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HISTORICAL ENERGY FLOW ACCOUNTS

Source and Uses Accounts

PRELIMINARY REPORT

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FEDERAL ENERGY ADMINISTRATION
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Submitted by

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CHAPTER 1

INTRODUCTION

OVERVIEW AND SCOPE OF PROJECT

The purposes and objectives of this project are several:

- to devise an accounting system for tracing energy flows in the U.S. economy

- to identify and evaluate data sources for quantifying this accounting system

- to quantify the accounting system as far as feasible for the period 1947-1972

Previous reports have detailed the classification systems (for energy products, functional use and economic sectors), and methodology and concepts in the accounts:

> Historical Energy Flow Accounts:
> > Taxonomic Report (Revised) Nov. 1974
> > Specifications for Accounts Dec. 1974

The accounting system is comprised by the following separate and interrelated accounts:

> Sources
> Inventory
> Uses

The Sources Account records data on new supply of energy products, quantity and value, by year. New supply includes domestic production detailed by industry of production and imports.

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The Inventory Account records data on major stocks held by producers, distributors and large users. Year-to-year changes in these stocks provide an adjustment to new supply to yield supply to be accounted for in consumption, exports, and storage and distribution losses.

The Uses Account records data on consumption by the detailed sectors of the economy, exports and storage and distribution losses. These data are recorded in physical quantities and purchasers' or delivered prices. The data are also converted to BTUs for purposes of aggregation of all energy inputs into each consuming sector.

Another summary account, the Energy Balance Account, represents an aggregation and consolidation of the data in the more detailed accounts for each year. As such, it traces the origin of energy supply by primary energy product through energy conversion processes and/or to final disposition. Energy losses in conversion processes are identified and total energy consumption in the economy is measured net or gross of conversion losses. This consolidated account is measured in BTUs.

These accounts are discussed further in the succeeding chapters in which preliminary data for each account are presented.

The data have been developed as far as feasible for each year 1947-1972 and are stored on computer tape. Generally, the quantity data (or estimates) are complete for the full time period for all the major fuels for most of the sectors. The value data are less complete and generally have not been interpolated when reasonably reliable data were not available.

The data in the Sources Account are given in the tables in this report for all years available. The data in the Uses Account are given in the tables only for selective years for which Census data were available: 1947, 1954, 1958, 1962, 1967, and 1971. The data in the Uses Account for the other years has been interpolated for many sectors based on production or output change in each consuming sector (adjusted for trend bias by individual fuel input).

These estimates then are not independent of output change and therefore have limited use for econometric fitting of price substitution functions. However, the aggregate BTU inputs into each sector are less closely related to output change since the interpolations were done separately by fuel input and each fuel input has an unique adjustment for time bias.

The fact that the uses data are shown for the selected years does not imply these are the years of the most reliable data for all sectors. For sectors other than manufacturing and mining the data are generally equally good or poor over the years except that the data for the later years are almost always as good, and usually more reliable, than the data for the earlier years.

It must be stressed that the data presented are preliminary and are subject to major revisions, due to possible miscoding or misinterpretation, after further reconciliation between the sources and uses accounts.

QUALITY MEASURES

The data have been coded to indicate the reliability attached to each data cell. Measures of reliability are necessarily subjective; however, we have attempted to introduce as much objectivity as feasible. Generally, reported data from government sources and from other well-established surveys were accepted as the most reliable data available and coded as very good. Data from other sources were coded very good, good, or lower, depending upon whether the general level and reasonableness of the data could be substantiated from more than one source. Estimates by the staff were coded depending upon the estimating procedure, the base data available, and the temporal proximity of the estimate to the base data.

The instructions for coding are reproduced below. Probable error denotes a two-thirds confidence level.

QUALITY MEASURE	DEFINITION

A   <u>DEFINITION</u>

<u>Very Good</u>. Highest confidence, with probable error in data of ± 10 percent or less. These data would be compiled from reputable survey results or administrative records with no or minor adjustments required by the analyst (e.g., benchmark years for Census of Manufactures in which whole SIC's constitute 90% or more of the total).

B   <u>Good</u>. Probable error in data is greater than ± 10 percent, but less than or equal to ± 25 percent. These data are compiled from reputable survey results or administrative records with adjustments made by the analyst representing less than 25% of the total. The data are developed through estimating procedures from at least four benchmark years spread over the 1947-72 period, in which each benchmark has a quality index of A.

C   <u>Fair</u>. Probable error is greater than ± 25 percent, but less than ± 50 percent. The data are developed through estimating procedures from at least four benchmark years spread over the 1947-72 period, in which each benchmark year has a quality index of B.

QUALITY MEASURE	DEFINITION
D	Poor. Probable error unknown. The data are developed from less than four benchmark years or they are developed from other imputed data.

If an arithmetic operation involves two data elements with different quality measures, the result should take on the lower quality measure.

BTU CONVERSION FACTORS

A heat conversion factor--or series of factors--was obtained for each specific product dealt with in the study, and the vast majority of them are considered to be highly accurate. Information of this type does not, in general, suffer from the same statistical and coverage problems as those of physical quantity or price data, because heat content relationships are basically chemical and thus immutable. There are variations among values derived from studies on different samples, but it is minor in comparison with variations in other types of data. Furthermore, there is concensus on conversion factors for a large number of major products.

Some additional products are defined as being aggregations of energy products nested within them. In such cases, weights (based on production magnitudes of each of the components for each year) were used to average the conversion factors of the component products in order to obtain the factors for the aggregate product. This procedure was followed in several important areas, most notably liquified petroleum gases, total natural gas liquids, total coal, other petroleum products not elsewhere classified, coal tar derivatives, and total gases.

Table 4 in the Appendix presents a complete matrix of conversion factors used in the Energy Flow Accounts along with their sources. This table clearly delineates the methods followed in deriving the large majority of conversion factors. The following areas, however, require further clarification.

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1) Crude oil is one of the few aggregate products not treated on a weighted-average basis. This is because of the large number of components involved and also because of the different physical state of these components. The Bureau of Mines figures on crude oil were accepted as the closest available year-by-year approximations of average BTU factors. Unfinished oils were also assumed to have the same factors because their average composition is probably close to that of crude oil.

2) Two different heat conversion series were obtained for bituminous coal, because there is a very real difference in heat content quality between metallurgical and other coal. These were then averaged to generate a heat factor for all bituminous coal.

3) In several cases where a product definition encompasses negligible amounts of several unnamed products, development of an independent heat conversion rate is impossible. Such situations were overcome by assigning the factors of the next level of aggregated product (of which the product in question is a component) to the catch-all. For example, the category "Other Liquified Gas Mixtures -- 10740" has been assigned the same BTU values as "Liquified Gases -- 10700".

4) Sodium Phenolate/Carbolate, a marginal product at best, was treated by deriving a simple average of the heat factors of related products-- naphthalene and tar (pitch). No other information could be obtained on this substance; and thus averaging was the only alternative left.

5) Several products in the 10800 series (liquified gases of various descriptions including butylene, propylene, and ethylene) were assigned the same factors as their counterparts in the 10700 series (pure paraffinic liquified gases) in the absence of any information about the weight composition of the 10800 series products.

CHAPTER 2

ENERGY BALANCE ACCOUNT

The Energy Balance Account is designed as a summary and consolidation of
the more detailed accounts. It accounts for the supply and disposition of
all primary and converted energy products in a somewhat more aggregated
product classification than in the detailed accounts. Energy inputs and
outputs of each conversion process are shown with conversion losses calcu-
lated by difference. Final disposition is shown for each product yielding
unduplicated totals (across all products) for energy consumption, exports,
inventory change and storage and distribution losses. Consumption totals
are shown for each year both net and gross of conversion losses.

Table 2.1 presents the energy balance account for six years: 1947, 1954,
1958, 1962, 1967 and 1971. The table can be constructed for the other years
for the detailed accounts. It should be stressed that these data are preliminary
and subject to possible major revision in the detailed cells.

TABLE 2-1.—U.S. ENERGY BALANCE ACCOUNT

1947

(Trillions of BTU's)

Primary Energy Products

	NEW SUPPLY			ENERGY MATERIAL INPUTS TO CONVERSION PROCESSES						FINAL DISPOSITION					TOTAL
	DOMESTIC PRODUCTION	IMPORTS	TOTAL	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL	CONSUMPTION	EXPORTS	INVENTORY CHANGE (+ or −)	STORAGE & DISTRIBUTION LOSSES	TOTAL	
Crude Oil	10771	566	11336	10743					10743	324	269			593	11336
Natural Gas	7764		7764				4728		4728	568			2468 c	3036	7764
Bituminous Coal & Lignite	15379	7.1	15386		2077	2557		162	4818	4618	1683	123		10568	15386
Anthracite	1456	.3	1453		89.5	6.7			96.2	1141	216			1357	1453
Uranium															
Nuclear Energy Products, NEC															
Hydroelectric Power	283		283							283				283	283
Wood for fuel [f]															
Other Energy Sources, NEC [g]															
Total Primary Energy Products	35649	573	36222	10743	2188	2564	4728	161	20385	11078	2168	123	2468	15836	36222

Converted Energy Products

	DOMESTIC PRODUCTION						IMPORTS	TOTAL	ENERGY MATERIAL INPUTS						FINAL DISPOSITION					TOTAL
	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL			PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL	CONSUMPTION	EXPORTS	INVENTORY CHANGE	STORAGE & DIST. LOSSES	TOTAL	
Gasoline	4187				132	4319	1.9	4321							4094	220	7.5		4321	4321
Naphtha (excl. Solvent Naphtha)	89.2					89.2		89.2							85.0	4.2			89.2	89.2
Kerosine	640					640		640							599	41.1			640	640
Jet Fuel																				
Liquified Gases (incl. Butylene & Propylene)			118			118		118	45.0					45.0	67.4	5.2			72.6	118
Ethane (incl. Ethylene)			N.A.																	
Distillate Fuel Oil	1837		N.A.			1837	24.3	1862							1637	174	50.3		1862	1862
Residual Fuel Oil	2986					2986	341	3327		285 e				285	2975	66.8			3042	3327
Still Gas	513					513		513							513				513	513
Petroleum Coke	72.8					72.8		72.8							60.2	12.6			72.8	72.8
Natural Gas-Dry				4067		4067		4067		392			124	516	3401	19.1		132	3552	4067
Natural Gas Liquids, NEC				384		384		384	377					377	6.6		1.3		7.9	384
Absorption Oil	3.5					3.5		3.5							3.5				3.5	3.5
Lubricating Oils, Greases & Related Products	314					314	.2	314							217	90.1	7.5		314	314
Other Finished Petroleum Products, NEC	394					394	7.6	402							373	28.7			402	402
Unfinished Oils [j]							10.9	10.9	7.1					7.1			3.8		3.8	10.9
Coke & Breeze		1955		127		2083	2.5	2085							2082	2.0	1.5		2085	2085
Other Gases, NEC		534			384	918		918					225	225	693				693	918
Coal Chemical Products, NEC	245	33.1		245		523	.1	523					245	245	273	4.8	+.5		278	
Finished Petrochemicals, NEC	8.1	25.8		4.6		39.4		38.4					4.6	4.6	33.7		+.1		36.4	38.4
Petrochemical Feedstocks (excl. Liquified Gases) [k]																				
Processed Uranium																				
Fabricated Thorium																				
Electric Energy (excl. Hydropower)		606			172	778	6.9	785					172	172	613				613	785
Total Converted Energy Products	11290	606	2548	4701	932	20078	396	20474	429	677			770	1875	17776	669	72.5	132	18559	20474
Totals — Primary and Converted Products							969	56696	11172	2865	2564	4728	932	22260	28854	2837	196	2600	34436	56696

Gross Energy New Supply (Total Primary Products plus Imports of Converted Products)	36618
Less: Additions to Inventory (±)	+190
Exports	2837
Gross Energy Consumption (including all Losses)	33585
Less: Conversion Losses — total	2181
Petroleum Refining	−119
Electric Utilities	2258
Coke	15.9
Natural Gas Plants	26.3
Other	
Storage and Distribution Losses	2600
Net Energy Consumption	28804

Conversion Losses	2181
Final Disposition of Gross Energy New Supply	36618

Please see footnotes following the tables.

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TABLE 2-1.—U.S. ENERGY BALANCE ACCOUNT

1954

(Trillions of BTU's)

Primary Energy Products

	NEW SUPPLY — DOMESTIC PRODUCTION	IMPORTS	TOTAL	Inputs — PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL	Final — CONSUMPTION	EXPORTS	INVENTORY CHANGE (+ or -)	STORAGE & DISTRIBUTION LOSSES	TOTAL	TOTAL
Crude Oil	13427	1389	14516	14730					14730	7.6	78.9			86.4	14916
Natural Gas	12492	7.8	12500				8483		8483	1467			2550	4016	12500
Bituminous Coal & Lignite	9620	4.9	9625		2834	2101		40.8	4976	4173	766	-291		4649	9624
Anthracite	739	0.2	739		80.4	5.8			86.2	608	72.4	28.2		653	739
Uranium															
Nuclear Energy Products, NEC															
Hydroelectric Power	381		381							340			41.4	381	381
Wood for fuel			--												
Other Energy Sources, NEC			--												
Total Primary Energy Products	36658	1402	38060	14730	2915	2106	8483	40.8	28275	6595	918	-319	2591	9785	38060

Converted Energy Products

	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL	IMPORTS	TOTAL	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL	CONSUMPTION	EXPORTS	INVENTORY CHANGE (+ or -)	STORAGE & DIST. LOSSES	TOTAL	TOTAL
Gasoline	6357			145		6502	6.2	6509							6388	133	-12.5		6509	6509
Naphtha (excl. Solvent Naphtha)	117					117		117							110	6.9			117	117
Kerosine	709					709		709							682	27.7			709	709
Jet Fuel																				
Liquified Gases (incl. Butylene & Propylene)				373		373		373	48.8					48.8	308	15.8			324	373
Ethane (incl. Ethylene)																				
Distillate Fuel Oil	3165					3168	18.6	3186							2975	141	70.2		3186	3186
Residual Fuel Oil	2657					2657	812	3469		420				420	2364	168	17.2		2550	3469
Still Gas	615					615		615							615				615	615
Petroleum Coke	146					146		146							119	19.6	7.5		146	146
Natural Gas-Dry				7440		7440		7440		1234			201	1435	5751	30.2		223	5974	7440
Natural Gas Liquids, NEC				511		511		511	490					490	18.5		2.7		21.2	511
Absorption Oil	16.3					16.3		16.3							16.3				16.3	16.3
Lubricating Oils, Greases & Related Products	323					323		323							229	91.4	2.8		323	323
Other Finished Petroleum Products, NEC	581					581	22.3	604							582	21.1			603	603
Unfinished Oils							43.9	43.9	46.2					46.2			-2.3		-2.3	43.9
Coke & Breeze			1565		31.2	1596	2.8	1599							1598	1.0			1599	1599
Other Gases		478			327	505		506							689				689	506
Coal Chemical Products, NEC	156	34.7		186		407	1.4	409					117	117	223	0.2	-.5		222	409
Finished Petrochemicals, NEC	41.8	24.7			3.8	70.4		70.4					3.8	3.8	66		+.5		67	70.4
Petrochemical Feedstocks (excl. Liquified Gases)																				
Processed Uranium																				
Fabricated Thorium																				
Electric Energy (excl. Hydropower)		1244			250	1494	9.2	1503					250	250	1086			167.5	1253	1503
Total Converted Energy Products	14918	1244	2103	8468	798	27532	916	28448	585	1653			757	2996	24320	656	86.0	391	25452	28448
Totals — Primary and Converted Products							2318	66508	15314	4568	2106	8483	798	31271	30915	1574	-233	2982	35237	66508

Gross Energy New Supply (Total Primary Products plus Imports of Converted Products)	38976
Less: Additions to Inventory (±)	-233
Exports	1574
Gross Energy Consumption (including all Losses)	37636
Less: Conversion Losses -- total	3739
Petroleum Refining	306
Electric Utilities	3314
Coke	3
Natural Gas Plants	15.1
Other	0
Storage and Distribution Losses	2982
Net Energy Consumption	30915

Conversion Losses	3739
Final Disposition of Gross Energy New Supply	38976

PRELIMINARY UNRECONCILED DATA SUBJECT TO REVISION

Please see footnotes following the tables.

TABLE 2-1.-U.S. ENERGY BALANCE ACCOUNT
1958
(Trillions of BTU's)

| | NEW SUPPLY | | | | DISPOSITION | | | | | | | | | | | | TOTAL |
| | | | | | ENERGY MATERIAL INPUTS TO CONVERSION PROCESSES | | | | | | FINAL DISPOSITION | | | | | | |
		DOMESTIC PRODUCTION	IMPORTS	TOTAL	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER[h]	TOTAL	CONSUMP-TION	EXPORTS	INVENTORY CHANGE (+ or -)	STORAGE & DISTRIBUTION LOSSES	TOTAL	
Primary Energy Products																
Crude Oil		14204	2018	16222	16101					16101	207	25.2	-111		121	16223
Natural Gas		14893	154	15046				9575		9575	3074			2397[c]	5471	15046
Bituminous Coal & Lignite		10160	7.6	10168		3718	1899		21.7	5639	3410	1249	-130		4529	10168
Anthracite		539	.1	539		65.0	6.5			71.5	428	57.9	-19.5		466	538
Uranium																
Nuclear Energy Products, NEC																
Hydroelectric Power		490		490	......						449			41.4	490	490
Wood for fuel[f]																
Other Energy Sources, NEC[g]																
Total Primary Energy Products		40284	2180	42465	16101	3783	1906	9575	21.7	31387	7567	1332	-260	2439	11078	42465

| | DOMESTIC PRODUCTION | | | | | | IMPORT. | TOTAL | | | | | | | | | | | |
	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER[h]	TOTAL			PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL	CONSUMP-TION	EXPORTS	INVENTORY CHANGE	STORAGE & DIST.	TOTAL	TOTAL
Converted Energy Products																				
Gasoline	7294				145	7438	72.3	7511							7471	101	-61.5		7511	7511
Naphtha (excl. Solvent Naphtha)	116					116		116							111	5.6			116	116
Kerosine	616				7.3	624	.2	624							616	7.6			624	624
Jet Fuel																				
Liquified Gases (incl. Butylene & Propylene)	5.9				604	610		610	178					178	421	11.5			432	610
Ethane (incl. Ethylene)																				
Distillate Fuel Oil	3694				4.5	3698	86.7	3775							3806	111	-142		3775	3775
Residual Fuel Oil	2353					2353	1145	3498		488[e]				488	2851	162	-2.8		3010	3495
Still Gas	756					756		756							756				756	756
Petroleum Coke	228					228		228							215	26.5	-13.8		228	228
Natural Gas-Dry				8296		8296		8296		1421			141.7	1563	6400	40.1		293	6734	8296
Natural Gas Liquids, NEC				502		502		502	492					492	11.9		-1.6		10.3	502
Absorption Oil	10.1					10.1		10.1		.					10.1				10.1	10.1
Lubricating Oils, Greases & Related Products	311					311		311							241	78.9	-8.9		311	311
Other Finished Petroleum Products, NEC	666					666	49.2	715							700	15.0			715	715
Unfinished Oils[j]							-195	195	-189					189			6.2		6.2	195
Coke & Breeze			1404		17	1420	3.0	1423							1393	9.6	20.5		1423	1423
Synthetic Natural Gas			434		166	600		600					19.1	19.1	581				581	600
Coal Chemical Products, NEC	175		32.5		175	382	1.6	384						175	209	0.1	-.2		209	384
Finished Petrochemicals, NEC	72.0		20.7		4.2	96.9		96.9					4.2	4.2	93		-.2		93	96.9
Petrochemical Feedstocks (excl. Liquified Gases)[i]																				
Processed Uranium										.9				.9			-.9		-.9	
Fabricated Thorium																				0
Electric Energy (excl. Hydropower)		1722 .5e3			268[a]	1991	13.9	2005					268[a]	268	1569			168	1737	2005
Total Converted Energy Products	16256	1723	1891	9559	630	30009	1566	31655	858	1910			608	3376	27455	568	-205	461	28279	31655
Totals -- Primary and Converted Products						70374	3746	74120	16959	5694	1906	9575	630	34763	35022	1900	-465	2899	39356	74119

Gross Energy New Supply (Total Primary Products plus Imports of Converted Products	44031	
Less: Additions to Inventory (±)	-465	
Exports	1900	
Gross Energy Consumption (including all losses)	42596	
Less: Conversion Losses -- total		4675
Petroleum Refining	673	
Electric Utilities	3971	
Coke	14	
Natural Gas Plants	16	
Other	0	
Storage and Distribution Losses		2899
Net Energy Consumption	35022	

Conversion Losses	4675
Final Disposition of Gross Energy New Supply	44031

PRELIMINARY UNRECONCILED DATA SUBJECT TO REVISION

Please see footnotes following the tables.

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TABLE 2-1.-U.S. ENERGY BALANCE ACCOUNT

1962
(Trillions of BTU's)

NEW SUPPLY — Primary Energy Products

Primary Energy Products	NEW SUPPLY: DOMESTIC PRODUCTION	IMPORTS	TOTAL	DISPOSITION — ENERGY MATERIAL INPUTS TO CONVERSION PROCESSES: PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL	FINAL DISPOSITION: CONSUMPTION	EXPORTS	INVENTORY CHANGE (+ or -)	STORAGE & DISTRIBUTION LOSSES	TOTAL	TOTAL
Crude Oil	15522	2384	17906	17804					17804	49.0	10.4	42.6		102	17906
Natural Gas	17959	450	18408				12417		12417	3570			2421c	5991	18408
Bituminous Coal & Lignite	10343	5.7	10349		4678	1819		10.7	6508	2853	942	45.8		3840	10348
Anthracite	429	.2	430		58.3	10.7			69.0	309	45.8	5.4		360	429
Uranium															
Nuclear Energy Products, NEC								73.3	73.3			-73.3		-73.3	0
Hydroelectric Power	586		586							539			47.0	586	586
Wood for fuel															
Other Energy Sources, NEC															
Total Primary Energy Products	44839	2840	47678	17804	4736	1830	12417	84	36871	7420	998	20.5	2468	10607	47672

NEW SUPPLY — Converted Energy Products (DOMESTIC PRODUCTION)

Converted Energy Products	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL	IMPORTS	TOTAL	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER	TOTAL	CONSUMPTION	EXPORTS	INVENTORY CHANGE	STORAGE & DIST. LOSSES	TOTAL	TOTAL
Gasoline	8047				67.3	8114	72.8	8187							8138	24.7	23.7		8187	8187
Naphtha (excl. Solvent Naphtha)	196					196		196							189	6.7			196	196
Kerosine	892				5.7	898	36.4	935							932	2.4			935	935
Jet Fuel																				
Liquified Gases (incl. Butylene & Propylene)	270			821		1091	9.1	1100	200					200	885	15.6			901	1100
Ethane (incl. Ethylene)					62.6	62.6		62.6							62.6				62.6	62.6
Distillate Fuel Oil	4199				2.9	4202	68.9	4270							4270				4270	4270
Residual Fuel Oil	1883					1883	662	3545		539c				539	2894	80.8	30.8		3005	3545
Still Gas	785					785		785							785				785	785
Petroleum Coke	474					474		474							433	44.9	-3.4		474	474
Natural Gas-Dry				10787		10787		10787		2035			190	2225	8256			290	8562	10787
Natural Gas Liquids, NEC				625		625		625	619					619	5.2		.8		6.0	625
Absorption Oil	13.2					13.2		13.2							13.2				13.2	13.2
Lubricating Oils, Greases & Related Products	373					373	.2	373							265	107	1.1		373	373
Other Finished Petroleum Products, NEC	814					814	43.6	857							839	14.8	3.7		857	857
Unfinished Oils							189	189	161					161	12.6		15.2		27.7	189
Coke & Breeze			1361		8.2	1369	.3	1369							1368	.9	.7		1369	1369
Other Gases, NEC		421			212	633		633					19.1	19.1	614				614	633
Coal Chemical Products, NEC	169		43.7		159	370	.8	372					159	159	212	.1	-.9		212	372
Finished Petrochemicals, NEC	146		20.0		2.3	168		168					2.3	2.3	166		-.5		166	168
Petrochemical Feedstocks (excl. Liquified Gases)																				
Processed Uranium							73.3	73.3		13.4b				13.4	59.9b				59.9	73.3
Fabricated Thorium																				
Electric Energy (excl. Hydropower)		2330 / 8.0			304a	2638	7.0	2645					304a	304	2127			214	2341	2645
Total Converted Energy Products	18258	2334	1846	12372	759	35569	2089	37658	979	2587			675	4242	32528	315	71.3	504	33417	37658
Totals -- Primary and Converted Products							4929	85336	18783	7324	1830	12417	759	41113	39847	1313	92	2972	44223	85336

Gross Energy New Supply (Total Primary Products plus Imports of Converted Products)	49767
Less: Additions to Inventory (±)	92
Exports	1313
Gross Energy Consumption (including all Losses)	49030
Less: Conversion Losses -- total	5544
Petroleum Refining	525
Electric Utilities	4990
Coke	-15.7
Natural Gas Plants	45.2
Other	0
Storage and Distribution Losses	2972
Net Energy Consumption	39847

Conversion Losses	5544.?
Final Disposition of Gross Energy New Supply	49767

PRELIMINARY UNRECONCILED DATA
SUBJECT TO REVISION

Please see footnotes following the tables.

TABLE 2-1.--U.S. ENERGY BALANCE ACCOUNT
1967
(Trillions of BTU's)

	NEW SUPPLY			DISPOSITION												TOTAL
				ENERGY MATERIAL INPUTS TO CONVERSION PROCESSES						FINAL DISPOSITION						
	DOMESTIC PRODUCTION	IMPORTS	TOTAL	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER [b]	TOTAL	CONSUMP-TION	EXPORTS	INVENTORY CHANGE (+ or -)	STORAGE & DISTRIBUTION LOSSES	TOTAL	
Primary Energy Products															
Crude Oil	18651	2388	21039	20779					20799	50.9	149	+59.5		260	21039
Natural Gas	23304	649	23953				17999		17999	3560			2394 [c]	5954	23953
Bituminous Coal & Lignite	13097	5.4	13103		6447	2187		11.5	8645	2792	1211	-454		4458	13103
Anthracite	311		311		55.5	13.4			68.9	221	15.1	+5.9		242	311
Uranium	2.2	.3	2.5					287	287			-284		-284	2.5
Nuclear Energy Products, NEC															
Hydroelectric Power	768		768							706			62	768	768
Wood for fuel [f]			---											---	
Other Energy Sources, NEC [g]															
Total Primary Energy Products	56134	3043	59176	20779	6502	2200	17999	298	47778	7331	1376	235	2456	11398	59176

	DOMESTIC PRODUCTION						IMPORTS	TOTAL							
	PET. REFINING	ELECTRIC UTILITIES	COKE	NATURAL GAS PLANTS	OTHER [h]	TOTAL									
Converted Energy Products															
Gasoline	9649				38.1	9687	79.8	9767			9671	25.6	69.8		9767	9767
Naphtha (excl. Solvent Naphtha)	407				0.3	407	3.4	410			399	10.4	0.8		410	410
Kerosine	562				7.3	569	0.2	569			567	0.9	1.5		569	569
Jet Fuel	1514				0.2	1515	180	1694			1667	11.2	16.3		1694	1694
Liquified Gases (incl. Butylene & Propylene)	421			1167		1587	39.8	1627	276		276	1213	37.3	101	1351	1627
Ethane (incl. Ethylene)				113		113		113				111		2.0	113	113
Distillate Fuel Oil	4690			2.1		4692	108	4800			4742	24.9	32.7		4800	4800
Residual Fuel Oil	1755					1755	2492	4247		955	955	3143	138	21.7	3669	4247
Still Gas	897					897		897				897			897	897
Petroleum Coke	548					548		548				447	98.1	2.9	548	548
Natural Gas-Dry				15295		15295		15295		2834		128	2962	11546	84.2	12333	15295
Natural Gas Liquids, NEC				824		824		824	811		811	10.		2.8	12.9	8236
Absorption Oil	9.8					9.8		9.8				9.8			9.8	9.8
Lubricating Oils, Greases & Related Products	394					394	0.2	395				269	113	12.7	395	395
Other Finished Petroleum Products, NEC	937					937	42.6	979				954	14.1	10.6	979	979
Unfinished Oils [j]							198	198	193		193			5.6	5.6	198
Coke & Breeze			1684		8.8	1693	2.3	1695				1617	17.4	60.8	1695	1695
Other Gases, NEC			528	139		667		667			8.1	8.1	658			658	667
Coal Chemical Products, NEC	190		58.3	180		429	6.5	435			180	180	254	0.6	+.8	255	435
Finished Petrochemicals, NEC	260		15.3			275	10.6	285				285		+.6	285	285
Petrochemical Feedstocks (excl. Liquified Gases)																
Processed Uranium					287	287		287	43.4 [b]		43.4	243 [b]			243	287
Fabricated Thorium																
Electric Energy (excl. Hydropower)		3361 21.0			343	3730	13.0	3743			343 [a]	343	3099		301	3400	3743
Total Converted Energy Products	22236	3397	2285	17447	957	46312	3173	49485	1280	3836		659	5775	42082	576	348	704	43710	49485
Totals -- Primary and Converted Products							6216	108662	22059	10339	2200	17999	957	53554	49413	1952	583	3160	55108	108662

Gross Energy New Supply (Total Primary Products plus Imports of Converted Products)	62350
Less: Additions to Inventory (±)	584
Exports	1952
Gross Energy Consumption (including all Losses)	59814
Less: Conversion Losses -- total	7242
Petroleum Refining	-177
Electric Utilities	6952
Coke	89.1
Natural Gas Plants	552
Other	
Storage and Distribution Losses	3160
Net Energy Consumption	49413

Conversion Losses	7242
Final Disposition of Gross Energy New Supply	62350

PRELIMINARY UNRECONCILED DATA
SUBJECT TO REVISION

Please see footnotes following the tables.

