976. If the annual growth rate of consumption that existed in 1973 had continued to FY76, energy costs would have been approximately $141 million more than actual costs, which indicates the major impact that installation operations energy reduction has had from a budgetary standpoint.

The Army is continuing to exploit most of the low cost opportunities for energy reduction such as: reducing heating temperatures (65° F during working hours and 55° F during nonworking hours in offices, and lower temperatures in warehouses and other facilities where occupancy and activity permit), raising cooling temperatures (thermostats set no lower than 78° F), and reducing lighting levels to the minimum of 50 footcandles. The Army is also operating equipment during off-peak hours, consolidating activities into the minimum number of buildings, weatherstripping, caulking leaks, reducing hot water temperature levels, and fine tuning mechanical equipment to achieve better efficiency. Other energy related actions taken or underway are: the processing of 360 minor MCA projects for energy reduction, publishing AR 420-49 to provide policy guidance on energy selection for new facilities and conversion of existing equipment, establishing a moratorium on electrical resistance heating, publishing guidelines on the use of waste oil as a fuel, and expanding the use of coal. Future energy reductions will depend increasingly on additional funding.

Concurrent with energy reduction, the Army must also insure that energy supplies are available to meet minimum essential needs and insure against total interruption of utilities services. Consequently, the Army has a program for stockpiling fuel at major heating plants. One such ongoing project is increasing heating oil storage at boiler plants to a 30-day capacity. Although not directed toward energy conservation, this program is an essential part of the overall program to insure continuity of essential supplies and operations.

4.2.2 Funding. Executive Order 12003 requires that energy consumption in existing facilities be reduced by 20 percent on a Btu per square foot basis by 1985, with FY75 as the base year. The Army's funding to meet this requirement is being achieved through a dedicated MCA program entitled the Energy Conservation Investment Program (ECIP). It is currently planned to achieve 12-percent reduction by expansion of ECIP. The remaining 8-percent reduction is to be achieved largely through improved energy management at installation levels. Proposed ECIP funding, as approved by DOD, to achieve the 12-percent energy reduction is as follows:

	FY79	FY80	FY81	FY82	FY83	TOTAL
Proposed ECIP Funding $M	68.5	77.3	77.9	74.0	71.0	368.7

In order to identify what energy conservation measures must be utilized to achieve this 20-percent reduction, the Army initiated a program in FY77 to survey basewide all continental United States (CONUS) active installations. Studies have been funded for Redstone Arsenal and Forts Campbell and Rucker to develop an integrated basewide energy use and control system. From these studies and the others to follow when funding permits, a program will be developed and prioritized based upon meeting energy reduction goals at minimum costs.

ECIP funding priorities for FY76-78 were largely determined on the basis of amortization. Individual projects with early dollar amortization were given the highest priority, resulting in deferral of many worthy projects which had a potential for high energy savings rather than quick payback. For programs starting with FY79, funding criteria have been changed and projects are required to amortize within the life of the facility or the retrofit action, rather than within a specified number of years. Projects will then be prioritized on the basis of MBtu's of energy saved per year per thousand dollars invested.

Executive Order 12003 further stipulates that a 45 percent reduction in the use of energy by new facilities will be achieved by 1985, again measured against energy use per square foot by existing facilities in 1975. This will be achieved by installing additional insulation, using solar screening, introducing heat recovery systems and enthalpy control, and improving energy management systems. The Army calls for the reduction to be achieved in the MCA program years FY79-83. The estimated increased costs for achieving this 45 percent reduction are:

	FY79	FY80	FY81	FY82	FY83	TOTAL
$ Millions	30	32	34	37	39	172

4.2.3 Alternate Sources of Energy

4.2.3.1 Solar Energy. The Army is involved actively in demonstrating the feasibility of solar energy to heat domestic hot water, to heat and cool buildings, and to generate electric power. The funding for these projects has been provided by the Congress directly under military construction appropriation.

A total of 44 Army projects are being provided with Solar Energy systems, and are either under design, being constructed, or completed. Five projects are completed, four are scheduled for completion in 1979, seven are scheduled for completion in 1980, and the remainder soon thereafter. Solar demonstration projects either under design or construction include the following facilities:

Project	Location	
Army Reserve Centers	El Monte, CA	Albuquerque, NM
	Seagoville, TX	Fort Sam Houston, TX
	Greenwood, MS	Fort Totten, NY
Dental Clinics	Fort Ord, CA	Fort Sill, OK
	Fort Huachuca, AZ	Fort Riley, KS
	Fort Bliss, TX	Fort Carson, CO
	Fort Sam Houston, TX	Fort Stewart, GA
	Fort Polk, LA	Fort Benning, GA
	Fort Knox, KY	Fort Bragg, NC
	Schofield Bks, HI	Fort Hood, TX

Other projects include family housing, barracks, administrative buildings, range operation centers, hospitals, field houses, maintenance shops, and solar ponds. The Army is providing DOE with assistance in the design, construction, and evaluation of a solar total energy system at Fort Hood, TX. The plant will provide the electrical power, space heating and cooling, and hot water generation requirements for a complex of five selected buildings with an output of 200 KWE. Design is now underway and construction is scheduled to start in 1979. New initiatives as a part of a $100 million, 3-year solar energy demonstration program implementing the President's National Energy Plan are forthcoming.

The cost experience to date with use of solar energy systems follows:

a. A solar energy system of stated capacity can be installed in a new building for about one-half of the cost of retrofitting the system to an existing building.

b. The payback period under present amortization rules is up to 25 years time. However, under current rules, the authorized fuel cost escalation rates beyond 5 years in the future are suspect and penalize the use of solar energy systems.

c. Successful solar energy installations require unusual attention to design details, equipment selection, and careful construction installation.

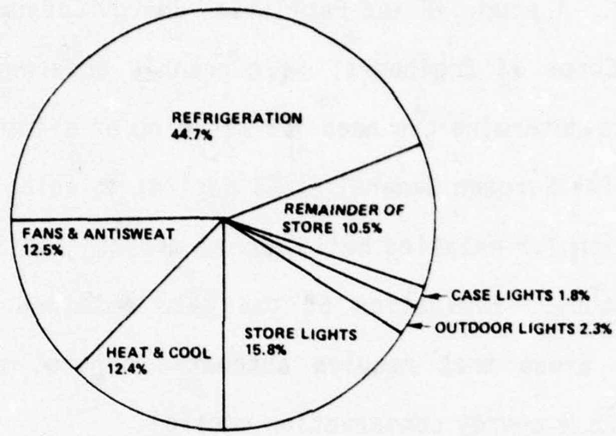
4.2.4 Other Installation Actions

4.2.4.1 Medical Facilities. As a result of guidance from the U.S. Army Health Facility Planning Agency (SGFP), the Office of Chief of Engineers (OCE) has written Medical Facilities Interior Design Criteria to minimize energy use without compromising patient care. Additionally, the SGFP has recommended to OCE that solar energy be used in medical and dental facilities when feasible.

Because of the wide variety of energy sources and the ages of health care facilities, medical activities have been directed to work with their installation facility engineer to maximize energy conservation on an installation by installation basis. As improved methods of energy conservation are surfaced, these methods will be incorporated in pertinent regulations for utilization at medical facilities. A study, Fixed Facilities Energy Consumption Investigation conducted by the Corps of Engineers, is currently underway at Forts Belvoir, Carson, and Hood to determine the need for metering of all medical facilities on an installation. The Surgeon General (TSG) desires to establish a true baseline of energy consumption for existing buildings at medical facilities utilizing the results of the study. Evaluation of the data obtained from metering will identify specific areas that require automatic control monitors which will permit highly reliable energy conservation control.

4.2.4.2 Improved Troop Support. A principal energy conservation objective is to insure that the latest energy conservation technology is being considered and applied during the design and construction phases of new commissary stores. Also, an energy conservation program has been developed for recently constructed commissaries and for commissaries in buildings neither designed nor constructed as commissaries. As shown in the diagram (figure 4-2) refrigeration equipment is the major consumer of energy in commissary stores, and has the highest potential for energy savings through the application of effective conservation measures. The commissary at Fort Riley, Kansas, has been designated as a test facility for energy conservation procedures to be used in the modernization of existing commissary stores. The Invitation for Bid for construction of a new commissary at Fort Stewart, Georgia, includes the requirement for maximum use of energy conservation subsystems.

A second, equally important energy conservation objective is the development of a program by Troop Support Agency to advise and assist commands and installations in conserving energy in dining facilities, laundry/drycleaning facilities, clothing sales stores, and troop issue support activities.



SOURCE: U.S. TROOP SUPPORT AGENCY
FORT LEE, VIRGINIA

Figure 4-2. ENERGY CONSUMPTION - COMMISSARY STORES

Since 1976, management assistance visits have included the distribution to installation food advisors of the FEA's "Guide to Energy Conservation for Food Service." Also, the Troop Support Agency has prepared and distributed to the field a booklet, "An Introduction to Energy Conservation in Army Dining Facilities."

In the laundry/drycleaning facility area, an energy checklist has been developed which is being used during technical assistance visits to identify conditions where energy is being wasted. Where waste is observed, corrective actions are recommended, and in many instances on the spot corrections are achieved. Heat reclamation equipment is now specified for modernization/new construction of laundry/drycleaning facilities, and such equipment has been installed in the new facilities at Schofield Barracks, Fort Dix, and Walter Reed Hospital. In addition, existing facilities are phasing in the use of low temperature detergents that require 140° F water instead of 160° F water. One energy cost saving device under consideration is a tunnel washer which utilizes 3/4 gallon of 140° F water for a pound of wash, compared to the conventional washer which requires 3-1/2 gallons of 160° F water for the same job. Also being considered is a shirt finisher requiring only one operator who can finish 250 to 400 shirts per hour, compared with the current finisher which requires two operators to finish 75 shirts per hour. The use of the new finisher is expected to consume less than half the energy required for a similar capacity in current finishing machines. The result will be considerable time, manpower, energy, and cost savings.

4.2.4.3 Improved Uniforms. The Army has adopted, or has under consideration, several items of clothing that will allow personnel greater comfort in the normal temperature range and greater flexibility in coping with temperature variations, permitting fuel savings for both heating and cooling offices and buildings. Already adopted are durable press uniforms which will eliminate energy expended for pressing and reduce energy consumption for laundry. Total energy savings of 33 percent are estimated when the conversion to durable press uniforms is completed. In addition, there are fabrics and uniform items under development that will have greater versatility and thus permit a reduction in the number of clothing items supplied to soldiers. Since many uniforms contain a high amount of polyester fiber, which is derived from petroleum, a reduction in the number of uniforms supplied will assist in reducing the nation's petroleum consumption.

4.2.5 Near Term New Initiatives (FY78-83)

4.2.5.1 Meeting Presidential Goals. In order to achieve the Presidential goal of a 20-percent reduction in energy consumption over FY75 by 1985 in existing buildings, it is anticipated that ECIP projects will lead to the reduction of 12 percent of this goal, with the remaining 8 percent to be achieved through improved energy management. Indicated below are the funds required to meet the President's 20-percent goal and the portion of these funds covered by the FY78 to FY83 Program Objectives Memorandum (POM). In figures 4-3 and 4-4 are, respectively, the unfunded requirements above POM and the mandated requirements without resources needed to fulfill the 20-percent reduction goal.

Funding Requirements by FY ($ Millions)

	FY79	FY80	FY81	FY82	FY83	TOTAL
Required to meet 20% reduction goal	100.1	126.0	155.6	189.3	226.9	797.9
Funded (FY79-83 POM & 12 Aug 77 PDM)	68.4	77.4	82.9	86.7	93.0	408.4

The second Presidential goal is to reduce energy consumption on a Btu per square foot basis by 45 percent in new buildings by 1985, based on FY75 energy consumption figures. This will be achieved through more energy efficient architectural and mechanical design which will include installing additional insulation over and above that customary in previous years. Solar screening will be a regular approach. Heat recovery systems and enthalpy control as well as modern energy management systems will be introduced. Total and selective energy systems will be considered and successful construction procedures demonstrated by General Services Administration (GSA) will be included in new buildings. The funding requirements to meet this goal are listed as a mandated requirement without resources in figure 4-4.

4.2.5.2 Basewide Studies. Comprehensive energy conservation studies on a basewide scale are necessary to support the development of basewide energy systems. These studies will provide the impetus for integration of energy

APPROPRIATION	PROJECT DESCRIPTION	FY 79	FY 80	FY81	FY 82	FY 83	TOTAL	ESTIMATED ANNUAL ENERGY SAVINGS (MBTU)
MILCON	Fuel Conversion Program (18 Plants)	(15.1)	-	-	-	-	(15.1)	N/A
	Coal Conversion	(20.0)	(20.0)	(30.0)	(40.0)	(90.0)	(200.0)	N/A
	Basewide Energy System Demo	-	(90.0)	-	-	-	(90.0)	TBD
	Solar Ground Array	-	(15.0)	-	-	-	(15.0)	TBD
	Family Housing Energy Systems	-	(69.8)	(50.6)	-	-	(120.4)	3,780,000
	TOTAL MILCON	35.1	194.8	80.6	40.0	90.0	440.5	
OMA	Energy Conservation Studies	(19.0)	(6.8)	-	-	-	(25.8)	N/A
	Coal Conversion Feasibility Studies	(10.0)	(10.0)	(5.0)	-	-	(25.0)	N/A
	TOTAL OMA	29.0	16.8	5.0	0.0	0.0	50.8	
RDT&E	Energy Motivated	(5.3)	(6.5)	(2.2)	(2.1)	(0.1)	(16.2)	N/A
	TOTAL RDT&E	5.3	6.5	2.2	2.1	0.1	16.2	
	TOTAL UFR	69.4	218.1	87.8	42.1	90.1	507.5	

Figure 4-3. UNFUNDED REQUIREMENTS (UFR) ($ MILLIONS)

APPROPRIATION	PROJECT DESCRIPTION	FY 79	FY 80	FY81	FY 82	FY 83	TOTAL	ESTIMATED ANNUAL ENERGY SAVINGS (MBTU)
MILCON	Additional Funds Required to Meet 20% Reduction in Existing Facilities	(31.7)	(48.6)	(72.7)	(102.6)	(133.9)	(389.5)	10,042,000
	Reduce Energy Use Per *Square Foot* by 45% in New Facilities	(30.0)	(32.0)	(34.0)	(37.0)	(39.0)	(172.0)	TBD
	TOTAL Mandated Requirements Without Resources	61.7	80.6	106.7	139.6	172.9	561.5	

Figure 4-4. MANDATED REQUIREMENTS WITHOUT RESOURCES ($ MILLIONS)

conservation, energy use, and energy control systems and will result in the optimum use of the energy resources available. Recommended but yet unfunded requirements for these studies in FY79 and FY80 are cited in figure 4-3.

