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U.S. ENERGY FLOW - 1980

C. K. Briggs
and
I. Y. Borg

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Lawrence Livermore Laboratory

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ABSTRACT

The United States Energy Flow diagram is a graphical device to illustrate energy sources and end-uses in a single figure. It has been prepared for 1980. The total energy consumption in 1980 was 75 quads (or 75×10^{15} Btu), which is 3.6 percent below 1979. Oil continued to be the largest single source of energy to the U.S. by comprising 34 quads or 45 percent of the total used. Natural gas and coal make up 28 percent and 22 percent of the remainder.

Oil imports fell 19.2 percent below 1979 levels resulting in a 9.2 percent net decrease in total oil use from 1979. There was a consequent drop in total energy consumption which was not compensated by increased overall use of either natural gas, which actually fell, or coal, which increased slightly. Coal exports increased 41 percent.

Conversion to fuels other than oil for electrical power generation continued; coal and natural gas use for this purpose increased 7.6 and 5.5 percent respectively over 1979. Nuclear energy produced about the same amount of power in 1980 as in 1979 or about 11 percent of the total.

The broad, end-use sectors of residential/commercial, industrial and transportation showed declines on the order of 5-7 percent each in energy use. These three categories of end-users consumed approximately 28, 40, and 32 percent respectively of useful energy, i.e., exclusive of waste heat, conversion and transmission losses.

INTRODUCTION

United States Energy Flow Charts tracing primary resource supply and end use have been prepared by members of the Energy and Resource Planning Group at the Lawrence Livermore National Laboratory since 1972.[1] They are a convenient graphical device to show relative size of energy sources and end uses since all fuels are compared on a common Btu basis. The amount of detail on a flow chart can vary substantially, and there is some point where complexity begins to interfere with the main objectives of the presentation. The charts shown here have been drawn so as to remain clear and be consistent with assumptions and style used previously.

ENERGY FLOW CHARTS

Figures 1 and 2 are energy flow charts for calendar year 1980 and 1979[2] respectively.

Data for the flow chart were provided by tables in the Department of Energy Monthly Energy Review, DOE/EIA-0035 (81/06).[3]

The Residential and Commercial Sector consists of housing units, non-manufacturing business establishments, health and educational institutions, and government office buildings. The Industrial Sector is made up of construction, manufacturing, agriculture, and mining establishments. The Transportation Sector combines private and public passenger and freight transportation and government transportation including military operations. Utility electricity generation includes power sold by both privately and publicly owned establishments.

The appendix lists conversion factors used in converting fuel quantities to Btu.

The division between "useful" and "rejected" energy is arbitrary and depends on assumed efficiencies of conversion processes. In the residential and commercial end-use sectors, a 75 percent efficiency was assumed which is a

weighted average between space heating at approximately 60 percent and electrical lighting and other electrical uses at about 90 percent. Eighty percent efficiency was assumed in the industrial end-use sector and 25 percent in transportation. The latter percent corresponds to the approximate efficiency of the internal combustion engine.

COMPARISON WITH 1979 AND PAST YEARS

Figures 1 and 2 provide graphic comparison of energy use for 1979 and 1980. Table 1 lists the consumption of energy resources in the United States for the past five years and gives percentage differences between 1979 and 1980. The table consists of the latest revised data provided in Monthly Energy Review, DOE/EIA-0035 (81/06).

Natural gas use dropped 1.6 percent from 1979 but of greater significance was the 9.2 percent drop in net oil use. Domestic crude and NGL production changed only slightly (+0.6 percent), but foreign imports were down 19.2 percent from 1979. (Figure 3.) The drop in oil imports and oil consumption in general accounts for the drop in total energy consumption from 78 quads (10^{15} Btu) in 1979 to 75 quads in 1980. The decrease in oil use was not completely compensated for by increased coal or natural gas use in any use sector except electric power generation.

Table 2 gives 1980 crude oil sources and illustrates the sharp decline in specific OPEC countries' imports to the U.S. OPEC oil production dropped dramatically in 1980. One of the factors contributing to this drop was the Iran/Iraq War in late 1980. (Figure 4.)

Continued deregulation of domestic crude oil resulted in higher prices which were passed on to consumers. A price driven conservation more than compensated for reduced supply to importing nations from the Middle East. A shortage of fuels did not materialize. At year end use of petroleum products (Table 3) had fallen to the point where there was a glut on world crude oil markets.