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TABLE 2-1.-U.S. ENERGY BALANCE ACCOUNT

1971

(Trillions of BTU's)

Primary Energy Products

1971	BTU SUPPLY — Domestic Production	Imports	Total	Inputs — Pet. Refining	Electric Utilities	Coke	Natural Gas Plants	Other	Total	Final Disp. — Consumption	Exports	Inventory Change (+ or -)	Storage & Distribution Losses	Total	TOTAL
Crude Oil	20033	3558	23591	23709					23709	-24.7[d]	2.9	-97.0		-119	23591
Natural Gas	24878	1042	25920				21469		21469	2655			1796[c]	4452	25920
Bituminous Coal & Lignite	13087	2.1	13089		7733	1963			9696	2110	1344	-60.5		3393	13089
Anthracite	222		222		41.8	10.7			52.5	168	1.7	-.1		169	222
Uranium	2453	376	2829					2236	2236				594	594	2829
Nuclear Energy Products, NEC															
Hydroelectric Power	920		920							839			81.0	920	920
Wood for fuel [f]															
Other Energy Sources, NEC [g]															
Total Primary Energy Products	61593	4978	66571	23709	7775	1974	21468	2236	51163	5747	1349	436	1877	9409	66571

Converted Energy Products

	Domestic Production — Pet. Refining	Electric Utilities	Coke	Natural Gas Plants	Other [h]	Total	Imports	Total	Inputs — Pet. Refining	Electric Utilities	Coke	Natural Gas Plants	Other	Total	Consumption	Exports	Inventory Change (+ or -)	Storage & Distribution Losses	Total	TOTAL
Gasoline	11533			26.4		11559	114	11673							11615	8.7	+49.5		11673	11673
Naphtha (excl. Solvent Naphtha)	432			1.7		434	23.2	457							454	7.6	-4.2		457	457
Kerosine	489			7.0		496	1.1	498							514	1.0	-17.8		497	497
Jet Fuel	1701			.1		1701	367	2068							2058	8.6	.7		2068	2068
Liquified Gases (incl. Butylene & Propylene)	485			1352		1837	103	1940	320					320	1480	37.6	103		1621	1940
Ethane (incl. Ethylene)				248		248		248							242		6.3		248	248
Distillate Fuel Oil	5214			8.0		5222	325	5547							5604	16.1	27.1		5647	5547
Residual Fuel Oil	1756					1756	3506	5262		2492[e]				2492	2652	83.1	35.8		2771	5262
Still Gas	1039					1039		1039							1039				1039	1039
Petroleum Coke	657					657		657							494	163			657	657
Natural Gas-Dry				16910		16910		16910		4117				4117	14279	82.7		431	14792	16910
Natural Gas Liquids, NEC				886		886	60.7	947	946					946	3.2		-2.6		0.5	947
Absorption Oil	7.8					7.8		7.8							7.8				7.8	7.8
Lubricating Oils, Greases & Related Products	400					400	.1	400							303	95.6	2.0		400	400
Other Finished Petroleum Products, NEC	1146					1146	48.2	1195							1156	13.0	25.4		1195	1195
Unfinished Oils [j]							253	253	244					244			8.9		8.9	253
Coke & Breeze			1506			1506	4.3	1510							1491	36.9	-17.9		1510	1510
Other Gases, NEC		474				474		474							474				474	474
Coal Chemical Products, NEC	180	29.0			173	382	5.2	387					173	171	216		-1.5		214	387
Finished Petrochemicals, NEC	339	11.7				341	38.1	379							379		-.2		379	379
Petrochemical Feedstocks (excl. Liquified Gases) [i]																				
Processed Uranium / Fabricated Thorium					2236	2236		2236		215[s]				215	2021[b]				2021	2236
Electric Energy (excl. Nuclear Hydropower) Other Hydropower		4469 / 129			345[e]	4943	24.0	4967					345[e]	345	2494	1694		434	4622	4967
Total Converted Energy Products	2569	4598	2020	21439	2754	56280	4872	61153	1510	6823			518	8851	48975	2248	214	865	52302	61153
Totals -- Primary and Converted Products							9851	127724	25219	14598	1974	21469	2754	66013	54722	3597	650	2742	61711	127724

Gross Energy New Supply (Total Primary Products plus Imports of Converted Products)	71443
Less: Additions to Inventory (±)	650
Exports	3597
Gross Energy Consumption (including all Losses)	67196
Less: Conversion Losses -- total	9733
Petroleum Refining	-250
Electric Utilities	10000
Coke	-46.8
Natural Gas Plants	29.6
Other	
Storage and Distribution Losses	2742
Net Energy Consumption	54721

Conversion Losses	9733
Final Disposition of Gross Energy New Supply	71443

PRELIMINARY UNRECONCILED DATA SUBJECT TO REVISION

Please see footnotes following the tables.

TABLE 2-1.-U.S. ENERGY BALANCE ACCOUNT
Footnotes

[a] Represents electric energy produced and consumed in industrial establishments. No information is available on the mix of fuel inputs to this process.

[b] The sole use of uranium is as an input to the energy conversion process. The total reported for consumption reflects the amount placed in reactors but not actually used up during the current year.

[c] Composed of repressuring and vented and flared losses at natural gas wells.

[d] Apparent consumption is negative due to discrepancies in the Bureau of Mines data.

[e] This figure is reported by the FPC as "fuel Oil," including distillate. Most of it is residual, however, and there is no satisfactory way of estimating the distribution.

[f] No data is available for this energy product.

[g] No data is available for these energy products. Included herein are geothermal, solar and coal gasification energy sources.

[h] Represents utility gas producers, tar distilleries, some organic chemcial producers and nuclear fuel processors.

[i] Included primarily under "Still Gas" and "Other Finished Petroleum Products, NEC" categories.

[j] Production of unfinished oils is not represented because the Bureau of Mines reports only net consumption of this product.

CHAPTER 3

ENERGY SOURCES ACCOUNT

The Sources Accounts measure the new supply of energy available in the economy for consumption, export or inventory accumulation. This includes primary energy types, e.g., coal, crude oil, etc., at the point of extraction, as well as refined and generated energy types. Domestically produced and imported energy are components of new supply. Domestic production of each energy product is identified in the account by its producing industries.

This chapter will examine the sources and availability of data used to compile the information in this Account. Since most of the domestic production and import data are available only in physical units, e.g. barrels, tons, etc., the extent to which data are available in the Account will be discussed in terms of physical unit data.

Producers' price series have been developed for many of the energy products in this Account; these price series are presented in Section 2 along with an examination of their data sources.

Tables 2A-2C in the Appendix present the Sources Account data for the 1947-1972 period. Table 2A is New Supply in physical units, while Tables 2B and 2C are in BTUs and producers' value.

SECTION 1

DOMESTIC PRODUCTION AND IMPORTS

This section will examine the availability and sources of data measuring production and imports of each energy product in the Sources Account. Most of the information compiled was only in physical units, e.g. barrels, tons etc., with no corresponding values. Therefore, unless otherwise noted, production and imports will be discussed in terms of physical units in this section. The last section of this chapter is devoted to an examination of producers' prices which may be used to price out the physical unit data.

Along with a discussion of the sources of data used to develop this Account, comparisons will be made between various data sources purporting to measure the same thing--particularly Bureau of Mines and Bureau of the Census data on domestic production and imports.

CRUDE OIL (including Lease Condensate)

Data measuring the domestic production of crude oil (including lease condensate) covering the 1947-1972 period are available in the Bureau of Mines, Mineral Industries Surveys entitled "Crude Petroleum and Petroleum Products, Natural Gas Liquids--Annual Petroleum Statement." The annual data are reported to the Bureau of Mines by each state. For some states, the Bureau of Mines surveys individual producers, and these data are used as monthly or preliminary measures of annual production.

Prior to 1967, lease condensate was included in the data on domestic crude production. In order to produce a consistent time series, lease condensate was added to crude from the 1968-1972 period.

Data on the imports of crude petroleum are available over the full time period. These data were obtained from a questionnaire completed by petroleum refineries, except for three companies operating pipelines across the

Canadian border, which supply data to the Bureau of Mines without a questionnaire. This information is published in the Mineral Industry Surveys noted above.

NATURAL GAS

Information measuring the gross production of natural gas is available for the 1947-1972 period in the Minerals Yearbook, "Fuels" volume, "Natural Gas" chapter. These are the same data used by the American Gas Association in its Gas Facts. Gross production is composed of marketed production plus quantities used in repressuring, vented and flared.

Imports of natural gas are published in the Minerals Yearbook over the 1952-1972 period.

GASOLINE

Motor gasoline and aviation gasoline make up the gasoline family of energy products. While motor gasoline is produced at petroleum refineries and natural gas processing plants, aviation gasoline is only the product of petroleum refineries.

Aviation gasoline production information is available for each year over the 1947-1972 period in the Bureau of Mines, Mineral Industry Surveys, "Annual Petroleum Report". For the 1947-1963 period, transfers were subtracted from total production since the production data from 1964 on are on a net basis (less transfers).

Motor gasoline produced at refineries is also available over the 1947-1972 period. Prior to 1964, these data were calculated by subtracting aviation gasoline production data from the production of total gasoline at refineries. The production of motor gasoline at natural gas processing plants is available directly from the Bureau of Mines, Mineral Industry Surveys, "Annual Petroleum Report" for the 1964-1972 period. Prior years were obtained by

finding the difference between production of total gasoline by all producers and production at refineries. Production information was gathered by the Bureau of Mines using their Refinery Report and Natural Gas Processing Plant Report.

The domestic production of total gasoline is also available in the "Annual Petroleum Report." For the 1947-1963 period, both naphtha and the net output of unfinished gasoline were deducted from the gasoline quantities reported. This produced a consistent time series measuring the production of gasoline over the 1947-1972 period.

Imports of motor gasoline as published by the Bureau of Mines are collected by the Office of Oil and Gas, which is now in the Federal Energy Administration. These data are available for the 1947-1972 period and are substantially different than those published by the Bureau of the Census. The section of this chapter which compares data published by the Bureau of Mines and the Bureau of the Census will provide illustrations and a discussion of the differences in the motor gasoline import data.

KEROSINE (excluding Jet Fuel)

Domestic production of this energy product occurs at both refineries and natural gas processing plants. Data are available measuring production at the former for the 1964-1972 period and at the latter from 1955 to the present. These data are published in the Mineral Industry Surveys, "Annual Petroleum Statement".

Imports of kerosine, though published by the Bureau of Mines, are collected by the Federal Energy Administration, Office of Oil and Gas. These data are available for the 1964-1972 period. In prior years, imports of kerosine included jet fuel.

KEROSINE (including Jet Fuel)

The production of kerosine (including jet fuel) by all producers is available for the 1947-1972 period. Prior to 1965, kerosine included jet fuel and no adjustments were made to the data. In order to develop a consistent time series, data measuring the domestic production of kerosine type jet fuel were added to the production of kerosine between 1965 and 1972.

Data measuring the production of kerosine at refineries are available for the 1965-1972 period. Both total production and that at refineries are published in the Minerals Industry Survey, "Annual Petroleum Report".

Imports of kerosine including jet fuel were also obtained for the 1965-1972 period by combining import information for kerosine and kerosine type jet fuel.

JET FUEL

Jet fuel is composed of kerosine type and naphtha type fuel. Data are available on the domestic production of both types at petroleum refineries and only naphtha type at natural gas processing plants for the 1965-1972 period. This information is reported to the Bureau of Mines monthly and annually and is published in the Minerals Industry Surveys, "Crude Petroleum and Petroleum Products, Natural Gas Liquids."

Imports of both kerosine and naphtha type jet fuel are reported in the Bureau of Mines document noted above. These data are compiled by the Federal Energy Administration, Office of Oil and Gas.

LIQUEFIED GASES

Liquefied gases are members of the natural gas liquids family of energy products and are composed of butane, propane, butane-propane mixtures and other liquefied gas mixtures. Butane is further disaggregated into normal butane, isobutane and other butanes, nec. Much of the data measuring the

domestic production of liquefied gases as defined here are only available for natural gas processing plants. The production of many of these products at petroleum refineries is clouded by the inclusion of propylene and butylene in the data. This will be discussed more extensively below.

The domestic production of normal butane as a distinct energy product at natural gas processing plants has been measured through Bureau of Mines' surveys since 1970. From 1947-1965, the criteria used by producers in reporting figures on "normal butane" appear to have differed from the actual Bureau of Mines' definition--a definition introduced in the mid-1960's. Over this time period, it is felt that the greater part of the reporting producers considered "normal butane" only that butane which met commercial specifications for normal butane. However, the present definition used by the Bureau of Mines is inclusive of products not strictly meeting those specifications.

Data are not available measuring imports of normal butane as distinct from butane as a whole.

The domestic production of isobutane at gas plants is reported by the Bureau of Mines in the Mineral Industry Survey, "Crude Petroleum and Petroleum Products, Natural Gas Liquids" for the 1967-1972 period and in the Minerals Yearbook "Fuels" volume for the earlier years. Import data are not available for this energy product. Production at petroleum refineries is available for the 1963-1972 period in the data sources noted above. Prior to 1963, isobutane from refineries is not published separately and is a part of the liquefied refinery gas (LRG) data.

Domestic production of other butanes, nec, compiled for natural gas processing plants is available for the 1970-1972 period. In the earlier years, separate data for these energy products were not published by the Bureau of Mines.

Information on the production of propane at natural gas processing plants is available for the 1947-1972 period in the Bureau of Mines, Mineral Industry Surveys, "Crude Petroleum and Petroleum Products, Natural Gas Liquids," and the Minerals Yearbook "Fuel" section.

Domestic production of butane-propane mixtures at petroleum refineries and gas plants is available for the 1957-1972 period. The Bureau of Mines _Refinery Report_, which is used to gather these data, asks refineries to distinguish between the production of butane-propane mixtures for petrochemical feedstock use and for all other uses. Production for these two uses are separately published in the _Mineral Industry Surveys_ noted above, but only the total is recorded in the Sources Account. The Bureau of Mines questionnaire to the natural gas processing plants does not ask that a distinction be made as to the uses of the mixtures.

Measures of the production of "other liquefied petroleum gas mixtures" are published in the _Minerals Yearbook_ for the 1959-1965 period. From 1959 to 1962, the production of isobutane at refineries was included in this energy type category. This is not the case for gas plants, where the production of isobutane was separately enumerated over this period.

LIQUEFIED GASES (Including Butylene and Propylene)

The components of this energy type family include those in the previous energy family discussed as well as liquefied gases which include butylene and propylene. This was done in order to quantify all liquefied gases. Actually, this energy product overstates the production of liquefied gases by including butylene and propylene, while the data on liquefied gases alone, discussed previously, understates. Total butane production at petroleum refineries is only tabulated with the inclusion of butylene. This is also true for propane and propylene. Attempts were made to disaggregate these products, but they were unsuccessful. This problem is not present, of course, for production at natural gas processing plants, since butylene and propylene are not produced at these establishments.

Measures of domestic production of total liquefied gases including butylene and propylene are available for petroleum refineries and natural gas processing plants from 1959 to 1972. Imports of this energy product are available from 1960 to the present. This information was collected by the U.S. Bureau

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of the Census, and adjusted and published by the Bureau of Mines. The adjustment techniques used will be discussed later in this chapter. Both production and import data are published by the Bureau of Mines in the Mineral Industry Surveys, "Crude Petroleum and Petroleum Products, Natural Gas Liquids--Annual Petroleum Statement."

Besides the production of liquefied gas excluding butylene and propylene, at gas plants, this energy product includes the production of normal butane including butylene at refineries which is available over the 1957-1972 period. Imports of this product are published by the Bureau of Mines from 1967 to the present.

Data on the production of propane including propylene at refineries cover the 1957-1972 period and appear in the Bureau of Mines "Annual Petroleum Statement." Imports of propane including propylene are compiled by the Bureau of the Census and published by the Bureau of Mines after adjustments are made.

ETHANE

Ethane is another member of the broad natural gas liquids family. This product is produced only at natural gas processing plants, since a comparable energy product produced at refineries includes ethylene. Ethane production at gas plants is measured over the 1959-1972 period and published by the Bureau of Mines in the Mineral Industry Surveys, "Annual Petroleum Statement."

ETHANE (Including Ethylene)

This product includes the ethane produced at natural gas processing plants and the ethane including ethylene produced at petroleum refineries. These data are also published by the Bureau of Mines in the "Annual Petroleum Statement". No import data are available for this specific product.

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NATURAL GAS LIQUIDS, NEC

Natural gas liquids comprise a broad range of products which are predominantly produced at natural gas processing plants. Along with the liquefied petroleum gases and ethane previously examined, natural gas liquids include output at gas plants of motor gasoline, naphtha type jet fuel, kerosine, distillate fuel oil, and special naphtha as well as the energy products discussed here.

Natural gasoline, isopentane and plant condensate production are measured over the 1947-1972 period and are published by the Bureau of Mines in the _Mineral Industry Surveys_, "Annual Petroleum Statement" since 1967. For prior years, production data are available in the _Minerals Yearbook_, "Fuels" volume. Information on the imports of these products are not available.

Other natural gas liquids, nec, is a category used to provide closure for the natural gas liquids family. The composition of this category varies over the twenty-six years of the accounts. The data are published in the _Minerals Yearbook_ "Fuels" volume. No imports measures are available for this product.

FUEL OIL

Fuel oil is composed of numbers 1, 2, and 4 distillate heating oil and diesel fuel oil as well as numbers 5 and 6 residual fuel oil. The distinction between distillate heating oil and diesel fuel oil is one of functional use. Along with the production of distillate and residual fuel oils compiled by the Bureau of Mines, crude petroleum used as distillate and residual was included to obtain total production data for these products.

Distillate fuel oil produced at petroleum refineries is reported for the 1947-1972 period, while the production at natural gas processing plants is available since 1955. Imports of distillate cover the full time period of the Historical Accounts and were compiled by the Bureau of the Census.

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Residual fuel oil is produced only at refineries. Data measuring production are available for the 1947-1972 period as are import data.

Both production and import data for fuel oil are published by the Bureau of Mines in the Mineral Industry Surveys, "Crude Petroleum and Petroleum Products, Natural Gas Liquids--Annual Petroleum Statement."

STILL GAS

Still gas is produced in the refining process. Measures of production are published by the Bureau of Mines over the 1947-1972 period.

This energy product is a part of the general category of products classified as manufactured gases. In this report, this product was not included under manufactured gases, while in the final report, it will be.

PETROLEUM COKE

This petroleum product is produced at refineries and data measuring its production are available in the Mineral Industry Surveys for the 1947-1972 period. No import data are published for this specific product.

NAPHTHA

Special naphtha and naphtha 400° are included in this energy family, while solvent naphtha--a light oil derivative from coal--is not classified under the naphtha family.

The domestic production of special naphtha and naphtha 400° from petroleum refineries is available over the 1963-1972 period. No data are available for these products individually prior to this period since special naphtha or "naphtha from crude" is combined with naphtha 400°. Production of special naphtha at natural gas processing plants is published in the Mineral Industry Surveys, "Annual Petroleum Statement" for the 1967-1972 period and in the Minerals Yearbook from 1964 to 1967. Naphtha 400° is not produced at gas plants.

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Imports of special naphtha are available for the 1964-1972 period, while import data for naphtha 400° start in 1965. These data are published in the "Annual Petroleum Statement."

ABSORPTION OIL

The production of absorption oil at petroleum refineries is measured by the Bureau of Mines using a survey titled "Production of Other Finished Products at Petroleum Refineries." These data cover the 1948-1972 period and are published in the Minerals Yearbook under the caption "miscellaneous finished oils." Imports are not published for this product.

LUBRICATING OILS, GREASES AND RELATED PRODUCTS

Lubricants are composed of lubricating oils and greases. Specific production data were not found for greases and the data classified under lubricants are lubricating oils only. These data are published in the Minerals Yearbook and cover the 1947-1972 period. Between 1962 and 1972, production by grade—bright stock, neutral and other grades—is also published, though it is not disaggregated in the Energy Flow Accounts.

Imports of lubricants are presented in the Mineral Industry Surveys "Annual Petroleum Statement" for 1947-1948 and 1960-1972.

The production of insulating oil and hydraulic fluid at refineries is presented by the Bureau of Mines for the 1964-1972 period. In prior years, these products are not disaggregated but included under the heading "specialty oils" in the Minerals Yearbook. Imports of these two products are not available.

UNFINISHED OILS

These are oils which require further processing at the refinery. The Bureau of Mines reports this product as net output or input, therefore production is reported when output of unfinished oils is greater than inputs, otherwise production is reported as zero.

Domestic product and import data are both available for the 1947-1972 period.

OTHER FINISHED PETROLEUM PRODUCTS, NEC

The products included in this energy grouping include medicinal oils, petrolatum, spray oil, asphalt, road oil, waxes and other products.

The domestic production of medicinal oils and petroleum are measured over the 1948-1972 period, while data on spray oil product covers the 1960-1972 period. No import data are available for these products. These data are presented in the Minerals Yearbook, usually as a footnote to a table titled "Production of Miscellaneous Finished Oils in the United States" in the "Crude Petroleum and Petroleum Products" section.

Data measuring the production of asphalt are published over the 1947-1972 period in the Mineral Industry Surveys, "Annual Petroleum Statement." Imports of asphalt are also available over the same time period.

The production of road oil at petroleum refineries is presented for the 1947-1972 period in the "Annual Petroleum Statement." Import data are not available.

Data on wax production at refineries covers the period 1947-1972. This includes the production of "microcrystalline-fully refined" and "crystalline-other." Imports are published for the full time period of the Energy Flow Account in the "Annual Petroleum Statement."

COAL

Anthracite production is measured for the 1947-1972 period, though the data prior to 1951 may not be strictly comparable with the more recent years. This is due to the problem of "bootlegging." Briefly, during the depression years of the 1930's, some independent operators began producing anthracite from lands

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neither owned nor leased by them. Prior to 1951, production figures exclude, for the most part, the amount of production by these so-called "bootleggers" (although figures for some of these years do include coal purchased for preparation by legitimate operators from bootleggers), due to inadequate coverage. Beginning with 1951, however, amounts of production by such independent operators (now 100 percent legitimized, largely through legal agreements with the land owners) are included in the anthracite production figures.

Imports of anthracite are available between 1947 and 1963. In 1963, the Bureau of the Census discontinued issuing separate data on the imports of anthracite and the small quantities imported are combined with bituminous.

The production of both bituminous coal and lignite are available over the 1947-1972 period. Bituminous production was obtained from the Minerals Yearbook by subtracting lignite production from that of bituminous and lignite combined. These data were collected by the Bureau of Mines using a survey titled Bituminous Coal and Lignite Production and Mine Operation.

Import data are available for bituminous coal and lignite combined. This information was tabulated by the Bureau of the Census from custom entry forms.

COKE AND BREEZE

The production of coke is available for the full time period. Coke production data represent, in most cases, the sum of production at high-temperature coke-ovens, beehive ovens, medium and low temperature ovens and coal-gas retorts. In the later years, when data for high-temperature coke-ovens and beehive ovens were the major ones available, the data are the sum of only these two. The amount attributed to other producers decreases over the years, ranging from 1.1 to 0.2 of that produced by the two main producers.

Breeze production also covers the 1947-1972 period, though production of breeze for medium and low-temperature carbonization plants and coal-gas retorts were not published for 1954, and subsequent years. Production reported by these minor producers as a percentage of that reported by all producers ranged from 1.45 percent in 1947 to less than 0.1 percent in 1953.

Between 1970 and 1972 data exclude production of breeze at beehive coke plants in Pennsylvania and Virginia--this data withheld to avoid disclosing individual company confidential data.

Import data are not availabe for coke or breeze.

FINISHED PETROCHEMICALS

This broad energy family is composed of petrochemicals which are produced by industries which are major fuel producers, i.e., petroleum refineries and coal carbonization plants. Therefore, if a petrochemical is produced only in the chemical industry, e.g., carbon clack, it will not be included in the data under this energy product family. The finished petrochemicals which are examined in the Energy Flow Accounts are benzene, toluene, xylene, butylene, propylene, and ethylene. Production of butylene, propylene and ethylene are not indiviually enumerated in the Accounts since their production at petroleum refineries is clouded by their inclusion with butane, propane and ethane.

The domestic production of benzene (benzol) occurs in petroleum refineries, coke-oven plants, and tar distillers. Production at refineries cover the 1950-1972 period; these data appear in the U.S. Tariff Commission publication Synthetic Organic Chemicals, Production and Sales, for the years 1952-1971, under the headings "Benzene, Specification and Industrial Grades, Petroleum Operators." For 1950 and 1951, the data are termed "Benzene, specification and industrial grades, petroleum refiners." Footnote to the published tables from which these figures were taken indicate that for the years 1946-1949, some benzene produced from petroleum was included in the figures for benzene produced by tar distillers.

Measures of production at coke-oven plants cover the 1947-1972 period. These data are collected on a Bureau of Mines questionnaire titled Coke and Coal-Chemical Materials, which survey beehive coke plants and oven-coke plants. For the 1965-72 period production was composed of items entitled "specification grades (1°, 2°, 90%) and "other industrial grades". From 1957 to 1964 benzene production at coke-oven plants included "specification grades, excluding motor grade" and "motor grade". In the earlier years production was published under the captions "specification grades (1°, 2°, 90%)", "other industrial grades" and "motor grade". These data appear in the Minerals Yearbook, "Fuels" volume, "Coal and Coal Chemicals" section.