In conjunction with the above studies, the Army proposes to construct, at one division size CONUS installation, a complete Demonstration Basewide Energy System. This system will consist of a central, coal-fired, total energy plant/selective energy plant of approximately 50 megawatts electric size using supplemental waste-derived fuel. The system will include new regional central plants utilizing absorption chillers; reconstruction of exterior energy conveying utility systems; reconstruction of interior energy conveying utility systems in large existing old buildings; passive conservation measures in existing buildings; and add-on solar energy packages, primarily for domestic hot water generation in dining facilities and barracks. A tentative base has been designated as the result of a 27-base survey, and a design start will soon be made. Design progress will permit some accomplishment of this project in the FY80 program year. The $90 million currently unfunded requirement for this project for FY80 is reflected in figure 4-3.

The Army's family housing inventory is a high volume user of natural gas. As such, it readily lends itself to near term conservation projects which can provide significant reductions of total Army natural gas consumption. Recommended unfunded requirements to achieve these savings are shown in figure 4-3.

4.2.5.3 Fuel Conversion. Army energy initiatives in this ongoing program include reduction in the consumption of natural gas by conversion of qualifying heating plants away from natural gas to a dual natural gas/oil capability. At this point, there are a few plants remaining to be converted with the unfunded requirements cited in figure 4-3. Additionally, the Army has plans for the conversion of large boiler plants to the use of coal, the unfunded requirements for which are also included in figure 4-3.

4.2.5.4 Alternate Sources of Energy. The Army proposes $15 million in FY80 (figure 4-3) for a solar energy ground array system. This system would be a centrally located solar energy plant that would serve a community of family quarters which on most Army installations are so compactly arranged that they easily lend themselves to such a plan. The tests could begin in FY80 if the requested funds are provided. Should this demonstration project prove successful, a total of 73 locations on Army installations have been identified that lend themselves to the ground array system. The systems initially would be designed for heating and domestic hot water, with cooling incorporated as improved technology provides for more economical systems.

The FY79 Army Construction Program includes the proposal for a modular refuse-fired steamplant for Fort Eustis, Virginia. This will consist of two 20-ton per day refuse burners in an incinerator connected to one steam generating, water tube type package boiler which will provide steam to the existing steam supply system at a post boiler plant. Solid waste which is processed through a shredder is to be burned.

4.2.5.5 Energy Conservation Award. The OCE has proposed an annual Army-wide Energy Conservation Award. The objectives of the award are to provide added incentive to reduce energy consumption and to recognize the achievements of installations exceeding energy reduction goals. If the program is approved, three awards will be presented annually to the active Army, Army National Guard, and Reserve installation which conducted the most outstanding energy reduction program during the preceding fiscal year.

4.2.6 Long Range Programs (FY84-2000)

4.2.6.1 General. Since 84 percent of the total energy used by the Army is consumed by installation operations, it is essential that maximum energy reductions be achieved in that area in order to insure that sufficient petroleum will be available for mobility operations requirements. A determination of what long range facilities programs to pursue to meet the Army's long range energy goals and objectives and to carry the major portion of the Army's energy reduction must be prefaced by the following broad assumptions and guidelines:

a. Assumptions:

(1) Force structure/stationing will remain basically the same except for the planned relocation of forces from Korea.

(2) Real property inventory will remain relatively the same and, by the year 2000, a significant portion of the real property will have been replaced.

(3) Retrofit of existing facilities will be extensive in the near term and continuing.

(4) Cooperation will be essential in environmental areas, particularly on an interim basis, where direct coal combustion is utilized.

b. Guidelines:

(1) Natural gas, liquid petroleum gas, and oil derived from natural crude oil will gradually be replaced by alternate energy sources.

(2) Use of coal and refuse-derived fuel will be increased.

(3) All feasible alternate sources of energy will be exploited.

(4) On-post gasification of coal will increase.

(5) A broad range of innovative techniques will be applied to new construction.

(6) New construction will include multiple use facilities.

(7) New facilities will eliminate occupant control of internal temperatures.

(8) Total energy/selective energy systems, based largely on solid fuels, will be constructed at major installations.

4.2.6.2 Long Range Outlook. The Army's facilities operations programs for the long range period will be limited to a great extent by the state-of-the-art. The Army has under consideration many programs in its efforts to minimize the effect of energy shortages and high costs on military facilities and the Army mission. The Army remains current on the progress being made by private industry, continuously testing developments for possible inclusion in the Army's facility operations energy programs. Listed below are key areas of development which have potential as long range programs for the achievement of the Army's facilities operations goals of reducing energy consumption by 50 percent, eliminating use of natural gas and reducing the use of petroleum fuels by 75 percent by the year 2000:

a. Construction:

(1) Increased underground construction.

(2) More multiple use facilities.

(3) Decreased facility energy loss.

(4) Total energy and selective energy systems.

b. Utilities:

(1) Filtering and recirculation of air.

(2) Reclamation of waste energy.

(3) Use of solar energy for heating and cooling buildings.

(4) Use of waste-derived fuels as a fuel supplement or as a primary fuel.

(5) Use of nuclear energy for military facilities.

(6) Use of coal as the primary energy source for military facilities while meeting environmental standards.

(7) Increased utilization of heat pumps.

(8) Metering of all facilities to include family housing.

(9) Implementation of a 4-day, 10-hours per day work week.

(10) Use of geothermal energy for heating and cooling.

(11) Use of wind-driven energy for heating and cooling.

(12) Increased utilization of coal gasification.

c. Management:

(1) Prediction, reporting, and analysis of energy consumption for a military installation.

(2) Control facility energy use with reliable automated energy control systems.

4.3 MOBILITY OPERATIONS

4.3.1 General. The Army has several management programs designed to reduce energy consumption in mobility operations. They are:

a. POL Management.

b. Traffic Management.

c. Transportation Management.

The above programs are all dedicated to the Army's energy management objective of conserving energy while maintaining readiness.

4.3.2 POL Management

4.3.2.1 Gasoline Consumption. Army gasoline consumption dropped dramatically in FY74 as a result of conservation measures imposed during the oil embargo and the ensuing petroleum shortage. After a slight increase in consumption in FY75, as the worldwide petroleum situation eased, Army gasoline consumption has consistently improved on the FY75 zero growth objectives. Gasoline consumption showed a 6.3-percent decline in FY76 and a 3.3-percent decline in FY77 when compared to FY75 figures (figure 4-5).

FY73	3,868,000
FY74	2,943,000
FY75	3,085,000
FY76	2,890,000
FY77	2,982,000
FY85 (PRESIDENTIAL TARGET)	2,676,000 (90% of FY75)

SOURCE: ARMY ENERGY OFFICE

Figure 4-5. ARMY GASOLINE CONSUMPTION (BARRELS)

4.3.2.2 POL Consumption. The Army National Guard has initiated two programs designed to curtail POL consumption. The first program is energy allocation, based on FY75 consumption, with some increase for aviation fuel necessitated by an increased flying hour program. An allocation is made to each state without regard for any specific type of fuel. To exceed this allocation, a state must present justification to and receive approval from the Chief, National Guard Bureau. The second program estimates fuel requirements in barrels. The allocation for aviation fuel has increased due to an authorized increase of 33,334 flying hours in FY77 over FY75. Although the density of track and wheeled vehicles has increased considerably since 1975, the petroleum limits for FY75 hold. Each state is held strictly responsible for energy conservation while meeting training readiness requirements.

The United States Army Reserve (USAR) actively participates in energy conservation measures that are operationally oriented and command influenced (e.g., POL, electricity, and other forms of energy conservation for installation/facility activities, training activities, etc.) as directed and managed by United States Army Forces Command.

4.3.2.3 Other POL Actions. The Army is conducting physical property testing of oil to determine the condition and degree of contamination of lubricating oil in operating equipment. Data collected from this testing provides a basis for extending oil change intervals. As a result, DA has thus far extended oil change intervals to twice the period described in their lubrication orders for tactical wheeled vehicles, military design motor vehicles, construction equipment, motor generator sets, and material handling equipment.

DA is in the process of directing that transportation motor pools and tactical units comply with the Clean Air Act provisions for inspection and maintenance. Compliance involves periodic testing of exhaust emissions to insure that emission contaminants are within Environmental Protection Agency certification parameters. Meeting these standards will require that vehicle engines be properly tuned which should provide the added benefit of reduced fuel consumption.

In the Army's evaluation of logistic acceptability and supportability of material systems under development or deployed, fuel economy is included as an important factor. Among ongoing actions stressing this factor is curtailment in the production of the 10-kilowatt (kW) turbine generator, due to a determination that the turbine uses three times as much fuel and costs three times as much as the diesel version of this generator. Since the turbine weighs less than half the weight of the diesel, it will still be used where transportation weight is a factor.

Another fuel saving development is a recent user/developer action to design a 1.5 kW tactical generator to run on methanol (alcohol) instead of gasoline or diesel fuel. Future developments will include larger generators using this fuel, resulting in further reduction in use of gasoline and diesel fuel.

As a result of a U.S. Army Logistics Evaluation Agency (USALEA) survey which indicated potential high fuel consumption, automatic transmissions for a new series of heavy vehicles, XM 915/920, for engineer and transportation units have been taken under advisement. In June 1977, the ASA (IL&FM) permitted initial buy of the vehicle family, directing that further procurements will incorporate fuel consumption as a significant evaluation factor.

The Army's Carpooling and Parking Controls Regulation, AR 210-4, expands the use of carpools and mass transit modes over one car, one person travel to and from work. Although this does not conserve Army energy, it does make a significant contribution to energy conservation and environmental quality on a national basis.

4.3.3 Traffic Management. A number of traffic management actions have been taken with energy conservation spinoff benefits. In some instances the Army receives credit for energy savings only in terms of reduced cost for the service provided. In all cases, the energy savings assist in meeting the national goals.

a. Stress adherence to the 55 mph maximum speed limit for motor vehicles.

b. Consolidate Army group passenger movements to make maximum use of carrier capability.

c. Increase use of surface transportation (bus/rail) for short-haul movement (450 miles or less) of Army passenger traffic.

d. Use scheduled commercial airlift in lieu of military aircraft, when it is available and meets requirements, and restrict use of special aircraft missions whenever possible.

e. Encourage consolidation of hold baggage with household goods (HHG) for surface transportation in international movements.

f. Establish an approval authority for air shipment of HHG, limiting air shipment to only those cases when hardship to service member would result.

g. Encourage service members to utilize the do-it-yourself method of moving personal property.

h. Maximize surface shipments of cargo whenever responsive.

i. Encourage consolidation of cargo shipments and maximum use of cube of vehicles, vessels, planes, and containers.

4.3.4 Transportation Management

4.3.4.1 Vehicle Management. During the FY74 oil embargo and ensuing gasoline shortage, the Army initiated action to reduce the total number and size of the vehicles in its sedan fleet. On-hand, large, high fuel consumption vehicles are being replaced with smaller sizes through the normal replacement process as the large vehicles meet replacement eligibility criteria. Smaller sedans will assist in meeting the Army's gasoline consumption objective along with the improved gasoline mileage expected of newer models. Figure 4-6 outlines the Army's planned phased conversion of its sedan fleet from regular and intermediate sedans to more fuel efficient compacts.

	FY77	FY78	FY79	FY80	FY81
SUBCOMPACT	364	364	364	364	364
COMPACT	4,483	6,603	9,566	11,417	11,417
INTERMEDIATE	2,364	2,364	2,165	314	314
REGULAR	4,913	2,793	29	29	29
MEDIUM*	(2)	(2)	(2)	(2)	(2)
TOTAL	12,124	12,124	12,124	12,124	12,124

*Leased not included in total

SOURCE: ARMY ENERGY OFFICE

Figure 4-6. ARMY SEDAN FLEET

4.3.4.2 Aircraft Management. The following actions limiting aircraft utilization have had a definite impact on energy conservation:

a. Elimination of Combat Readiness Flying (CRF) requirements for aviators with less than 1,500 hours total time who are not in operational flying positions.

b. Introduction of Synthetic Flight Training System (SFTS) for Army aircraft. This greatly reduces actual flying time by substitution of synthetic flight time for CRF annual minimums and basic entry flight training. The Army has saved an estimated 18 million gallons of jet fuel in just the last 25 months. Additional savings are expected as more systems are introduced.

c. Consolidation of aircraft within company-, brigade-, and divisional-sized organizations--also consolidation in specific geographical areas. This amalgamation of aircraft reduces the number of aircraft while still providing the same or better mission support.

4.3.5 Near Term New Initiatives (FY78-83). One of the greatest challenges facing the Army in the near term is the selection and procurement of mobility equipment that insures no degradation in the state of readiness but maximizes fuel economy. The task is far from simple, particularly if the Army decides to restructure its 16 divisions, a decision which could come as early as 1980 as the result of tests now underway at Fort Hood, Texas. The restructuring under consideration calls for greatly increased mechanization of the fighting force with highly mobile logistics support oriented well forward in the battle area. Studies conclude that almost all of the combat vehicles of the maneuver battalions will have to be replaced during the first days of combat. The vast logistics fleet needed to support the fighting force will be subject to similar risk of early destruction and requirement for replacement operating so close to the battle area.

Lack of sufficient data on wheeled vehicle energy consumption in an Army use environment caused the ASA (IL&FM) to issue a memorandum to the Director of the Army Staff in June 1977, suggesting that future wheeled vehicle procurement give particular attention to the attainment of maximum fuel economies. To this end, and in furtherance of the President's energy conservation program, the memorandum further suggests that effo[illegible] be directed towards:

a. Purchase and test of commercially available vehicles in the military environment where adequate test data is not available.

b. Use of incentives which will encourage innovative design features and materiel usage to maximize fuel economy, with fuel consumption incorporated as a significant evaluation factor among established source selection criteria. It is further suggested that contracts include incentives that reward contractors for the achievement of fuel performance goals.

c. Conduct of a comprehensive study directed at methods of attaining fuel economies in our wheeled vehicle fleet.

In projection of the above guidance, the USALEA intends to insure that future vehicles and other fuel consuming equipment under development have fuel economy as an evaluation factor included among established source selection criteria in the Integrated Logistic Support (ILS) function.

An important Army near term energy motivated program which meets the criterion of fuel economy is the M113A1 Armored Personnel Carrier modernization. The improved powerplant efficiency is expected to realize a 20- to 30-percent fuel savings which will have an even greater significance from a fuel economy standpoint, if the restructured division currently being tested is adopted by the Army.

