[illegible] fuels used to produce electricity. As your office agreed, we are providing you with information on the energy efficiency of nuclear fuel, including a comparison of nuclear and fossil fuels. We obtained much of the data from the Atomic Energy Commission (AEC).

AEC uses large quantities of electricity to operate its facilities for enriching uranium for nuclear weapons and for nuclear power reactor fuel. From the mid-1940s to the mid-1960s the facilities enriched uranium principally for weapons. 743

Beginning about 1966 the facilities began enriching large quantities of uranium for nuclear power reactor fuel. Until 1970 the cumulative electrical energy used to enrich uranium for power uses exceeded the cumulative electrical energy domestic nuclear power reactors produced. The statistics on electric power consumption and production, in billions of electrical kilowatt-hours (kwhs), are in the following table.

Calendar year	Electrical energy used to enrich uranium for power uses		Domestic nuclear power reactor electrical energy production	
	Annual	Cumulative	Annual	Cumulative
	(billion kwhs)			
1967	6.7	33.9	7.7	28.2
1968	10.3	44.2	12.5	40.8
1969	14.9	59.1	13.9	54.7
1970	14.8	73.9	21.8	76.5
1971	19.2	93.1	37.9	114.4
1972	17.1	110.3	54.0	168.4
1973	27.1	137.6	83.6	252.0

This table shows that the ratio of kwhs produced by domestic nuclear power reactors to the kwhs used to enrich uranium for power uses is increasing each year. Although such quantities generally indicate the growth of the nuclear power industry, they are not a reasonable measure of the energy efficiency of nuclear fuel, principally because

--Not all the electrical energy used to enrich uranium for power used is for use by domestic nuclear power reactors. foreign nuclear power reactors use some of this energy, and some of it is produced for future use. In 1973 the energy used to enrich uranium for domestic nuclear power reactors was about 6.4 billion kwhs, or about 23 percent of the 27.1 billion kwhs used to enrich uranium for all power uses. At the end of 1973, AEC's stockpile of enriched uranium had an estimated electrical energy content of 744 billion kwhs.

--The uranium enriched for domestic nuclear power reactors during a given period is not necessarily used to produce electricity during that same period. Only part of the 6.4 billion kwhs used to enrich uranium for domestic nuclear power reactors in 1973 was applicable to enriched uranium used to produce electrical power in that year.

--Many of the licensed nuclear power reactors have recently gone through, or are in, their initial phase of operation, when AEC permits only a low level of power output. About one-third of all domestic nuclear power reactors received their licenses to operate during 1973.

One way to determine the efficiency of any energy source is to compute the net electrical energy produced; that is, the total electrical energy produced less the electrical energy required to prepare the fuel for use. The following table, developed from an AEC study, shows the net electrical energy produced annually for different kinds of fuels by a 1,000-megawatt electrical (MWe) generating facility.

Type of fuel	Electricity generated by facility (note a)	Electricity required to produce fuel needed by facility (note b)	Net electrical energy produced
	(billion kwhs)		
Uranium	6.570	0.274	6.296
Coal	6.570	0.102	6.468
Oil	6.570	0.067	6.503
Gas	6.570	0.011	6.559

[a]Facility operating at 75 percent of annual capacity.

[b]Includes the entire fuel cycle exclusive of waste disposal. For nuclear fuel about 96 percent of the electrical energy is used to enrich the uranium fuel for a water-cooled reactor. Does not include fossil fuel used for other than production of electricity.

Another way of determining the efficiency of an energy source is to compute the quantity of raw material required to produce a given amount of electricity. The following table shows the approximate annual quantities of raw material required by a 1,000-MWe generating facility.

Type of fuel	Approximate annual raw material requirements
Uranium	85 thousand tons
Coal	3 million tons
Oil	12 million barrels
Gas	73 trillion cubic feet

A ton of uranium ore yields more than 35 times the electrical energy of a ton of coal. When the electrical energy required to produce fuel for a 1,000-MWe generating facility is considered, a ton of uranium ore yields more than 34 times the electrical energy of a ton of coal.

AEC believes the following anticipated future developments will increase the ratio of the electrical energy produced by domestic nuclear power reactors to the electricity used to enrich uranium for such reactors.

--The use of a new process (gas centrifuge) for enriching uranium, which requires an electrical energy consumption per unit of output of only 10 percent of the consumption under the current process (gaseous diffusion).

--The use of plutonium created by domestic nuclear power reactors as nuclear fuel.

--The use of the enriched uranium stockpile as fuel for domestic nuclear power reactors.

--A more mature nuclear power industry with a majority of its reactors producing electricity at higher levels of power output.

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Acting Comptroller General of the United States