Production of benzene by tar-distillers over the 1947-1963 period is published in the U.S. Tariff Commission volume Synthetic Organic Chemicals United States Production and Sales. For 1952-1963, the published figures are termed "Benzene, Specification and Industrial Grades--Tar Distillers". For 1946-51, production is the sum of items termed: "Benzene, all other grades--tar-distillers" and "Benzene, motor grade--tar-distillers".

Imports of benzene are compiled and published by the Bureau of the Census for the full time period.

Toluene production at petroleum refineries is measured over the 1947-1972 period and is published by the U.S. Tariff Commission in Synthetic Organic Chemicals, U.S. Production and Sales.

Production of toluene at coke-oven plants is available from 1947 to 1972. These data were collected by the Bureau of Mines and published in the Minerals Yearbook.

Production by tar-distillers cover the 1947-1963 period and is published by the U.S. Tariff Commission.

Imports of toluene are measured by the Bureau of the Census for the 1947-1972 period.

Xylene produced at petroleum refineries is measured by the U.S. Tariff Commission between 1947-1972 and published in Synthetic Organic Chemicals, U.S. Production and Sales.

Production of this petrochemical at coke-oven plants has been tabulated by the Bureau of Mines for the 1947-1972 period and in the Minerals Yearbook.

Xylene production by tar-distillers is available in the Tariff Commission publication noted above for the 1947-1963 period.

Just as in the case of the other petrochemicals discussed, imports of xylene are collected and published by the Bureau of the Census.

COAL CHEMICAL PRODUCTS, NEC

This energy family is composed of crude tar, tar derivatives, intermediate light oil, crude light oil, light oil derivatives and ammonia from coal.

Crude tar production by all industries is measured over the 1947-1972 period. Data for 1947 to 1949 are the sum of crude tar produced at coke-ovens, medium and low-temperature plants, coal-gas retorts, and of water-gas and oil-gas tar, while the production at medium and low-temperature plants are not published from 1950 to 1952 and therefore are not included in the sum described above for total production. Production data for 1953-1954 are the sum of crude tar produced at coke-ovens, water-gas and oil-gas tar, and an aggregate figure for crude tar produced at medium and low temperature plants and at coal-gas retorts. Data for production of crude tar at medium and low temperature plants at coal gas retorts as well as water-gas and oil-gas were no longer published from 1955 on and therefore are not a part of the total shown in the Sources Account in the more recent years. These data appear in the Mineral Industry Surveys, "Coke and Coal Chemicals" which is published monthly and an annual summary.

Imports are compiled and published by the Bureau of the Census for the 1963-1972 period.

Tar derivatives include sodium phenolate or carbolate, naphthalene, road
tar, pitch of tar and other tar derivatives.

Sodium phenolate or carbolate production data at coke-oven plants are pub-
lished by the Bureau of Mines in the Mineral Industry Surveys, "Coke and
Coal Chemicals" annual report for the 1947-1972 period.

Imports are not available for this product of the historical period examined.

The combined production of naphthalene at coke-oven plants and tar-distillers
are available from 1947 to 1972. Published data for the years 1962-1972,
appear as the item "naphthalene, crude: total" in the "Tar Crudes" section
of the annual U.S. Tariff commission report Synthetic Organic Chemicals,
Production and Sales, "Naphthalene, Crude: Total" the sum of two other items:
"Naphthalene, Crude : Solidifying at less than 79°C" and "Petroleum Naph-
thalene, All Grades." "Naphthalene, Crude: Solidifying at less 79°C" appears
to be derived from a Bureau of Mines questionnaire titled Coke and Coal-
Chemical Materials and a Tariff Commission Survey--Synthetic Organic Chemicals,
U.S. Production and Sales the first covering coke-oven operators and the
second covering tar distillers. For 1959-1961, the data appear as the item
"Naphthalene, crude (tar distillers and coke-oven operators) total" in the
"Tar Crudes" in the Synthetic Organic Chemicals Production and Sales report.
Naphthalene is the sum of the three items: "Solidifying at less than 74°C,"
"74°C to less than 76°C", and "76°C to less than 79°C". While petroleum-
derived naphthalene does not appear separately, it is part of the data for
these three years. For 1947-1959, these data element are the sum of figures
for production of crude naphthalene by coke-oven operators taken from U.S.
Department of the Interior, Bureau of Mines, Minerals Yearbook, chapter
entitled "Coke and Coal Chemicals". Production data of crude naphthalene
(solidifying at less than 79°C) by tar distillers is reported in the U.S.
Tariff Commission publication, Synthetic Organic Chemicals, Production and
Sales.

Imports of naphthalene are reported by the Bureau of the Census from 1947
to 1972.

Road tar production at tar-distillers is measured over the 1947-1972 period. Imports of this product are published by the Bureau of the Census since 1963, to the extent that there is production of road tar by producers other than tar distillers, the data element will be understated. Neither the Tariff Commission's survey of products from petroleum and natural gas for chemical conversion Synthetic Organic Chemicals, United States Production and Sale:, nor the Bureau of Mines's monthly or annually Coke and Coal Chemicals surveys canvas data for road tar as a separate product. The figure for 1965 production as published includes the amount of production of an item termed "tar (crude and refined) for other uses," and therefore will be overstated to that extent.

Pitch of tar is produced at coke-oven plants and tar-distillers. Data measure the production of this product over the 1947-1972 period. Imports of pitch of tar are reported by the Bureau of the Census since 1963.

Other tar derivatives, nec, include such products as crude chemical oil or tar acid oil, and creosote oil. Data measuring production at coke-oven plants and tar-distillers for the 1947-1972 period.

The sources of data for this energy product are the U.S. Tariff Commission, questionnaire and publication both entitled Synthetic Organic Chemicals, Production and Sales as well as the Minerals Yearbook, "Fuels" volume, "Coke and Coal Chemicals" chapter.

Imports for these products are published by the Bureau of the Census over the full time period of the Historical Energy Accounts.

The production of intermediate light oil at coke-oven plants is measured over the 1950-1972 period and is published in the Minerals Yearbook, "Fuels" volume, "Coke and Coal Chemicals" chapter.

Crude light oil production is available for coke-oven plants for the full twenty-six years of the Sources Account, while production at tar-distillers

cover 1947 to 1958. Data for coke-oven plants is published in the Minerals Yearbook and production at tar-distillers is reported in the Tariff Commission, Synthetic Organic Chemicals, Production and Sales.

Light oil derivatives, nec, include solvent naphtha and other light oil derivatives, nec. Solvent naphtha production at coke-oven plants are measured over the 1947-1972 period, while production at tar-distillers is available for 1947-1948, 1953-1963, 1965, and 1970. These data are published in the Bureau of Mines and U.S. Tariff Commission documents noted above. Import data are not available for this product.

Other light oil derivatives, nec, include products classified by the Bureau of Mines as "other light oil products", "pyridine crude", and "pyridine refined". Data are published by the U.S. Tariff Commission for production at tar-distillers from 1947 to 1967. The Bureau of Mines provides production data for coke-oven plants for the 1947-1972 period. Import data were not compiled for this aggregate energy product.

Only production data of ammonia manufactured at coke-oven plants were compiled and included in the Source Account. This was done so that the total output of coke-oven plants would be accounted for. Production data are available over the 1947-1972 period from the Minerals Yearbook, "Fuels" volume, "Coke and Coal Chemicals" chapter. Imports of ammonia were not compiled in the Sources Account.

TOTAL GASES

Gases are composed of dry or residue natural gas and other gases. The other gases category is disaggregated into manufactured and mixed gases. Manufactured gases are further broken into coke-oven gas and other manufactured gases. Still gas is another type of manufactured gas, but it is not included under the heading total gases in this Preliminary Report. It will be in the final report.

All dry or residue natural gas production was considered to occur at natural gas processing plants. Actually approximately one-fifth does not come from

gas plants, but directly from wells. This is particularly true when the natural gas produced by the extraction industry is not rich in natural gas liquids. The production of residue natural gas was measured by the Bureau of Mines and published in the Minerals Yearbook for the 1962-1972 period. In earlier years these data were not available and estimates were made of residue gas production. These estimates are based on information obtained from the Bureau of Mines that the natural gas process at gas plants, there is a reduction of 34 cubic feet per gallon of natural gas liquids produced. By multiplying 34 by the production of natural gas liquids and subtracting the product from the cubic feet of natural gas process, values for residue natural gas were obtained for the 1947-1961 period.

All imports of natural gas were assigned to the total natural gas energy product and not to residue natural gas.

Manufactured gases are composed of coke-oven gas, carburated water gas, retort gas, and still gases. Production data for coke-oven gas will be separately delineated from the other manufactured gases.

Coke-oven gas has been produced historically at gas utilities as well as coke-oven plants. Measures of its production at gas utilities is available from the American Gas Association, Historical Statistics of the Gas Industry, for the 1947-1956 period. Production at coke-ovens cover the full time period of the Historical Energy Flow Accounts. These latter data are published by the Bureau of Mines, Minerals Yearbook, "Fuels" volume "Coke and Coal Chemicals" chapter.

The production of the other manufactured gases cover the 1947-1956 period and are published by the American Gas Association. Besides the disaggregation of manufactured gases discussed above. Total manufactured gas produced at gas utilities is available between 1947 and 1968. These data are also published by the American Gas Association.

Mixed gas which is a combination of natural and manufactured gases, is produced at gas utilities and measured by the American Gas Association for the 1947-1968 period.

ELECTRIC ENERGY

The production of electric energy measured in the Sources Account has been disaggregated by type of fuel used in the generating process as well as the type of producing sector.

Electric energy generated by all fuels by federal, state and local, and private utilities as well as manufacturing establishments is measured by the Federal Power Commission over the full time period examined in the Historical Energy Flow Accounts. State and local utility generation is the result of combining production data at "municipal electric utilities", "cooperatives, power districts and state projects," and "non-central stations" as delineated by the Federal Power Commission.

Measures of the production of electric energy by the former Atomic Energy Commission for the 1947-1972 period were obtained from the Energy Research and Development Administration (ERDA). Electric generation by railroads is published in the American Transit Association report, Transit Fact Book for the 1947-1957 period.

Imports of electric energy are reported in a Federal Power Commission document entitled Imports and Exports of Electric Energy. These data are available from 1947-1972.

The production of electric energy through the combustion of fossil fuels is measured for federal, and state and local utilities over the 1950-1970 period. Generation by the consumption of fossil fuels by the private utilities covers the 1947-1972 period. These series are not published but compiled on worksheets by Mrs. McMillan, of the Federal Power Commission. Electric generation by manufacturing industries through the combustion of fossil fuels is measured over the full twenty-six year period.

The generation of electric energy by federal, and state and local governments was measured from 1955 to 1970, while hydro-electric generation by manufacturing industries are reported over the 1947-1972 period.

The production of electric energy using nuclear fuel, particularly uranium, is published for the 1957-1972 period. Over this period, private utilities were the only commercial producers of electric energy using nuclear power.

NUCLEAR PRODUCTS

The two nuclear products for which production data were obtained were milled uranium and fabricated uranium. The data measuring the production of milled uranium (U_3O_8) is published in the <u>Minerals Yearbook</u> for the 1963-1972 period.

The quantity of fabricated nuclear products produced in the U.S. over the 1961-1972 period was obtained through the Federal Energy Administration from a private firm. It was assumed that most of the output of the fabricated products was made up of fabricated uranium.

Production of nuclear products which fall between the milling and the fabricated process were not available over the historical period. Data were not collected measuring the quantity of uranium hexafloride or enriched uranium produced. Nor were the production measures of other types of nuclear products compiled.

COMPARABILITY OF BUREAU OF MINES AND BUREAU OF
CENSUS PRODUCTION AND IMPORT DATA

PRODUCTION DATA

As previously noted in this chapter, the Federal Power Commission has compiled extensive data measuring the generation of electric energy by federal, state and local, and privately owned utilities, as well as manufacturing establishments. Much of this information is also collected in terms of the fuels used in the generating process.

The Federal Power Commission also collects natural gas production data, but its domain covers only interstate production companies, and thus its coverage is incomplete. The Bureau of Mines data were considered to have greater coverage, and therefore were used in the Sources Account.,

Other than the Federal Power Commission, the Bureau of Mines and the Bureau of the Census were the only other federal organizations from which systematically collected historical data measuring the production of energy products were available. Attempts were made to obtain historical data from the Atomic Energy Commission, but with little success.

In addition are found quite a few federal agencies, state agencies, and private trade organizations which collect data on particular products or under particular definitional circumstances. However, the differences in scope, survey size and methods, and statistical techniques among these groups made their results less useful than those noted above.

Briefly, some of the more prominent other sources of energy data are:

A) The U.S. Geological Survey which appears on the surface to be
   a good source of data on crude oil and natural gas production
   on federally-owned lands. Information on reserves, drilling,
   and well characteristics is more generalized.

B) The American Petroleum Institute which only collects original
data on a few consumption characteristics such as service sta-
tion sales, and on certain data on oil well operations. All
other A.P.I. data are basically second-hand, having been de-
rived from the Bureau of Mines, the Census Bureau, and others.

C) Several organizations, such as the National Coal Association,
that have interests in specific products publish data on en-
ergy production. There are several problems with these data.
Differences in procedures make these organizations' data troble-
some to integrate with the rest of the production data. In add-
ition, much of the data collected by private agencies are also
second-hand, having been originally obtained from the Bureau of
Mines or the Census Bureau.

D) Numerous state agencies collect production data on a variety of
products within their states. These data were not thoroughly
investigated due to time and expense limitations. Procedural
differences make the integration problem a factor in this area,
too, but in certain cases, the data had in fact been used by
the Bureau of Mines in its own data reporting.

Almost all of the production data collected were obtained from Bureau of Mines
sources. The only exceptions were electric energy production which is published
by FPC and nuclear materials production which was obtained from Nuclear Assurance
Corporation. This decision was made on the basis of the following information:

A) Most important is the fact that the Census of Manufactures
(for refined products) and the Census of Mineral Industries
(for crude oil, coal, and natural gas) are conducted roughly
every five years, while the Bureau of Mines collects data
yearly. Since 1939, the Census of Mineral Industries have
been taken only five times, in 1954, 1958, 1963, 1967, and
1972. If their data had been chosen, interpolation would have

been necessary to fill in the intervening years. Such a procedure would have rendered the entire product much less valuable than a comparable, year-by-year consistent time-series of Bureau of Mines data.

B) The Census of Mineral Industries canvasses what it believes to be the entire universe of producing entities, collecting production data on an establishment basis. As the Census Bureau is not a specialized mineral or fuel agency, and as it only performs this task once every five years, there is some question as to whether it can keep up-to-date on the extent of this universe and how it changes over five-year periods.

The Bureau of Mines, on the other hand, uses the results of state collection agencies—who follow the same total canvass procedure for their individual states—to determine yearly mineral-fuel production data. Such a method is less overwhelming on the state level and thus the results are more reliable. In addition, both the Bureau of Mines and the individual state agencies are specialized, having developed a great deal of expertise on the nature of products and procedures over the years. These agencies maintain close contact with the industry and know who to contact in order to obtain information; thus their results have a high degree of reliability.

C) In the area of refined petroleum products, both the Census of Manufactures and the Bureau of Mines collect information from petroleum refineries. Only about 250 refineries exist in the U.S., and they are large, easily identifiable establishments. At first glance, it would appear that both agencies know perfectly the nature of this universe, and that their results would be equally reliable (if not identical).

However, the Bureau of Mines again has the edge in that it better understands the industry. Refineries very often have different production emphasis, thus they sell products back and forth to be used as inputs in further refining or blending. For example, a finished output such as aviation gasoline may be sold from one refinery to another and be subsequently used as an input to a special blend of motor gasoline. Such a phenomenon can lead to considerable double counting if it is not treated properly. Thus, the Bureau of Mines, whose main concern is net production of specific products, has less potential for error than does the Census Bureau, which is interested in total output on an establishment basis.

In addition, the Census Bureau stresses the collection of data on shipments while the Bureau of Mines collects actual production data. These Census data generally must be adjusted for inventory changes to derive production data. Since the Census Bureau collects data only every five years, there is potential for misrepresenting inventory levels at the beginning and end of the year. The Bureau of Mines also has such a potential, but as it collects data every year, errors at least are compensating within a span of two years.

It should be noted, however, that even though the Bureau of Mines was ultimately chosen as the better source in the fossil fuel production area, the Census Bureau results are not really very different. Table 3-1 shows some comparisons of selected fuel data in the appropriate years. In many of these cells, the differences are not more than 5 percent. Such similar results obtained on the basis of significantly differing procedures should tend to reinforce the belief that the production data collected for the Energy Source Account is quite reliable.

TABLE 3-1.—COMPARISON OF BUREAU OF MINES AND U.S. BUREAU OF THE CENSUS
DATA MEASURING PRODUCTION FOR SELECTED FUELS

Year	Crude Oil (MBBL)			Natural Gas (MMCF)			Bituminous Coal (M TONS)			Motor Gasoline (MBBL)			Distillate Fuel Oil (MBBL)			Residual Fuel Oil (MBBL)			Jet Fuel (MBBL)			Asphalt (MBBL)		
	BOM	Census	BOM as % of Census	BOM	Census	BOM as % of Census	BOM	Census	BOM as % of Census	BOM	Census	BOM as % of Census	BOM	Census	BOM as % of Census	BOM	Census	BOM as % of Census	BOM	Census	BOM as % of Census	BOM	Census	BOM as % of Census
1947	census data not available -->									832892	815654	102.11	315436	341907	92.26	474886	488069	97.30	data not available			data not available		
1954	2314956	2221452	104.21	10984850	10701793	102.53	391706	392078	99.91	1250734	1159440	107.87	543778	556968	97.63	422681	398898	105.96						
1958	2448987	2367809	103.43	13146635	12152585	108.16	410446	421306	97.42	1412771	1332785	106.00	633128	661316	95.74	374323	350692	106.68	available			↓	↓	↓
1963	2752723	2703520	101.82	16973368	15956981	106.37	458928	461900	99.36	1571889	1544646	101.76	765874	799000	95.85	279215	286300	97.53	↓	↓	↓	111948	108600	102.89
1967	3215742	3064800	104.93	20251776	19308900	104.88	552626	551900	100.13	1808709	1832500	98.70	805518	871000	92.48	279627	277000	100.95	273229	275000	99.28	127767	138500	92.25
1972	census data not available -->																							

IMPORT DATA

Import statistics have been obtained when available from the Bureau of Mines. BOM uses import data from the Office of Oil and Gas of the Federal Energy Administration for crude petroleum and other petroleum products, but in most instances, BOM uses imports for consumption data from the Census Bureau for its energy products.

Imports for consumption are a combination of entries for immediate consumption and withdrawals from customs-bonded warehouses. The statistics for consumption on U.S. imports of merchandise are compiled from information reported on customs import documents filed with customs officials.

Any of the "imports for consumption" merchandise stored in bonded warehouses could conceivably be exported subsequently to its release from customs custody, and thus never enter actual U.S. consumption channels. Further, merchandise for "immediate consumption" may, in fact, be warehoused by the importers outside the customs custody. This merchandise may be held for a period of time before it is released for consumption and/or it may be exported.

Census import statistics include imports of merchandise into the U.S. customs area (50 states, the District of Columbia and Puerto Rico). The data therefore do not include imports to the U.S. from Puerto Rico and other U.S. possessions while including imports to Puerto Rico and U.S. possessions from foreign countries. (For a comparison of BOM and unadjusted Census import figures, see Table 3-2.)

The measurement of domestic production used in the National Energy Accounts does not include production taking place in Puerto Rico and other U.S. territories. In order to include production taking place in U.S. possessions and consumed in the U.S., we adopted the Bureau of Mines' convention in which imports from Puerto Rico and U.S. territories are considered as imports into the U.S. Correspondingly, imports from foreign countries into Puerto Rico and U.S. possessions were excluded. Similarly, exports to U.S. possessions are not considered domestic transactions and are included in the export data where possible. In order to adjust Census data to conform to the BOM geographic definition of the U.S., the following procedure must be followed.

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TABLE 3-2.--COMPARISON OF BOM AND CENSUS IMPORTS--1970

Product Name	BOM Q	Unadjusted Census Q	Unit of Measure
Crude Oil	483293	533876	Barrels, Thousand
Coal	36	36	Short Tons, Thousand
Natural Gas	820780	1004983	Cubic Feet, Million
Motor Gasoline	24320	2824	Barrels, Thousand
Kerosine	1451	2643	Barrels, Thousand
Jet Fuel	52696	54025	Barrels, Thousand
Natural Gas Liquids	18921	19098	Barrels, Thousand
Butane	9454	9533	Barrels, Thousand
Propane	9467	9565	Barrels, Thousand
Coke	153	153	Short Tons, Thousand
Residual Fuel Oil	557845	532167	Barrels, Thousand
Distillate Fuel Oil	53826	18766	Barrels, Thousand
Lubricants	224	239	Barrels, Thousand
Asphalt	1127	943	Short Tons, Thousand
Unfinished Oils	39261	63179	Barrels, Thousand

Geographical Adjustment of Census Import Data to Conform to
the BOM Geographic Definition of the U.S.

The following procedure is conceptually the reverse of the procedure used for
adjusting export figures to the 50 state definition of the U.S. used by the BOM
and in this study.

    Step 1:   Census U.S. imports for consumption (FT110, FT246)

    Step 2:   Include shipments from Puerto Rico to the U.S. (FT800)

    Step 3:   Include shipments to the U.S. from U.S. possessions (FT800)

    Step 4:   Exclude imports into Puerto Rico (IA253, IA245)

    Step 5:   Exclude shipments from the Virgin Islands to Puerto Rico
              (IM161)

Application

The Census import data are used here for two purposes: valuation of BOM import
quantities and determination of quantities and values for those products which
are not tabulated by BOM or at a sufficient level of detail for the purposes of
this study.

The adjustment procedure is time consuming and in many cases, quite difficult
because of the use of Census tabulations in Steps 4 and 5. Further, in Step 2,
data are classified using Schedule P which corresponds to broad groupings of
Schedule B numbers. For example, the Schedule P number 33295 includes eight
Schedule B numbers placing coal, coke and briquets; crude petroleum; petroleum
and coal products, NEC, into one class. (Census From 7525-V, "Shippers Export
Declaration", is used by shippers of merchandise from Puerto Rico to the U.S. but
aggregate Schedule P numbers are used instead of more detailed Schedule B numbers.)
This use of Schedule P numbers is a serious roadblock in developing figures on the

BOM geographic basis and works to mask the flow of detailed data on energy products into the U.S. (50 state basis) when such data are available, for example, from the Virgin Islands to the U.S. Schedule P data are also not verified by Customs officials.

For the purposes of valuation of imports for consumption, c.i.f (costs plus insurance plus freight) plus duty should be used to obtain producers' values required conceptually for the Energy Flow Accounts. However, data did not become available on this basis until 1974 and no adjustment has been made in the accounts to remove the understatement of the value of imports.

Another serious problem is that even after adjustment of the Census data for geographic differences, there may still be differences between Census and BOM quantity figures due to differences in and quality of data sources used. In an unpublished FEA paper by John Phelps, he found that definitional differences, quality of data, timing, etc., did result in BOM/Census differences for various product types. This paper covered the period 1972 and 1973 and the differences in total imports for consumption of the products studied showed that even after the adjustment process was carried out, adjusted Census figures were 4.2 percent higher for 1973, although virtually the same for 1972. Comparisons by products showed wide differences in both years.

As a result of the unavailabilty of c.i.f. data for the 1947-1972 time period and the lack of time, only the aggregate unadjusted Census figures were used for valuation of BOM imports. In those cases where energy products are not compiled or comparable with BOM, quantity and value estimates were compiled using the above procedure, except that for some of these products (benzene, toluene, xylene) Schedule P data are not available at sufficient detailed levels. As a result, imports of these products are understated. Further analysis of import valuation is expected to be carried on for the final report of this study.

SECTION 3

PRODUCERS' PRICES

The matrix of producers' prices derived for this study, while not complete,
covers a very significant part of the universe in question. Many major
products are represented by a complete time series of prices, and almost
all products are at least represented by prices in the benchmark (i.e.,
Census) years. In general, the reliability of the values obtained is very
good. Definitions are clearly stated in the published sources, and it is
believed that these prices are quite reliable in most cases.

Prices for domestically produced products are in general different from
import prices. These two situations are discussed in turn.

DOMESTIC PRICES

Time series' of prices for a large number of products were obtained from
the U.S. Tariff Commission publication Synthetic Organic Chemicals: United
States Production and Sales in the appropriate years. Prices were obtained
from Table 1 of the "Tar and Tar Crudes" chapter for road tar (17733), pitch
of tar (17734), other tar derivatives, n.e.c. (17739), intermediate light
oil (18100), crude light oil (18300), light oil derivatives, n.e.c (18590),
benzene (18910), toluene (18920), and xylene (18930). Prices of normal
butane (10711), isobutane (10712), other butanes, n.e.c. (10713), propane
(10720), ethane (10900), and naphthalene (17732) were obtained from Table
1 of the "Crude Products from Petroleum and Natural Gas for Chemical Conversion"
chapter.

In general, these prices are reported F.O.B. producing plant, although in
certain unidentifiable cases there is suspicion that the prices may represent
delivered values. This latter phenomenon may occur in industries which

characteristically charge in such a manner.

These prices have been recorded directly from the published source in all available years, except for the following special situations:

1) In the case of some products, data are unavailable for a simple isolated year. Where this occurs, an arithmetic average of the years on either side is used to estimate the unknown value. In cases where more than one year is missing, no estimation has been attempted.

2) Where necessary, prices were converted to the proper units needed in the study by means of standard weight and volume conversion factors.

Another large number of producers' prices was obtained through various chapters of the Bureau of Mines, _Minerals Yearbook_ in the appropriate years. Herein, the prices of crude oil, natural gas, coal and coke oven products are considered to be extremely accurate. Refined petroleum product prices, on the other hand, are generally averages of regional prices (obtained from _Platts' Oilgram Price Service_); in addition they are spot prices rather than total averages. Consequently, they are not completely reliable, but still good enough to be recorded.

Products for which prices were obtained are the following: within the chapter entitled "Crude Petroleum and Petroleum Products", crude oil (10002) prices are from the table "Value of Crude Petroleum at Wells in the United States, by State"; motor gasoline (10110), kerosine excluding jet fuel (10300), distillate fuel oil including diesel oil (11100), residual fuel oil (11300), lubricating oil (15711), and waxes (16560) are represented in the table,

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"Average Monthly Price of Petroleum Products in the United States". The
"Natural Gas" chapter contains natural gas (10003) prices in the table "Sa-
lient Statistics of Natural Gas in the United States", while the "Natural Gas
Liquids" chapter contains prices of natural gasoline (13710), plant condensate
(13730) and liquefied petroleum gases (10700) in the table "Comparison of
Natural Gas Liquids Production and Values". The "Coal Bituminous and Lignite"
chapter contains bituminous and lignite (17200) prices in the table "Salient
Statistics of the Bituminous Coal and Lignite Industry in the United States",
while the "Coal--Pennsylvania Anthracite" chapter contains anthracite (17100)
prices in the table "Salient Statistics of the Pennsylvania Anthracite Industry".
The chapter entitled "Coke and Coal Chemicals" contains coke (17510) and
breeze (17520) prices in the table "Statistical Summary of the Coke Industry
in the United States", as well as coke-oven gas (13611), crude tar (17720),
sodium phenolate/carbolate (17731), and ammonia products (18700) prices
in the table "Coal-Chemical Materials, Exclusive of Breeze, Produced at
Oven-Coke Plants in the United States".

These prices are generally taken from the published sources without adjust-
ment. The following idiosyncracies, however, should be noted:

1)   Crude oil and natural gas prices are at the wellhead
     and are deemed reliable.