U.S. ENERGY FLOW – 1980
(NET PRIMARY RESOURCE CONSUMPTION 75 QUADS)

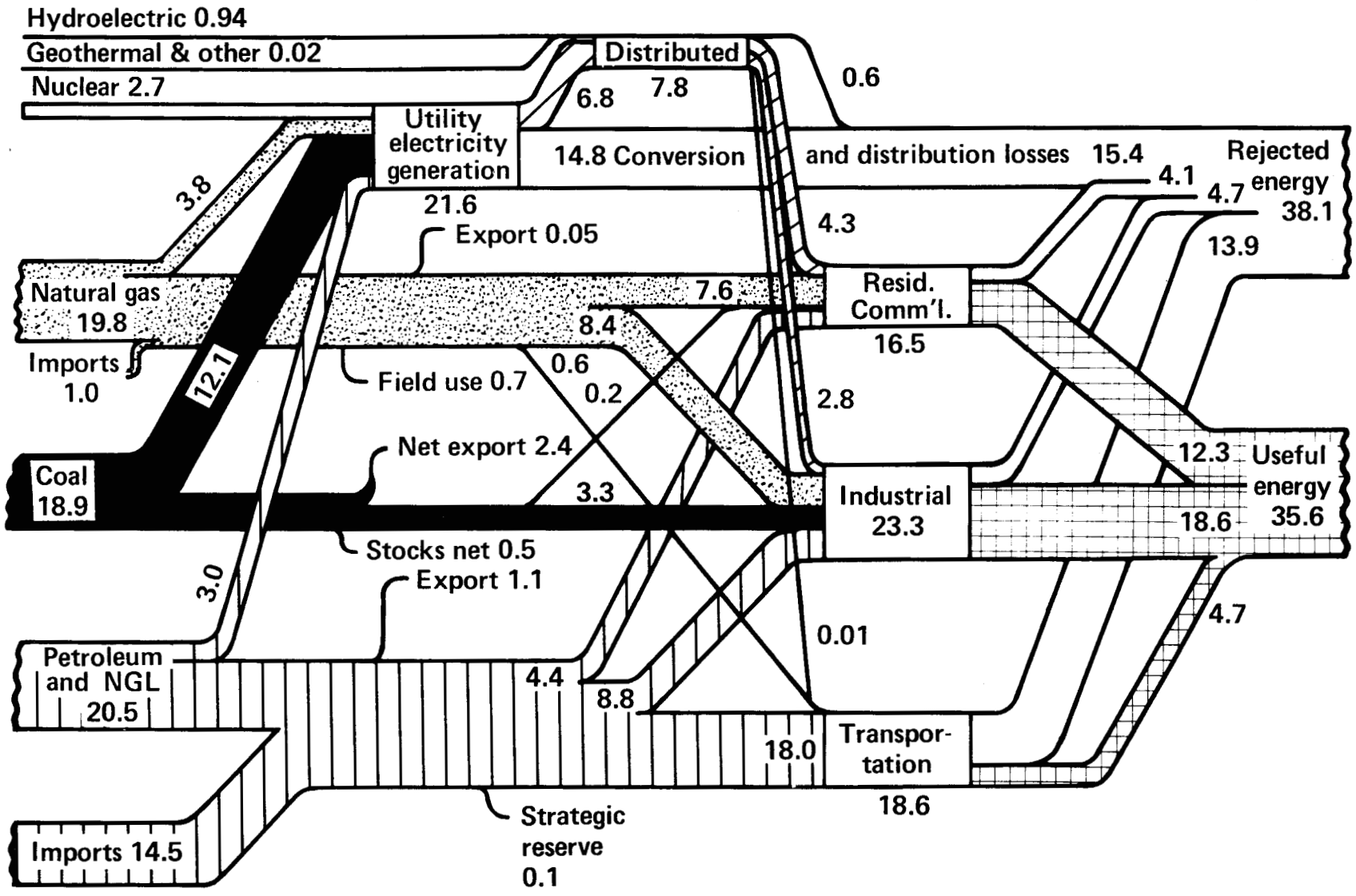


Figure 1

U.S. ENERGY FLOW - 1979
(NET PRIMARY RESOURCE CONSUMPTION 77.8 QUADS)