The requirement imposed on the Armed Forces by DOD that they meet the substantive portions of state and local air quality regulations has caused the Army to develop an exhaust gas analyzer for use in inspection and maintenance (I&M) procedures for tactical and administrative wheeled vehicles. Early in FY78, 500 of these systems will be distributed to the field. This program for monitoring and analyzing each vehicle's exhaust at intervals not to exceed the state requirement is expected to provide a fuel saving spinoff, by keeping vehicle engines properly tuned to meet primary standards for carbon monoxide and hydrocarbon emissions.

4.3.6 Long Range Programs (FY84-2000)

4.3.6.1 General. Readiness is the key word that motivates mobility operations programs. The capability of Army equipment, in well-trained hands, to best the enemy on the field of battle is the minimum acceptable standard. Energy consumption by this equipment is of major concern from the standpoint of the logistics effort necessary to keep it operational. A determination of what long range mobility programs to pursue to meet the Army's energy goals and objectives while maintaining a high state of readiness must be prefaced by the following broad assumptions:

a. Force structure (total strength)/stationing will remain the same except for the planned relocation of forces from Korea.

b. Army divisions will be restructured with emphasis on mechanization.

c. Current world East-West power balance will remain stable.

d. Synthetic fuels will replace petroleum based fuels whenever possible.

4.3.6.2 Long Range Outlook. Long range planning has begun to more closely scrutinize and to incorporate the energy factor. The "Army Environment 1985-95" study by the Strategic Studies Institute, Army War College, contains numerous references to energy needs and resources as an item of major interest to the Army of the future. The Science and Technology Objectives Guide (STOG) will place greater emphasis and higher priority ratings on energy factors in the revision of STOG currently underway. As the principal users' document, identifying force needs and requirements, the STOG plays an important role in establishing the parameters on which future equipments and weapons systems will be structured. These requirements are carefully analyzed in formulating specific weapons systems or equipment items to be incorporated into the Extended Planning Annex of the POM. Thus, energy factors will enter directly into the long range development cycle.

The incorporation of energy factors into the specifications for design and engineering of future Army combat mobility and operational requirements will require additional resources as well as trade-offs of other requirements considerations. For this reason the specific nature of the Army's program in force structuring (equipment) will require very careful analysis and critical judgments. Many of the current high mobility, high maneuverability equipment have increased rather than decreased fuel requirements. A major example is the XM-1 tank which will be powered with a turbine engine. To achieve the higher speeds required by the user and to power the additional tank-borne equipment items will require much higher fuel consumption rates. This in turn will increase the logistic requirements factor in terms of the additional tankers, pipelines, pumps, etc., required to meet the increased needs. A similar statement may be made for most mobility equipment, whether land or air. Listed below are key energy projects under development, all with potential as long range programs for the achievement of the Army's mobility operations goals of reducing energy consumption to zero growth from FY85 to the year 2000, and converting 20 percent of petroleum requirements to synthetic or alternate fuels by the year 2000, while increasing the efficiency of nonrenewable energy dependent mobility systems by 15 percent with no degradation to readiness.

a. Tire style versus fuel consumption.

b. Storage and delivery means for synthetic and alternative fuels.

c. Lighter weight vehicles.

d. Utilization of synthetic fuels.

e. Utilization of alternative fuels (gasohol, methanol).

f. Utilization of synthetic lubricants.

g. Energy efficient diesel engines.

h. Battery powered vehicles.

i. More highly efficient engines and engine components.

4.4 TRAINING

4.4.1 General. The Army, in conjunction with energy conservation goals, continues to allocate energy resources to training activities to the extent required to maintain readiness. The Army objective in meeting required readiness standards within the framework of energy conservation goals is to accomplish necessary training more efficiently and effectively.

4.4.2 Simulators. In attaining the above objective, a full spectrum of simulators and training devices continues to be developed and incorporated into training programs. These simulators include subcaliber and laser devices for direct and indirect fire weapons which reduce the requirement for large caliber ammunition and allow training to be conducted in local training areas, thereby reducing transportation requirements. The use of the Army's 16, 2B24, UH-1 flight simulators, during FY77, has resulted in a total savings of 115,997 flight hours. At a net cost savings of $182 per hour the Army has realized $21 million savings and a corresponding fuel and maintenance energy decrease. It is anticipated that additional flight simulators will be placed into service, for which similar data will be developed.

Simulators recently developed which, when incorporated as an integral part of training, will have a definite beneficial effect on the Army's energy conservation. Among these are:

Simulator	FY Availability
Rimfire Adaptor	1978
Flight Simulator CH-47FS	1978

Arcade-type simulators are under study to determine the extent of their application, learning reinforcement potential, and overall savings. Positioning a family of such simulators, which cover a broad spectrum of requirements, in troop billeting areas is under consideration. Also under development and being used Armywide are simulations which enhance training by permitting training managers to better prepare commanders and their staffs for subsequent field training, thus producing more judicious use of equipment and resources.

The Army National Guard has also adopted the policy of maximum use of mechanical simulators, as shown below, in order to reduce energy consumption while maintaining unit readiness:

M55 Laser Device

M31 Field Artillery Trainer

Sabot 81mm Subcaliber Device

Tank Turret Trainers

LAW 35mm Subcaliber Device

Sand Tables

Terrain Boards

Pneumatic Devices for Mortars

6-Wheel ATV Combat Vehicle Simulators/Train Tracked Vehicle Operators

Flight Simulators

4.4.3 Other Training Actions. Other actions in progress that are associated with troop training and exercises are:

a. Improving POL handling techniques to reduce waste and theft.

b. Consolidating garrison stay-behind detachments, thus reducing billet and support facility operating requirements.

c. Leaving equipment onsite when training will continue and troops must be returned to garrison.

d. Consolidating field training and range firing.

e. Moving heavy equipment on most fuel efficient vehicles.

f. Substituting nontactical vehicles for tactical vehicles wherever practical.

g. Developing 1/4-ton vehicle and/or dismounted training exercises in lieu of those using vehicles with greater energy consumption.

h. Utilizing dismounted troop movement when feasible.

The energy situation, the need for energy conservation, and training in energy conservation techniques are incorporated in the curriculum and training programs of all schools and training centers. Also, energy conservation is being stressed, on a continuing basis, in the Army Suggestion, Incentive Awards, and Command Information Programs. The Chief of Staff of the Army launched an Armywide suggestion campaign "Project 77/77" on 23 December 1976. Promotional information has emphasized the need for ideas to reduce costs and increase efficiency and economy of operations. Energy conservation has been among the major areas of concern.

4.4.4 Near Term New Initiatives (FY78-83)

4.4.4.1 Simulators. Simulators will play an ever-increasing role in training for the Regular Army, National Guard, and USAR during this period. There is no other individual means currently capable of making a more substantial contribution to energy and dollar savings in Army training than utilizing simulators in lieu of a major item of equipment. The Army will continue to develop and seek improvement in its current simulator inventory and to search for new areas of training in which simulators can be utilized. Listed in figure 4-7 are the Army's estimated dollar savings for the near term period through the increased use of flight simulators. Simulators currently under development with expected availability during the near term period are:

		FY78		FY79		FY80		FY81		FY82		FY83	
		Hours	Dollars	Hours	Dollars	Hours	Dollars	Hours	Dollars	Hours	Dollars	Hours	Dollars
	Flying	755257		812481		812481		812481		812481		812481	
UH-1	Simulator	243229		264084		262600		259829		234518		215481	
Savings	Total		62996		68584		68013		67296		60740		55810
	Flying	57031		58684		58684		58684		58684		58684	
CH 47	Simulator	3750		3750		3750		11250		18750		26250	
Savings	Total		5212		5212		5212		15638		26063		36488
	Flying	139370		138557		138557		138557		138557		138557	
AH-1	Simulator	3750		3750		3750		11250		18750		18750	
Savings	Total		3412		3412		3412		10238		17063		17063
	Flying			7681		27600		60912		95764		130504	
UH-60	Simulator			2500		6000		6000		10000		42000	
Savings	Total				605		1452		1452		2420		10164
	Flying												
AH-64	Simulator											2500	
Savings	Total												2358
	Flying	951658		1017403		1037322		1070634		1105486		1140226	
Grand	Simulator	250729		274804		2761000		288329		282018		304981	
Total	Total Savings		71620		77813		78089		94624		106286		121883

Figure 4-7. ESTIMATED DOLLAR SAVINGS - USE OF FLIGHT SIMULATORS (FY78-83) ($000)

Simulator	FY Availability
Observed Fire Trainer	1979
Tank Weapons Gunnery Simulator System	1981
Marksmanship/Gunnery Laser Device	1981
Command Group Simulator	1981
Flight Simulators	
AH-IFS	1979
UH-60FS	1979
AH-64FS	1982

4.4.4.2 Other Training Actions. The in-process revision of Army Regulation 350-1 (Army Training) will emphasize resource conservation in consonance with Army energy goals. The estimated publication date is August 1978.

Several state National Guard training actions are planned for the period FY78-83 to assist in meeting energy conservation goals while still maintaining a condition of readiness. Among these are:

a. Idaho's establishment in FY78 of miniranges for subcaliber firing which will reduce gasoline and diesel consumption for travel to regulation size ranges.

b. Illinois' plan for construction of a weekend training site near Marseilles, Illinois, in FY78 where equipment can be consolidated, thereby eliminating movement of many vehicles to and from the training site.

c. Arizona's planned construction of bulk fuel dispensing system at decentralized facilities in order to reduce fuel consumption in refueling vehicles and equipment.

d. Washington's study being conducted to determine the economic advantage of installing air spoilers on cabs of trucks used to deliver equipment to units throughout the state.

e. Michigan's experimental program for an "Audio-Visual Conferencing System" which would reduce travel to conferences or meetings but permit conferees to go to a central conference facility in their respective city and be able to communicate with each other from each location.

The USAR plans expansion of existing Equipment Centralization Sites (ECS) at Annual Training Sites (ATS) and construction of new ECS's where necessary to minimize the requirement for convoying vehicles to ATS for training.

4.4.5 Long Range Programs (FY84-2000). It is axiomatic that the keynote for success on the battlefield is a quality training program. However, a viable training program in the past has meant energy consumption on a large scale. The Army has two programs which are aimed at reducing energy consumption in training which will continue to be pursued vigorously in the near term and at this time appear to offer the best opportunity for the savings in training energy consumption needed to meet the Army's long range mobility operations goals. These programs are Training Energy Conservation Actions as outlined in section 4.4.3 and the Use of Simulators, which are in use by the Active Army, National Guard, and Army Reserve. As new items of equipment are added to the Army's inventory during the long range period, the Army will continue to actively pursue development and use of a full spectrum of simulations, simulators, and other training devices.

4.5 RESEARCH AND DEVELOPMENT

4.5.1 General. Energy conservation research and development in the Army is increasing in magnitude in direct proportion to the opportunities provided by developments in private enterprise. The Army follows up on breakthroughs in the civilian sector in its search for new ways to reduce energy consumption. The Army Energy Research and Development Program (AERDP) involves two types of projects: energy-motivated projects and energy-related projects. Generally, facilities projects such as energy resources conservation and improved energy utilization for military installations and total energy/utility systems are energy motivated. Mobility projects such as vehicle energy conservation and transmission and power systems are usually energy related.

An energy-motivated program of major significance to the Army is directed toward demonstrating the feasibility of solar cell (photovoltaic) energy conversion for a wide variety of military electrical power consuming equipment. To date, several items of military equipment have been converted to solar cell power and transported to various military installations to be operated under more realistic military conditions. These include a small battery charger, radio relay systems, telephone communications station, and a 10 kW water purification plant. An 8 kW solar cell power system for a radar station has become operational, and plans have been finalized for a 60 kW power augmentation facility which, when constructed in November 1978, will include the world's largest solar cell array.

Also under development is a 10 kW small gas turbine generator. Extensive progress has been made with this generator utilizing ceramics in improved components, increased power density, heat recovery system, and engine operation at higher temperatures resulting in dramatic improvements in fuel economy.

An ongoing energy-related project worthy of special note is the previously mentioned improvement in powerplant efficiency for M113A1 Armored Personnel Carriers. A new transmission, the Allison X-200, is to replace the Allison TX-100 transmission on the M113. The X-200 is far more efficient, providing an estimated 38-percent improvement in operating characteristics and 20- to 30-percent fuel savings. Five production models are to be validated for performance, to include fuel economy, commencing in February 1978. The funding for the program is currently planned as follows:

Funding	FY79	FY80	FY81
($ Millions)	28.2	26.7	32.3

Programed over a 10-year period, 85 percent of the fleet, or 24,000 carriers, will be equipped with this new transmission. In contrast to many energy saving actions where a tradeoff in performance is required to achieve energy savings, this new transmission is expected to provide improvement in both areas.

4.5.2 Energy R&D Programs. The AERDP categories are four in number: Basic Research, Exploratory Development, Advanced Development, and Engineering Development. The general program types and project totals included in each category are shown in figure 4-8. Several projects are part of an extensive cooperative effort between the Army and DOE. These projects are identified in the discussion of individual projects contained in appendix A. In addition to the joint Army-DOE effort, the Army, Navy, and Air Force are engaged in an energy R&D information exchange program designed to avoid duplication and to conserve energy.

4.5.2.1 Basic Research Program. The Basic Research Program provides fundamental knowledge for the solution of identified military problems and is part of the base for subsequent exploratory and advanced developments. In energy basic research, the technology of small engines for aircraft propulsion is being studied, with the payoff being reduced fuel consumption and cost. Power generation is being studied in terms of energy transformation, storage, and conversion systems for use in providing energy required for Army communication surveillance, fuzing, propulsion, and other critical applications.

During FY77, basic research on aircraft propulsion continued on aerodynamics, heat transfer materials sciences, and lubrication. Research also included walls on primary lithium cells with new inorganic electrolyte solvent, direct oxidation hydrocarbon/air fuel cells, magnetic field calculations in near-saturated media, computer-aided design for mobile electric powerplants, and superconductors to produce high temperature material in forms suitable for applications to superconducting generators and motors.