2)   Prices of motor gasoline, kerosine, distillate oil,
     residual oil, lubricating oil, and wax are all derived
     as arithmetic averages of Oklahoma refinery, New York
     harbor and other relevant regional prices given in the
     tables. Consequently, they cannot be considered totally
     reliable.

3) Natural gasoline prices include isopentane, and liquefied
    petroleum gas prices include ethane. Neither of these
    aberrations create significant discrepancies in the
    data, however, as the quantities of impurity are small
    and their values are similar to the major products in
    both cases.

4) Coke and breeze prices are both obtained by examining
    quantities and values used by producing companies;
    this practice avoids adding in unwanted margins.

The U.S. Census Bureau publication, Census of Manufactures, provided some
additional price data in benchmark years for major products not covered
elsewhere. Table 6-A in the chapter on petroleum refining (Industry 29,
Volume II, Industry Statistics) was found to contain reliable quantity and
value data on total gasoline (10100), aviation gasoline (10120), kerosine
jet fuel (10510), naphthenic jet fuel (10520), kerosine including jet fuel
(10310), total jet fuel (10500), still gas (11500), petroleum coke (11700),
road oil (16550), petrolatum (16520), asphalt (16540), special naphtha (14510),
and unfinished oils (16900). These prices were obtained directly from the
published source without adjustment. They are considered to be very reli-
able.

Additionally, a series of electric energy (00100) prices was obtained from the
Edison Electric Institute publications, Statistical Yearbook of the Electric
Utility Industry, the tables entitled "Energy Sales--Total Electric Utility
Industry" and "Energy Revenues--Total Electric Utility Industry". These
data actually represent purchasers' prices, but margins on electric energy
transmission are virtually negligible; thus they are good approximations of
producer prices as well. These data are of fair to good reliability, primarily
because of EEI's lack of coverage of the entire electric energy market.

Table 3-3 presents the producers' prices compiled for domestically produced
energy products.

TABLE 3-3.—PRICES—DOMESTIC PRODUCTS

Year	Crude Oil 10000 $/BBL	Natural Gas 10003 $/MCF	Bituminous Coal and Lignite 17200 $/Ton	Pennsylvania Anthracite 17100 $/Ton	Electricity 00100 $/KWH	Normal Butane 10711 $/BBL	Iso-Butane 10712 $/BBL	Other Butane 10713 $/BBL	Propane 10720 $/BBL	Ethane 10900 $/BBL	Natural Gasoline 13710 $/BBL	Plant Condensate 13730 $/BBL	Asphalt 16540 $/BBL	Coke Oven Gas 13611 $/MCF	Intermediate Light Oil 18100 $/BBL	Coke 17510 $/Ton	Breeze 17520 $/Ton	Sodium Phenolate or Carbolate 17731 $/BBL	Crude Tar 17720 $/BBL	Ammonia Products 18700 $/Ton	Benzene 18910 $/BBL	Toluene 18920 $/BBL	Xylene 18930 $/BBL	Road Oil 16550 $/BBL	Special Naphthas 14510 $/BBL
1972	3.392	.185997	7.664	12.006	.018	2.046	2.756	3.940	2.130	1.180	3.068	3.39	N.A.	.269124	3.783	27.503	10.591	3.115	4.680	23.583	8.399	7.144	7.147	N.A.	N.A.
1971	3.392	.182070	7.071	11.864	..017	2.250	2.955	3.940	2.130	1.180	2.984	3.37	N.A.	.265188	3.783	29.813	10.805	2.819	4.539	17.938	8.399	7.144	6.723	N.A.	N.A.
1970	3.182	.171003	6.260	10.834	.016	2.046	2.167	3.940	1.953	1.180	2.859	3.18	N.A.	.254118	3.783	27.503	9.746	3.741	4.081	19.947	9.245	7.568	7.147	N.A.	N.A.
1969	3.091	.167076	4.991	9.626	.015	2.250	1.774	3.940	1.776	1.180	2.900	3.10	N.A.	.231978	3.360	19.554	8.137	3.660	4.081	23.375	9.245	7.568	7.560	N.A.	N.A.
1968	2.941	.164101	4.671	8.480	.015	2.250	2.167	3.940	1.776	1.049	2.775	2.99	N.A.	.231978	5.043	17.753	7.343	3.492	4.248	24.830	8.829	7.144	6.300	N.A.	N.A.
1967	2.920	.160055	4.622	7.850	.016	2.250	2.756	4.728	2.309	1.049	2.816	3.16	3.063	.228042	3.360	17.390	8.460	4.246	3.997	31.409	10.090	7.982	7.560	3.456	5.682
1966	2.881	.157080	4.544	7.788	.016	2.455	2.756	4.728	2.130	1.180	2.775	3.19	N.A.	.227058	1.684	17.299	7.277	4.750	4.036	29.955	10.090	7.144	7.560	N.A.	N.A.
1965	2.863	.156009	4.442	8.214	.016	2.455	2.756	4.728	1.598	1.180	2.775	2.98	N.A.	.229026	4.206	16.844	7.563	4.791	4.204	34.561	10.090	7.144	7.812	N.A.	N.A.
1964	2.880	.154105	4.452	8.649	.016	2.455	2.561	4.728	1.598	1.049	2.732	N.A.	N.A.	.227058	4.206	17.753	7.446	4.541	4.332	34.561	9.245	7.144	7.560	N.A.	N.A.
1963	2.893	.159103	4.393	8.400	.016	2.455	2.363	4.728	1.776	1.180	2.732	N.A.	3.313	.226074	4.620	17.553	7.174	4.628	4.500	30.578	9.660	7.144	7.983	2.977	6.005
1962	2.902	.155057	4.481	7.948	.017	2.046	2.363	4.728	1.776	1.049	2.944	N.A.	N.A.	.230994	5.466	18.099	7.710	6.560	5.087	30.128	10.506	7.982	9.243	N.A.	N.A.
1961	2.893	.151011	4.583	8.045	.017	2.455	2.756	4.728	2.130	1.180	2.816	N.A.	N.A.	.233208	6.304	17.772	8.306	7.610	5.338	38.232	13.444	8.405	9.243	N.A.	N.A.
1960	2.881	.140063	4.690	7.823	.017	2.863	3.349	5.510	1.953	1.312	2.944	N.A.	N.A.	.241080	7.142	18.317	8.276	6.687	5.383	34.145	13.028	7.982	8.820	N.A.	N.A.
1959	2.902	.128996	4.773	8.347	.017	2.250	3.742	5.510	2.130	1.049	2.900	N.A.	N.A.	.239112	7.565	17.772	7.490	5.887	5.338	35.877	12.183	8.405	9.243	N.A.	N.A.
1958	3.010	.119000	4.860	8.880	.017	1.840	3.150	5.510	2.130	1.180	2.900	N.A.	3.335	.246000	7.980	18.190	7.350	5.800	5.590	34.630	13.860	8.820	10.080	2.812	6.651
1957	3.091	.113050	5.084	8.995	.017	1.840	2.756	5.510	2.130	1.312	2.859	N.A.	N.A.	.240096	7.565	18.208	6.902	5.759	5.467	29.539	14.705	10.919	11.340	N.A.	N.A.
1956	2.790	.108052	4.821	8.196	.016	2.046	1.969	4.728	1.776	1.312	2.984	N.A.	N.A.	.228042	10.502	17.590	6.196	5.087	5.048	34.284	15.121	10.919	10.927	N.A	N.A.
1955	2.772	.104006	4.500	7.877	.017	2.250	2.756	N.A.	1.776	.787	2.944	N.A.	N.A.	.227058	7.980	16.244	5.535	5.423	4.835	39.444	15.551	11.766	11.340	N.A.	N.A.
1954	2.781	.101031	4.520	8.525	.018	1.840	2.561	N.A.	1.598	.787	3.028	N.A.	2.751	.230010	7.142	15.916	5.454	4.918	4.539	43.080	17.228	12.180	11.340	2.368	5.828
1953	2.682	.092106	4.923	9.670	.018	2.046	3.938	N.A.	1.776	1.312	3.028	N.A.	N.A.	.220170	7.980	14.679	5.270	9.373	4.332	43.218	17.228	12.604	10.927	N.A.	N.A.
1952	2.531	.078064	4.904	9.360	.018	2.455	N.A.	N.A.	1.776	N.A.	2.984	N.A.	N.A.	.213036	7.980	14.461	4.925	10.591	4.204	43.218	15.967	11.766	10.080	N.A.	N.A.
1951	2.531	.073066	4.923	9.510	.018	N.A.	N.A.	N.A.	1.776	N.A.	3.028	N.A.	N.A.	.212052	7.565	14.115	4.594	10.133	4.165	38.578	14.705	12.604	11.340	N.A.	N.A.
1950	2.510	.065093	4.841	8.907	.018	N.A.	N.A.	N.A.	N.A.	N.A.	2.775	N.A.	N.A.	.219186	6.304	13.442	3.866	6.641	3.617	36.327	10.922	10.081	9.667	N.A.	N.A.
1949	2.540	.063070	4.884	8.383	.019	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.222138	N.A.	13.242	4.058	7.233	3.572	45.989	7.983	9.667	9.243	N.A.	N.A.
1948	2.601	.065093	4.991	8.170	.018	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.207132	N.A.	12.406	4.050	6.560	4.371	43.461	7.983	9.667	8.820	N.A.	N.A.
1947	1.932	.060095	4.160	7.219	.018	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.371	.189174	N.A.	10.568	3.491	3.196	3.197	33.730	6.722	7.982	8.820	2.113	3.947

TABLE 3-3 (CONTINUED)

	Other Tar Derivatives	Crude Light Oil	Light Oil Derivatives n.e.c.	Road Tar	Pitch of Tar	Naphthalene	Gasoline (Motor)	Kerosene (ex. Jet Fuel)	Kerosene (in. Jet Fuel)	Distillate (inc. Diesel)	Residual	Lubricating Oils	Petroleum Waxes	Gasoline (Aviation)	Total Gasoline	Kerosinic Jet Fuel	Napthenic Jet Fuel	Total Jet Fuel	Liquefied Petroleum Gases	Still Gas	Petroleum Coke	Petroleum	Unfinished Oils
	17739 $/BBL	18300 $/BBL	18590 $/BBL	17733 $/BBL	17734 $/Ton	17732 $/Ton	10110 $/BBL	10300 $/BBL	10310 $/BBL	11100 $/BBL	11300 $/BBL	15711 $/BBL	16560 $/S. Ton	10120 $/BBL	10100 $/BBL	10510 $/BBL	10520 $/BBL	10500 $/BBL	10700 $/BBL	11500 $/MCF	11700 $/S. Ton	16520 $/BBL	16500 $/BBL
1972	11.347	4.627	N.A.	7.560	48.268	100.080	5.382	4.830	N.A.	4.701	3.351	9.919	122.094	N.A.	N.A.	N.A.	N.A.	N.A.	1.91	N.A.	N A.	N.A	N.A.
1971	10.922	3.780	N.A.	7.560	46.672	80.040	5.424	4.830	N.A.	4.742	3.560	9.919	122.094	N.A.	N.A.	N.A.	N.A.	N.A.	1.84	N.A.	N.A.	N.A.	N.A.
1970	10.081	5.043	N.A.	5.882	35.945	80.040	5.299	4.788	N.A.	4.534	2.992	9.831	122.094	N.A.	N.A.	N.A.	N.A.	N.A.	1.68	N.A.	N.A.	N.A.	N.A.
1969	9.665	5.043	N.A.	5.466	31.688	100.080	5.127	4.662	N.A.	4.461	2.271	9.831	122 094	N.A.	N.A.	N.A.	N.A.	N.A.	1.32	N.A.	N.A.	N.A.	N.A.
1968	9.240	5.043	N.A.	5.043	33.653	100.080	5.299	4.704	N.A.	4.489	2.492	9.959	122.094	N.A.	N.A.	N.A.	N.A.	N.A.	1.57	N.A.	N.A.	N.A.	N.A.
1967	9.240	5.882	7.560	5.882	36.314	80.040	5.210	4.578	4.030	4.408	2.492	9.831	122.094	5.857	5.236	3.939	4.093	3.999	1.93	N.A.	N.A.	12.333	3.475
1966	8.824	5.882	3.780	5.882	36.928	80.040	5.168	4.410	N.A.	4.155	2.461	10.717	122.094	N.A.	N.A.	N A.	N.A.	N.A.	1.81	N.A.	N.A.	N.A.	N.A.
1965	6.302	5.882	3.780	6.297	36.437	80.040	5.127	4.326	N.A.	4.029	2.420	10.087	122.094	N.A.	N.A.	N.A.	N.A.	N.A.	1.55	N.A.	N.A.	N.A.	N.A.
1964	8.399	5.043	4.627	5.882	39.057	60.000	4.877	4.284	N.A.	3.989	2.442	9.744	122.094	N.A.	N.A.	N.A.	N.A.	N.A.	1.51	N.A.	N.A.	N.A.	N.A.
1963	7.983	4.627	4.627	6.297	37.255	60.000	5.127	4.662	3.869	4.196	2.380	9.744	122.094	5.390	4.885	3.752	3.850	3.806	1.47	.360433	10.682	12.638	3.202
1962	8.824	5.466	5.882	6.721	38.033	100.080	5.299	5.586	N.A.	4.241	2.380	9.576	122.094	N.A.	N.A.	N.A.	N.A.	N.A.	1.60	N.A.	N.A.	N.A.	N.A.
1961	8.824	7.560	7.560	7.144	37.951	120.000	5.382	5.460	N.A.	4.282	2.480	9.456	122.094	N.A.	N.A.	N.A.	N.A.	N.A.	1.72	N.A.	N.A.	N.A.	N.A.
1960	8.824	7.560	7.560	7.144	37.255	100.080	5.252	5.292	N.A.	3.944	2.430	9.121	124.110	N.A.	N.A.	N.A.	N.A.	N.A.	1.93	N.A.	N.A.	N.A.	N.A.
1959	8.824	6.305	7.560	7.560	42.414	100.080	5.085	5.334	N.A.	4.155	2.451	7.980	126.000	N.A.	N.A.	N.A.	N.A.	N.A.	1.85	N.A.	N.A.	N.A.	N.A.
1958	9.240	7.560	7.560	7.560	40.940	120.000	5.210	5.250	4.015	4.070	2.380	7.980	126.000	6.446	5.208	N.A.	3.878	N.A.	1.84	.277632	11.308	11.609	3.879
1957	8.399	8.823	8.407	7.560	40.408	120.000	5.168	5.586	N.A.	4.575	2.942	8.866	126.000	N.A.	N.A.	N.A.	N.A.	N.A.	1.66	N.A.	N.A.	N.A.	N.A.
1956	7.143	8.823	7.983	7.560	37.296	120.000	4.918	5.376	N.A.	4.322	2.711	8.028	120.078	N.A.	N.A.	N.A.	N.A.	N.A.	1.72	N.A.	N.A.	N.A.	N.A.
1955	7.143	8.823	8.830	6.721	35.577	120.000	4.668	5.166	N.A.	4.115	2.361	6.472	109.998	N.A.	N.A.	N.A.	N.A.	N.A.	1.37	N.A.	N.A.	N.A.	N.A.
1954	7.983	9.662	8.830	6.297	34.799	100.080	4.621	5.082	3.938	3.903	2.030	6.384	106.092	7.055	5.068	N.A	4.080	N.A.	1.44	.265776	7.675	9.697	3.295
1953	8.824	10.085	13.026	6.721	33.530	100.080	4.621	4.998	N.A.	3.903	1.921	7.812	92.106	N.A.	N.A.	N.A.	N.A.	N.A.	1.71	N.A.	N.A.	N.A.	N.A.
1952	11.347	8.407	10.924	6.297	30.910	120.000	4.455	4.914	N.A.	3.822	2.311	9.408	84.042	N.A.	N.A.	N.A.	N.A.	N.A.	1.59	N.A.	N.A.	N.A.	N.A.
1951	10.081	7.893	8.823	6.297	31.524	120.000	4.455	4.956	N.A.	3.822	2.542	9.791	118.062	N.A.	N.A.	N.A.	N.A.	N.A.	1.60	N.A.	N.A.	N.A.	N.A.
1950	8.824	5.882	7.144	5.882	28.904	100.080	4.330	4.704	N.A.	3.525	2.221	7.270	84.042	N.A.	N.A.	N.A.	N.A.	N.A.	1.35	N.A.	N.A.	N.A.	N.A.
1949	9.240	4.627	7.560	5.466	28.494	120.000	4.288	4.620	N.A.	3.443	1.892	6.767	98.028	N.A.	N.A.	N.A.	N.A.	N.A.	1.71	N.A.	N A.	N.A.	N.A.
1948	6.302	4.627	7.560	5.882	27.635	120.000	4.710	5.082	N.A.	4.070	3.082	11.930	160.020	N.A.	N.A.	N.A.	N.A.	N.A.	2.24	N.A.	N.A.	N.A.	N.A.
1947	5.886	3.780	8.573	4.203	21.166	74.040	3.532	3.990	2.997	2.939	2.361	11.052	152.082	4.804	3.709	N.A.	N.A.	N.A.	1.48	N.A.	7.686	7.346	2.372

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IMPORT PRICES

Prices of a large number of imported products have already been generated
by making use of the U.S. Census Bureau's foreign trade division publication
United States Imports of Merchandise for Consumption (FT 246--was FT 110
until 1964) in the appropriate years. Prices for more products are herein
available as well, but have not as yet been generated due to time constraints.
They will be generated for the final report, however.

These import price series are considered generally reliable. One problem
to be noted, however, is that the Census Bureau's definition of the United
States includes Puerto Rico while the Bureau of Mines' definition does not;
thus these price data are not exactly comparable to the Bureau of Mines
import quantities being collected for the Sources Account. The discrepancies,
however, are minimal. (See part of previous section entitled "Comparability
of Bureau of Mines and Bureau of Census Import Data".)

Table 3-4 presents import prices.

TABLE 3-4.-PRICES--IMPORTS

	Other Light Oil Derivatives, NEC	Benzene	Xylene	Toluene	Pitch of Tar	Crude Tar	Other Tar Derivatives, NEC	Grease	Crude Tar and Pitch	Electricity
	18590 $/BBL	18910 $/BBL	18930 $/BBL	18920 $/BBL	17734 $/Ton	17720 $/BBL	17739 $/BBL	15712 $/BBL	17721 $/BB1	00100 $/KWH
1972	38.72	7.56	7.98	5.88	38.00	4.73	9.90	156.25	N.A.	0.0059
1971	32.89	7.56	6.30	5.04	20.20	4.39	8.88	98.84	N.A.	0.0045
1970	31.55	8.82	5.88	5.46	29.80	4.39	8.28	83.05	N.A.	0.0048
1969	107.34	8.82	6.72	5.88	28.40	4.59	7.97	99.78	N.A.	0.0026
1968	21.19	8.82	8.40	6.30	26.40	3.71	8.20	98.48	N.A.	0.0021
1967	120.73	10.08	9.24	7.14	69.40	3.67	7.93	64.61	N.A.	0.0021
1966	60.48	10.50	13.86	5.88	37.20	3.89	11.98	58.38	N.A.	0.0018
1965	00.00	10.92	17.22	6.30	37.00	3.95	7.89	66.87	N.A.	0.0021
1964	36.40	12.18	24.78	6.72	36.20	3.40	8.12	75.41	N.A.	0.0016
1963	87.72	11.34	15.54	6.72	14.80	3.58	8.15	N.A.	N.A.	0.0035
1962	115.92	8.82	10.08	6.72	N.A.	N.A.	8.22	N.A.	3.31	0.0033
1961	130.74	11.76	9.24	7.98	N.A.	N.A.	8.33	N.A.	5.11	0.0032
1960	135.17	10.08	9.24	7.98	N.A.	N.A.	8.48	N.A.	4.54	0.0030
1959	143.67	10.08	10.08	8.40	N.A.	N.A.	7.81	N.A.	5.69	0.0033
1958	157.84	10.08	12.60	12.60	N.A.	N.A.	7.87	N.A.	3.43	0.0035
1957	105.17	10.92	00.00	9.66	N.A.	N.A.	8.01	N.A.	4.35	0.0037
1956	171.51	10.92	00.00	00.00	N.A.	N.A.	7.23	N.A.	5.11	0.0035
1955	49.08	9.24	00.00	12.60	N.A.	N.A.	7.68	N.A.	5.33	0.0028
1954	168.18	13.44	00.00	00.00	N.A.	N.A.	7.99	N.A.	4.53	0.0031
1953	193.08	15.12	00.00	13.86	N.A.	N.A.	7.71	N.A.	4.42	0.0037
1952	472.83	14.70	00.00	12.18	N.A.	N.A.	6.98	N.A.	4.16	0.0037
1951	334.03	15.54	00.00	14.70	N.A.	N.A.	6.91	N.A.	3.89	0.0036
1950	207.52	11.76	00.00	00.00	N.A.	N.A.	6.46	N.A.	9.05	0.0032
1949	265.83	9.24	00.00	00.00	N.A.	N.A.	6.91	N.A.	8.72	0.0031
1948	193.23	7.98	00.00	10.50	N.A.	N.A.	7.15	N.A.	8.55	0.0028
1947	130.43	6.30	00.00	00.00	N.A.	N.A.	7.04	N.A.	3.64	0.0027

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CHAPTER 4

ENERGY USES ACCOUNT

The Uses Account measures the sectoral and functional uses of major energy products including exports and storage and distribution losses. Losses in energy conversion processes are tabulated in the Energy Balance Account.

This chapter provides detailed descriptions of the methods employed to develop the data in the Uses Account. Unlike the Sources Account, where a large body of relatively consistent historical data are available for domestic production and imports, data measuring sectoral and functional uses of energy are fragmented over the 1947-1972 period. Significant bodies of cross-sectional data are available for the Census of Manufactures, "Fuel and Electric Energy Consumed for Heat and Power," benchmark years—1947, 1954, 1958, 1962, 1967 and 1971, as well as reliable data measuring consuming for many non-manufacturing sectors for scattered years. Many of the estimates of consumption were developed by interpolating between data for benchmark years. In other instances consumption estimates were generated from reliable control totals and the application of output or employment indexes. Where employment indexes were used, it was assumed that the functional use of the energy product was for space conditioning and lighting.

Tables 1A and 1B of the Appendix present totals for apparent consumption of each energy product. Apparent consumption is the result of deducting measures of exports, material inputs to conversion processes, inventory additions, and storage and distribution losses from total new supply, which is the sum of domestic production and imports. Apparent consumption is developed from data with high measures of quality, therefore the results are controls against which the sum of the detailed consumption data for each energy product may be compared.

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Table 3 of the Appendix presents the Uses Account data in physical units and purchasers' value where available. Functional uses of energy are detailed under each consuming sector with the sum of the energy uses next to the sector title.

SECTION 1

MANUFACTURING SECTORS

Data on energy consumption in manufacturing are more comprehensive and detailed than for any other major sector of the economy. Even so, there are major deficiencies in the time-series available and in the detail for a number of energy products. The data are relatively complete for six years: 1947, 1954, 1958, 1962, 1967, and 1971. For these six years, data in both quantity and delivered value of the principal fuels consumed were collected and published generally for SIC four-digit industry detail. In the other years, detail by type of fuel was not collected; in these years only the total value of fuels and the quantity and value of electric energy were collected.

Totals on fuel consumption in manufacturing are given for each of the six years listed above in Table 4-1. The data are also converted to BTUs, summed over all fuels, and related to total value added, expressed in constant dollars. The coefficients, so calculated, show how overall energy consumption has changed per unit of net output. The improvement in the coefficients over time has occurred in spite of greater mechanization and intensity in energy use. Therefore, the gain in efficiency in the use of energy is understated by these measures. They are probably further understated by shifts in production toward higher energy intensive industries. A detailed analysis of the data in sector detail would be necessary in order to ascribe the changes to the three elements: efficiency, energy substitution, and production shifts.

The manufacturing sectors include those industries in SICs 19-39 and I-O 2-digit codes 13-64 (the modified I-O classification used in this study includes 64 manufacturing sectors).

TABLE 4-1.--ENERGY CONSUMED FOR HEAT AND POWER, MANUFACTURING

(BTUs in Trillions)[1]

	1947 Quantity	BTU	1954 Quantity	BTU	1958 Quantity	BTU	1962 Quantity	BTU	1967 Quantity	BTU	1971 Quantity	BTU
Coal (Thous. of Tons)									75100	1832	61393	1455
Purchased	110869	2705	91457	2250	81784	2036	89438	2200				
Coal, Coke & Breeze (Thous. of Tons)												
Purchased	19258e	471	15833e	388	13585	333	17747	435	13562	333		
Produced & Consumed	46913e	1147	38539	944	36221	887	38194	936	47542	1166		
Petroleum Coke (Thous. of bbls.)												
Produced & Consumed												
Fuel Oil (Mil. of bbls.)												
Purchased	167	1019	187	1127	166	996	196	1168	179	1064		
Produced & Consumed	49	299	49	295	43	258	35	209	42	250		
Gas[2] (Bil. of Cubic Feet)												
Purchased	3669	3678	5814	5829	3059	3067	4234	4245	5233	5246		
Produced & Consumed	724e	707	800	519	1291	879	1385	954	1480	1049		
Electric Energy (Mil. of KWH)												
Purchased	102822	351	187148	639	252909	863	313961	1071	427465	1459	517780	1767
Produced & Consumed	38125	(130)	60639	(207)	66850	(228)	74261	(253)	78356	(267)	82750	(282)
Total BTU (Trillion)		10377		11991		9319		11218		12399		
Value Added (Bil. of 1958 dol.)	91.8		119.5		123.7		154.6		205.4		223.1	
Thous. of BTU/dol. V.A.		113.0		100.3		75.3		72.6		60.4		

[1] *See Appendix, Table A-4 for BTU conversion factors other than gas. See footnote 2 for gas.*

[2] *Includes natural manufactured coke-oven and still gas, but excludes blast furnace gas.*

[3] *Due to inclusion of still gas, modified BTU conversion factors were used as follows (BTUs per cubic foot): 1947--977.1; 1954--648.5; 1958--680.7; 1962--688.6; 1967--678.1; 1971--708.9.*

[4] *Not included in total BTUs to avoid double counting.*

e *Represents estimate from worksheets prepared for this study.*

Source: Bureau of the Census, Census of Manufactures, "Fuels and Electric Energy Consumed," special report series where available.

Data available from Census may differ slightly from data developed in this study due to estimates made at the sector levels.

The primary source of detailed consumption data is the Census of Manufactures, with detailed fuels data collected for the years 1947, 1954, 1958, 1962, 1967, and 1971. (In 1962 and 1971 the fuels data were collected in conjunction with the Annual Survey of Manufactures rather than in the complete censuses for 1963 and 1972, respectively.) Consumption data were collected for the following fuels in these years, and generally published for SIC four-digit industry detail (disclosure occasionally prevented publication and coverage was not always complete for industries consuming little fuel):

> Fuel oil (quantity and cost)--separate data on residual and
>   distillate oil beginning with the 1967 census.
> Coal (quantity and cost)--bituminous and anthracite combined.
> Coke and breeze (quantity and cost)--coal coke and petroleum
>   coke combined.
> Gas (quantity and cost)--all types combined (natural, manu-
>   factured, mixed, coke-oven, blast furnace, and still)
>   except in 1947 when separate data were given for manu-
>   factured, natural, and mixed.
> Electric energy (quantity and cost).
> Fuels not specified by kind (cost)--consisting largely of
>   data from small plants not required to give detailed
>   data.
> Other fuels (cost)--includes LPG, gasoline for non-highway
>   use, wood, and miscellaneous fuels.

The above detail is given for purchased fuels only. Fuels produced and consumed are important in the steel industry (coke, coke-oven gas, and blast furnace gas) and in the petroleum refining industry (fuel oil, still gas, and petroleum coke).