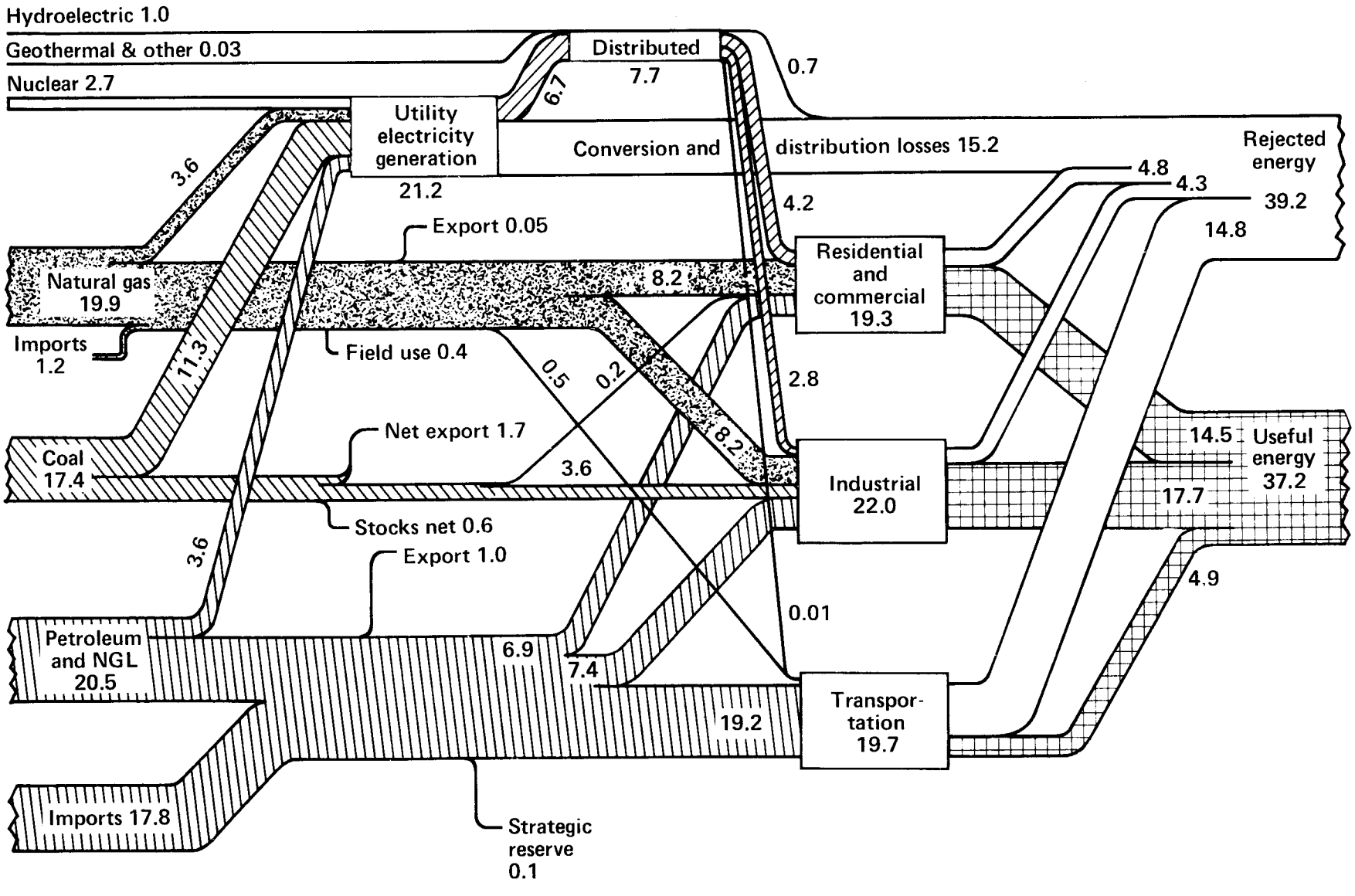


Figure 2

Table 1.

COMPARISON OF ANNUAL ENERGY USE IN U.S.