NUMBERS OF PROJECTS BY TYPE AND PROGRAM CATEGORY

TYPE PROJECT	6.1 BASIC RESEARCH	6.2 EXPLORATORY DEVELOPMENT	6.3 ADVANCED DEVELOPMENT	6.4 ENGINEERING DEVELOPMENT	NOT IDENTIFIED BY CATEGORY	TOTALS
ENERGY SYSTEMS	1	9	2	2	2	16
ALTERNATE ENERGY SOURCES	2	3			1	6
FUEL IMPROVEMENT		5			1	6
POWER GENERATION	8	8	7	1	3	27
VEHICLE ENGINE DEVELOPMENT		3	9		2	14
VEHICLE TRANSMISSION STEERING		1			2	3
AIRCRAFT PROPULSION	1	1	4			6
OTHER	1	7	3		8	19
TOTALS	13	37	25	3	19	97

Figure 4-8. ENERGY R&D PROJECTS

4.5.2.2 Exploratory Development Program. The dominant characteristic of the Exploratory Development effort is that it is pointed toward specific military problem areas with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters. Energy exploratory development:

a. Includes the provision of propulsion technology for gas turbine engines.

b. Provides technological advances for the improvement of Army engine durability, fuel economy, fuel tolerance, simplicity, low emission, and compactness.

c. Improves on technology in liquid hydrogen and gaseous fuels and their utility as alternate fuels in Army surface and air powerplants.

d. Develops more efficient fuel cell systems.

e. Improves efficiency in energy use at Army facilities.

f. Identifies cost effective alternate energy sources for use at Army installations.

g. Provides innovative facility oriented energy management techniques.

During FY77 exploratory development, the Army explored technologies that offered significant improvements in the small gas turbine engines. Research investigated the sensitivity of new engine/systems components to alternate and emergency fuels and continued research to develop cheaper and more efficient fuel cell systems. Also considered were the application of atomic, nuclear, and coal technologies to Army power needs and the efficient operation of energy systems with presently available resources.

4.5.2.3 Advanced Development Program. The Advanced Development Program includes all projects which have reached the stage of developing hardware and nonmateriel technological prototypes or techniques for experimental or operational test. The program includes advanced technological propulsion systems to insure satisfaction of mission requirements. Vehicle transmission/steering unit development provides for design development and testing of these systems and their associated subcomponents for both wheeled and track vehicles. Under energy conservation, the program evaluates and validates criteria for solar energy systems used for heating and cooling of buildings at military installations.

Aircraft engine efforts, begun in FY76 in the 800 hp class advanced technology demonstrator program, will continue in FY78. The vehicle transmission/steering unit development emphasized development of the 600 hp hydromechanical transmission system for the 20-ton combat vehicle family. The vehicle engine program was concerned with developmental turbine diesel and rotary engines.

4.5.2.4 Engineering Development Program. This program includes those development projects which are being engineered for military service use but have not yet been approved for procurement or operation. It is characterized by major line item projects.

4.5.3 Near Term New Initiatives (FY78-83). In facilities R&D, short term exploratory development in facilities energy technology will be pursued to support the President's goals for 20-percent reduction in energy consumption in existing buildings and a 45-percent reduction in energy consumption in new construction. This program will focus on techniques for managing the use of energy, installation energy consumption prediction to establish conservation goals, evaluation of energy consumption for alternative design and operating conditions to provide a basis for energy system optimization, and to provide designers and facilities engineers with techniques for conservation investment maximization.

Additional facilities R&D new initiatives include the examination, field testing, validation or rejection of products, systems and techniques developed to improve efficiency, effectiveness, and economy of energy in military energy systems. Included for consideration in the examination are peak electrical demand, the efficiency of large boiler plants, detection of thermal loss, boiler convertibility, geothermal sources, low energy heat recovery, and non-tactical generators.

The development of Army equipment requires a long leadtime, and as a result the current and upcoming generation (FY78-83) of Army equipment was not designed with energy consumption as a principal consideration. However, the Army is developing an expanded mobility R&D plan with emphasis placed on direct energy conservation, to include tactical wheeled vehicles. The funding impact will be included in the FY80 budget submission. New initiatives in the mobility area involve fuel savings research into engine performance as well as fuel and lubricating oil improvement.

4.5.4 Long Range Programs (FY84-2000). The Army's long range R&D facilities operations program is a continuing extension of the current and near term orientation toward military energy technology which entails energy systems research designed to contribute to the achievement of the Army's long range facilities operations goals. The objectives of this research address the requirement to minimize the adverse impacts of increasing fuel cost and the decreasing availability of petroleum supplies for strategic, tactical, training, and routine Army operations. These objectives are:

a. The development of effective energy conservation techniques to reduce energy consumption at military facilities.

b. The development of alternative energy sources for military facilities.

c. The development of techniques, procedures, and systems for effective management of energy resources used by the Army.

In the mobility operations area the Army's R&D will be a continuing effort to meet the Army's long range mobility operations goals in reduction of both energy consumption and dependence on petroleum fuels. General areas planned for reduction of energy consumption in field operations are:

a. Development of novel engine cycles and geometry for improved efficiency, especially at part load.

b. Improvement of operational efficiency of internal combustion engines through development of diagnostic procedures and equipment.

c. Improvement of process control monitoring devices, e.g., "fluid pump," fluidic temperature, and fuel control sensors to optimize system efficiencies.

d. Improvement of operational efficiencies of internal combustion engines through incorporation of synthetic lubricants.

e. Extension of oil change intervals for aviation and automobile equipment.

f. Reduction of energy consumption in food processing by:

(1) Systems approach to energy management of food service operations

(2) Reconstituting frozen foods.

(3) Flexible packaging.

(4) Radiation preservation.

g. Development of improved laundry systems for conservation of energy and water.

h. Development of high efficiency area lighting equipment.

i. Elimination of unnecessary losses in electric power generation and utilization for military equipment.

Reduced dependence on petroleum fuels is to be pursued by:

a. Evaluation of synthetic fuels for aviation, automotive, and power generation.

b. Utilization of low grade heat for alternate fuel production (by biological means).

c. Development of methods for production, storage, and utilization of coal petroleum slurry fuel.

d. Production of methanol from municipal trash.

e. Application of solar energy for electric power (solar cells).

f. Investigation of new technology for high efficiency hand-cranked generators.

g. Development of a high power, fast charge, lead acid battery for peak load operation.

For a list of mobility operations projects being considered for implementation and funding in the long range period see appendix B. These projects have not, as yet, been officially screened for relevance or priority.

4.6 PUBLIC AFFAIRS. The Office, Chief of Public Affairs had in operation a Command Information Mini Plan on Energy Conservation during calendar year 1977. This plan was used by all public affairs officers and was supported by both DA and DOD produced materials. The objectives of the plan were to create awareness among all members of the Army of the importance of energy conservation and to realize a condition of zero growth in the area of energy consumption. A Public Affairs Plan which covers both the near term and long range periods has been developed to support the Army's overall energy plan as it evolves and is implemented. In pursuit of the above-cited objectives, a wide variety of materials has been prepared and made available to all segments of the Army to publicize energy conservation and the energy program. Among these are five ARNewS articles in CY76 and nine ARNewS articles and two Spotlights in CY77. Additional support includes 33 recorded radio spots, 10 recorded news spots, and artwork covering topics on energy shortages, conservation, consumption, synthetic fuels, and strategic fuel reserves for use by some four hundred

Army National Guard, Reserve, and Active Army publications. It is estimated that 75 percent of these 400 publications used at least one article on energy in each 3-month period. A 1976 DOD study established that there is a potential readership audience for these materials of 35 million persons which includes active and reserve Army, National Guard, civilian employees, retirees, and dependents.

4.6.1 Public Affairs Plan

4.6.1.1 Purpose. To provide public affairs support for the Army Energy Plan and for the implementation of Army energy conservation programs and policies.

4.6.1.2 Objectives. The objectives of the Public Affairs Plan are to:

a. Inform internal and external audiences through the use of all available media resources of the Army's plans, goals, and achievements in energy conservation.

b. Inform the internal audience of the need to exercise initiatives in conserving energy.

c. Demonstrate to the general public and the media the Army's concern for conserving energy and its contributions to the Nation's overall energy conservation efforts.

d. Obtain feedback to insure understanding of the Army Energy Plan and to refine continuing public affairs programs.

4.6.1.3 Execution. Guidelines and assignments for the execution of the Public Affairs Plan are outlined below.

a. General.

(1) Public affairs programs may use informational materials provided by all staff agencies and commands.

(2) Informational materials for national release will be coordinated with the Office of the Chief of Public Affairs (OCPA), attn: SAPA-PP.

(3) Close coordination will be maintained between OCPA, DA Staff agencies, and all major commands to provide maximum public affairs support for the Army Energy Plan.

(4) Public affairs programs should be developed, established, and executed in accordance with AR's 360-5, 360-61, 360-81, 11-27, and the Army Energy Plan.

b. Responsibilities.

(1) DA Staff Agencies.

(a) Comply with the provisions of paragraph 4b, CSR 360-1.

(b) Provide a knowledgeable spokesperson to respond to media queries about tests/evaluations/studies/programs/policies/accomplishments pertaining to energy conservation which have been or are being conducted through the respective staff agencies.

(c) Use staff agency media to disseminate information about Army energy programs.

(2) ODCSLOG.

(a) The Army Energy Office (DALO-TSE) will provide fact sheets, information briefs, and similar materials for use in preparing news releases and feature articles.

(b) Provide a knowledgeable spokesperson to respond to queries or requests for interviews from the media about the Army Energy Plan and energy conservation programs in general.

(3) OCPA.

(a) Coordinate and monitor the provisions of the Army Energy Plan and provide additional guidance as required.

(b) Insure that all appropriate public affairs resources are used in diseminating information about Army energy conservation programs and in executing the Army Energy Plan.

(c) Coordinate through the Office of the Assistant Secretary of Defense (Public Affairs) all information materials for release to the national media.

(d) Respond to queries from the media and public.

(4) OCAR and the National Guard Bureau (NGB). Develop public affairs support, as appropriate, for Army Reserve and Army National Guard execution which fully responds to the objectives of the Army Energy Plan.

(5) Major Commands (MACOM's).

(a) Develop and execute command, public information, and community relations programs to support the objectives of the Army Energy Plan.

(b) Forward appropriate or newsworthy informational materials to SAPA-PP for clearance and/or release to the national media.

(c) Insure that subordinate elements develop, establish, and execute public affairs programs to support the objectives of the Army Energy Plan.

4.7 REPORTING

4.7.1 General. Presently, the Army relies primarily on DEIS I and II reports, which are concerned solely with energy consumption data for energy management information. The DEIS is designed to facilitate energy management by providing timely, up-to-date, reliable, and accurate information on all forms of energy except nuclear energy. For each energy resource, the system provides information on:

Quantity consumed.

Quantities on hand.

Prior FY/baseline period consumption.

Source of receipts.

Quantity sold to other services.

Usage by category.

An explanation of variance from the standard.

The DEIS further provides a means for evaluating energy consumption against established goals.

The DEIS procedure for reporting energy status applies to all Army activities including COE activities and the Army National Guard. Energy status of USAR activities is reported by host activities. The policies, procedures, and responsibilities concerning Army input to DEIS are outlined in chapter 5 of AR 11-27. The reports are used by DOD and DA for management purposes and are furnished to non-DOD Federal departments and agencies and to Congress upon request. Therefore, it is mandatory that input data to DEIS be accurate.

In an effort to reduce computational errors, and in anticipation of Federal reporting requirements, a proposal has been made to ASD (MRA&L) Defense Energy to reprogram the DEIS so that reports could be accepted in normal energy units or measure and the computations to convert them to Btu be made at the Defense Logistics Agency computer to reflect Btu's per square foot for each reporting installation. Reporting consumption by Btu's per cubic foot is also a possible embellishment that could more accurately reflect requirements and consumption at installations.

In addition to the DEIS I and II reports, the OCE receives annual reports summarizing costs (including manpower, supplies, and energy) and quantity data. The Technical Data Reports cover fixed installation usage with the exception of Army National Guard and Army Civil Works responsibilities. While these reports suffer from a time lag factor, they are extremely useful to facilities engineers in managing their energy programs. An Annual Summary of Operations containing data compiled by Army installations is published and distributed to all installation engineers and other interested personnel.

4.7.2 DEIS I. DEIS I is a monthly report which reflects bulk petroleum fuels inventory, receipts, sales to DOD and non-DOD activities, and Army consumption and usage. The report is prepared as of 0800 hours local mean time on the last Friday of each month and reflects data to that time and date from the cutoff of the previous month.

4.7.3 DEIS II. The DEIS II is a quarterly report which provides information on utility type energy resources. The report reflects inventories of coal and LPG, plus baseline and current consumption information on purchased electricity, natural gas, LPG, coal, and purchased steam, and includes data for tenants supported by the reporting agency.

4.7.4 New Reporting Initiatives. A recent Army Energy Management Study performed for the AEO, DCSLOG, DA, reflected a breakdown in the crossfeeding of information at the major command level. The study indicated the need for development of a command management information program in lieu of the present requirement of merely assuring the validity and timeliness of energy data for higher authority. The study recommended that appropriate information be periodically forwarded to the AEO as part of an overall energy management information program with the specific requirement that an annual narrative report be submitted by 31 October of each year from each major subordinate command outlining significant accomplishments and shortfalls.

The Construction Engineering Research Laboratory (CERL) is currently developing the Energy Consumption Reporting and Analysis System (ECRAS). ECRAS is intended to be a single system for facility engineering energy consumption management and planning. It will employ energy utilization indexes to predict building energy consumption based on weather data and descriptive data on the facility. The final systems data base is being designed to automatically provide the input data for a number of existing standard reports to include DEIS II. ECRAS intended benefits include:

a. One-time entry of consumption data.

b. Budgeting by requirements.

c. Analysis of energy conservation program progress.

d. Automated reporting to higher headquarters.

e. Analysis of energy impact due to changes (actual or proposed) in real property inventory.

CHAPTER 5

FEDERAL ENERGY LEGISLATIVE SUMMARY

5.1 INTRODUCTION. Congress has passed into law over 60 pieces of legislation directly related to energy matters since the oil embargo in 1973. This section will highlight and summarize enacted laws and proposed legislation most pertinent to the Army's energy situation and its energy plan. A complete listing of these laws is provided in appendix B of this document.

5.2 PUBLIC LAWS ESTABLISHING NATIONAL ENERGY POLICY

5.2.1 Federal Nonnuclear Energy Research and Development Act of 1974 (Public Law 93-577). This act established policy guidelines for the Energy Research and Development Administration and provided authority for development of an overall National program to conduct nonnuclear research, development, and demonstration.

The Army has provided support to this program primarily through use of its facilities to provide for the demonstration element of energy projects. Importantly, this law provided the Army with clear indication of the Federal Government's commitment to energy research.

5.2.2 Energy Policy and Conservation Act of 1975 (Public Law 94-163). Under the provisions of this act is the authority for the establishment of a Strategic Petroleum Reserve (SPR). This reserve is an additional potential source of crude oil to be used in the event of war. The Defense Production Act of 1950 would have to be evoked, however, in order to provide for refinement of SPR crude oil.