In addition, a considerable quantity of electric energy is generated and used in the heavy industries (some of this energy is sold to other industries and a small amount is sold to utilities). The treatment of fuels and energy produced and consumed in the same establishment and the data problems associated with it are discussed under a separate heading below. At this point, it should be noted that in principle this energy is added to purchased energy and included in the energy inputs in the accounting system, except in cases where it would result in double counting of the energy inputs. No double counting results if the industry is treated as an energy conversion process and the basic energy inputs recorded as raw materials rather than as energy.

Energy inputs treated as raw materials to manufacturing conversion processes (coal into coke-ovens and crude petroleum and selected petroleum products into petroleum refining are also reported by the Census but separately from the fuels data. These data are discussed elsewhere in this report under the sections on the conversion processes.

Fuels consumption for the intervening years between the complete censuses are collected in the Annual Survey of Manufactures (available for all years except 1948 and 1949). However, the information is limited to total cost of purchased fuels and quantity and cost of electric energy. These data were only collected for two-digit industries prior to 1958 and for three-digit industries after 1958.

Estimates of the fuel detail (quantities only) were developed for the intervening years via an interpolation procedure as follows. Preliminary consumption estimates were made for each fuel for each input-output sector by indexing forward the data for each benchmark year (1947, 1954, 1958, 1962, 1967, 1971) by the production index for that sector. These estimates obtained by indexing were extended to overlap the next benchmark year; the ratio of the actual reported figure in the next benchmark year to the estimate was then calculated to be used as a bias adjustment factor in the esti-

mates in the intervening years. The bias factor was time-phased so as to be
a cumulative precentage adjustment each year, yielding the actual reported
figure in the next benchmark year. The terminal year, 1972, was estimated
simply based on the production index change from 1971 since there was no
forward benchmark year on which to base a bias factor.

The above procedure was applied to estimate all energy inputs except electric
energy. No attempt was made to price out the quantity estimates so obtained
and to reconcile the total with the total value of purchased fuels reported;
the procedure would have involved scaling the individual values (and quantities)
across the fuel types to accord with the total reported, a very nebulous pro-
cedure at best with no assurance of improvement in the estimates for individual
fuels.

In the case of electric energy, however, totals were provided in the Census for
both quantity and value at the two-digit SIC level in earlier years (to 1957)
and at the three-digit SIC level after 1958 (1958 is a full Census [benchmark]
year for which four-digit detail was given for electric energy as well as for
the individual fuels). These data were used to adjust the interpolation for
electric energy—since the three-digit data (available for the later years)
define I-0 sectors in most cases they could be used in lieu of the interpolation
for these cases.

The data have been coded for quality following the general procedures given
in the Introduction. In general, the data for the six benchmark years are
of high quality and the intervening years of lower quality; the data for
electric energy is of generally high quality for all years since 1957.

ENERGY PRODUCED AND CONSUMED IN COKE-OVENS

Coke-ovens are treated as an energy conversion sector in the accounting
system. The basic input is coal together with processing fuels. The output

is coke, coke-oven gas, and coal chemicals. The convention in the energy
accounting system is to account for all processing fuels whether produced
and consumed or purchased (the coal input for coke is identified by a dis-
tinguishing functional use code to avoid double counting of energy inputs).

Much of the output of coke and coke-oven gas is used in the same establishment
(steel mills) and is not reported as purchased fuels by the Census. Census re-
ports totals for fuels produced and consumed but not by individual industries.
Data on both coke and coke-oven gas used in steel mills and in coke-oven gas
recycled to coke ovens for fuels was reported in the Minerals Yearbook, and
this source was used. This source was also used to develop estimates in other
processing fuels used in coke ovens.

BLAST FURNACE GAS

Blast furnace gas is produced and used almost completely within the steel
industry and has not been identified as a separate product flow in the energy
accounts.

ENERGY PRODUCTS PRODUCED AND CONSUMED IN PETROLEUM REFINERIES

Still gas, petroleum coke, fuel oils, and LPG, produced in petroleum refineries,
are also used as fuels in the same plants. Data on the total consumption of
these fuels consumed in petroleum refineries (whether purchased or produced
and consumed) were obtained from the Minerals Industry Surveys and the Minerals
Yearbook and were substituted for the Census figures which reported purchased
fuels only. In the case of gas, Census combined data for purchased natural gas
with other purchased gas (mainly still gas) and it was necessary to use a sep-
arate series from the Minerals Yearbook representing natural gas only.

The data on still gas and fuels oils were not complete for the years before
1961 and were estimated based on incomplete data. The data on LPG were not

available before 1955 and were also estimated prior to that year. The quality
of data codes denote the poorer quality of the data for the earlier years.

ELECTRIC ENERGY PRODUCED AND CONSUMED

A considerable amount of electric energy is produced and consumed in the
manufacturing industries. A relatively small amount of this energy is sold
to other plants and to electric utilities. The generation is mainly con-
centrated in a few industries as shown in Table 4-2.

This energy is generated using fossil fuels already accounted for in the energy
use accounts. Since the amounts of fossil fuels used to generate electric
energy are not reported separately, it is not feasible to treat the electric
energy generation as a conversion process. Therefore, the electric energy
so generated is not treated as a separate energy flow in the use accounts to
avoid duplication. However, the amount of electric energy produced and
consumed is identified by sector and given a special functional use code to
distinguish it from purchased electric energy. (The data did not permit. for
identifying the total generated by sector, but sales to others are relatively
small.)

Total electric energy generated and used, and totals including sales for the
years available, are shown by year in Table 4-3 along with totals for purchased
electric energy.

NOTES ON DATA COVERAGE AND PROBLEMS IN
EACH CENSUS YEAR

Generally, fuel and electric energy consumption data for the six benchmark
years were obtained by the Census Bureau through standard form questionnaires
sent to the larger establishments comprising at least 90 percent of the total
fuel consumed. Short forms were sent to the small firms, employing one or
more persons, requesting total fuel information rather than individual fuel
figures. Some field visits were made to complete instances of "insufficient

TABLE 4-2.–ELECTRIC ENERGY PRODUCED AND CONSUMED IN MANUFACTURING INDUSTRIES

(Millions of KWH)

SIC Code	Industry	1947	1954	1958	1962	1967	1971
281	Industrial Chemicals	3046	7103	12913	14613	17735	15839
2621	Papermills, Except Paperboard			9187	10844	11770	12513
2631	Paperboard Mills	9018^a	12471^a	5660	6970	9508	10385
2611	Pulp Mills			1191	1892^e	1606	2315
331	Blast Furnaces & Basic Steel Prdts.	7463	9695	10794	11881	9771	12292
3334	Primary Aluminum	1052^e	7998	8968	9616^e	11648	10976^e
2911	Petroleum Refining	2369	1557	3800	3999^e	4088	5413
282	Plastics Materials & Synthetics	3980	6824	2478	2709	3155	3243
206	Sugar	406	510	541	810	935	1239
204	Grain Mill Products	137	85	924	864	920	835
242	Sawmills & Planing Mills	648	859	828	794	295	630
3241	Cement, Hydraulic	1760	2084	1893	4391	923	607
	Other Manufacturing Industries	8246	11453	7673	4878	6002	6463
	Total	38125	60639	66850	74261	78356	82750

Source: Bureau of the Census, _Census of Manufactures_, "Fuels and Electric Energy Consumed," Special Report Series where available.

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^{a}Due to SIC re-classification, papermills and paperboard mills were not reported separately prior to 1958.

^{e}Represents estimate from worksheets prepared for this report.

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TABLE 4-3.—ELECTRIC ENERGY USE IN MANUFACTURING

1947-72

(Millions KWH)

	Purchased	Generated Less Sales	Sales	Total Generated	Total Used (sum of cols. 1&2)
1972					
1971	517780	82750			600530
1970	508142	81418			589560
1969	488336	83352			571688
1968	458908	82752			541660
1967	427465	78356			505821
1966	402291	82047			484338
1965	373428	80453			453881
1964	357292	79740			437032
1963	333512	72949			406461
1962	313961	74261	7895	82156	388222
1961	298325	68533			366858
1960	291949	70016			361965
1959	281301	69291			350592
1958	252909	66850	8655	75505	319759
1957	259414	66031			325445
1956	257126	66208			323334
1955	233702	65559			299261
1954	187027	60639	9044	69683	247787
1953				64469	216898
1952	155965			56106	
1951	146531			55395	
1950	131222			52478	
1949	No data collected				
1948	No data collected				
1947	102822	38125	5811	43936	140947

Sources: Bureau of the Census, *Census of Manufactures* and *Annual Survey of Manufactures*, various years.

data" where the lack was significant. Based on previous surveys, together with information from other agencies, Census estimated total employment for all indistries and inflated their sample data to the estimated total at the establishment level to correct any undercoverage errors.

According to Census policy, information was withheld either due to failure of meeting publication standards or due to disclosure of identity problems. Lack of individual fuels data for some I-O sectors presented problems with both 1958 and 1967 benchmark years because detailed fuel information was not required where the fuel consumed was less than $5,000 as well as with the short forms used for the small firms. Estimates for these census years were developed with the basic interpolation method described earlier before any interpolations were made for the intervening years. Costs were estimated by applying a unit cost for each fuel of a related SIC group for the estimated year to the proper estimated quantities. Where isolated fuels data were lacking, estimates were made at the SIC level through a residual method either where the bulk of the information was given or where an SIC figure comprised two industries, one of which was very small, in which case the figure for the small industry was interpolated and subtracted from the given SIC total.

1947 BENCHMARK YEAR

In the 1947 Census survey, data covered over 98 percent of the total manufacturing industry employment, excluding sawmills. Small establishments representing approximately 1.5 percent of the total employment of the manufacturing industries reported on short forms but were excluded from the 1947 tabulations. These exclusions were noted in the Census of Manufactures tables and represented omissions ranging from 3 to 39 percent of an industry at the four-digit SIC level, affecting most of the major industry groups to some extent. However, the majority of cases fell under 5 percent. Compensating estimates were made to include these data for each of the fuel categories of the indicated industries by multiplying each item with the midpoint of each designated percentage range, e.g., 4.5 percent was used as the midpoint for the 3 to 6 percent range. Estimates were also made for logging camps and logging contractors which were excluded in 1947.

Separate information was given for bituminous and anthracite coal which were combined so as to be comparable with other benchmark periods. Natural, manufactured, and mixed gas were also reported separately, but were combined on supplementary worksheets to yield total gas consumed.

1954 BENCHMARK YEAR

A concentrated effort was made by Census to improve the data coverage of 1947 which resulted in information representing over 98 percent of the total employment in the manufacturing sector, including sawmills.

Individual fuels data in 1954, as well as for 1958, were not available for two of the manufacturing industries, i.e., Apparel and Related Products, SIC 23, and Printing and Publishing, SIC 37, total cost of purchased fuels was obtainable. For both of these industries, separate data for each fuel was estimated by using the quantities for 1947 and 1962, a 15-year span to interpolate the intervening base years of 1954 and 1958. Costs for these quantities were estimated based on unit costs of related industries. These derived costs were summed and compared with the total cost of purchased fuels at the SIC level. Adjustments were made by allocating the dollar difference to the Other Fuels category for 1954 or to Fuels Not Specified by Kind for 1958.

1958 BENCHMARK YEAR

Approximately 92 percent of the detailed fuel data were covered in the 1958 survey due to the exclusion of industries which were comprised of less than 5,000 establishments and whose total fuel costs were less than $250,000. Detailed fuel information was not required where the fuel consumed was under $5,000. A new fuel category, Fuels Not Specified by Kind, was added in 1958 to account for the cost of estimated fuels consumed by the excluded small establishments and accounted for approximately 12 percent of the total cost of purchased fuels in manufacturing. This category was deleted after these

costs (and implied quantities) were distributed by a scaling factor to each
fuel quantity and cost at the I-O level, before any intervening year interpo-
lations were made, so that the sum of the adjusted individual fuel costs equalled
the given total cost of purchased fuels. Due to a major industry classification
change in 1958, I-O components for 1947 and 1954 were re-defined to be comparable
with each industry sector of 1958.

1962 BENCHMARK YEAR

The 1962 fuel data, collected by Census in a special survey in order to better
distribute the workload of the Census Bureau and the establishments contacted,
were included with the 1963 Census. All the large establishments having 100
or more employees were included in the sample, whereas the smaller firms were
included on the basis of a sampling-by-size ratio. Approximately 60,000
establishments were included in the sample which showed about a one-sixth in-
crease over the previous Census report. To reduce the sampling error, an
additional 1,000 establishments covering fourteen heavy fuel consuming indus-
tries were included in a supplemental survey. No allocation was made for
Fuels Not Specified by Kind in the 1962 Census report. Since the smaller
firms covered in the sample were requested to provide individual fuel data,
more complete information was given at the SIC level for each fuel.

1967 BENCHMARK YEAR

For 1967 data were obtained through mail questionnaires sent to the larger
establishments, but small firms employing less than ten employees were ex-
cluded. For these firms, estimates were derived by Census using industry
averages based on Social Security Administration and Internal Revenue Service
records. Less than 3 percent of total manufacturing industries were affected.

As experience with 1958 data, a major problem encountered with this period
was the absence of individual fuel information for approximately one-fourth
of the aggregated I-O sectors because only total cost of purchased fuels was

required where the fuels consumed was less than $5,000, as well as with the short survey form. Estimates were derived as mentioned for 1958.

Although in previous surveys, individual data for distillate and residual fuel oils were not reported, this detail was available at the four-digit SIC level beginning with 1967.

1971 BENCHMARK YEAR

As in 1962, the Fuels and Electric Energy Consumed Special Report covered data representing the year previous to the regular Census survey to reduce the workload of the Census Bureau by including the fuels portion with the Annual Survey of Manufactures. Large establishments having 250 or more employees were included in this sample, whereas previously a distinction was made at the 100 employee level. Smaller firms were selected on a size-measure basis determined by such factors as value added, value of shipments and employment. Detailed fuels consumed data were requested from all establishments covered by the Annual Survey of Manufactures which probably resulted in more complete individual fuel data at the SIC industry level.

Although in previous studies, figures for gas included natural gas as well as other types, 1971 data represent only natural gas which comprises the major portion of total gas.

In 1971 the Fuels Not Specified by Kind category, as occurred in 1958 and 1967, represented not only the aggregated cost of fuels for the smaller establishments, but also an adjustment to correct any imbalances due to any estimating, statistical, or reporting procedures encountered in the survey. However, for 1971, unlike 1958 and 1967, no problem was encountered due to lack of individual fuel data.

SECTION 2

MINING SECTORS

The mining sectors cover the extraction of naturally occurring minerals, both solids and fluids and/or the quarrying, milling, and other preparation and beneficiating needed to render the material marketable. Also included are the exploration and development of mineral properties.

The mineral sectors are classified in this study as shown below. The principal departure from the conventional I-O classification is the separation of the crude petroleum and natural gas industry into three separate components, the separation of coal between anthracite and bituminous and lignite, the separate identification of uranium-radium-vanadium ores, and the separate identification of oil and gas well drilling, the last of which is treated as part of construction activity.

MINING SECTORS

I-O Code		SIC Code
05000	Iron and Ferroalloy Ores	1011, 106
06010	Uranium-Radium-Vanadium Ores	1094
06020	Nonferrous Metal Ores (excluding 601)	102-105, 108, pt. 109
07010	Anthracite Coal Mining	11
07020	Bituminous and Lignite Coal Mining	12
08010	Crude Petroleum	pt. 1311
08020	Natural Gas	pt. 1311
08030	Natural Gas Liquids	1321
09000	Stone and Clay Mining and Quarrying	141, 142, 144, 145, 148, 149
10000	Chemical and Fertilizer Mineral Mining	147
11010	Oil and Gas Well Drilling	pt. 138

Comprehensive data on energy consumption in the mining sector are reported in the Census of Mineral Industries which, unfortunately, is currently available for most sectors for only four years (1954, 1958, 1963, and 1967). 1972 data have been released to date only for part of I-O 05000, iron ore, 07010, anthracite mining, and 08030, natural gas liquids.

The coverage of energy products is fairly complete, including data on quantity and value of purchases of the following products:

    Fuel Oil (Distillate and Residual combined)
    Coal (Anthracite, Bituminous, and Lignite combined)
    Gasoline (For both Highway and Off-highway use)
    Gas (Natural, Manufactured, and Mixed combined)
    Electric Energy
    Other Fuels (Cost)
    Fuels Not Specified by Kind (Cost)

Although data were available only for the selective years as described above, estimates were made for the intervening years using the same interpolating procedures as described for the manufacturing sector. Briefly, the procedure involved extending the data reported for the so-called benchmark years to intervening years proportionate to change in production in the industry, adjusted for trend bias.

The quality of the data are generally good for the census years except for small cells which may have been estimated. The estimates for the intervening years are believed to be fairly good to poor and less reliable than the manufacturing sector data where more benchmark years were available. The quality codes in each cell denote the varying quality of the data.

The census reports data separately for fuels produced and consumed in the same establishment, and these quantities are added to purchased fuels. These fuels are important in the coal industry and in the crude petroleum and natural

gas industries. Electric energy produced and consumed is relatively minor in the mineral industries but has been identified with a special functional-use code to avoid double counting in the energy inputs. Problems in identifying the figures for fuels produced and consumed in the same establishment are discussed below.

COAL PRODUCED AND CONSUMED

The quantity figures given for each industry, anthracite and bituminous and lignite, were of high quality but did not specify the type of coal within the latter; and, thus, the opportunity costs assigned were based on an aggregated figure and reflect cost data of dubious quality.

CRUDE PETROLEUM AND NATURAL GAS PRODUCED AND CONSUMED

Figures for these two fuels were obtained for the crude petroleum industry, the natural gas industry, and the oil well drilling industry. However, the latter two industries' figures for crude petroleum were so small relative to purchased fuels, they were considered insignificant and therefore excluded. In addition, figures for natural gas produced and consumed were obtained for the natural gas liquids industry.

ELECTRIC ENERGY PRODUCED AND CONSUMED

Generally, these data were recorded for all industries, but, except for the heavy extraction industries (i.e., iron ores), was of little significance relative to purchased.

NOTES ON DATA COVERAGE AND PROBLEMS IN EACH CENSUS YEAR

Data were obtained in the same method as described in the manufacturing section and only problems specific to this study will be elaborated here.

1954 BENCHMARK YEAR

. One minor problem area relative to other census years was the different SIC codes used for the oil and gas extraction industries; the census data aggregated the crude petroleum and natural gas industries in this year. The fuel oils data were not separated between distillate and residual fuel oils.

1958 BENCHMARK YEAR

Census data for coal purchased for the oil and gas extraction industries was included within the "Other Fuels" category, as was purchased gasoline. Fuel oil data were not separated between distillate and residual.

1963 BENCHMARK YEAR

The 1963 benchmark year is considered the most complete and accurate of the benchmark years.

1967 BENCHMARK YEAR

On a general scale, 1967 census data were the most troublesome due to the non-aggregated, four-digit SIC level and the resultant higher-than-average occurrance of census omissions.

1972 BENCHMARK YEAR

The partial data available caused no special problems.

SECTION 3

TRANSPORTATION FUELS

In this section estimates of fuel use for transportation are described. Conceptually, transportation is herein treated as a functional use rather than a consuming sector, in that fuel has been allocated across all sectors based on relevant transportation modes within each sector.

For example, the major transportation mode in the U.S. is and has been highway transportation. Wthin this broad mode, highway fuels have been allocated across all consuming sectors based on their individual uses of cars and trucks.

In addition, the strict commercial transportation sectors (such as railroads or for-hire trucking) have been treated; and both highway and specialized transportation fuels have been allocated to them. Only in the case of the railroad sector--where the ICC provides complete data--have total fuel estimates (including non-transportation uses) been made.

Within the broad area of highway fuels, estimates of gasoline, diesel fuel and liquefied petroleum gases (LPG) across all consuming sectors are described. These allocations were accomplished based on data on use by vehicle type.

The aviation fuel estimates are described next. These include aviation gasoline and jet fuel. While their use is mainly confined to the commercial aviation sector, some small general aviation fuel quantities are more broadly allocated.

Next follows a description of the specialized mode sectors. All railroad fuels are allocated to the railroad sector. These include diesel fuel, residual oil, coal, electricity and gasoline. Marine fuel is allocated mainly to the water transportation sector, although some gasoline will go to personal consumption and some diesel fuel to commercial fishing. Finally the pipeline sector fuel estimates are made. These include electricity, natural gas and diesel oil used only as pipeline fuel.

The allocation of lubrication materials to specific transportation uses is treated separately in a final section. Herein are developed technological relationships between fuel and lubrication in the specific modal areas of transportation.

HIGHWAY FUELS

Control totals were developed for the three major fuels used in highway transportation --gasoline, diesel fuel, and LPG. These are presented in Table 4-4. All figures here were taken from Highway Statistics volumes. (The data are considered very strong, as they are developed from tax records and are as close as possible to actual highway fuel consumption.) Total on-highway fuel is found in Table MF-23. Highway gasoline use is found for each year by subtraction. In addition, Table VM-1 of the same publication makes estimates of the amount of total fuel going to each of different vehicle types (autos, commercial buses, school and non-revenue buses, trucks) and these figures are used to distribute fuels to the consuming sectors.

The only estimations necessary were in the special fuels category:

   A. Some states are not estimated as recently as 1960 and
       the national totals are, to a greater or lesser degree,
       incomplete for 1947-60. Using Table MF-25 in Highway Statistics,
       Summary to 1965, these states were identified, their
       consumption growth rates were determined for 4 or 5 years
       and this rate was used to trend back. This was deemed
       the quickest, easiest way to inflate FHWA's data where
       they were incomplete and the addition is only 1-5% in
       most years.

   B. For 1947 and 1948 no special fuels use was reported and
       thus the adjusted figures from 1949-54 were examined
       to determine a growth rate over those years. This derived
       growth rate was then used to trend the data back to 1947.

TABLE 4-4.-HIGHWAY FUEL CONTROL TOTALS
(Millions of Gallons)

YEAR	GASOLINE	DIESEL FUEL	LIQUEFIED PETROLEUM GASES
1947	27916.2	280.5	19.0
1948	30101.2	341.8	17.7
1949	31999.5	416.7	14.8
1950	35113.9	514.3	24.7
1951	37419.0	654.3	55.1
1952	39747.3	766.8	70.5
1953	41791.5	845.7	94.6
1954	43318.5	943.0	103.9
1955	46526.2	1080.5	123.9
1956	48804.1	1260.2	150.0
1957	50552.9	1467.9	168.2
1958	51552.9	1657.7	207.9
1959	54100.7	2029.1	202.0
1960	55427.1	2237.0	216.8
1961	56607.7	2494.3	204.2
1962	58746.4	2748.5	202.2
1963	61275.0	3024.7	216.8
1964	64268.6	3375.8	256.4
1965	66978.5	3902.6	223.3
1966	69931.6	4514.2	177.2
1967	72640.3	4808.1	244.2
1968	77253.9	5403.8	286.1
1969	81791.1	6031.9	299.3
1970	85596.5	6325.5	406.1
1971	89977.3	7139.6	430.3
1972	96542.7	8049.1	470.3

The Diesel/LPG disaggregation was determined in the following way: LPG sales for internal combustion use were reported in Bureau of Mines, Mineral Industry Surveys, Sales of Liquefied Petroleum Gases and Ethane, Table 1, for each of the years. Then unpublished National Liquefied Petroleum Gas Association data on carburetor sales by use (trucks, bus, auto, and all other non-highway by type) were used to determine what percentage went to on-highway uses. These figures were then subtracted from total special fuels data to arrive at diesel consumption.

Automobiles

Estimates were made of the distribution of total automobile fuel to the complete range of consuming sectors. All automobile fuel was assumed to be gasoline. No diesel fuel or LPG was allocated.

The control on total automobile fuel is a firm figure, coming directly from Table VM-1 of Highway Statistics volumes. However, the distributions to the various sectors are considerably less so.

The major disaggregations to business, personal and government sectors are derived using updated BEA auto stock estimates. While better than any other technique, these can only be considered approximate as almost no firm information is available anywhere on this problem. These broad controls are presented in Table 4-5.

Furthermore, the detailed distribution within the business category is done by means of Census of Population data on occupation by industry. This appears only three times (1950, 1960 and 1970) throughout the range of the study and the results must otherwise be interpolated.

Detailed Distribution

The control total in this area comes from Highway Statistics (Table VM-1) and all fuel used was assumed to be gasoline. The first step was to destribute this on-highway gasoline total for autos to its three basic sectors-- business, personal, and government. This was done using BEA auto stock

TABLE 4-5.-AUTOMOBILE GASOLINE DISTRIBUTION
(Millions of Gallons)

| YEAR | TOTAL USE | BUSINESS USE | PERSONAL USE | GOVERNMENT USE | |
				Federal	State/Local
1947	20195	6014	14127	11	43
1948	21492	6253	15183	10	46
1949	22993	6306	16627	10	50
1950	24355	6547	17748	9	51
1951	26206	6817	19324	10	55
1952	27970	7133	20766	10	61
1953	29716	7470	22169	10	67
1954	31069	7799	23186	10	74
1955	33652	8404	25152	11	85
1956	35434	8503	26817	12	102
1957	36769	8613	28024	13	119
1958	38095	9085	28863	15	132
1959	40056	8710	31183	16	147
1960	41169	9056	31927	19	167
1961	42033	8549	33272	21	191
1962	43771	9287	34255	23	206
1963	45246	9490	35486	28	242
1964	47567	9352	37936	29	250
1965	50275	10144	39839	30	262,
1966	53312	10541	42476	32	263
1967	55110	10549	44270	33	258
1968	58524	11102	47133	31	258
1969	62448	11719	50434	33	262
1970	65784	12796	52682	34	272
1971	69514	13367	55828	34	285
1972	73643	14148	58979	36	300

figures (acquired from T. Petska). These figures are said to accommodate all potential problems (such as partial business use of personal autos and partial personal use of business autos) and are the first steps in the latest revised approach to the problem being undertaken by BEA. They are therefore considered to be the most up-to-date method to use in the estimation but still far from perfect because some tenuous assumptions had to have been made in deciding what percentage of each mixed-use vehicle to allocate to business and personal. The government estimates are much less tenuous.

Then average vehicle miles per year (VM/year) figures were determined--for business no information was available so two times the average Highway Statistics estimate was used, and for government the General Services Administration, Annual Motor Vehicle Report estimates on federal VM/year were used to approximate a figure for each year--and total vehicle miles for business and government were figured. Personal vehicle miles were determined as a residual, the control being again from Highway Statistics (VM-1) (adjusted to count motorcycle vehicle miles as 1/5 of their stated value, thus effectively converting all vehicle miles to auto vehicle miles).

Miles per gallon (MPG) estimates were then obtained for business and government in the following way: Government MPG were taken equal to total MPG as derived from Highway Statistics (adjusted again to be consistent in treatment of motorcycle VM's) and Business MPG were taken to be 10% better than total MPG in 1947 through 1959 and then trended down to be 5% better by 1972. These arbitrary percentages were chosen because it was assumed that business would keep newer, better tuned cars and drive a greater percentage of long-distance highway miles. However, business would also use larger cars tending to reverse the effect of the first two factors. In early years (before compact cars around 1960) the larger car argument would be less viable, hence it was decided to allow business to be 10% more efficient in early years due to the first two factors, but to lessen that efficiency gradually as compact cars became more and more of a factor.

Once these MPG estimates were derived, fuel use was determined for business and government, and personal fuel use was derived as a residual, the control being from Table VM-1 again.