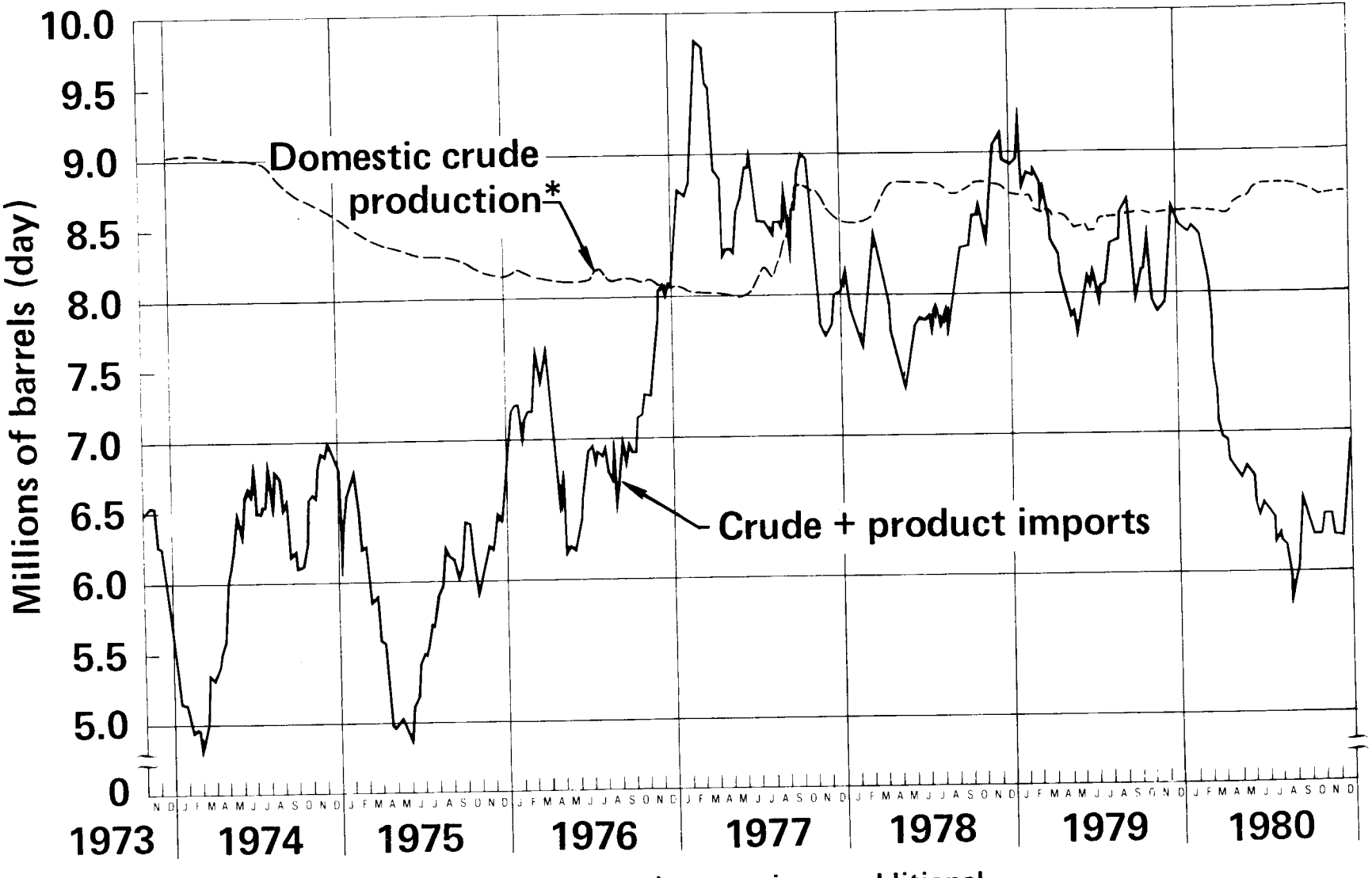
	Quads					
	1976	1977	1978	1979	1980	Change 1979 vs 1980
Natural Gas	19.48	19.57	19.49	20.08	19.75	-1.6%
Imports	0.96	1.01	0.97	1.25	0.99	-20.8%
Crude Oil and NGL						
Domestic Crude & NGL	19.59	19.78	20.68	20.39	20.51	+0.6%
Foreign Imports (incl. products & SPR)	15.48	18.64	17.70	17.90	14.46	-19.2%
Exports	0.47	0.51	0.77	1.00	1.15	+15.0%
SPR Storage Reserve*		0.04	0.34	0.14	0.10	-28.6%
Net Use (Minus Exports & SPR)	34.60	37.87	37.27	37.15	33.72	-9.2%
Coal (incl. exports)	15.85	15.83	15.04	17.65	18.88	+7.0%
Electricity						
Hydroelectric (net only)	0.97	0.75	0.96	0.96	0.94	-2.1%
Geothermal & Other (net only)	0.01	0.01	0.01	0.02	0.02	--
Nuclear	2.11	2.70	2.98	2.75	2.70	-1.8%
Gas	3.15	3.29	3.30	3.61	3.81	+5.5%
Coal	9.71	10.25	10.13	11.26	12.12	+7.6%
Oil	3.45	4.03	3.81	3.39	2.99	-11.8%
Total Fuel	19.40	21.03	21.19	21.99	22.58	+2.7%
Total Transmitted Energy	6.96	7.25	7.53	7.67	7.80	+1.7%
Residential and Commercial	18.12	17.87	18.24	17.31	16.52	-4.6%
Industrial	22.07	22.51	22.74	24.57	23.40	-4.8%
Transportation	19.04	19.71	20.59	19.93	18.60	-6.7%