The Energy Policy and Conservation Act contained amendments to the Emergency Petroleum Allocation Act that provided the new oil price policy which initially rolled back the price of crude oil. Provisions for gradual cost increases of domestically produced oil were frozen, however, because of increases in prices due to inflation and other causes. The freeze on this policy was lifted as of 1 September 1977.

Ultimately, the impact on the Army will be increased costs, but thus far, due to the pricing rollback and the policy freeze, the impact has been favorable.

5.2.3 Energy Conservation and Production Act of 1976 (Public Law 94-385). This law incorporates provisions to minimize the use of energy in residential housing, commercial, and public buildings, and industrial plants through Federally supported State energy conservation implementation programs. Four major areas for energy savings cited are: transportation, residential and commercial buildings, industry, and utilities planning (rate structure reform).

The Army is a bulk consumer of electricity. It pays a commodity as well as a demand charge. The commodity billing is based on a flat rate per kilowatt-hour. A demand charge is an additional charge levied on the basis of the period or time of day that electrical consumption occurs. As such, the Army pays more for electricity during periods of peak demand. While the impact of existing utility rate reform has generally not been determined, any legislation providing for shifting of the cost burden from residential to high volume users will cause Army utility costs to rise significantly. It might well also cause the Army to consider generating its own electricity should it become cost effective to do so.

5.2.4 Department of Energy Organization Act (Public Law 95-91). This act established the DOE and assigned to it the authority for many energy functions heretofore vested in FEA, ERDA, Department of Housing and Urban Development, Department of the Interior, and other Federal agencies. The purpose of consolidation of Federal energy functions is to provide added focus and coordination in National energy matters and to implement a National Energy Plan. For the general functions and organization of the DOE, refer to figure 2-1 of this report.

5.3 FEDERAL LAWS HAVING DIRECT EFFECT UPON THE ARMY

5.3.1 Defense Production Act of 1950, As Amended (Public Law 94-152). The Army's fuel requirements are protected by this act in that availability of necessary fuels and equipment are guaranteed in the interest of national security. This is accomplished through provisions for expansion of production capacity and supply. It also establishes a system of priorities and allocation for materials and facilities and provides for their requisition. The provisions of this act can be evoked by the President at his discretion.

5.3.2 Solar Energy Research, Development, and Demonstration Act of 1974 (Public Law 93-473). This law provides for ERDA initiation of a research, development, and demonstration program to resolve major technical problems that inhibit commercial utilization of solar energy in the United States. Some of the technologies with which this R&D program deals include:

a. Direct solar heat

b. Thermal energy conversion

c. Photovoltaic processes

d. Windpower conversion

e. Solar heating and cooling of buildings

f. Energy storage

While the Army is involved in some direct research into photovoltaics and power cells, its primary contribution has been in demonstration projects.

5.3.3 Electric Vehicle Research, Development, and Demonstration Act (Public Law 94-413). This law specifically calls for the Secretary of Defense to provide for demonstration of electric test vehicles to the greatest extent feasible. The Army Tank-Automotive Command was lauded during events leading to passage of this act in the House Committee Report for its support in development of ground propulsion engines. It is expected that Army participation in research and demonstration projects of this kind will continue.

5.3.4 Emergency Natural Gas Act of 1977 (Public Law 95-2). This act authorized the President to order emergency deliveries and transportation of natural gas to deal with existing or imminent shortages. While this authority expired on 30 April 1977, it is pertinent that, should the need arise again for emergency legislation concerning natural gas, precedence exists for enactment of remedial authority. The Army did indeed receive assistance in obtaining natural gas during the severe winter of 1976-77 as a result of this act.

5.4 PROPOSED LEGISLATION

5.4.1 National Energy Act (S. 1469, H.R. 6831). This legislation is intended to establish a comprehensive national energy policy. The following outline is of both Title I and Title II of the House version:

Title I - Pricing, Regulatory, and Other Nontax Provisions

- Part A - Energy Conservation Programs for Existing Residential Buildings
- Part B - Energy Efficiency of Consumer Products
- Part C - Energy Conservation Program for Schools and Hospitals
- Part D - Natural Gas
- Part E - Public Utility Regulatory Policies
- Part F - Amendments to the Energy Supply and Environmental Coordination Act

Title II - Tax Provisions

Part A - Residential Energy Tax Credit

Part B - Transportation (includes fuel efficiency incentive tax and gasoline conservation program)

Part C - Business Energy Tax Credit

Part D - Crude Oil Tax

Part E - Oil and Gas Consumption Taxes (and Rebate)

Part F - Energy Development Tax Incentives

Part G - Federal Energy Initiatives (includes a Federal vanpooling program, amendments to EPCA and demonstration of solar heating and cooling in Federal buildings)

Impact of this legislation on the Army would be far reaching. Key issues of concern to the Army are provisions in Title I, Part E, and Title II, Part D, whereby energy tax and rate policies would be reformed. An additional wellhead tax, for example, would cause petroleum costs to rise an expected 3 cents per barrel. Utility rate structure realinement would be expected to cause utility costs for the Army to rise.

Overall impact of this National Energy Act could be characterized as an effort to conserve energy, but at the expense of increased energy costs.

5.4.2 Synthetic Fuels Act of 1977 (S. 429). This is a bill to amend the Federal Nonnuclear Energy Research and Development Act of 1975 to provide assistance (loan guarantees) in development and demonstration of synthetic fuels.

5.4.3 Coal Utilization Act of 1977 (S. 977). This bill would require that new electric powerplants and fuel burning installations be constructed with the capacity to use coal or fuels other than natural gas or petroleum.

Second, it would require that by 1 January 1979, any existing powerplants or fuelburning installations with the capability to use coal or fuels other than gas or petroleum, shall use such fuel.

Third, the bill would require that by 1 January 1979, powerplants or installations which now use natural gas as its primary energy source shall acquire the capability to use and shall use energy sources other than natural gas.

Finally, it would require that any installations which cannot be converted to coal utilization improve or modernize in order to conserve natural gas or petroleum.

Whereas the Army is already in the process of converting or modernizing many of its fuelburning installations, this bill, if enacted, would only serve to accelerate achieving the Army's goals. The impact on the Army's budget could be significant.

5.4.4 Federal Employees Flexible and Compressed Work Schedules Act of 1977 (S. 517, H.R. 2732, 2930). This legislation authorizes a 3-year experimental program to determine the possibility of providing a 4-day week and other compressed work schedules. The requirement to pay premium pay to employees for working more than 8 hours, or working at night, would be dropped where employees voluntarily choose to work such a schedule but would continue in effect where management directs such work. Operating an installation or a portion of an installation 10 hours per day, 4 days per week as opposed to 8 hours per day 5 days per week could provide installation commanders an additional means by which energy conservation goals might be achieved. However, current legislation requires that overtime pay rates must be given to employees working in excess of 8 hours during any 1 day. This makes the 4-day workweek economically infeasible under present conditions.

5.5 NEEDED LEGISLATION. The following briefly outlines areas that need to be included in national legislation in order to facilitate implementation of the Army Energy Plan and to help achieve the goals and objectives set forth therein.

5.5.1 Coal. Part of the Army's energy plan calls for conversion of oil and natural gas burning facilities to coal. The future availability and use of coal is therefore important.

5.5.1.1 Coal Supplies. It is anticipated that national legislation will also require widespread conversions by industry and Government from oil and natural gas to coal. Consequently, it is essential that provisions be made to expand the nation's coal supply. However, environmental concerns pertaining to coal mining, labor unrest, leasing agreements, and inadequate mining equipment and rail transportation facilities are problems that can potentially thwart the expansion of coal production. Therefore, broad legislative action is needed in these areas to insure adequate coal supplies in the future.

5.5.1.2 Coal Usage. The Clean Air Act of 1970 has had the effect of prohibiting the burning and thus eventually the mining of much of the underground coal which contains sulfur beyond specified levels. Only a small percentage of eastern coal reserves (estimates as low as 5 percent) are available for use as low sulfur fuel. Legislation is needed that will provide the means for development of the capability of using high sulfur content coal that will be environmentally acceptable in light of the Nation's energy requirements in both the near and far term.

5.5.2 Alternative Fuels. If the Army is to meet its goal of discontinuing use of natural gas by the year 2000 and reducing oil consumption by 75 percent, it is essential that legislation continue to provide increasing funds for research, development, and demonstration of alternative fuel production, delivery, and use. Coal gasification and liquification, alcohol production from various sources, refuse derived fuels, and solar energy to include photovoltaics are some of the more promising alternatives that require further funding through legislation.

5.5.3 Nuclear Power. A limited number of Army installations consume energy in sufficient quantity to warrent consideration for use of total (centralized) energy systems. Nuclear powerplants are theoretically a viable option in such circumstances. However, the environmental and safety aspects of establishing nuclear powered facilities which are provided for in current legislation all but eliminate use of nuclear power as a practical option. Therefore, further clarification and/or adjustment of legislation concerning nuclear powerplants is needed to facilitate what is currently an arduous process for nuclear plant licensing and operation.

5.5.4 Refuse-Derived Fuel (RDF). Commerical firms that do business in the area of refuse-derived fuels have offered certain Army installations a no cost retrofit of their heating facilities to burn RDF. In return, these firms require long term commitments from the retrofitted installations to purchase all of the RDF from that firm. However, because of the Federal Government's legal prohibition against entering into long term contracts, the Army cannot take advantage of such offers. Therefore, legislation is needed which would authorize the use of operation and maintenance funded contracts over an extended period of time at those installations which could achieve energy savings without adverse personnel or operational effects.

APPENDIX A

CURRENT ARMY RESEARCH AND DEVELOPMENT
ENERGY CONSERVATION PROJECTS

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
Hybrid Power Source for Electric Propulsion	62708A/1L762708AH67	To evaluate the advantages of a hybrid power source (fuel cell - battery) for electric propulsion.	MERADCOM	FY77 - $25K	CONT.
Battery Evaluation, Testing and Duty Cycle Generation	62708A/1L762708AH67	To select, test, and evaluate the most applicable and current electrochemical power sources for engineering of systems for ground power and propulsion applications.	MERADCOM	FY77 - $75K	CONT.
Electrocatalysts for Acid Electrolyte Fuel Cells	61102A/1L161102AH51	To find Co tolerant anodic electrocatalysts for use in H2/air fuel cells that are useful at moderate temperatures below 130° C.	MERADCOM	FY77 - $15K	CONT.
Mechanisms of Electro-oxidation of Simple Hydrocarbon Fuel Electrodes	61102A/1L161102AH51	(A) To determine the mechanisms and reaction steps by which simple hydrocarbons are electrooxidized on the mechanism and the rate limiting step. (B) To evaluate selected non-noble materials for possible use as electrocatalysts.	MERADCOM	FY77 - $10K	CONT.
Physical Characteristics of Fuel Cell Electrolyte Systems	61102A/1T161102AH51	To determine the physical characteristics of acid fuel cell electrolytes over the operating temperature range of practical cells.	MERADCOM	FY77 - $50K	CONT.
Electrochemical Evaluation of Fuel Cell Electrolyte Systems	61102A/1T161102AH51	To determine the electrochemical behavior of possible fuels and oxidants in acid electrolyte solutions and to examine the interaction of fuel cell reactants with electrode surfaces in these acid electrolyte systems.	MERADCOM	FY77 - $50K	CONT.
Optimization of Platinum Doped Kocetet (R) Electrodes in H3PO4 Fuel Cells*	62708A/1L762708AH67	To determine the performance of supported pyropolymers (kocetet) as electrocatalysts in the reduction of oxygen in air and the oxidation of pure hydrogen as well as hydrogen-carbon monoxide mixtures.	MERADCOM	FY77 - $60K	CONT.
Application of Ceramic Turbine Nozzles to the 10KW Gas Turbine Engine	63702A/1G763702DG11	To design, fabricate, and evaluate a ceramic turbine nozzle ring assembly for the gas turbine engine of the MERDC 10KW turboalternator.	MERADCOM	FY77 - $98K	SEP 78

*In cooperation with DOE

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
Application of Ceramic Ball Bearings to the 10KW Gas Turbine Engine	63702A/1G763702DG11	To compare the performance of analytically optimized HP 513N4 ceramic and M50 steel ball bearings in order to determine the desirability of such a substitution in the gas turbine engine of the MERADCOM developed 10KW turbo-alternator.	MERADCOM	FY77 - $98K	SEP 78
1.5KW Sleep Inverter	63702A/1L763702DG11	To develop a low cost, light weight, efficient inverter to produce a sinesoidal output of nominally 1.5KW at either 60Hz or 400Hz, 120 or 240 V ac, when fed from a fuel cell or battery with an input voltage of 36 to 60 V dc.	MERADCOM	FY77 - $95K	JUN 78
3KW Sleep Inverter	63702A/1L763702DG11	To develop a low cost, light weight, efficient inverter to produce a sinusoidal output of nominal 3KW of either 60Hz or 400Hz, 120/240 V ac 10-120/208 volts, 30, when fed from a fuel cell or battery with an input voltage of 30 to 60 V dc.	MERADCOM	FY77 - $125K	CONT.
Family of Low Power (300 watts/5KW) Power Conditions for Fuel Cells and Other DC Prime Power Sources	63702A/1L763702DG11	To provide design guidance and prototype to be used as multiple frequency inverters (DC-to-AC) for fuel cells and variable frequency inverters to be used as solid state-drivers for air conditioning compressors and condenser fan motors.	MERADCOM	FY77 - $150K	JUL 79
Indirect 1.5KW Methanol-Air Fuel Cell Power Plant	63702A/1L763702DG11	To provide a power plant meeting the Army's silent, lightweight, efficient, electric power source (Sleeps) requirements.	MERADCOM	FY77 - $40K	COMPLETED JAN 78
Metal Hydride Fuel Cell Power Source	63702A/1L763702DG10	To develop metal hydride fuel cell power sources for applications requiring high energy density at low power output (0.1 to 10 watts) such as sensors, relays, and other remote equipment.	MERADCOM	FY77 - $52K	CONT.
Hydrocarbon Fuel Conditioner (Thermal Cracker)	63702A/1L763702DG10	To develop a practical, multifuel, fuel conditioning subsystem for use in military fuel cell power plants.	MERADCOM	FY77 - $25K	JUN 78

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
Alternate Energy Sources for Army Surface and Air Power Plants	62611A/1F662611AH69	Based on world liquid hydrocarbon fuel shortages, evaluate and assess suitability of using alternate, emergency and nonspecification fuels in military ground powered equipment.	MERADCOM	FY77 - $100K	CONT.
New Techniques for Fuel Analysis Being Applied to Military Fuels	62611A/1F662611AH69	To develop analytical methods (instrumental and conventional) applicable to petroleum fuels and petrochemicals permitting their characterization, identification, and compositional analysis.	MERADCOM	FY77 - $20K	CONT.
Foreign Fuel Sampling Program for Army Intelligence Purposes	62611A/1F662611AH69	To obtain a representative sample of automotive fuels from foreign sources for AMC RDT&E programs.	MERADCOM	FY77 - $10K	CONT.
Research on Fuel and Lubricants Related Emissions Phenomena	62720A/1T762720D048	To define the effect of fuel and lubricant composition and potential specification changes on emissions from Army material.	MERADCOM	FY77 - $20K	CONT.
Coordination on Fuels and Lubricant Research	62611A/1F662611AH69	To coordinate test programs and R&D among the petroleum industry, automotive industry, and the U.S. Government.	MERADCOM	FY77 - $110K	CONT.
Military Engine Fuel Requirements	62611A/1F662611AH69	To determine the necessary requirements for fuels to meet expected military vehicle requirements, provide in-depth analysis of field problems, and participate in cooperative fuel programs with other military laboratories and research committees.	MERADCOM	FY77 - $220K	CONT.
Hydrogen Generation from Aluminum	61101A/1T161101A91A	To produce safe, compact, and efficient hydrogen generators for use with low power fuel cell power sources.	MERADCOM	FY77 - $11K	OCT 78
Air Cycle ECU	62708A/1G762708AH67	To find new air conditioning and heating concepts with potential payoff for the Army.	MERADCOM	FY77 - $41K	CONT.
Absorption Air Conditioning	62708A/1G762708AH67	To find new refrigeration concepts that are cost-effective when compared to existing standard family of vapor cycle air conditioners.	MERADCOM	FY77 - $30K	CONT.