Out of total business fuel use, an estimate for taxi fuel use was derived
in the following way: estimates on the number of cabs and also cab vehicle
miles for 1947-61 were obtained from Auto Facts and Figures, Motor Vehicle
Manufacturers Association (these data were originally from estimates made
by the Cab Research Bureau). From these, VM/year figures were derived.
However, these figures represented only cabs in fleets, and thus they had
to be expanded (and projected through the later years) by estimates made
from the Bobbit Publishing Company (publishers of Auto Fleet) and also by
FHWA. In addition, the VM/year estimates were reduced by 20% to account
for the addition of non-fleet cabs which are driven less (given that they
are generally driven by only one person). The MPG figures for taxis were
obtained by deflating the total MPG data for all autos (from Highway Statistics
again) by 10% to allow for a greater percentage of stop-and-go driving.

Thus, the component parts of taxi fuel were derived and the fuel itself
was thus figured and subtracted from total business auto fuel. The residual
was distributed among all sectors in the following way: using the Census
of Population volume entitled "Occupation by Industry", a weighted distribution
of the major employment categories relevant to auto travel (such as sales,
professional, managerial, etc.) was derived using information gleaned from
the Nationwide Personal Transportation Study (Volume 10, FHWA, 1974 and 72),
"Motor-Vehicle Use Studies in Six States", and Public Roads (28-5, December
1954) p. 99. The Census of Population appears in 1950, 1960 and 1970, and
thus the distribution of percentages were derived for these benchmark years
to the maximum disaggregation level possible. Where it was necessary to
have greater detail (as determined by the general taxonomic scheme for consuming
sectors governing the entire project) the disaggregations were made on the
basis of standard total output and total employment figures developed for
general use throughout the project.   .

The control totals for the benchmark years were then distributed across
the sectors, and finally an interpolation scheme was derived whereby the
intervening years were filled in based on output series within each sector.
These results, coupled with the taxicab fuel estimates (added into the appropriate
sector) and the government and personal fuel estimates, constituted the
complete distribution of auto fuel across all sectors.

Highway fuel used by buses is treated here, and it is ultimately distributed to four major consuming sectors, whose use of buses is significant. They are:

1) Local, Suburban and Interurban Highway Passenger
   Transportation -- Sector 65020

2) Medical, Eucational Services and Non-Profit
   Organizations (private school buses) -- Sector 77000

3) State and Local Government Purchases (mainly
   public school buses) -- Sector 98000

4) Federal Government Purchases -- Sector 97000

The major fuels distributed are gasoline, diesel fuel and LPG.

In general, the estimates made in the commercial bus area should be considered stronger than those in the school and non-revenue bus area, because the commercial bus data are firm and little estimation is done. The raw data comes from Highway Statistics and the American Transit Association, Transit Fact Book, both of which are accurate data sources.

In regard to school and non-revenue buses, however, only the Highway Statistics control total is firm. The estimating technique is necessarily based on tenuous assumption, because no data other than what was used are available.

Detailed Distribution

In this area two categories are present and are treated separately. They are 1) commercial buses and 2) school and non-revenue buses. The control totals (on total fuel and on VM's) again come directly from Highway Statistics, Table VM-1, and are reproduced in Table 4-6.

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TABLE 4-6.-DISTRIBUTION OF BUS AND TRANSIT COMPANY FUELS

(Liquid Fuels in Millions of Gallons;
Electricity in Millions of KWHs)

Year	Local, Suburban & Inter-Urban Highway Passenger Transportation Sector -- 65020					Medical, Education Services & Non-Profit Organizations -- Sector 77000		State/Local Government -- Sectors 98000 and 79000		Federal Government Sectors -- 97000 and 78000
	Diesel Fuel	Gasoline	Liquefied Petroleum Gases	Electricity		Gasoline	Diesel	Gasoline	Diesel	Gasoline
				Generated	Purchased					
1947	136.1	583.1	.8	2093	4654	15.2	0.1	41.9	0.1	0.4
1948	151.2	564.7	1.5	2113	4083	15.8	0.1	46.0	0.1	1.1
1949	165.5	539.6	2.9	2123	3396	14.9	0.1	48.1	0.1	0.9
1950	162.6	494.3	5.4	2070	3181	15.7	0.1	52.9	0.1	0.9
1951	182.0	478.2	10.3	1870	2956	17.4	0.1	61.2	0.1	1.0
1952	198.9	447.4	18.7	1770	2589	20.7	0.2	78.8	0.2	1.2
1953	223.7	428.6	20.3	1590	2470	20.1	0.2	77.0	0.2	1.0
1954	233.4	389.9	26.8	1510	2140	20.9	0.2	82.5	0.2	0.9
1955	314.4	318.4	30.3	1480	1980	22.8	0.2	83.9	0.2	0.8
1956	363.0	294.4	30.3	1450	1790	27.9	0.2	85.2	0.2	0.8
1957	364.4	263.1	34.2	1440	1600	39.1	0.3	122.5	0.3	1.0
1958	370.5	233.5	35.1	1484	1609	39.8	0.3	128.5	0.3	1.1
1959	387.9	218.7	36.6	837	2125	41.9	0.3	136.4	0.3	1.0
1960	401.4	201.3	38.3	--	2908	42.7	0.4	142.0	0.3	1.0
1961	426.4	171.8	35.7	--	2851	45.0	0.4	149.4	0.3	1.0
1962	447.3	151.0	36.1	--	2768	46.0	0.4	154.9	0.3	1.0
1963	450.6	144.1	35.9	--	2642	46.3	0.4	159.2	0.4	1.0
1964	475.1	139.2	33.4	--	2597	48.5	0.4	165.9	0.4	1.0
1965	502.7	136.1	32.7	--	2584	50.0	0.4	170.5	0.4	1.2
1966	510.5	120.4	33.6	--	2467	51.8	0.4	177.5	0.4	1.4
1967	538.6	102.2	33.0	--	2531	52.4	0.4	181.4	0.4	1.6
1968	560.3	93.6	32.2	--	2586	58.6	0.5	184.9	0.4	1.5
1969	569.5	89.1	31.6	--	2618	62.6	0.5	192.0	0.4	1.4
1970	561.5	87.2	31.0	--	2561	67.3	0.6	194.5	0.4	1.5
1971	561.6	83.0	26.5	--	2556	75.5	0.6	197.8	0.4	1.7
1972	501.6	75.1	24.4	--	2428	75.6	0.6	201.6	0.4	1.8

For commercial buses the universe is divided into local (transit) and inter-city buses. The transit bus fuel data (including electricity consumed) comes directly from the Transit Fact Book, American Transit Association, (Table 14 [1958], Table 12 [1965], Table 16 [1972-1973]). (Note: the method for determining electricity consumption is to be found in the railroad electric energy section), and the data for each of the four fuels (gasoline, diesel, LPG and electricity) were extended where necessary by using growth rate extrapolation. The residual figures (between the FHWA and American Transit Association data) were assumed to represent total intercity fuel, and they were allocated between gasoline and diesel (none was allocated to LPG due to the generally agreed upon fact that intercity buses must be able to refuel anywhere and LPG is not universally available) based on conversations with authorities at National Association of Motor Bus Owners..

The School and Non-Revenue bus area was handled in the following way: From Highway Statistics, Table VM-10, data on the number of buses by major non-revenue categories (private shool, federal, state/local school) were obtained. These classifications are subject to considerable error because they are vaguely defined, and FHWA has no real basis other than tax data for determining the distribution, but they represent the best method available. The private school category is further broken down into for-hire school (allocated to commercial transit) and school-owned school (allocated to educational services) based on vehicle miles data taken from the supplemental report of the 1965 Highway Cost Allocation Study, Department of Commerce, Table 13. The study only covers one year and is, in effect, used to distribute data for all 26 years of the study, admittedly an inaccurate practice. But it is the only information available. Furthermore, the distribution within each of these categories between gasoline and diesel (again no LPG is allocated) is obtained from the small table, so these data are also questionable.

The fuel control totals in the school and non-revenue bus area were then distributed to the appropriate sectors based on a combination of the bus stock data in the Highway Cost Allocation Study vehicle mile data. These estimates were then combined with the commercial bus estimates and assigned to the appropriate sectors..

Trucks

As in the treatment of automobile fuel, estimates were herein made of the
distribution of total truck fuel to the complete range of consuming sectors.
Gasoline, diesel fuel and LPG were allocated separately.

The estimation of control totals for the truck use of each fuel was done in
the following way: a firm series of total truck fuel data was obtained from
the standard source, Highway Statistics, Table VM-1. Since no diesel and LPG
was allocated to automobiles, it was all assumed to be used by trucks and buses.
Thus, for diesel and LPG figures, the bus estimates (see previous section, "Buses")
were subtracted from the total highway estimates of these two fuels (see section
entitled "Highway Fuels") to yield truck use estimates as residuals. Then the
sum of these figures was subtracted from the total fuel figures in Table VM-1
to yield gasoline use estimates. These three derived series were then allocated
to consuming sectors.

The quality of these controls is considered good as they are derived from Highway
Statistics data and from the bus fuel estimates. The only large weakness is in the
school and non-revenue bus area, and these data are a very small part of the total.
The data appear in Table 4-7.

Detailed Distribution

The distribution of truck fuels to consuming sectors began with the controls
on the use of fuels (gasoline, diesel and LPG), the development of which
is described above. In summary the procedures used are as follows:

- Distributions of vehicle miles for nine major use classes
  (groups of sectors) by size class and fuel type of truck
  were made for three years for which special data were
  available (1972, 1963 and 1947).

- Factors of fuel consumption (miles per gallon) were
  developed and used to convert the distributions of vehicle
  miles to distributions of fuel use.

TABLE 4-7.-HIGHWAY TRUCK FUEL USE -- CONTROL TOTALS

(Millions of Gallons)

YEAR	DIESEL FUEL	GASOLINE	LIQUEFIED PETROLEUM GASES
1947	144.2	7080.6	18.2
1948	190.4	7981.6	16.2
1949	251.0	8403.1	11.9
1950	351.5	10195.2	19.3
1951	472.1	10654.1	44.8
1952	567.5	11229.7	51.8
1953	621.6	11549.1	74.3
1954	709.2	11754.7	77.1
1955	765.7	12448.7	93.6
1956	896.8	12961.5	119.7
1957	1102.9	13034.1	134.0
1958	1286.6	13054.6	172.8
1959	1640.6	13647.0	165.4
1960	1834.9	13871.7	175.4
1961	2067.2	14207.3	168.5
1962	2300.5	14622.4	166.1
1963	2573.3	15677.8	180.9
1964	2899.9	16347.1	223.0
1965	3399.1	16345.3	190.6
1966	4002.9	16268.5	143.6
1967	4268.7	17193.1	211.2
1968	4842.6	18385.5	253.9
1969	5461.5	18997.8	267.7
1970	5763.0	19461.9	375.1
1971	6577.0	20105.2	403.8
1972	7546.5	22725.6	445.9

●   The fuel use distributions were extended to the full
    sector detail for these three years by distributions
    within the major uses using occupational or output distributions.

●   Detailed distributions for all other years were made
    by interpolation using factors of output change and
    trends in the intensity of fuel use per unit of output.

Details on the sources and procedures are provided below.

The first step in the allocation of truck fuels to consuming sectors was
to complete a distribution of truck vehicle miles (by size class of truck
and fuel use) to 10 principal uses for 1972, 1963 and 1947. These years
were chosen because special sources of information were available for these
years. For 1972 and 1963 the Truck Inventory and Use Surveys of the Censuses
of Transportation provided most of the information required to make these
distributions. In 1947 vehicle miles by major use and size class were
previously estimated by Jack Faucett Associates using data from a variety
of sources. The most detail was available for 1972. For 1963 and 1947
the use class distribution of diesel was assumed to be exceptionally concen-
trated in for-hire trucking. Fortunately the total use of LPG and diesel are
much less important than in the later years when better data are available.
The major use classes consist of groups of sectors. They are Agriculture,
Personal, For-Hire, Construction, Manufacturing, Wholesale/Retail, Services,
Forestry and Lumber, Mining and Government. The size class data were used
to help achieve a more accurate translation of vehicle miles to fuel use
since miles per gallon factors are substantially different for different
size classes of trucks.

In the second step the distributions of vehicle miles were changed to distri-
butions of gallons using fuel conversion factors of miles per gallon. The miles
per gallon factors were derived from sources such as reports of the Highway
Cost Allocation Study and worksheet estimates of the Federal Highway Adminis-
tration. In summary these factors of miles per gallon are as follows.

	Gasoline and LPG	Diesel
Pickup	12	13
Light	10	8
Medium	8	7
Light heavy	6	6.5
Heavy-heavy	5	5.5

The fuels allocated to the 10 major sectors for the three years were then distributed to individual sectors using either distributions of employment or output. The output distributions were used for the construction and agriculture sectors while the employment data were used for all other major uses. The sources of the employment distributions were the 1970, 1960 and 1950 Census of Population volumes detailing occupation by industry. The occupations used were those of truck drivers and delivery men and route men and these were updated or backdated to 1972, 1963 and 1947 using relative output changes.

The detailed distributions for all other years were then made by means of a computer program which interpolated between the estimates. The interpolation took into account both the trends in changes in the ratio of fuel use per unit of output and the output changes of the various sectors. Following these adjustments the truck fuel uses across all sectors were then scaled to the controls for each of the three fuel types for each of the years.

AVIATION FUELS

In this area data were developed on aviation gasoline and jet fuel consumption in the commerical and general aviation sectors. The commercial fuel consumption data are obtained from the Civil Aeronautics Board publication Handbook of Airline Statistics. It has been manipulated somewhat but is still basically sound and can generally be relied upon.

On the other hand, the general aviation estimates for aviation gasoline are based on data reported by the Bureau of Mines in <u>Mineral Industry Surveys</u>, <u>Annual Petroleum Statement</u>, the table entitled "Shipments of Aviation Fuels", and are trended back to 1947 based on an index of Federal Aviation Administration (FAA) estimates; while the jet fuel estimates are taken directly from the FAA series. The FAA figures are considered generally inaccurate because they are based initially on FAA survey data on miles flown. These surveys were conducted only periodically and it is felt that their coverage was far from complete. Furthermore, some tenuous assumptions about average miles per aircraft and average fuel consumption per aircraft compounded the problems.

The FAA jet fuel data are slightly better than the aviation gasoline data, however, because of the fact that jet fuel users in the general aviation area--more than likely being commercial and business rather than personal-- users probably keep better records and respond more accurately to surveys. Furthermore, the Bureau of Mines jet fuel data are suspect because of the fact that Bureau of Mines monitors refinery sales to small fixed-base distributors and calls it general aviation use. However, commercial airlines very often will buy from these same distributors in small airports. Since commercial aviation use of jet fuel is so great, this phenomenon can create large errors in jet fuel use figures. Thus the FAA series was chosen.

<center>Commercial Aviation--Sector 65050</center>

The basic data here come from the Civil Aeronautics Board, <u>Handbook of Airline Statistics</u>, (Table 58 and Table 59, Part II). For both aviation gasoline and jet fuel the procedures are the same, except that the aviation gasoline data are reported back only to 1951 and had to be estimated for the first four years. Data were collected on fuel consumption by 1) Domestic Certificated and 2) International Certificated U.S. Air Carriers, and the estimation procedures for extending aviation gasoline data back to 1947 were as follows: for the several earliest years in which fuel consumption was reported (1951-1955) a ratio was developed which represented (Total available ton-miles [Part II, Table 2]/Thousand gallons of aviation gasoline) in each

<center>85</center>

of the two data categories. The ratio was then extended back to 1947 using growth rate methods. Finally, the ratios were applied to available ton-mile figures reported for the two categories for each of the years 1947-1950, and aviation gasoline consumption figures were thus derived.

This estimation procedure having been carried out, the complete time-series was adjusted in the following ways:

A)   The international figures were multiplied in each year by a factor representing (Total departures by U.S. International Certificated Carriers in 50 states/Total departures by U.S. International Certificated Carriers throughout the world), which were taken from Part III, Table 3 of <u>Airport Activity Statistics of the Certificated Route Air Carriers</u>, Civil Aeronautics Board (CAB) and FAA. From 1962 on back and in 169 and 1970 the series was extended with data from FAA <u>Handbook of Airline Statistics</u> (Table 8.5 and Table 9.4) representing (after adjustments) the same two variables.

These data originally came from "Air Commerce Traffic Patterns" the forerunner of the <u>Airport Activity Statistics</u>. The jumps in the series (at 1960 and 1970) are due to definitional changes. In 1960 for the first time Alaska and Hawaii are considered in the 50-state departures, so the ratio goes up. In 1970 for the first time, flights between Alaska and Hawaii and the mainland are all transferred to the domestic carrier group and thus international departures as a whole will shrink and the ratio goes back down. Once this series representing fuel consumed by U.S. International Certificated Carriers loaded in the 50 states only, was derived, two things were done with it:

B)   It was multiplied by a ratio representing (Foreign International Certificated and Supplemental enplanements in U.S. Stations/U.S. International Certificated enplanements in U.S. Stations) which was obtained (1973-1965) from the <u>Aviation Costs Allocation Study</u> W.P. #5, (DOT), Table 24, p. 81. This series was extended back using balance of payments data from <u>Balance of Payments Statistical</u>

Supplement (Revised), Survey of Current Business, 1963, p.141
on value of air travel to and from the U.S. for 1950, 1952, 1954,
1956, 1958 and 1960. It shows the foreign air carriers starting
off very slowly but capturing a significant portion of the market
as time goes on, which is verified in Strasheim's study, The In-
ternational Airline Industry, (Brookings, 1969) pp. 11-12.

This series then represents fuel loaded on foreign Certificated
and Supplemental carriers in the 50 states. Added to the re-
sults of A), it gives total fuel loaded on International Certi-
ficated carriers in the 50 states.

C)   Thus were developed total consumption data by both International
and Domestic Certificated carriers. Then an available ton-mile
ratio was taken (for Domestic and International separately) of
(Supplemental/Certificated) from Handbook of Airline Statistics,
Part II, Table 2 to determine how much additional fuel the supple-
mental carriers used. This series started in 1953 but was exten-
ded back to 1947 based on its relationship to revenue ton-miles
data in each of the early years. Thus the available ton-miles
were derived from the revenue ton-miles (based on averaging
ratios) and the ratios were extended back.

This method was duplicated, in total, from the Jack Faucett Associates study
Energy Consumption by Transportation Mode (May 1973) and the only new work
was done in extending the ratios needed for each year of the study. After
all the adjustments were made on the data, the following derived figures
were aggregated for each year: 1) Domestic Certificated loaded in U.S.,
2) Domestic Supplemental loaded in U.S., 3) International Certificated
(U.S.) loaded in U.S., 4) International Certificated and Supplemental (For-
eign) loaded in U.S., and 5) International Supplemental (U.S.) loaded in U.S.
The results are presented in Table 4-8.

TABLE 4-8.-COMMERCIAL AVIATION FUEL USE -- SECTOR 65050

(Millions of Gallons)

YEAR	JET FUEL	AVIATION GASOLINE
1947	--	336.4
1948	--	394.8
1949	--	441.2
1950	--	504.4
1951	--	591.2
1952	--	694.3
1953	--	796.8
1954	--	894.6
1955	1.9	1050.2
1956	34.9	1168.9
1957	82.7	1357.7
1958	94.3	1397.7
1959	447.5	1349.4
1960	1207.0	1111.9
1961	1863.4	905.3
1962	2546.2	709.6
1963	2971.5	638.9
1964	3445.7	582.6
1965	4224.9	511.0
1966	5131.8	384.9
1967	6824.7	259.6
1968	8455.7	134.4
1969	9605.7	32.5
1970	9248.3	14.5
1971	9202.5	12.4
1972	9299.4	12.7

General Avation

Two different data series were available in this area: FAA general aviation
fuel estimates from the Statistical Handbook of Aviation, Table 5.7, (all
years): and Bureau of Mines, Mineral industry surveys, Annual Petroleum
Statements, Table entitled "Shipments of Aviation Fuels", (all years back to
1964). The details involved in choosing among these series and the procedures
followed in completing the estimations are described at the beginning of
this section (see: "Aviation Fuels").

The final series used for general aviation fuel consumption appear as Table
4-9.

Detailed Distribution

The controls on the use of aviation gasoline and jet fuel by general aviation
were allocated across the individual sectors using the procedures outlined
below:

- Distributions of plane hours for principal use classes
  were made for 6 selected years.

- The distributions of hours were changed to distributions
  of fuel consumed using factors of gallons per hour.

- A detailed distribution to sectors was made for 1964
  using data from several sources.

- Detailed distributions for the other 5 selected years
  were made using the controls by principal use, the complete
  distribution for 1964 and relative output changes of
  the individual sectors.

- The detailed distributions for all other years were found
  by extrapolation or interpolation.

TABLE 4-9.-GENERAL AVIATION FUEL USE -- CONTROL TOTALS

(Millions of Gallons)

YEAR	AVIATION GASOLINE	JET FUEL
1947	168.2	--
1948	192.6	--
1949	141.5	--
1950	140.8	--
1951	141.6	--
1952	148.0	--
1953	181.4	--
1954	189.7	--
1955	204.0	--
1956	212.7	--
1957	225.5	--
1958	221.0	--
1959	236.2	--
1960	266.6	--
1961	267.2	18.8
1962	258.6	19.7
1963	268.3	31.5
1964	289.4	41.4
1965	304.1	55.8
1966	326.9	83.2
1967	376.9	99.8
1968	361.1	115.5
1969	380.1	167.6
1970	362.3	207.6
1971	396.8	225.5
1972	404.5	244.7

Details of these steps are described below.

The procedure of distributing the general aviation fuels to sectors was begun by obtaining distributions of plane hours for seven principal use classes for six selected years, 1947, 1954, 1957, 1961, 1964 and 1970. (The data are not available for all years). The use classes are personal, air taxi, aerial application, instructional special, business and other. The detail included four or more size classes for the aviation gas-powered planes. The data were gathered from several Federal Aviation Administration (FAA) studies and one by the Civil Aeronautics Administration (1947).

These distributions of hours flown were translated into estimates of fuel consumed using estimates of gallons per hour for 1970 which were obtained from an unpublished FAA source. Four or more size classes of aviation gas-powered planes were used to help achieve a more accurate translation of hours to fuel using the gallons per hour factors. These preliminary estimates were then scaled to the control totals for general avaition fuel in these years.

The detailed distribution to sectors was achieved for 1964 based mostly on data assembled by Jack Faucett Associates in earlier work for the U.S. Department of Transportation. The basic assignments are

- personal use assigned to Personal Consumption Expenditures (96600)

- air taxi assigned to Air Transportation (65050)

- aerial application assigned to Agricultural Services (04000)

- instruction assigned to Educational Services (77000)

Industrial special--distributions were largely based
on the SIC distributions of business flying activities
in a survey report prepared by the Tri-State Transportation
Commission

Using this complete distribution as a guide the distributions to sectors
for other years for which controls were available by use class (1970, 1961,
1957, 1954 and 1947) were made first by adjusting the 1964 distributions
based on output change and then by scaling to the individual controls.

The detailed distributions for the other years were made by extrapolation
or interpolation using a computer program that took account of the changes
in sector outputs and the trends in the fuel to output ratios. The program
scaled the results to the controls on fuel use.

RAILROAD FUELS--SECTOR 65010

The data developed represent total fuel use in the railroad sector. The
data are considered to be extremely firm because they are obtained almost
exclusively from ICC surveys with only minor coverage adjustments. The ICC
clearly has the best insight into accurate data on railroads, as a result
of its regulatory functions.

The fuels covered in this section are 1) distillate oil (including diesel),
2) residual (fuel) oil, 3) coal, 4) gasoline and 5) electricity. These
data represent use of these fuels for all purposes, not just transportation
and motive power uses. However, in general, nothing is known about what
is used for which purposes, except insofar as locomotive fuel is reported
separately in the diesel, residual oil and coal categories. The results
are presented in Table 4-10.

TABLE 4-10.-RAILROAD FUEL USE (including TRANSPORTATION and NON-TRANSPORTATION USES) -- SECTOR 65010

YEAR	GASOLINE (Millions of Gallons)	ELECTRICITY (Millions of KWHs)	DISTILLATE FUEL, including DIESEL (Millions of Gallons)	COAL (Thous. of Tons)	FUEL OIL, RESIDUAL (Millions of Gallons)
1947	45.0	2032	815.4	114511.7	4263.9
1948	46.7	2270	1188.8	101425.5	3786.2
1949	45.4	2410	1548.6	72821.6	2895.9
1950	42.5	2414	1996.1	65302.2	2608.9
1951	44.6	2539	2404.2	57412.5	2427.9
1952	44.1	2531	2850.2	40810.3	1801.4
1953	46.4	2284	3182.0	30101.0	1269.1
1954	43.7	2368	3337.3	17997.2	726.2
1955	43.9	2378	3592.8	16391.4	646.1
1956	46.3	2462	3786.5	13500.4	466.3
1957	46.7	2399	3807.9	9039.6	297.5
1958	43.3	2087	3638.3	4404.6	247.9
1959	43.1	1816	3745.0	3127.4	243.6
1960	45.1	1600	3739.4	2560.7	236.6
1961	42.9	1577	3644.0	2174.0	224.0
1962	43.9	1700	3710.6	1883.2	232.2
1963	43.0	1787	3813.8	1594.2	221.9
1964	46.3	1890	3894.9	1588.0	228.1
1965	48.2	1835	4044.4	1491.8	170.6
1966	50.6	1825	4232.1	1514.0	161.7
1967	50.0	1768	4184.7	1377.6	234.2
1968	50.3	1721	4204.7	1173.3	183.1
1969	50.4	1677	4202.1	994.1	144.1
1970	48.8	1842	4071.8	866.7	94.7
1971	49.0	1751	4124.4	634.7	53.8
1972	52.2	1793	4386.0	429.2	48.5

Diesel Fuel and Distillate Oil

The basic data were derived from ICC, Transport Statistics. Two series were taken directly from the source: 1) a series representing total diesel use from Table 70, and 2) a series representing diesel use only in rail vehicles from Table 72. Both series represent use by class I line-hauls only, and the total use series (Table 70) runs only from 1947 to 1963.

Table 14 gives total locomotives, by motive power type, for both Class I and all other railroads. Ratios were derived of total number of locomotives to Class I locomotives within each motive power type to derive inflators for each year. Those for diesel locomotives were then multiplied by the data of Table 72 to give adjusted diesel consumption for locomotives, then added to the unadjusted non-locomotives diesel (as it was felt non-locomotive diesel consumption in Class II railroads was too small to consider) to give adjusted figures for total diesel. This figure represents also distillate used for heat, etc., but it cannot be broken out from non-locomotive diesel consumption.

In order to extend the non-locomotives diesel series (and by inference, the total diesel series) out past 1963, the following was done: the growth rate in the number of highway tractors (from Table 36, ICC) was examined over 3-year intervals from 1947 to 1971. This growth rate was felt to parallel closely enough the trend of the non-locomotives diesel series so that it could roughly be used to extend the series. The results appear to be reasonable in that the 1963-1970 period exhibits a decline, but in 1971 the consumption shoots up again. 1971 was just around the time of the growth in piggyback freight in the railroad sector.

Residual (Fuel) Oil

The basic data here were obtained again from ICC. Both tables were used (Table 70 and Table 72) but in the source it is called fuel oil. It was determined that this represented residual oil only by careful comparison with Bureau of Mines data (Mineral Industry Surveys, Sales of Fuel Oil and Kerosine representing explicitly residual oil consumed by railraods.

It was again necessary to inflate the locomotives only use figures to total industry, so Table 14 was used to develop inflators. In early years, all residual oil was used in steam locomotives, so the steam locomotive inflators were used. In 1957 however, for the first time a significant percentage of total residual oil was used in gas turbine locomotives, so the inflator was adjusted in each succeeding year to give increasing weight (based on breakdown of residual oil use between steam and gas turbine) to the gas turbine locomotive ratio. Finally in 1960 it was all burned in gas turbine locomotives, and the steam data were phased out. In 1967 the gas turbine locomotive data stopped, so the inflators which had been effectively 1.0000 since 1960 were extended as 1.0000.