*Strategic Petroleum Reserve Storage Began in October 1977

Source: Monthly Energy Review DOE/EIA-0035 (81/06)
Revised data as of June 1981. Some figures differ from earlier flow charts

PETROLEUM IMPORTS AND DOMESTIC PRODUCTION

Moving four week average



*Note: NGL currently comprise an additional ~ 1.5 million barrels/day domestic oil production

Figure 3

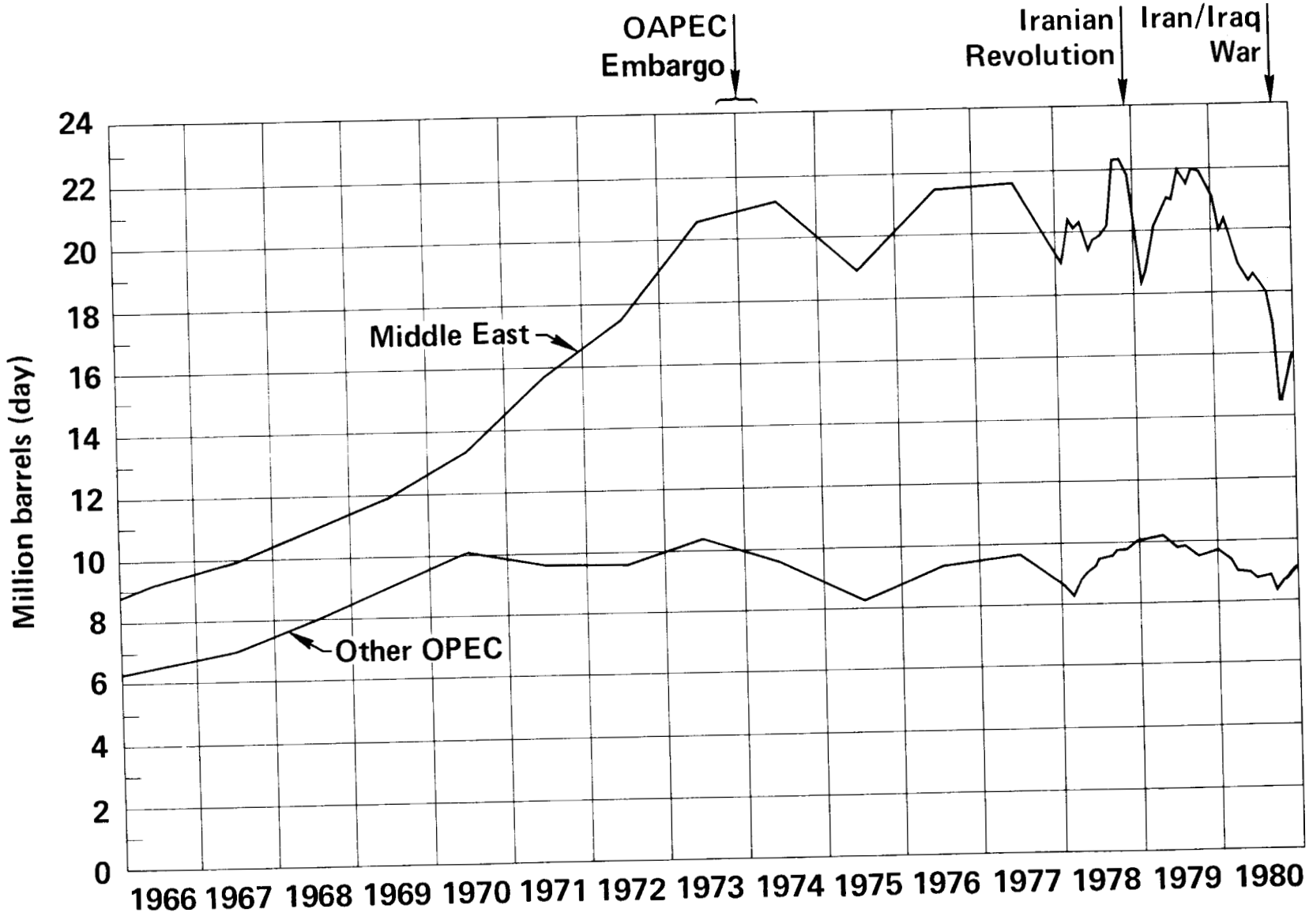
Table 2.