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
TECS Alternate Solid State Control	63726A/1G63726DH39	To design and fabricate a solid state control system for the TECS-18 to allow operation from any required voltage/frequency combination.	MERADCOM	FY77 - $54K	NOV 79
TECS - Solid State Control	64717A/1G764717DL39	To perform a redesign of a control system designed under contract DAAK02-73-C-0005 aimed at component reduction, simplification, and cost of manufacture reduction.	MERADCOM	FY77 - $6K	FY 85
Air Cycle Environmental Control Unit	62708A/1G762708AH67	To find new refrigeration concepts with potential payoff for the Army.	MERADCOM	FY77 - $18K	CONT.
Feasibility Investigation for New or Novel Electrical Machinery	62708A/1F762708AH67	To conceive and evaluate new and novel electrical machinery for use by the field Army.	MERADCOM	FY77 - $50K	CONT.
New Concepts in Solar Thermal Collectors	61101A/1T161101A91A	To use black fluid as absorption and heat transfer medium, thereby attaining higher energy conversion efficiency.	MERADCOM	FY77 - $16K	COMPLETED SEP 77
Low Temperature Thermal Energy Storage for Solar Applications	61101A/1T161101A91A	To show temperature feasibility of low temperature (250° F or less), low pressure thermal storage of liquids in a new sequential arrangement of conventional materials.	MERADCOM	FY77 - $4K	COMPLETED SEP 77
Investigation of Energy Loss in NB35N Multifilament Superconducting Solenoids	61101A/1T161101A91A	To measure losses generated by pulsed operation of NB35N multifilament superconducting solenoids in order to evaluate these new materials for engineering applications.	MERADCOM	FY77 - $8K	SEP 78
Chemical Vapor Deposited Silicon Carbide Radial Inflow Turbine Motor Investigation	63702A/1G763702DG11	To produce a chemical vapor deposited silicon carbide radial inflow turbine rotor for a small gas turbine application.	MERADCOM	FY77 - $33K	MAR 78
Free-Rotating Vaneless Diffuser Compressor Development	63702A/1G763702DG11	To extend the results of previous work with model free-rotating vaneless diffuser by design, fabrication, test, and development of a free-rotating vaneless diffuser in a full-scale, high pressure ratio, centrifugal compressor test-rig.	MERADCOM	FY77 - $53K	COMPLETED DEC 77

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
Medium Power (1.5 to 30KW) Militarized Power Conditioners for General Purpose Field Usage	63702A/1L763702DG11	To provide prototypes and design guidance for inverters (dc-ac), converters (ac-dc), and power conditioners (ac-ac) to be used for general purpose Army wide usage.	MERADCOM	FY77 - $110K	CONT.
Electric Power Transmission and Distribution Concepts	62708A/1F762708AH67	To improve the capability of electric power transmission to all power consuming load devices of the Army during peacetime environment and during a time of hostilities.	MERADCOM	FY77 - $65K	CONT.
Advanced Concepts for Power Conditioning Equipment	62708A/1L762708AH67	To conduct in-house experimentation, fabrication, and evaluation of advanced concepts for power conditioning equipment.	MERADCOM	FY77 - $72K	CONT.
Flexible Wick Heat Pipe	61101A/[illegible]101A91A	To develop a high capacity heat pipe.	MERADCOM	FY77 - $15K	COMPLETED SEP 77
Self-Powered Multi-Fuel Army Space Heater - 250,000 BTUH	64717A/1G764717DL39	To design and fabricate DT11/OT11 model heater based upon advanced development prototype.	MERADCOM	FY77 - $309K	SEP 81
Military Applications of Photovoltaic Systems*	Not available	To demonstrate the feasibility of solar cell (photovoltaic) energy conversion for a wide variety of military electrical power consuming equipment.	MERADCOM	FY77 - $921K (ERDA)	CONT.
Solar Cell Power for Instrumentation System at White Sands Missle Range	Not available	To design, fabricate, test, and deliver a solar cell power supply system for a selected application at White Sands Missle Range.	MERADCOM	FY7T - $60K (TECOM)	CONT.
Analysis of Potential Solar Cell Power Applications	Not available	To prepare preliminary analyses of the feasibility of applying solar cell power to various DOD and other Federal agencies.	MERADCOM	FY77 - $17K	CONT.
Solar Cell Power Supplies for CDEC RMS "A" Stations	Not available	To design, fabricate, test, and deliver solar cell power systems for Range Measuring System (RMS) "A" Stations for Combat Development Experimentation Command at Fort Hunter, Liggett, CA.	MERADCOM GEN. DYNAMICS/ ELECTRONICS DIVISION	FY76 - $150K	CONT.
*In cooperation with DOE					

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
Endurance Testing of Solar Cell Arrays*	Not available	To install solar cell panels at six DOD facilities for conducting real-time endurance tests, in support of DOE program on terrestial solar photovoltaic energy conversion R&D.	MERADCOM	FY77 - $12K (NASA)	
Energy Systems	62731/4A762731AT41	To improve the effectiveness with which energy is used at Army facilities, reduce energy consumption without impairing operational effectiveness in accordance with the President's energy policy; identify Army and DOD land-based applications where the use of alternative sources of energy can replace dependance on fossil fuels.	Chief of Engineers CERL	FY78 - $700K	CONT.
Military Energy Technology	62781/4A762781AT45	To reduce the consumption of energy used in Army facilities through the development and application of new technology to be applied to conservation and energy management both on an installation wide basis and within buildings, and to provide alternate sources of energy to reduce dependence on fossil fuel.	Chief of Engineers CERL	FY79 -$1800K	New Start FY79
Energy Systems	63734/4A763734DT09	To field test, validate, and transfer to the field, products, systems, and techniques developed to improve efficiency, effectiveness, and economy of energy in military energy systems.	Chief of Engineers CERL	FY79 - $300K	CONT.
Demonstrator Engines	63201/1F263201D447	To reduce size, weight, and specific fuel consumption of the aircraft turboshaft engine.	AVRADCOM	FY78 -$2700K	FY81
Propulsion Components	63201/1F263201DB72	To reduce rotorcraft drive train size and weight, thus reducing total aircraft size, weight, and fuel consumption.	AVRADCOM	FY78 - $100K	CONT.
Advanced Aircraft Structures	63211/1F263211DB41	To develop and demonstrate advanced structures technology concepts for reduced weight and cost, and improve performance.	AVRADCOM	FY78 - $120K	CONT.
Advanced Rotors and Flight Controls	63211/1L263211D157	To develop, verify, and apply technology for those areas that have restricted the success of current Army airmobile systems, and prevented the achievement of Army Aviation objectives.	AVRADCOM	FY78 - $600K	CONT.

*In cooperation with DOE

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
Aeronautical Technology	62209/1F262209AH76	To reduce aircraft size, weight, and fuel consumption by improving aerodynamic and structural efficiency, and reducing specific fuel consumption.	AVRADCOM	FY78-$5000K	CONT.
Aeronautical Research	61102/1L161102AH45	To reduce aircraft size, weight, and fuel consumption by improving aerodynamic and structural efficiency, and reducing specific fuel consumption.	AVRADCOM	FY78-$1700K	CONT.
Adiabatic Engine	62601/1L662601AH9(FY79) 63621/1L663621DG07(FY80)	To develop the technology for a high temperature engine which reduces weight and volume, improves fuel economy, and virtually eliminates cooling requirement.	TARADCOM	FY79-$1300K FY80-$2500K	CONT.
Advanced Turbine Component Research	62601/1L662601AH91	To develop the technology to produce turbine components with high temperature and high efficiency capabilities.	TARADCOM	FY79-$1600K FY80-$2000K	CONT.
Lightweight Composite Materials	62601/1L662601AH91	To develop lightweight composite materials for vehicular application.	TARADCOM	FY79-$450K FY80-$500K	CONT.
Turbine Combustion Research	62601/1L662601AH91	To study turbine combustion with emphasis on fuel economy and fuel tolerance.	TARADCOM	FY79-$200K FY80-$300K	CONT.
Differential Turbo-Compound Engine	62601/1L662601AH91	To develop an engine which integrates major power train components into a common unit which utilizes highly responsive controls and turbo-compounding.	TARADCOM	FY79-$600K FY80-$900K	CONT.
Mechanical Infinitely Variable Transmission	62601/1L662601AH91	To develop a transmission with infinite gear ratios which will allow the engine to operate at optimum conditions regardless of vehicle operating conditions.	TARADCOM	FY79-$400K FY80-$1000K	CONT.
Energy Efficient Diesel Engine	62601/1L662601AH91	To develop a diesel engine through fundamental modifications of a production base engine for high efficiency operation and compactness.	TARADCOM	FY79-$500K FY80-$1000K	CONT.
Electric Drive Vehicles*	62601/1L662601AH91	To test existing electric vehicles (supplied by DOE on geographically diverse Army installations for performance evaluation.	TARADCOM	FY79-$300K FY80-$300K	CONT.
AGT-1500 Fuel Economy Program	63621/1L663621DG07	To build complete AGT-1500 engines with improved fuel economy and performance characteristics.	TARADCOM	FY79-$2200K FY80-$1900K	CONT.

*In cooperation with DOE

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
Advanced Fuel Injection Systems	63621/1L663621DG07	To develop an advanced fuel injection system which will provide control of injected fuel volume with high consistency, over a wide variety of engine parameters.	TARADCOM	FY79-$600K FY80-$800K	CONT.
700 HP Highly Efficient Diesel Program	63621/1L663621DG07	To modify a production based engine for high-output, military combat application.	TARADCOM	FY79-$1100K FY80-$1500K	CONT.
650-700 HP Hydromechanical Transmission	63621/1L663621D395	To develop a 650-700 hp hydromechanical transmission to improve vehicle mobility, performance, and fuel economy.	TARADCOM	FY79-$1200K FY80-$1700K	CONT.
Metal Matrix Composites	63621/1L663621A424	To develop matrix composites using metals which have high strength, high performance characteristics and lighter weight than comparable metals.	TARADCOM	FY79-$340K FY80-$480K	CONT.
Engine Applications of Synthetic Lubricants	63621/1L663621DG07	To evaluate synthetic lubricants within engine applications.	TARADCOM	FY79-$400K FY80-$400K	CONT.
Power Boost Evaluation With Fuel Economy Emphasis	63621/1L663621DG07	To perform a detailed evaluation of the combustion characteristics of highly boosted piston engines, emphasizing methods of achieving improved fuel economy.	TARADCOM	FY79-$500K FY80-$500K	CONT.
Friction Reduction in Engines	63621/1L663621DG07	To explore the engine technology needed to develop material, components, and lubricant solutions which minimize frictional losses within internal combustion engines.	TARADCOM	FY79-$700K FY80-$900K	CONT.
Optimum Military Vehicle Test Cycle Development	63622/1L663622D203	To develop an optimum vehicle engine test cycle to allow adjustment for maximum vehicle performance and prediction of component failure.	TARADCOM	FY79-$500K FY80-$500K	CONT.
Comprehensive Analysis of Radial vs Bias Ply Tires	Military Adaptability of Commercial Items (MACI) T796003	Not identified	TARADCOM	FY79-$950K FY80-1040K	CONT.

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
Poly-Oil Lubricated for Life Bearings	MACI-T794301	Not identified	TARADCOM	FY79-$20K	CONT.
Commercial Engines and Emission Control Devices	MACI-T79430	Not identified	TARADCOM	FY79-$450K FY80-$500K	CONT.
Commercial Vehicles for Tactical Application	MACI-T794331	Not identified	TARADCOM	FY79-$1000K FY80-$1050K	CONT.
Commercial Evaluation of Transmission and Transfer Cases	MACI-T794501	Not identified	TARADCOM	FY79-$365K FY80-$400K	CONT.
Evaluation of Commercial Vehicles with Unique Energy Conservation Features	MACI	Not identified	TARADCOM	FY79-$1500K FY80-$2000K	CONT.
Laser Welding Techniques for Military Vehicles	Manufacturing Methods and Technology (MMT) T794575	Not identified	TARADCOM	FY79-$150K	CONT.
Heavy Aluminum Plate Weld Fabrication	MMT-T795091	Not identified	TARADCOM	FY80-$420K	CONT.
Establishment of Non-Destructive Testing Techniques for Ceramic Engine and Turbine Components*	Manufacturing Testing Technology (MTT)	Not identified	TARADCOM	FY79-$100K FY80-$200K	CONT.
Ultrasonic Tire Inspection	MTT	Not identified	TARADCOM	FY79-$70K FY80-$70K	CONT.
M113A1 Modernization Program	Not available	To improve the power plant efficiency of M113A1 vehicle.	TARADCOM	FY79-$28.2M FY80-$26.7M FY81-$32.3M	CONT.