The same procedure as for diesel fuel was followed to arrive at total residual oil used. The inflated locomotive residual oil numbers were added to the non-inflated non-locomotive numbers. The series was extended beyond 1963 by indexing it on a Bureau of Mines series from Mineral Industry Surveys, Sales of Fuel Oil and Kerosine. The index was derived by taking ICC with Bureau of Mines values from 1956 to 1963 and averaging them. Eight years was felt to be enough to detect a trend if there was one.

<center>Coal</center>

The basic data were obtained from Table 70 and Table 72 again. Both anthracite and bituminous/lignite are included. Coal for locomotive use was inflated using the steam locomotive ratios from Table 14 and was added to non-locomotive coal use. The series was extended beyond 1963 by indexing on a Bureau of Mines series from the "Distribution of Bituminous Coal and Lignite ....." table in each annual Minerals Yearbook. The indexing was taken back to 1957 (the start of the Bureau of Mines series) and averaged.

<center>Gasoline</center>

Gasoline for all uses was obtained from Table 70. It was not inflated since it is used mainly in trucks, cars and other support vehicles of which Class I line-hauls are virtually all comprised.

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However, the series only ran through 1963 and had to be extended. A series of number of vehicles used by railroads was first looked at, but little correlation was observed (it was assumed that there is more correlation between the vehicle series and the non-locomotive diesel series, and this appears to be true), so the alternative was to look at the ratio of gasoline to locomotive diesel fuel consumed[1] and index forward on those numbers. The ratios from 1963 back to 1955 were averaged, as at that point the ratio seemed to begin trending, and it was assumed that the function changed at that point.

Electric Energy

A data series reported in the Edison Electric Institute, Statististical Yearbooks of the Electric Utility Industy in the appropriate years was obtained. It represents total electricity (including maintenance electricity) used in railroads and railways, but included herein are total use by rapid transit and subway companies, both of which belong in sector 65020, "Local, Suburban and Interurban Highway Passenger Transportation." Adjustments were made in the following way.

Two other data series were obtained from the American Transit Association, Transit Fact Books representing 1) electricity (operations only) generated and 2) electricity (operations only) purchased by rapid transit, subway and street railway companies. These ran from 1947 to 1957 and beginning in 1958 only one total use figure was reported.

Through conversations with subway officials in New York, Chicago, and Philadelphia (the three largest) it was learned that maintenance use of electricity is usually 9-10% of operations use. Also, Chicago and Philadelphia stopped

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[1] A similar method was used in the Peat, Marwixk, Mitchell & Co. Study, Industrial Energy Studies of Ground Freight Transportation, Peat, Marwick, Mitchell & Co. and Jack Faucett Associates, July 1974.

generating their own electricity before 1947 while New York stopped generating in 1959. Based on comparison of magnitudes, it was determined that almost all self-generated electricity was made by the New York system, and thus halting the generation series in 1959 would be legitimate.

The American Transit Association series (purchased electricity from 1947 to 1957 and electricity from 1960 to 1972) were thus inflated by 9% to estimate total electricity by rapid transit and subways, and then subtracted from the Edison Electric Institute series to yield estimates for electricity consumption by railroads. The railraod series (which at this point had two gaps in 1958 and 1959) was then filled in by examination of ICC Table 72, which reports electricity use by railroad vehicles. These figures were used to determine growth rates in total electricity consumption over the period 1957-1960, and the missing data were thus estimated.

With the railroad series complete, the transit and subway series on electricity purchased was completed by subtraction from the Edison Electric Institute control totals; and the transit and subway series on electricity generated was subsequently completed by subtraction of the purchased electricity series from the American Transit Association control totals in 1958 and 1959.

WATER TRANSPORTATION FUELS--SECTOR 65040

The data in this area are based mainly on Bureau of Mines survey collection results, but there have been some major adjustments made. Furthermore, the adjustments are based on some very weak assumptions and thus, while necessary, they must be regarded as little better than rough order-of-magnitude methods.

The fuels treated herein are the following: residual oil has been allocated to water transportation entirely; distillate oil has been divided between water transportation and commercial fishing; coal has gone entirely to water transportation; and gasoline has been allocated to commercial fishing and personal consumption.

While the control totals should be considered firm--both those from
Bureau of Mines and those from FHWA--the sectoral distribution procedures
create major problems in the marine fuels area. The quality of these
estimates is tenuous. The results appear in Table 4-11.

Diesel Fuel, Distillate Oil and Residual Oil

The data for both distillate oil (which includes diesel fuel) and residual
oil come originally from the Bureau of Mines, Mineral Industry Surveys,
Sales of Fuel Oil and Kerosine (Annuals). Bureau of Mines collects
data on the consumption of these fuels in vessel bunkering uses, but
in the case of distillate oil, this definition includes a portion of
the fuel used by commerical fishing vessels as well. The amount by
which Bureau of Mines reported figures are in excess of the true water
tranportation use is unknown; and furthermore, since Bureau of Mines
monitors refinery sales to marine distributors and large marine transit
companies, it is assumed that not all commercial fishing use is captured
therein either (as many commercial fishermen buy fuel from small independent
jobbers).

To overcome this difficulty, the commercial fishing distillate fuel
estimates were used (see section on "Agriculture, Forestry and Fisheries"
for estimation procedures). A constant percentage of each year's data
was assumed to have been missed in the Bureau of Mines data, and the
residual was subtracted from the Bureau of Mines total to yield estimates
on distillate use for water transportation vessels. The residual use
was obtained directly.

Marine Gasoline

These data come from Highway Statistics, FHWA, annual volumes, Table
MF-24 in the years 1966-1972. Two problems existed, however. First
the data had to be extended back to 1947, and this was done in the following
way: the ratio (marine gasoline /total highway gasoline) was determined
over the period 1966-1972, and then it was used to derive marine gasoline

TABLE 4-11.-MARINE FUEL USE -- SECTORS 65040, 96600 AND 03000

YEAR	GASOLINE (Millions of Gallons)		DISTILLATE OIL, inc. DIESEL (Millions of Gallons)		COAL (Thous. of Tons)	RESIDUAL OIL (Millions of Gallons)
	Sector 03000	Sector 96600	Sector 03000	Sector 06540	Sector 06540	Sector 06540
	Forestry and Fisheries	Personal Consumption Expenditures	Forestry and Fisheries	Marine Transportation	Marine Transportation	Marine Transportation
1947	24.1	12.1	246.8	484.5	4242	4279.8
1948	27.1	12.0	227.5	470.7	3506	4022.0
1949	29.4	12.2	300.1	401.0	2825	3753.2
1950	31.8	13.9	324.9	378.2	2806	3903.8
1951	32.1	16.5	328.7	440.2	3050	4494.3
1952	31.7	19.9	324.6	560.7	2527	4637.3
1953	29.4	37.5	300.3	559.6	2527	4801.6
1954	32.0	46.0	326.8	490.2	1709	4569.2
1955	33.6	64.1	343.6	528.6	2060	4835.4
1956	35.2	81.9	360.0	596.4	2020	4932.7
1957	34.1	106.5	348.9	683.2	1900	5193.3
1958	34.6	135.5	353.9	611.3	1294	4463.3
1959	35.7	169.9	364.6	626.2	1561	4286.1
1960	35.4	197.4	362.2	605.6	1423	3951.5
1961	35.3	225.1	361.0	431.3	1086	3666.9
1962	34.8	258.9	355.8	487.2	1195	3545.4
1963	36.0	301.0	368.1	452.2	2008	3213.1
1964	36.6	355.5	374.0	485.0	1023	3487.0
1965	38.0	397.4	388.5	458.1	1017	3092.8
1966	40.2	445.6	411.2	493.3	1067	3092.9
1967	42.9	458.5	438.1	515.0	833	3327.3
1968	46.1	486.7	471.2	530.3	879	3687.2
1969	47.1	521.5	481.4	552.1	951	3506.2
1970	48.9	549.3	500.0	569.1	1072	3773.7
1971	51.7	593.7	523.3	618.6	713	3306.5
1972	54.6	632.1	547.7	739.4	595	3273.1

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figures (based on the total highway gasoline figures) going back to 1947.
However, the ratio was not held constant; instead it was allowed to decline
in earlier years in accordance with the way the ratio for California changed.
California was the only state with consistent marine gasoline data in all
years, and it is both a big highway and big recreation state. Therefore,
it was believed to be capable of yielding reasonable estimates.

The above algorithm was basically derived from conversations with FHWA personnel.
It is based on the method they use to make individual state estimates; and
the underlying theory is that most of highway gasoline—and most marine gasoline
as well—is personal consumption and thus both quantities are largely dependent
on leisure time.

The second major problem with the data was that it also contained the gasoline
consumption of commercial fishing. This was solved by obtaining the fishing
estimates (see section on "Agriculture, Forestry and Fisheries" for estimation
procedures) and subtracting them to arrive at net personal consumption of
marine gasoline data.

Coal

Two Bureau of Mines series on coal consumption for vessel bunkering were
used to estimate these data. Both are found in annual Minerals Yearbooks
in the "Bituminous Coal and Lignite" chapters. Based on the recommendations
of Bureau of Mines personnel, the series entitled "Distribution of Bituminous
Coal and Lignite by Destination and Consumer Use" was judged to capture
more of the total universe, and it was used in 1957 through 1972. Before
1957, the series was indexed on another, entitled "Consumption of Bituminous
Coal and Lignite, by Consumer Class" to extend it back to 1947.

OIL PIPELINE -- SECTOR 65060 AND NATURAL
GAS PIPELINE -- SECTOR 68210 TRANSPORTATION

In this area, only fuel used to power substances through pipelines was estimated.
Other transportation fuel use in the sector, such as auto use, etc., is
handled separately. Both natural gas pipelines and oil pipelines are included

in this section, and the estimating techniques are discussed separately for each. In the natural gas area, natural gas is the only pipeline fuel allocated, and for oil pipelines three fuels (natural gas, electricity and diesel fuel) are allocated. The quality of these estimations is variable, running from strong in the natural gas area (where the data are directly from Bureau of Mines) to very weak in the oil area (where some very tenuous assumptions must be made in order to derive any results). The results of the estimations appear in Table 4-12.

Detailed Distribution

This area was divided into two major parts, natural gas pipelines and oil. pipelines. In the natural gas area the data come directly from Bureau of Mines sources, and can thus be considered to be fairly firm. However, the oil pipeline data area based on a great deal of conjecture and can thus only be considered a rough approximation.

It was determined through conversations with several authorities, most notably the Interstate Natural Gas Association of America, that natural gas is virtually the only fuel used for propulsion by natural gas pipeline, and these consumption figures were taken directly from American Gas Association Gas Facts, 1973, Table 77. The figures are originally from the Bureau of Mines Natural Gas annuals (1950-1972), and were trended back through 1947 using growth rate projections.

In the oil pipeline area, the only firm data to be found were a yearly value for total ton-miles in the sector. This came from Transportation Assocation of America, Facts and Trends, 1973, p.8, and was originally taken from the ICC publication, Transport Economics in the appropriate years. In addition, an estimate of BTU's/TM was taken from the Jack Faucett Associates Study, Project Independence and Energy Conservation: Transportation Sectors (November 1974), p. 149, and this estimate was trended back to 1947 based on conversations with a number of representative experts in the field. Thus was a total necessary BTU figure developed in the sector for each year.

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TABLE 4-12.-PIPELINE FUEL USE -- SECTORS 65060 AND 68210

YEAR	NATURAL GAS PIPELINES -- SECTOR 68210	OIL PIPELINES -- SECTOR 65060		
	Natural Gas (Millions of Cu. Ft)	Natural Gas (Millions of Cu. Ft)	Electricity (Millions of KWHs)	Diesel Fuel (Millions of Gallons)
1947	146855	10184	3077	606
1948	157134	11639	3517	692
1949	168133	11154	3370	663
1950	125546	12512	3781	744
1951	192496	14258	6125	803
1952	207207	14355	8001	764
1953	230314	15034	10023	756
1954	230615	15325	12046	729
1955	245246	16877	15035	759
1956	295972	18526	18347	788
1957	299235	17459	18962	702
1958	312221	16004	18875	606
1959	349348	16780	21307	598
1960	347075	16392	22304	549
1961	377607	16198	23476	506
1962	382496	16101	24795	467
1963	423783	16586	27081	443
1964	433204	17168	29689	418
1965	500524	18914	34584	415
1966	535353	19981	38828	386
1967	575752	21048	43025	350
1968	590965	22114	47831	303
1969	630962	22599	51729	239
1970	722166	22987	55569	171
1971	742592	23666	57210	176
1972	766156	24345	58851	181

Based again on information obtained from the same Jack Faucett Associates Study augmented by the synthesis of a number of expert opinions, a notion of how this total BTU value was distributed among each of the three basic fuels (electricity, natural gas and diesel oil) used in the sector, and how the distribution changed over time, was developed. These BTU values were then converted to physical quantities based on standard conversion factors, and the estimation was thus completed.

LOCAL, SUBURBAN AND INTERURBAN HIGHWAY PASSENGER TRANSPORTATION FUELS -- SECTOR 65020

Methods for estimating fuel consumption in this sector have already been described in several sections of this report. The major fuel use estimations can be found in the section on highway buses, as bus and transit companies form the bulk of the sector. However, any private truck or automobile fuel use allocated to this sector has been described in the appropriate highway section as well.

In addition, taxicab fuel use, the estimation of which is described in the highway automobile section, forms a part of this sector.

MOTOR FREIGHT TRANSPORTATION AND WAREHOUSING -- SECTOR 65030

The estimation of for-hire truck fuels used in this sector is described in the highway truck section of the report. In addition, any private automobile fuel use allocated to the sector is found described in the highway automobile section.

TRANSPORTATION SERVICES -- SECTOR 65070

Estimating techniques used to allocate transportation fuels to this sector are found in the same places as the techniques used in the motor freight sector.

LUBRICATING OILS AND GREASES

Virtually no hard data exists for the consumption of oil and grease for
transportation uses, so these estimates must, across the board, be considered
only rough order-of-magnitude approximations. In the treatment of both
oil and grease consumption, the same procedure was followed. Several rough
series of engineering ratios (gallons of fuel/gallons of oil and gallons
of oil/gallons of grease for a typical engine) were developed to deal with
several broad categories of motive power engines, and then these time-series
were applied to previously estimated fuel quantities in the appropraite
transportation areas to derive oil and grease consumption estimates. Most
of the technique was based on conversations with authorities in the field,
but some data were acquired from the Census Bureau's Current Industrial
Report Series, "Sales of Lubricating Oils and Greases" in the years it was
published.

Detailed Descriptions

The lubrication area was treated generally by developing technological or
engineering relationships between certain types of fuels in certain types
of engines and their attendant lubrication requirements. In this way use
of lubricating oils and greased was derived.

In the aviation area, a relationship was developed, using the CAB Handbook
of Airline Statistics, 1973 between aviation gas (Table 58) and lubricating
oil (Table 60), and also between jet fuel (Table 59) and lubricating oil
as a residual, for each year. These figures were checked against the recom-
mendations of engineering authorities (speifically Avco Lycoming Corporation
and Air Research Corporation) and adjusted slightly to reflect this. Then
applied to the previous fuel estimates in the aviation gasoline and jet
fuel areas. Grease was determined to be an insignificant quantity in this
sector and was not allocated.

In the general area of highway fuel, a similar procedure was followed. For some years (i.e., 1947, 1951, 1956, 1958, 1960, 1962, 1965, 1967, 1969, and 1971) the Current Industrial Reports series, "Sales of Lubricating Oils and Greases", has been collected and published by the Census Bureau, and these figures (gallons of oil) were applied to previous fuel estimates to develop a series of ratios. Special care was taken to make sure that the definition of the coverage universe was the same in both cases. Then the intervening years were filled in by straight-line interpolations. These ratios are presented in Table 4-13.

Conversations with a number of authorities in the automobile and petroleum industries then pointed up the weaknesses in this ratio series, but it was generally agreed that it gave a very rough approximation of the truth. In addition, it was determined that the ratio for diesel highway engines was slightly lower, and through information provided by Mack Truck, Inc., a diesel lubrication series was developed as well.

Further research into the railroad and marine transportation areas then led to the determination of which of these series were to be used for which fuels in which sectors. The motor gasoline ratio was used for all railroad fuel except fuel oil. This ratio was set at a constant .005. In the marine sector, all fuels were subjected to the motor gasoline ratio.

In addition, a ratio was developed for the relationship between lubricating oil and grease use, using data found in the Current Industrial Reports series again. The intervening years were interpolated and this ratio series was used uniformly in all fuel areas to estimate grease use.

TRANSPORATION FUEL PRICES

In general prices of fuels used for transportation purposes are not consistently reported. Furthermore, in instances where price or value data have been gathered, these data are based on little specific information and quite

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TABLE 4-13.-FUEL TO LUBRICATION RATIOS DEVELOPED FOR
PARTICULAR TRANSPORTATION MODES

(Gallon of Oil/Gallon of Fuel)

Year	Highway Gasoline Vehicles[a]	Highway Diesel Vehicles[b]	Aviation Jet Fuel	All Modes
1947	0.0241	0.0220	--	0.1099
1948	0.0232	0.0213	--	0.1069
1949	0.0223	0.0206	--	0.1038
1950	0.0215	0.0199	--	0.1007
1951	0.0207	0.0193	--	0.0978
1952	0.0200	0.0187	--	0.0978
1953	0.0192	0.0181	--	0.0979
1954	0.0185	0.0175	--	0.0979
1955	0.0179	0.0169	0.0200	0.0980
1956	0.0172	0.0164	0.0200	0.0980
1957	0.0163	0.0159	0.0200	0.0973
1958	0.0155	0.0154	0.0200	0.0965
1959	0.0151	0.0149	0.0080	0.0955
1960	0.0148	0.0144	0.0020	0.0946
1961	0.0147	0.0139	0.0009	0.0866
1962	0.0145	0.0135	0.0008	0.0793
1963	0.0142	0.0120	0.0008	0.0761
1964	0.0138	0.0107	0.0007	0.0730
1965	0.0135	0.0095	0.0005	0.0701
1966	0.0131	0.0084	0.0003	0.0654
1967	0.0127	0.0077	0.0002	0.0610
1968	0.0121	0.0072	0.0002	0.0609
1969	0.0115	0.0066	0.0002	0.0607
1970	0.0110	0.0061	0.0002	0.0582
1971	0.0106	0.0056	0.0002	0.0559
1972	0.0102	0.0052	0.0002	0.0536

Note: A constant ratio of .0117 was used for all aviation gasoline en-
gines in the aviation mode. In addition, a constant ratio of .005
was used for all residual oil engines in the railroad mode.

[a] This ratio was also used for highway LPG, railroad gasoline and dis-
tillate oil, and marine gasoline.

[b] This ratio was also used for marine distillate and residual fuels.

a lot of simplifying assemptions. For example, the problem of highway fuel prices is very serious, both because of the lack of good information, and also because of the importance of highway fuels. There are simply no purchasers' prices for diesel fuel or liquefied petroleum gas (as differentiated from distillate heating oil or LPG for other than highway uses) reported anywhere in the statistical arena. In addition, the only gasoline price series available is one from Platt's Oilgram, which is derived by taking a straight arithmetic average of service station prices (by month) in 55 representative U.S. cities. Such a method does not even attempt to weight the average by the tax rate or margin values in the various states, to say nothing of providing information on variable prices paid by different consuming sectors.

The aviation and pipeline areas are perhaps worse, and in general it was felt that estimations of price data for transportation fuels, on the basis of such scant information, would not be worth the effort. However, in two cases it was felt that available price data were sound and worth using in the study. Railroad fuel prices from the ICC are reliable, and certain prices of bunkering fuels from Platt's Oilgram were felt to be acceptable as well.

Railroad Fuel Prices

Prices of distillate fuel (including diesel), residual fuel, coal and gasoline for all uses were available directly from ICC Transport Statistics , Table 71, in the years 1947-1963. The series were extended forward to 1972 by means of indexing on similar series (representing only locomotive use) from the Association of American Railroads publication, Statistics of Railroads of Class I in the U.S., 1961 to 1971, p. 15.

In addition, a purchaser price series for electricity was obtained directly from EEI Statistical Yearbooks in the appropriate years. Table 45 of these publications includes average revenues per kilowatt-hour for the sales category "Railraods and Railways". This series was also used to derive values for electricity consumed by transit companies (Sector 65020).

Bunkering Fuel Prices

Two price series, one for distillate (including diesel) oil and one for residual oil, were obtained directly from Bureau of Mines, Minerals Yearbooks, the chapter on "Crude Petroleum and Refined Products". These series originally came from Platt's Oilgram and are averages of delivered prices in three representative harbors, New York, New Orleans and San Pedro. They were used to derive values of distillate oil and residual oil used in marine transit (Sector 65040) only.

Non-Transportation Use of Natural Mixed and Manufactured Gas, Coal and Fuel Oil by the Transportation Industries

While no firm data, except for railroads, was available for non-transportation consumption by the transportation industries, estimates for five products—natural gas, mixed gas, manufactured gas, fuel oil and coal—were derived in conjunction with those for consumption by commercial industries.

For each of the three gases in all years except 1947, data published by the American Gas Association on "Commercial Sales" and "Gas Utility Industry Large Volume Sales," allowed an estimate of sales for non-transportation use in all transportation, and commercial industries, except railroads, hotels and personal services, and communications other than radio and television broadcasting. These sales were then distributed across the above sectors on the basis of employment. The allocations for each transportation sector were assigned to the appropriate I-O sector. For 1947, data on large volume sales were not available. For this year, it was consequently necessary to rely solely on an emloyment distribution of AGA's "Commercial Sales" estimate across agriculture, forestry, fisheries, transportation, and the commercial industries.

For fuel oil, Bureau of Mines data on total domestic sales of fuel oil, adjusted by information on consumption from the Bureau of the Census and in-house estimates, yielded a figure for non-transportation consumption in the construction, transportation, commercial, and civilian government industries

except oil and gas well drilling, railroads, and communications other than radio and television broadcasting. This estimate was distributed on the basis of employment in these sectors, and the allocations for each transportation sector were assigned to the appropriate I-O sector.

For coal, available data on coal consumption for individual sectors was deducted from Bureau of Mines estimates of total domestic sales of coal. This procedure produced a derived retail deliveries estimate which was comprised of non-transportation use in the transportation, commercial and civilian government industries except railroads and communications other than radio and television broadcasting. This estimate was then distributed across the above sectors on the basis of employment, and the allocations for each transportation sector were assigned to the relevant I-O sector.

A more detailed description of these estimating procedures is found in Section 8 (Commercial Industries).

SECTION 4

AGRICULTURE, FORESTRY, AND FISHERIES

The consumption of various fuels in Agriculture is described in this section. A sector overview is presented first, in which sector definition, fuels studied, data quality and sources are discussed in general terms. This is followed by a more detailed discussion of each fuel; stating in specific terms the estimating techniques used, the quality of data presented, the degree of sector coverage, the functional use to which each fuel is put, and documenting the published and unpublished data cited.

OVERVIEW

Agriculture is divided into four sectors: (1) Livestock and Livestock Products (01000), (2) Other Agricultural Products (02000)--hereafter referred to as "Crops", (3) Forestry and Fishery Products (03000), and (4) Agricultural, Forestry, and Fishery Services (04000).

Data are presented for eight different fuels, with varying degrees of sector coverage. This coverage is described in Table 4-14. No data are available on fuel consumption in either Agricultural Services or Forestry. As data on Agricultural consumption of energy are scarce, presentation of data for all years required much estimation. Consequently, the quality of the data presented varies greatly. Expenditure data are presented when available.

All data for both the Livestock and Crop sectors were collected as a total farm consumption figure for each fuel. The distribution of fuel consumption between sectors was based on an estimated 1970 breakdown by USDA, modified in each year by relative constant-dollar output. While providing more useful information, this procedure injected additional uncertainties into the estimates.

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TABLE 4-14.-SECTOR COVERAGE BY FUEL TYPE,

DATA TYPE AND YEAR

		(01000) Livestock & Livestock Products	(02000) Other Agri-cultural Products	(03000) Forestry & Fishery Products	(04000) Agricultural, Forestry & Fishery Service
Gasoline	BBL	1947-1972	1947-1972	Fisheries Only 1947-1972	NA
	$	1947-1972	1947-1972	NA	NA
Diesel Fuel	BBL	1947-1972	1947-1972	Fisheries Only 1947-1972	NA
	$	1947-1972	1947-1972	NA	NA
Distillate Fuel Oil	BBL	1947-1972	1947-1972	NA	NA
	$	1956-1972	1956-1972	NA	NA
LP Gases	BBL	1947-1972	1947-1972	NA	NA
	$	1963-1972	1963-1972	NA	NA
Natural Gas	MMCF	NA	1947-1972	NA	NA
	$	NA	NA	NA	NA
Motor Oil	BBL	1947-1972	1947-1972	Fisheries Only 1947-1972	NA
	$	1947-1972	1947-1972	NA	NA
Grease	BBL	1947-1972	1947-1972	Fisheries Only 1947-1972	NA
	$	1947-1972	1947-1972	NA	NA
Electricity	10^3 KWH	1947-1972	1947-1972	NA	NA
	$	1947-1972	1947-1972	NA	NA

The outstanding characteristics of data on energy consumption in Agriculture are that there are no sufficiently detailed and periodically published sources. As a result, the data collector is forced to rely on infrequently conducted surveys and studies or estimates compiled by professional staff members within the government. The Department of Agriculture provided the core of data through both means. Data on gasoline consumption are published by the Department of Transportation. The Department of Commerce released what scarce material is available for the Commercial Fisheries sector. Outside the Govermnent, an American Gas Association study formed the basis of estimates presented on natural gas consumption.

FUELS

Gasoline--10110

Gasoline consumption data are presented for the Livestock (01000), Crop (02000), and Forestry and Fishery (03000) sectors. The figures for the latter represent Commercial Fishery use only. Expenditure data are presented for all years in both the Livestock and Crops sectors, but are unavailable for commercial fisheries.

Gasoline consumption reported in this section is for off-road or marine transportation uses only, the majority of it being tractor and combine or fishery vessel fuel. On-road consumption is reported under Transportation Fuels in Section 3.

Annual consumption for off-road uses by state is reported to the Federal Highway Administration and published each year in Highway Statistics.[1] All states report a total for off-road uses each year and most specify how much is consumed in Agriculture. A few states, in some, but not all years, report only the total. For those states, it was necessary to estimate Agriculture's share of the total. In each state, this was done by determining, in the most recent five years around the data gap, the percentage of total consumption

[1] *Highway Statistics*

accounted for by Agriculture and allocating that percentage of total consumption to Agriculture in years for which separate data were missing. Individual state consumption figures were then summed to a national agricultural total. These totals reflect consumption in the Livestock and Crops sectors only.

The percent of agricultural consumption estimated is less than 10 percent in each year except 1947 and 1948. The combined consumption for both sectors would merit a good quality rating in those years and a very good rating in all others. Due to the uncertainty introduced by the sectoral breakdown, the quality ratings must be downgraded somewhat.

Expenditure data was generated by multiplying the number of gallons consumed each year by the price per gallon paid by farmers during each year. Two price series for gasoline are available: one for retail station purchase and another for tank truck purchases. The latter is generally a few cents per gallon lower than retail station charges. Due to the high percentage of off-road gasoline consumed in tractors, the latter series, for tank truck purchases, was used to reach expenditure estimates.