SELECTED DEVELOPED COUNTRIES: CRUDE OIL IMPORTS, BY SOURCE[4]

Thousand b/d

	Sep 1973 (Pre Crisis Level)	1977	1978	1979	1980	% of Total Dec. 1980
United States						
Algeria	124	544	634	608	452	7.3
Egypt	--	36	20	55	31	0.1
Iraq	17	74	62	88	88	Negl.
Kuwait	44	42	5	5	20	--
Libya	153	704	638	642	546	12.7
Qatar	41	67	64	31	22	0.4
Saudi Arabia	599	1373	1142	1347	1247	25.6
United Arab Emirates	88	333	385	281	179	1.6
Other	--		7	11	2	--
Ecuador	33	55	38	30	16	0.7
Gabon	--	35	38	42	25	0.6
Indonesia	249	507	533	380	307	4.5
Iran	205	530	554	297	7	--
Nigeria	409	1130	910	1069	831	18.9
Venezuela	405	250	181	293	154	3.7
Total OPEC	2367	5644	5184	5113	3894	76.1
Canada	998	279	248	271	199	4.0
Mexico	8	177	316	435	504	7.6
U.K.	--	97	169	197	174	3.9
Norway	--	48	104	75	141	1.9
Other	98	332	308	362	275	6.4
TOTAL	3471	6615	6356	6519	5220	100.0

OPEC CRUDE OIL PRODUCTION*



*Pre-1978 annual averages are plotted mid-year

Figure 4

Table 3.

PETROLEUM PRODUCTS*

	10^3 barrel/day (average)				
	1976	1977	1978	1979	1980
Motor Gasoline	6,978	7,177	7,412	7,034	6,579
Jet Fuel	987	1,039	1,057	1,076	1,069
Distillate Fuel Oil	3,133	3,352	3,432	3,311	2,865
Residual Fuel Oil	2,801	3,071	3,023	2,826	2,493

* Refined Petroleum Product Supplied: sum of production, imports, net withdrawals from primary stocks minus exports.

Source: Monthly Energy Review, DOE/EIA-0035 (81/06)

The total fuel required for electrical generation increased 2.7 percent. While oil use for electrical power generation dropped ∿12 percent from 1979, gas and coal use increased 5.5 and 7.6 percent respectively. Overall coal use exclusive of exports increased 5.0 percent over 1979. Coal exports increased 41 percent.

Nuclear sources for electrical generation dropped slightly. Nuclear development continued to lag in wake of the Three Mile Island reactor accident and growing public aversion to nuclear power as a viable alternative to fossil energy. (Table 4.)

Table 4.

NUCLEAR DEVELOPMENT STATUS OF NUCLEAR REACTOR UNITS*

	1976	1977	1978	1979	1980
Licensed Reactors	62	67	71	71	75
Construction Permits Granted	72	80	90	91	82
Construction Permits Pending	66	52	32	21	12
Reactor Units on Order	16	13	9	3	3
Total Reactor Units	235	221	206	186	172
Total Design Capacity (million net † kilowatts)	236	220	204	180	164
Nuclear Portion of Domestic Electricity Generation (%)	9.4	11.8	12.5	11.4	11.0

* As of December 31 of each year
† Minus nominal station service load (∿ 5%)

Source: Monthly Energy Review, DOE/EIA-0035 (81/06)

REFERENCES

1. A. L. Austin, U.S. Energy Flow in 1972, Lawrence Livermore National Laboratory Report UCID 16022 (1972).

2. William J. Ramsey, U.S. Energy Flow in 1979, Lawrence Livermore National Laboratory Report UCID 18769, July 22, 1980.

3. Monthly Energy Review, DOE/EIA-0035 (81/06)

4. International Energy Statistical Review, 25 August 1980, ERIESR 81-008, CIA, National Foreign Assessment Center.

APPENDIX: CONVERSION FACTORS

The energy content of fuels varies. Some approximate, rounded conversion factors, useful for estimation, are given below.

Fuel	Energy Content (Btu)
Short ton of coal	22,500,000
Barrel (42 gallons) of crude oil	5,800,000
Cubic foot of natural gas	1,000
Kilowatt hour of electricity	3,400
Fossil fuel to produce one hour kilowatt hour of electricity	10,000

More detailed conversion factors are given in the Department of Energy's Monthly Energy Review.

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