*In cooperation with DOE

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
High Power, Hand-Cranked Alternator for Field Use	61101A/1T61101A91A	To show the feasibility of developing a hand-cranked alternator to power a field radio.	Harry Diamond Laboratories	FY78-$75K (Proposed)	CONT.
Fluidic Temperature Sensor*	DOE/394700	To show the feasibility of building a fluidic temperature measuring system that can withstand 3500° F in a blast furnace and be cost effective for monitoring and process control.	Harry Diamond Laboratories	FY77-$7K FY78-$20K (Proposed)	CONT.
Two Phase Flow Measurements*	DOE/392700	To establish fluidic techniques that can be used in the measurement of two-phase flow in a reactor loss-of-coolant experiment.	Harry Diamond Laboratories	FY77-$20K FY78-$30K (Proposed)	CONT.
Fluidic Control for Turbines	62703A/1W162114AH73	To fabricate, test, and deliver a fluidic fuel control and air load control system for the Ai Research GTCP85-180 gas turbine engine.	Harry Diamond Laboratories	FY77-$90K	CONT.
Analysis for Optimization of "Fluidyne Pump"	61102A/1T161101A91A	To develop an algorithm for the operation of the "Fluidyne" pump and to estalish the thermodynamic process and efficiency attainable, and in so doing, to optimize its performance.	Harry Diamond Laboratories	FY77-$15K	CONT.
Electrodeless Light Bulb*	DOE/-	To assist DOE in the development of a producible electrodeless flourescent light bulb.	Harry Diamond Laboratories	FY77-$10K	CONT.
Conversion of High Sulfer Content Coal to Clean Fuel*	DOE/E(49-1B)-2221	To provide technical and managerial support/expertise to DOE's programs to demonstrate the technical and economic feasibility of converting high sulfer content coal into cleanburning, liquid, gaseous, and/or solid fuels to replace the nation's rapidly depleting fossil fuels, i.e., its petroleum and natural gas resources.	Harry Diamond Laboratories	FY77-$2869K	CONT.
Enzymatic Hydolysis of Cellulosic Materials*	Not identified	To convert cellulosic materials to glucose which can be used as a feed stock for chemicals, food, and clean burning fuel.	NARADCOM	FY78 to Comp $8756K	CONT.
Design Problems and Alternative Design Concepts in Liquid Fuel Space Heating	62723A/1T762723AH 98AF007	To develop an awareness of the design problems involved in liquid fuel space heating, and to investigate the technical feasibility of alternative design concepts.	NARADCOM	FY77-$26K	CONT.
*In cooperation with DOE					

CURRENT ARMY RESEARCH AND DEVELOPMENT ENERGY CONSERVATION PROJECTS

TITLE	PROG. ELEM/PROJECT #	OBJECTIVE	RESPONSIBLE ORGANIZATION	FUNDING	ESTIMATED COMPLETION
Cost and Evaluation of Frozen Food Reconstitution Using Several Energy Sources	AH99BB062	To estimate the capital and operating costs for reconstituting frozen foods, using several energy sources including steam, gas, and electricity, and to evaluate the quality characteristics of the reconstituted food.	NARADCOM	FY77-$11.7K	CONT.
Modification and Improvement of Flexible Packages for Thermoprocessed Foods	62724/1L762724AH99	To develop a flexible packaging system for thermally processed foods which will replace metal cans for use in operational rations. Reduced energy required for manufacture and processing.	NARADCOM	FY78 - Compl $286K	CONT.
Multiserving Size Packages for Thermoprocessed Foods	62724/1L762724AH99	To develop a family of multiserving containers for special purpose thermoprocessed foods compatible with food service systems. Reduces heating time by user.	NARADCOM	FY77-$165K	CONT.
Radiation Preservation of Food	6.2/AH99D and 6.4/DL47	To conduct basic and applied research regarding the radiation preservation of food, to develop specific irradiated food items, and to obtain approval by the Food and Drug Administation (FDA) for general consumption of irradiated food items. Decreases thermal and refrigeration requirements.	NARADCOM	6.2 FY77-$2286K 6.4 FY77-$3831K	CONT.
Energy Conservation in Military Food Service Operations	62724/1L762724AH99 CA041	To reduce energy consumption of military food service in garrison operations.	NARADCOM	FY77-$114K	CONT.
Rapid Thawing and Heating Equipment	62724/1Y762724AH99	To design, fabricate, test, and evaluate a heating device which will heat a full size steam table pan of frozen food to serving temperature in 20 minutes.	NARADCOM	FY77-$59.4K	CONT.
Cooking/Baking Equipment Studies	62724/1Y762724AH99	To develop new cooking/baking techniques to insure more consistent results, and to optimize the process in terms of energy, yields, and quality factors.	NARADCOM	FY77-$30K	CONT.
Investigation of Ignition, Vapor Generation and Design of a Diesel Fueled Burner Unit	6.2/73125311026	To investigate the modes of ignition and vapor generation of diesel fuel, and to determine the best methods of fuel ignition under variable temperature conditions.	NARADCOM	FY78 - Compl $65K	CONT.

APPENDIX B

ARMY ENERGY R&D PROJECTS

UNDER CONSIDERATION FOR IMPLEMENTATION AND FUNDING

IN THE LONG RANGE PERIOD (FY84-2000)

(Projects have not yet been officially

screened for relevance or priority)

ARMY ENERGY R&D PROJECTS
UNDER CONSIDERATION FOR IMPLEMENTATION AND FUNDING
IN THE LONG RANGE PERIOD (FY84-2000)

PROJECT TITLE	DESCRIPTION
Alternate Fuel Utilization in Army Aviation	The Army's gas turbine engines operate in different environments from those of the Air Force and Navy. Therefore, component testing will be necessary to determine critical fuel properties unique to Army usage.
Variable Capacity Engine	Apply various variable geometry features in a turboshaft engine that would enable it to operate near peak pressures and efficiencies over most of its operating range.
Extended Oil Change Interval	The current Army aircraft engines and transmissions utilize synthetic lubricants to meet extreme environmental requirements. If the Army could extend the oil change interval, it will result in a significant reduction in lubricant requirements.
Advanced Propulsion Components	The objective of this program is to demonstrate components (compressors, combustors, turbines) otherwise developed and having improved performance and/or materials into existing gas generator/engines.
Establish Energy Related Principals to Products and Processes Involved in the Army and DOD Feeding System	Obtain information pertaining to soldier in-the-field, in terms of dry weight equivalent of food consumed based on calories, protein, carbohydrate, and fat content. Translate input into production, processing, packaging, transportation serving and disposal of waste. Draft R&D plans for realization and control of major reductions in energy use.
Increase Vegetable/Meat Ratio in DOD Rations	Investigate 10-20% reduction in meat calories in favor of grain. On an equivalent calorie basis as eaten, beef requires 10 times the growing area and many times the energy use.

PROJECT TITLE	DESCRIPTION
Utilization of Low Temperature Heat	Identify and develop biological applications for recovery of waste low temperature heat.
Energy Reclamation from Military Food Service Operations	It has been estimated that close to 60% of the energy used in kitchens is lost in the process of cooking food. This study is directed toward reclaiming much of the energy lost in military food service operations.
Fluidic Temperature Sensing System	Develop a fluidic temperature sensing system capable of monitoring extremely high temperatures in industrial process facilities of military importance such as foundries and steel mills.
Scale Model Computer Simulation Program	Provide a low cost efficient means to test tank-automotive materiel prior to full scale prototype fabrication.
Radio-Frequency Joining of Dissimilar Metals	Reduce energy investment in joining metal parts when compared to conventional joining processes such as welding.
Laminated Polymers	Improved vehicle efficiency through use of lightweight materials.
Energy Conservation from Properly Tuned Engine with New Improved Diagnostic Procedures and Equipment	Develop optimum vehicle test cycle to insure maximum energy conservation on all fielded Army vehicles.
Mandatory Energy Design Review	Implement an energy design review to insure that energy has been fully considered during all phases of product development.

PROJECT TITLE	DESCRIPTION
Identify Energy Reduction Potentials in Current Vehicle Systems	Determine the impact on energy of items such as frontal drag, horsepower to weight, tire size, transmission type, mobility, requirements, etc.
Current Fleet Energy Reduction Program	Provide instructions to the field through publications recommending energy conservation measures to be taken in the current military fleet of equipment.
Electrical System Energy Conservation Program	Select, evaluate, develop, and produce an energy efficient electrical system for combat vehicles.
Identification of Optimal Propulsion Systems	Optimize future propulsion systems by minimizing specific weight and volume and maximize fuel economy and tolerance to variety of fuels.
Suspension/Locomotive Test Bed	Provide the capability of readily evaluating a number of suspension/locomotive concepts through the development of a flexible wheeled vehicle test bed.
Assessment of Castings for Energy Investment Reduction	Assess the opportunities for energy savings by using cast parts rather than forged ones.
Logistic Energy Conservation Model	Develop a model to minimize logistic energy expenditure.
Contracting Methodology	Highlight energy conservation and obtain greater contractor support through the award or reward approach.
Fuel Cell Plate Structure Development	Increase surface area for chemical reactions.
High Efficiency Solar Powered Lighting	High energy discharge lamps conditioned electronically from a storage battery which in turn will be recharged by solar photovoltaic conversion system.

PROJECT TITLE	DESCRIPTION
On-Site Power Generation	Conservation of energy by use of onsite generation of electric power.
Wind Driven Induction Generator	Induction generator, because it can be paralleled with available utility supply without synchronizing, could utilize wind energy to reduce average load.
Self-Contained Silent-Air Conditioning/Refrigeration Systems	An air conditioning or refrigeration unit that would require no external electric power for operation.
Methanol Derived from Municipal Trash, Could Be Used by Fuel Cells to Provide Electrical Power	Utilization of waste material and a significant reduction in local use of fossil fuels.
Cost Effective and Energy Saving Replacement of Electric Fork Lift Truck Batteries	Establish Army-wide criteria and means of evaluation for determining most economical time to purchase new fork lift truck batteries.
Hybrid Power Source for Ground Power	To evaluate the advantages of a hybrid power source (fuel cell battery) for ground power application with frequent high power loads of short duration.
Bipolar Lead Acid Battery for Load Leveling and Start-Up	To evaluate a very high power, fast charge, lead acid battery for peak loads operating electrically in parallel with smaller or other electrical power sources.
Iron REDOX Energy Storage System	To evaluate an Iron REDOX power source as an energy storage system for solar cell arrays and as an independent power source for ground power.
Assessment of Army Requirement for Electric Vehicles	Identify potential Army requirements for off- and onroad electrical propelled vehicles.

PROJECT TITLE	DESCRIPTION
Statistical Analog Monitor for Electric Vehicles	Uniform monitor for producing data independent of operator. Application could be applied for simulation in laboratory testing and analysis of loads and duty cycles.
EMI Measurement for Electric Vehicles	Determine electromechanical interference (EMI) signature of new electric vehicles.
Vibratory Dozer	To increase the productivity of existing Army bulldozers by using the principles of vibration.
Transportability of Container Handling Equipment	Reduce the energy required to operate and transport large container handling equipment.
Advanced Refrigeration Containers	Apply most advanced refrigeration techniques to refrigerated container needs and thereby reduce basic energy consumption through increased refrigeration efficiency.
Thermo-Mechanical Rocker Breaker	A new concept of thermal rock crushing examined by MERADCOM and U.S. Bureau of Mines suggests that the thermomechanical concept is feasible and energetically attractive.
Cable Winch Bulldozer	Investigate the use of anchored cables to achieve tractive earthworking force at one tenth the weight of conventional methods.
Explosive Type Excavation Aids	Develop an excavation aid for increasing the production rate of a crawler tractor with ripper.
Increase Utilization of Electric Forklift Trucks	Replace internal combustion engine powered forklift trucks with electric powered forklift trucks.
Scroll Engine Investigation	Conduct a feasibility study to identify scroll engine potential use in military environment.

PROJECT TITLE	DESCRIPTION
Improvement of Power Supply to Sensor Devices Protecting Ammunition Magazines and Fuel Storage Structures	Evaluate using an onsite solar/windmill power source for intrusion detector sensors - presently, DOD magazines and fuel storage structures are protected by intrusion detection sensors powered by dc.
Application of Soil Thermal Gradient Power Source for Buried Line Sensors	Evaluate using a soil thermal gradient power source to power buried line sensors. Presently use batteries which require periodic retrieval and replacement.
Army Radar Systems	Eliminate unnecessary power conditioning processes by providing relatively high frequency ac directly from an alternator for customers desiring all or nearly all dc. The system developer would be able to use appropriate transformer and rectifier to meet his particular needs.
Improve Efficiency of Florescent Lights	Evaluate and determine optimum frequency for maximum efficiency and corresponding power conditioning method.
Replacement of Low Efficiency Motors	Perform a study of Army motors presently in service and determine when to replace with new and more efficient ones.
Coolant Energy Recovery System	Conduct a paper study to determine the potential of a cooling system concept to: (1) improve fuel economy, (2) increase horsepower output, and (3) identify desirable military applications.

APPENDIX C

FEDERAL ENERGY LEGISLATION

APPENDIX C

FEDERAL ENERGY LEGISLATION

Public Law 93-28, approved 4/30/73 to extend and amend the Economic Stabilization Act of 1970 (Sec. 2. (a) Authority to Allocate Petroleum Products)

Public Law 93-153, approved 11/16/73 to amend section 28 of the Mineral Leasing Act of 1920, and to authorize a trans-Alaska oil pipeline, and for other purposes.

Public Law 93-159, approved 11/27/73, Emergency Petroleum Allocation Act of 1973, to authorize and require the President of the United States to allocate crude oil, residual fuel oil, and refined petroleum products to deal with existing or imminent shortages and dislocations in the national distribution system which jeopardize the public health, safety, or welfare; to provide for the delegation of authority; and for other purposes.

Public Law 93-182, approved 12/15/73, Emergency Daylight Saving Time Energy Conservation Act of 1973, to provide for daylight saving time on a year-round basis for a 2-year trial period, and to require the Federal Communications Commission to permit certain daytime broadcast stations to operate before local sunrise.

Public Law 93-236, approved 1/2/74, to authorize and direct the maintenance of adequate and efficient rail services in the Midwest and Northeast region of the United States, and for other purposes.

Public Law 93-239, approved 1/2/74, to conserve energy on the Nation's highways. (National speed limit 55 mph.)

Public Law 93-249, approved 2/8/74, to provide for advancing the effective date of the final order of the Interstate Commerce Commission in Docket No. MC 43 (Sub-No. 2). (Seeks to alleviate a serious and pressing transportation problem by requiring carriers to reimburse their owner-operators for all increases in the price of fuel over the base period May 15, 1973, etc.)

Public Law 93-275, approved 5/7/74, Federal Energy Administration Act of 1974, to reorganize and consolidate certain functions of the Federal Government in a new Federal Energy Administration in order to promote more efficient management of such functions.

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Public Law 93-316, approved 6/22/74, to authorize appropriations to the National Aeronautics and Space Administration for research and devel opment, construction of facilities and research and program management, and for other purposes. Authorized Space and nuclear research and technology, $79,700,000 of which $1,000,000 is designated for research on hydrogen production and utilization systems; also authorizes $1,000,000 for research on ground propulsion systems.

Public Law 93-319, approved 6/22/74, Energy Supply and Environmental Coordination Act of 1974, to provide for means of dealing with energy shortages by requiring reports with respect to energy resources, by providing for temporary suspension of certain air pollution requirements, by providing for coal conversion, and for other purposes.

Public Law 93-322, approved 6/30/74, Special Energy Research and Development Appropriations Act, 1975, making appropriations for energy research and development activities of certain departments, independent executive agencies, bureaus, offices, and commissions for the fiscal year ending June 30, 1975, and for other purposes.

Public Law 93-383, approved 8/22/74, Housing and Community Development Act of 1974, to establish a program of community development block grants, to amend and extend laws relating to housing and urban development, and for other purposes.

Public Law 93-386, approved 8/23/74, to clarify the authority of the Small Business Administration, to increase the authority of the Small Business Administration, and for other purposes.

Public Law 93-403, approved 8/30/74, to amend the Natural Gas Pipeline Safety Act of 1968, as amended, to authorize additional appropriations, and for other purposes.

Public Law 93-404, approved 8/31/74, making appropriations for the Department of the Interior and related agencies for the fiscal year ending June 30, 1975, and for other purposes. (Has funds for Energy and Minerals)

Public Law 93-409, approved 9/3/74, Solar Heating and Cooling Demonstration Act of 1974, to provide for the early development and commercial demonstration of the technology of solar heating and combined solar heating and cooling systems.

Public Law 93-410, approved 9/3/74, Geothermal Energy Research, Development, and Demonstration Act of 1974, to further the conduct of research, development, and demonstrations in geothermal energy technologies, to establish a Geothermal Energy Coordination and Management Project to provide for the carrying out of research and development in geothermal energy technology, to carry out a program of demonstrations in technologies for the utilization of geothermal resources, to establish a loan guarantee program for the financing of geothermal energy development, and for other purposes.

Public Law 93-426, approved 9/30/74, to amend the Defense Production Act of 1950 and to establish a National Commission on Supplies and Shortages Act of 1974.

Public Law 93-434, approved 10/5/74, to amend the Emergency Daylight Saving Time Energy Conservation Act of 1973 to exempt from its provisions the period from the last Sunday in October, 1974 through the last Sunday in February, 1975.

Public Law 93-438, approved 10/11/74, Energy Reorganization Act of 1974, to reorganize and consolidate certain functions of the Federal Government in a new Energy Research and Development Administration and in a new Nuclear Regulatory Commission in order to promote more efficient management of such functions.

Public Law 93-479, approved 10/26/74, to authorize the Secretary of Commerce and the Secretary of the Treasury to conduct a study of foreign direct and portfolio investment in the United States and for other purposes.

Public Law 93-482, approved 10/26/74, to amend the Tariff Schedules of the United States to provide for the duty-free entry of methanol imported for use as fuel, and for other purposes.

Public Law 93-485, approved 10/26/74, to amend the Atomic Energy Act of 1954 as amended, to enable Congress to concur in or disapprove international agreements for cooperation in regard to certain nuclear technology.

Public Law 93-500, approved 10/29/74, to amend and extend the Export Administration Act of 1969.

Public Law 93-503, approved 11/26/74, to amend the Urban Transportation Act of 1964 to provide increased assistance for mass transportation systems.

Public Law 93-511, approved 12/5/74, to extend the Emergency Petroleum Allocation Act of 1973 until August 31, 1975.

Public Law 93-523, approved 12/16/74, to amend the Public Health Service Act to assure that the public is provided with safe drinking water, and for other purposes. (Part C--Protection of Underground Sources of Drinking Water refers to regulations (A) the underground injection of brine or other fluids which are brought to the surface in connection with oil or natural gas production (B) any underground injection for the secondary or tertiary recovery of oil or natural gas.)

Public Law 93-577, approved 12/3/74, Federal Nonnuclear Energy Research and Development Act of 1974, to establish a national program for energy research and development in nonnuclear energy sources.

Public Law 93-627, approved 1/3/75, Deepwater Port Act of 1974, to regulate commerce, promote efficiency in transportation, and protect the environment, by establishing procedures for the location, construction, and operation of deepwater ports off the coasts of the United States, and for other purposes.

Public Law 93-643, approved 1/4/75, to authorize appropriations for the construction of certain highways in accordance with title 23 of the United States Code, and for other purposes (contains uniform national speed limit)

Public Law 93-646, approved 1/4/75, to amend the Export-Import Bank Act of 1945, and for other purposes.

Public Law 94-12, approved 3/29/75, Tax Reduction Act of 1975, to amend the Internal Revenue Code of 1954 to provide for a refund of 1974 individual income taxes, to increase the low income allowance and the percentage standard deduction, to provide a credit for personal exemptions and a credit for certain earned income, to increase the investment credit, and the surtax exemption, to reduce percentage depletion for oil and gas, and for other purposes.

Public Law 94-99, approved 9/29/75, to extend the Emergency Petroleum Allocation Act of 1973. (Extends Act to November 15, 1975)

Public Law 94-133, approved 11/14/75, to extend for 1 month until December 15, 1975, the Emergency Petroleum Allocation Act.

Public Law 94-152, approved 12/16/75, extending for 2-years, through June 30, 1977, Provisions of the Defense Production Act.

Public Law 94-153, approved 12/16/75, to amend the effective date of the Defense Production Act Amendments of 1975.

Public Law 94-163, approved 12/22/75, providing standby emergency authority to assure that the essential energy needs of the United States are met.

Public Law 94-165, approved 12/23/75, making Appropriations for the Department of the Interior (FEA Appropriations included).

Public Law 94-185, approved 12/31/75, to extend, until June 30, 1976, the Renegotiation Act.

Public Law 94-187, approved 12/31/75, authorizing funds for the Energy Research and Development Administration through September 30, 1976.

Public Law 94-197, approved 12/31/75, to revise the method of providing for public remuneration in the event of a nuclear incident.

Public Law 94-220, approved 2/27/76, effectuates the provisions of the Defense Production Act Amendments of 1975 on November 30, 1975, except that the provisions relating to voluntary agreements shall take effect 120 days after enactment of the Act.

Public Law 94-227, approved 3/11/76, authorizes the President to invite the States of the Union and foreign nations to participate in the International Petroleum Exposition to be held at Tulsa, Oklahoma, from May 16, 1976, through May 22, 1976.

Public Law 94-258, approved 4/5/76, National Reserves Production Act of 1976, authorizes the Secretary of the Interior to establish on certain public lands of the United States national petroleum reserves the development of which need to be regulated in a manner consistent with the total energy needs of the Nation, and for other purposes.

Public Law 94-269, approved 4/16/76, ERDA authorization increased for FY76 and transition period.

Public Law 94-291, approved 4/22/76, Nuclear Regulatory Commission Authorizations.

Public Law 94-332, approved 7/1/76, extend Federal Energy Administration until July 30, 1976.

Public Law 94-370, approved 7/26/76, amend Coastal Zone Management Act of 1972.

Public Law 94-373, approved 7/31/76, Department of the Interior and Related Agencies (FEA) Appropriations for FY77.

Public Law 94-377, passed over Presidential veto 8/4/76, amend Mineral Leasing Act of 1920.

Public Law 94-385, approved 8/14/76, Energy Conservation and Production Act (FEA Extension and other energy matters).

Public Law 94-413, passed over Presidential veto 9/17/76,Electric Vehicle Research, Development, and Demonstration Act of 1976, to authorize in ERDA a Federal program of research, development, and demonstration to promote electric vehicle technology.

Public Law 94-455, approved 10/4/76, Tax Reform Act of 1976.

Public Law 94-477, approved 10/11/76, amends the Natural Gas Pipeline Safety Act and authorizes appropriations for FY77.

Public Law 95-2, approved 2/2/77, Emergency Natural Gas Act of 1977, to authorize the President to order emergency deliveries and transportation of natural gas to deal with existing or imminent shortages.

Public Law 95-52, approved 6/22/77, Export Administration Amendments of 1977, to amend the Export Administration Act of 1969 to extend its authorities and to provide for stricter controls over exports of nuclear material and technology.

Public Law 95-70, approved 7/21/77, Energy Supply and Environmental Coordination Extension Act of 1977, to extend FEA and Coal Conversion.

Public Law 95-87, approved 3/10/77, Surface Mining Control and Reclamation Act of 1977, to regulate surface coal mining operations through a permit program administered by the Secretary of the Interior. Requires applicants to meet minimum environmental protection performance standards.

Public Law 95-91, approved 4/10/77, Department of Energy Reorganization Act, to establish a Department of Energy in the executive branch by the reorganization of functions within the Federal Government in order to secure effective management and to assure a coordinated national energy policy and for other purposes.

Public Law 95-95, approved 7/10/77, Clean Air Act Amendments of 1977, to provide a simple 1-year extension of current auto standards.

APPENDIX D

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APPENDIX D

BIBLIOGRAPHY

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AR 200-10, "Army Environmental Program," 28 December 1976.

AR 210-4, "Installations: Carpooling and Parking Controls," 20 May 1974.

AR 420-10, "Facilities Engineering: General Provisions, Organizations, Functions, and Personnel," 30 May 1975.

AR 420-49, "Facilities Engineering: Heating Energy Selection and Fuel Storage, Distribution, and Dispensing Systems," 18 November 1976.

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APPENDIX E

GLOSSARY

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AAP - Army Ammunition Plant

AEO - Army Energy Office

AERDP - Army Energy Research and Development Program

AGE - Advisory Group on Energy

API - American Petroleum Institute

AR - Army Regulation

ARNG - Army National Guard

ASA(IL&FM)- Assistant Secretary of the Army (Installation, Logistics, and Financial Management

ASD(MRA&L)- Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics)

ATS - Annual Training Site

AVRADCOM - Aviation Research and Development Command

Btu - British Thermal Unit

CERL - Construction Engineering Research Laboratory

CIA - Central Intelligence Agency

CNGB - Chief, National Guard Bureau

COE - Chief of Engineers

CONUS - Continental United States

CPA - Chief of Public Affairs

CRF - Combat Readiness Flying

CSR - Chief of Staff Regulation

DA - Department of the Army

DARCOM - United States Army Materiel Development and Readiness Command

DASD(EE&S)- Deputy Assistant Secretary of Defense (Energy, Environment, and Safety

DCSLOG - Deputy Chief of Staff for Logistics

DCSOPS - Deputy Chief of Staff for Operations and Plans

DCSPER - Deputy Chief of Staff for Personnel

DCSRDA - Deputy Chief of Staff for Research, Development, and Acquisition

DEIS - Defense Energy Information System

DLA - Defense Logistics Agency

DOD - Department of Defense

DOE - Department of Energy

ECD - Expected Completion Date

ECIP - Energy Conservation Investment Program

ECRAS - Energy Consumption, Reporting and Analysis System

ECS - Equipment Concentration Site

EPA - Environmental Protection Agency

EQ/ECIP - Equipment Energy Conservation Investment Program

ERDA - Energy Research and Development Administration

FEA - Federal Energy Administration

FHMA - Family Housing Management Account

FORSCOM - United States Army Forces Command

FY - Fiscal Year

GNP - Gross National Product

GSA - General Services Administration

HHG - Household Goods

HQAFSC - Headquarters, Air Force Systems Command

HQDA - Headquarters, Department of the Army

HTGR - High-Temperature Gas Cooled Reactor

I&M - Inspection and Maintenance

ILS - Integrated Logistic Support

IPR - In-process Review

KW - Kilowatt

LMFBR - Liquid Metal Fast Breeder Reactor

LPG - Liquified Petroleum Gas

MACOM - Major Command

MBTU's - Million British Thermal Units

MCA - Military Construction, Army

MCAR - Military Construction, Army Reserves

MCARNG - Military Construction, Army National Guard

MERADCOM - Mobility Equipment Research and Development Command

MILCON - Military Construction

MMT - Manufacturing Methods and Technology

MTT - Manufacturing Testing Technology

NAE - National Academy of Engineers

NARADCOM - Natick Research and Development Command

NAS - National Academy of Sciences

NGB - National Guard Bureau

OACSI - Office, Assistant Chief of Staff for Intelligence

OAPEC - Organization of Arab Petroleum Exporting Countries

OASA(IL&FM)-Office, Assistant Secretary of the Army (Installations, Logistics, and Financial Management)

OASD(MRA&L)-Office, Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics)

OCA - Office, Comptroller of the Army

OCE - Office, Chief of Engineers

OCAR - Office, Chief Army Reserve

OCPA - Office, Chief of Public Affairs

OCNGB - Office, Chief National Guard Bureau

ODCSLOG - Office, Deputy Chief of Staff for Logistics

ODCSOPS - Office, Deputy Chief of Staff for Operations

ODCSPER - Office, Deputy Chief of Staff for Personnel

ODCSRDA - Office, Deputy Chief of Staff for Research, Development, and Acquisition

OJCS - Office, Joint Chiefs of Staff

OMA - Operation and Maintenance, Army

OPEC - Organization of Petroleum Exporting Countries

OSD - Office of the Secretary of Defense

OTSG - Office of the Surgeon General

PAED - Directorate of Program and Analysis, Office of the Chief of Staff

PDM - Program Decision Memorandum

POC - Point of Contact

POL - Petroleum

POM - Program Objectives Memorandum

QRIP - Quick Return on Imvestment Program

R&D - Research and Development

RDF - Refuse-Derived Fuel

RDT&E - Research and Development Test and Evaluation

SAG - Study Advisory Group

SFTS - Synthetic Flight Training System

SGFP - U.S. Army Health Facility Planning Agency

SPR - Strategic Petroleum Reserve

STOG - Science and Technology Objectives Guide

TARADCOM - Tank Automotive Research and Development Command

TECOM - United States Army Test and Evaluation Command

TRADOC - United States Army Training and Doctrine Command

TSG - The Surgeon General

UFR - Unfunded Requirements

UH - Utility Helicopter

UII - Unified Industries Incorporated

USALEA - United States Army Logistics Evaluation Agency

USAEIGHT - Eighth United States Army

USAR - United States Army Reserve

USAREUR - United States Army, Europe

USGS - United States Geological Survey