Gasoline consumption in the Forestry and Fishery Products sector has been estimated by the National Marine Fisheries Service of the Department of Commerce for 1974. The estimate reached for that year resulted from an incomplete survey of sales at large marine terminals and was adjusted to account for smaller dealers. It is very rough and may be subject to an error of over 100%. The consumption figures presented for 1947-1972 are derived from that figure and carry equal uncertainty. They were estimated by finding a 1974 coefficient in gallons per ton of gross weight in the commercial fishing fleet and multiplying that coefficient by the total gross weight in tons for each year 1947-72. The tonnage statistics are from annual volumes of Fishery Statistics of the United States, Summary of Operating Units.[1] All Fishery data have been assigned the lowest quality rating.

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[1]_Fishery Statistics of the United States_

Consumption figures for diesel fuel are presented for the Livestock, Crop, and Fisheries sectors for all years. Expenditure data are given for the Livestock and Crop sectors only.

The diesel consumption reported for the Livestock and Crops sectors is predominantly tractor fuel. In 1959 tractors consumed 95% of all diesel used on farms.[1] The 1973 percentage has been estimated as 94%.[2] Very small amounts are consumed by other farm power machinery and trucks. Consequently, the consumption in these sectors is classified as off-road use. Consumption by commercial fisheries is classified as waterborne vehicle use.

Firm consumption data are available for a number of years for the Livestock and Crop sectors combined. The figures presented here for the years not covered were interpolated. The 1947 and 1953 figures are from USDA Statistical Bulletin No. 344.[3] Originally published as tractor consumption only, these were adjusted upwards to account for the roughly 5% non-tractor use reported in other years. The 1959 figure is from the same source but represents a published total.[4] The 1955 figure from USDA Statistical Bulletin No. 224 was converted from dollars to physical units by price data supplied by the USDA.[5] Figures for 1964, 1969-1972 are unpublished estimates made by the Department of Agriculture's Economic Research Service on February 20, 1973.

As a result of the uncertainty caused by sectoral breakdown, the data presented for those years is less than firm; the benchmark years have been graded "B", all other years, "C".

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[1] Economic Research Service, U.S. Department of Agriculture, Statistical Bulletin No. 344, "Liquid Petroleum Fuel Used by Farmers in 1959 and Related Data", Washington, D.C., May 1964, Tables 5,3.

[2] 93rd Congress, 2nd Session, Committee Print, The U.S. Food and Fiber Sector Energy Use and Outlook, prepared by Economic Research Service-USDA, September 20, 1974, Washington, D.C., Table 8.

[3] Statistical Bulletin, No. 344, op. cit., Table 3.

[4] Ibid., Table 6.

[5] Agricultural Research Service USDA, Bureau of the Census, Department of Commerce, Statistical Bulletin No. 224, "Farmers Expenditures in 1955 by Regions for Production and Farm Living", US GPO, Washington, D.C., 1958, Table 15.

Distillate Fuel Oil--11000

Consumption of distillate fuel oil excluding diesel fuel has been estimated for the Crops and Livestock sectors only. As price data are available only from 1956 to the present, expenditures have been presented from that data. Functional uses were not specified in the sources and are classified here in the general Fuel and Power category.

Total consumption is published in USDA <u>Statistical Bulletin</u> No. 188[1] for 1953 and USDA <u>Statistical Bulletin</u> No. 344[2] for 1959. Consumption for all other years has been interpolated from those data. The figures for years between 1953 and 1959 should be relatively firm. Those presented for post 1960 are of increasingly poor quality. Consumption was allocated to the two sectors as explained above.

Liquid Petroleum Gases--10700

The consumption of LP Gases is reported for all years for the Livestock and Crop sectors. Expenditures, converted from physical units by price data from USDA, are presented for 1963 to 1972.

LP Gas is used as a tractor fuel, as fuel for stationary engines, and more recently, in large volumes as fuel for crop dryers. Unfortunately, the distribution among uses is not known and functional use is classified at the most aggregate level.

Total Consumption is reported in a number of sources for various years. The figures for 1947, 1953, 1964, 1969, and 1971 are from <u>The US Food and Fiber Sector: Energy Use and Outlook</u>.[3] The 1955 figure is from USDA <u>Statistical</u>

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[1] *Agricultural Research Service and Agricultural Marketing Service, USDA, <u>Statistical Bulletin</u> No. 188, "Liquid Petroleum Fuel Consumption for Farm Purposes", Washington, D.C., July 1956, Table 13.*

[2] *<u>Statistical Bulletin</u> No. 344, op. cit., Table 9.*

[3] *<u>The U.S. Food and Fiber Sector</u>, op. cit., Table 6 for 1964, 1969, and 1971. Figures are converted from BTUs to gallons at the rate of 95,500 BTU/gallon. Figures for 1953, 1947 are from Table 10.*

Bulletin No. 224.[1] 1959 consumption is published in USDA Statistical
Bulletin No. 344[2], and those for 1970 and 1972 were estimated by the USDA
staff internally. All other years were estimated by interpolation.

Data for the benchmark years are considered fairly firm, more so in the
aggregate than when divided between sectors.

<div align="center">Natural Gas--13500</div>

Natural gas consumption is reported for the Crop Production sector only.
This is due to the nature of the data source and the functional use reported
therein. No expenditure data are available.

The extent of natural gas consumption in Agriculture is almost a total unknown.
According to Department of Agriculture sources, significant volumes are siphoned
off gas pipelines by farmers in exchange for right-of-way across farmland. Such
consumption is not metered and not paid for. Large volume sales data published
by the American Gas Association omits not only this use but misses small
volume purchasers as well. Consequently, the estimates reported in these
accounts are based not on sales data, but on a gas engine market survey con-
ducted by a research firm for the American Gas Association in 1968. That
study estimated natural gas consumption by irrigation pumps in 1966 and pro-
jected increases through 1971. Consumption figures are roughly three to four
times the sales reported by AGA for large volume users.

Consumption for other years was estimated by finding a coefficient of cubic
feet per acre irrigated (based on USDA Agricultural Statistics 1973 acreage
statistics) in each year covered by the study. As this coefficient showed a
continuous increase through time, an average percent change for each year
1966-1971 was found and used to extrapolate cubic-feet-per-acre-irrigated for
years prior to 1968. These yearly coefficients were then multiplied by the
number of acres irrigated to produce cubic feet consumed.[3]

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[1] Statistical Bulletin No. 224, op. cit., Table 15. Expenditures converted to
physical units.

[2] Statistical Bulletin No. 344, op. cit., Tables 6, 9. The figures presented
represent a sum of motor and non-motor uses.

[3] U.S. Department of Agriculture, Agricultural Statistics, 1973, US GPO,
Washington, D.C., 1973, Table 616.

It is impossible to confidently and accurately evaluate the quality of the estimates. As the error is uncertain, they have been rated "poor". They are more a best guess than a reflection of actual consumption.

Motor Oil--15711

Data are presented for consumption of motor oil in physical units for Livestock, Crops, and Forestry and Fishery sectors. Expenditure data are presented for the Livestock and Crop sectors only.

Functional uses are classified as off-road for the land-based sectors and as marine transportation for the Forestry and Fisheries sectors.

Farm expenditures for motor oil were estimated by the Department of Agriculture staff using two surveys, 1955 and 1971, as benchmark years and moving figures over the intervening years by the numbers of specific farm machine units.[1] Estimates were made for tractors, trucks and autos. The off-road use presented in these Accounts is the consumption estimated for tractor use only.

Price per gallon data from USDA worksheets were used to convert expenditures to physical units for 1947-1959. Price data for 1960 and 1961 are from Agricultural Statistics 1964. After 1961, separate prices were listed for different grades of motor oil. A consumption-weighted average price for all years was found using weights specified by a Department of Agriculture economist: Regular--43.8%, Heavy Duty--33.2%, All-weather--23.0%.[3] (See footnote for estimated prices.) The unweighted prices also came from various

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[1] Estimates released over the phone by Bill Paddock, USDA Economist, February 1975.

[2] U.S. Department of Agriculture, Agricultural Statistics, 1964, US GPO, Washington, D.C., 1964, Table 682.

[3] Sources of Weights is Bill Paddock, USDA. Prices estimated: 1962, $1.41; 1963, $1.42; 1964, $1.46; 1965, $1.48; 1966, $1.49; 1967, $1.53; 1968, $1.88; 1969, $1.63; 1970, $1.68; 1971, $1.77; 1972, $1.81.

editions of <u>Agricultural Statistics</u>.[1]

Forestry and Fishery consumption was estimated from coefficients of motor oil use per gallon of fuel for diesel and gas engines developed by Jack Faucett Associates, Inc. These coefficients were multiplied by estimated fuel consumption in each year for both fuels, the results then being combined to approximate a total for the sector.

Data quality are high for the combined Livestock and Other sectors. Distribution of consumption between them lowers it somewhat. As the fuel consumption estimates for the Forestry and Fishery sector are poor to begin with, the data reported for motor oil consumption are also poor.

<div align="center">Grease--15712</div>

Consumption of grease is reported for the Livestock, Other, and Forestry and Fishery sectors. Consumption in the latter is by Commercial Fisheries only. Expenditure data are presented for the first two sectors only.

Functional uses are classified as off-road for the Livestock and Other sectors, and as Marine Transportation for Forestry and Fisheries.

Farm Expenditures for Grease in the Livestock and Crop sectors are estimated from the USDA estimates of motor oil consumption. In both survey years 1955 and 1971, grease expenditures totaled exactly 30% of those for motor oil. This percent was assumed constant over all years and grease expenditure data generated on that basis. The resulting data were converted to physical units using price per pound statistics from USDA records and <u>Agricultural Statistics</u>.[2]

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[1] *Separate pieces for 1963-1965 are from <u>Agricultural Statistics, 1967,</u> Table 689; for 1966-1969 from <u>Agricultural Statistics, 1970;</u> for 1970-1972, from the 1973 edition, Table 666.*

[2] *USDA worksheets used prior to 1960. 1960-1962, <u>Agricultural Statics, 1964.</u> 1963-1965, <u>Agricultural Statistics, 1967.</u> 1966, <u>Agricultural Statistics, 1970.</u> 1967-1972, from Bill Paddock, USDA.*

Grease consumption in the Forestry and Fishery sector was estimated by using coefficients of pounds of grease per gallon of fuel for gasoline and diesel engines developed by Jack Faucett Associates, Inc. The coefficients were multiplied by gallons consumed of each fuel and summed to approximate a total for the sector.

The quality of original data for the Livestock and Crop sectors are firm but subject to uncertainty introduced by sector distribution. Data for the Forestry and Fishery use are very tenuous.

Electricity--00100

Consumption figures were developed for both the Livestock and Other Agricultural Products sectors in physical units as well as expenditures. There are no data available for either the Forestry and Fisheries or the Agricultural Service sectors.

Figures reported in these accounts reflect farm production use only. They have been broadly classified as Fuel and Power use.

Total farm consumption, published in The US Food and Fiber Sector: Energy Use and Outlook[1], was adjusted to eliminate space heating and lighting for farmhouse use (included with Personal Consumption Expenditures).

This was accomplished by interpolating the percentage use for production purposes from a 1955 figure of 43.27%[2] to a 1970 figure of 36%[3], and multiplying it by total farm consumption in each year. The resulting total was distributed between sectors by the usual method.

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[1] U.S. Food and Fiber Sector: Energy Use and Outlook, op.cit., Table 13.

[2] Statistical Bulletin No. 224, op.cit., Tables 15, 19. Separate home and production uses were combined, and the percentage for production use found.

[3] U.S. Food and Fiber Sector: Energy Use and Outlook, op.cit., p. 15.

Price data supplied by USDA were used to convert KWH to expenditures. The quality of these data is fair. The originally published totals are themselves only estimates and the functional use separation further reduces their quality.

Other Fuels

There are undoubtably quantities of other fuels consumed in the Agricultural sector; wood and coal in particular. For the former, no data have been found. For the latter, it is known that small amounts are consumed in commercial greenhouses. For the sector as a whole, however, this use is negligible and has been assumed zero.

SECTION 5

CONSTRUCTION--03000

Limited data on the consumption of energy in construction are presented
in this section. A sector overview comes first, followed by more detailed
information on separate fuels. For each fuel, the estimating techniques
used, the degree of sector coverage, the quality of data presented, and
the sources used are discussed in depth.

OVERVIEW

Construction, viewed on an activity rather than an establishment basis,
includes two sectors: (1) New Construction (11000), and (2) Maintenance
and Repair Construction (12000).

Due to a severe lack of data, consumption is reported for five energy pro-
ducts only: (1) Gasoline, (2) Asphalt, (3) Road Oil, (4) Electricity, and
(5) Fuel Oil. Data for the first three are collected for the entire con-
struction activity and have not been distributed between sectors. This was
felt inestimable due to expected different energy requirements for each. Data
for electricity and fuel oil have been allocated to sectors by employment fi-
gures.

The data presented cover all years 1947-72. No expenditure estimates have
been developed. The quality is good to very good in all cases except electri-
city, where it is considered uncertain.

ENERGY PRODUCTS

Gasoline--10100

Annual consumption of gasoline in construction for off-road uses, by state,
is reported to the Federal Highway Administration and published each year

in Highway Statistics[1]. Unfortunately, an average of only seventeen states
per year report. To estimate national consumption, it was necessary first
to estimate the average number of gallons per worker in contract construction
for those states reporting, and second, to multiply this average by the
number of contract construction workers in the United States. The statistics
on employment by state and for the nation as a whole are published in the
Bureau of Labor Statistics' Employment and Earnings: States and Areas, 1972[2].

As the estimates are derived from a solid annual series, they may be con-
sidered reasonably accurate.

Asphalt--16540

Domestic consumption of asphalt is published annually by the Bureau of Mines
in Minerals Yearbook[3]. While neither functional use nor consuming sector is
specified in the source, the major uses are paving and roofing. Consequently,
the entire domestic consumption figure has been allocated to construction
and its use labeled correspondingly.

Data is considered firm for all years. No estimation techniques were used.

Road Oil--16550

Domestic consumption of road oil is published in the same tables of
Minerals Yearbooks as Asphalt. Its major functional use is in road con-
struction and it has been allocated entirely to the construction sector.
Data is firm, no estimation was required.

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[1] Highway Statistics, U.S. Department of Transportation, Federal Highway
Administration, US GPO, Washington, D.C. For 1947-196 ; Tables 6-24.
For later years, Table MF-24.

[2] Employment and Earnings: States and Areas, 1972, U.S. Department of Labor,
Bureau of Labor Statistics, U.S. Government Printing Office, Washington, D.C.,
1972.

[3] Minerals Yearbook, U.S. Department of the Interior, Bureau of Mines, U.S.
Government Printing Office, Washington, D.C. Data for 1947-1950 are from
Table 48, p. 992, MY 1951; 1951-1954, MY 1954, Vol. II, p. 365; 1955-1957,
MY 1957, Vol. II, p. 286; 1958-1960, MY 1960, Vol. II, p. 415; 1961-1964,
MY 1964, Vol. II, p. 426; 1965-1966, MY 1967, p. 901; 1967-1968, MY 1969,
p. 855; 1969 -1970, MY 1971, p. 922; 1971-1972, MY 1972, p.

Non-Transportation Use of Electricity and Fuel Oil

While no firm data were available for non-transportation use of electricity and fuel oil by the contract construction sector, estimates were developed in conjunction with those for consumption by commercial industries. For electricity, the Federal Power Commission's "Commercial Sales" data were adjusted to take into account all consumption which could be attributed to individual commercial sectors covered by these sales. The residual was then distributed on the basis of employment between construction (excluding oil and gas well drilling) and those commercial sectors whose total consumption had not been accounted for by the individual allocations.

For fuel oil, Bureau of Mines data on total domestic sales of fuel oil, adjusted by information on consumption from the Bureau of the Census and in-house estimates, yielded a figure for non-transportation consumption in the construction, transportation, commercial, and civilian government industries, except oil and gas well drilling, railroads, and communications other than radio and television broadcasting. This estimate was distributed on the basis of employment in these sectors, and the allocation for construction was assigned to I-O 00003.

The procedure used in obtaining these allocations is discussed in greater detail in Section 8 (Commercial Industries).

SECTION 6

UTILITIES

Utilities are composed of electric and gas utilities as well as water and
sanitary services.

Electric utilities are further disaggregated into federal, state and local,
and private owned utilities. Within each of these electric utility sectors,
there is a further break-down by fossil fuel, hydroelectric and nuclear es-
tablishments. Since individual generating plants do not have the flexibility
to switch among these methods of generation, plants may be classified in this
manner.

Gas utilities are divided between pipeline establishments and gas utilities,
excluding pipelines.

The material inputs used in the generation of electric energy and in the pro-
duction of mixed and manufactured gases will not be examined in this section,
but rather in the "Material Inputs to Conversion Process" section of this
chapter. On-highway use of transportation fuels used by utilities is also
discussed elsewhere--in the "Transportation" section. Only fuel and power
uses excluding on-highway transportation use of energy products are considered
for examination here.

ELECTRIC UTILITIES

The only fuel for which consumption data are available for this industry is
electric power. The Edison Electric Institute in its Statistical Yearbook
publishes the kilowatt-hours which are used for "company use and free service"
and "energy used by producers". These two categories were combined to obtain
a total use of electric power by the industry. These data are available for
the 1956-1972 period. The data overstate consumption strictly in the utility

sector by the free service portion. Based on the distribution of kilowatt-hours generated by each type of establishment in the utility industry, the consumption of KWH was distributed to these establishment groups.

GAS UTILITIES

Natural gas was the only energy product for which specific data were available measuring the fuel and power consumption of the gas utilities. These data were obtained from the American Gas Association.

WATER AND SANITARY SERVICES

This industry does use significant quantities of energy in its processing operations. An exhaustive search for data measuring the consumption of fuel and power at water and waste treatment facilities was made without success. Even where fragments of data measuring consumption were available for one year, these could not be used in conjunction with an output index to calculate consumption over time, due to changes in technology over the twenty-six years covered by the Historical Energy Flow Accounts.

SECTION 7

COMMERCIAL INDUSTRIES

Unfortunately, there is no generally accepted definition of the "commercial" industries among the sources of data reporting energy consumption. In some instances, the term "commercial" has been applied to consumption in agriculture, small manufacturing, and government. In other cases, "commercial" consumption has been treated as a residual of all other consumption, without any attempt to precisely define the sector coverage of that residual.

In the present report, the term "commercial" has been given a relatively narrow definition, covering eleven input-output sectors. More specifically, commercial consumption is all consumption by the communications (I-O 66000, 67000), trade (I-O 69010, 69020), and service sectors (I-O 70000-73000; 75000-77000). (I-O 74000 has been eliminated as a separate industry, in line with the 1963 input-output study.)

The standard definition of real estate and rental used in the national accounts (I-O 71000) has been followed. All consumption by owner-occupied dwellings has been allocated to personal consumption expenditures, leaving only consumption by the real estate sector (I-O 71020) within the purview of sector 71000.

Total energy consumption by commercial industries is the sum of two components. The first, transportation use, is discussed in the section on transportation fuels, and includes consumption for private fleets of trucks, autos, and buses owned and operated by commercial establishments. The second, non-transportation uses, is the subject of the present section, and is composed of all consumption not accounted for under transportation, including off-highway use of gasoline, diesel, and LPG.

Under this heading of non-transportation uses, data were developed for eight energy types—electricity, natural gas, mixed gas, manufactured gas, fuel oil (the sum of distillate and residual), coal, LPG, and coke. The major data sources used in formulating estimates were the Federal Power Commission for electricity; the American Gas Association for natural, mixed, and manufactured gases; and the Bureau of Mines for fuel oil, coal, and LPG. A number of other private and governmental sources were drawn upon to supplement information provided by these organizations.

It should be immediately noted that data on some energy types known to have commercial uses, e.g., special naphtha used in dry-cleaning establishments, are not presented due to the insufficiency of existing information. For similar reasons, we have also not found reasonable methods for developing sector-by-sector allocations for all products. Only in those cases where the estimates were considered sufficiently reliable as to be of some analytical utility utility were allocations calculated and presented for individual sectors within the commercial industries as a whole.

The general approach taken to estimating commercial consumption involved three steps. The first was an attempt to develop a control total which approximated commercial consumption as closely as possible. Second, where existing data were sufficient, allocations to individual sectors covered by this control were made and subtracted from the control. And finally, if the sector coverage of the residual included any non-commercial industries, the residual was distributed on the basis of employment to all sectors included in this coverage whose total consumption had not already been accounted for by the individual allocations.

The use of employment data to obtain distributions of residual consumption was believed to provide as close an approximation of relative consumption across sectors as existing data permits. While it is fully recognized that per capita energy consumption is not uniform among consuming sectors, due

particularly to differences in the energy intensiveness of various activities, sector consumption for major uses such as space conditioning and lighting is felt, in most cases, to be linked to the number of persons engaged in production in that sector. In those sectors where allocations for non-transportation use would tend to be grossly overstated if based on total employment data, e.g., allocations to the motor freight sector based on the number of both operating and non-operating personnel, adjustments in the employment series were made.

The method used attempted to further minimize distortions which might result from employment distributions by excluding from those distributions all sectors for which individual sector allocations were felt to approximate total sector consumption. (Sectors for which the allocations covered only partial consumption, were left in the distribution.)

The portion of the residual thus allocated to the commercial industries appears as undistributed consumption by "commercial industries--total" (aggregate sector 00600). If the sector coverage of the residual was limited solely to the commercial industries, it was allocated directly to sector 00600 with our further adjustment.

The following section is a detailed presentation of the methodology used in obtaining data on non-transportation commercial consumption. Its organization is on a product-by-product basis, and will treat, within each energy type, the development of the control total, the estimation of individual sector allocations, and the treatment of the residual.

ELECTRICITY

Development of the Control Totals

The control totals for commercial consumption of electricity are identical to the Federal Power Commission's "Commercial Sales" data published in its

<u>Annual Report</u>. These data are compiled by the FPC on the basis of information collected on Forms 1 and 1-M.

The FPC's definition of "Commercial Sales" of electricity includes sales to customers with annual demands of 1,000 KW or less, and, in general, billed on a commercial rate basis. Sales to customers with annual demands of 1,000 KW or less, but billed on a different rate basis, e.g., residential customers, are excluded from the commercial sales total.

Based on conversations with personnel in the FPC's Bureau of Power, it is believed that this "Commercial Sales" total corresponds quite closely to the sum of sales to trade, communications, services, and construction, though the correspondence is not exact. For example, sales to some large commercial establishments may be reported under the "Industrial Sales" classification, while sales to some small industrial concerns may be included in the "Commercial Sales" total. Also, sales to rented residential units of less than five households are included in residential sales. Some sales allocated to real estate under the definition used in the present report are consequently not captured in these controls. On the whole, however, it was felt that "Commercial Sales" of electricity, as reported by the FPC, generally reflected sales to the sectors mentioned above.

<u>Individual Sector Allocations Within the Control Totals</u>

From existing information it was possible to allocate portions of this control total to individual sectors covered by the control, i.e., the commercial sectors and construction. These allocations will be discussed below.

Communications excluding Radio and Television Broadcasting--I-O 66000

Consumption of electricity for all years by I-O 66000 has been estimated from information supplied by the American Telephone and Telegraph Company on con-

sumption by the Bell System for 1972. Total consumption by the Bell System
in 1972 is printed in graph form in Energy Conservation and Consumption: Bell
System Performance for December, published in February, 1975. Numerical totals
adjusted to eliminate manufacturing use were made available to JFA by AT&T.

In order to estimate total sectoral consumption, it was necessary to adjust
upwards the figures for the Bell System alone. This was done by determining
average consumption per Bell System telephone, and multiplying by the number
of telephones in the United States each year. Statistics for both the number
of phones in the Bell System, and the number in the nation as a whole, are
published in the Federal Communications Commission's Common Carrier Statistics,
1971. 1972 data are available in preliminary reports for the 1972 edition.

It is believed that the estimates developed for telephone and telegraph service,
though omitting miscellaneous communications services, approximate total electric
consumption for the sector. It should be noted, however, that while the estimate
for 1972 is considered firm, the quality of the estimates for the benchmark
years are unknown since the mix of fuels and fuel efficiency per telephone is
assumed to be constant over time.

Radio and Television Broadcasting--I-O 67000

1972 consumption of electricity for transmission purposes was estimated by the
Federal Communications Commission and made available to JFA. 1972 is the only
year for which the FCC made such an estimate, and its reliability is uncertain.

Consumption for transmission purposes in all other years was estimated by
deriving the average number of kilowatt-hours per broadcast station in 1972,
and multiplying that average by the number of broadcast stations in the other
years. (The "number of broadcast stations" for any given year is defined as
the sum of television, AM, and FM stations operating during that year.) All
data are published in annual volumes of the FCC's Broadcasting Yearbook.

Recognizing that average consumption per station is certainly much greater today than in 1947, and that different energy needs separate AM and FM stations from television stations, all data are considered to be of uncertain quality, particularly for the earlier years.

Real Estate and Rental--I-0 71000

Total electric consumption by the real estate and rental sector is defined as including not only consumption for general operating purposes, e.g., office lighting and heating, but also all electric consumption by rented residential units which is paid for directly by the owner or realty agent, rather than by the tenant himself. In other words, if the cost of utilities is included in the contract rent, the expenditure is allocated to the real estate sector. If utility costs are paid by the tenant, they are considered personal consumption expenditures and allocated to residential demand.

While there is no precise information on electricity consumption by the real estate sector, estimates of real estate utility expenditures for rented residential units were derived from published data contained in the 1970 Census of Housing and the Survey of Current Business. These expenditure figures were then related to JFA estimates on residential consumption to obtain that portion of electricity consumption for residential units which is most properly allocated to real estate. Detailed procedures used to make the estimates follow:

First of all, data found in the 1970 Census of Population and Housing, Fourth Count Summary Tape for the Total United States provided figures for annual specified gross rent and annual specified contract rent (the difference between specified rent and total rent is that specified rent excludes rent paid for one-family homes on ten acres or more. Gross rent is essentially contract rent plus direct utility expenditures by tenants of rented dwellings, i.e., by subtracting specified contract rent from specified gross rent, total utility expenditures for specified units paying their own utilities are obtained.)

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The Fourth Count tape also provided information on the number of specified rented units for which utility expenditures were paid by the tenants themselves, and the number for which utility costs were paid by the real estate sector, i.e., those in which utilities were included in contract rent.

The above information was sufficient to allow an estimation of utility expenditures by the real estate sector. First, the average gross rent per specified rented unit was determined by dividing the total annual specified gross rent by the total number of specified units. By multiplying this average specified gross rent figure by the number of specified rented units paying their own utilities. Total annual specified gross rent for specified rented units paying their own utilities was calculated.

Second, by dividing utility expenditures of specified rented units paying their own utilities (the difference between specified gross and specified contract rent) by the gross rent of those units, an average percentage of utility expenditures in gross rent was obtained. This percentage was applied to specified gross rent of units not paying their own utilities (i.e., average per unit gross rent multiplied by the number of units paying no utilities) to arrive at total utility expenditures for specified rented units paying no utilities. It was assumed that these costs were paid by the real estate sector. Utility expenditures as a percentage of total specified contract rent was determined by dividing total utility expenditures by the real estate sector by the total specified contract rent. The resulting figure was 5.869 percent.

To obtain utility expenditures by real estate over time, two assumptions were made. First, it was assumed that this percentage (5.869 percent) applied to all rented units, not just specified units, and second, that the percentage of utility expenditures by real estate in contract rent remained stable over time. Beginning from these premises, Survey of Current Business data on contract rent (adjusted to take into account imputed space rental value of farmhouses) were used to obtain utility expenditures by real estate from 1947-1972. These expenditures were then distributed among energy types by applying the same percentage distribution of expenditures as that for residential consumption. Finally, physical quantities were calculated by dividing the total expenditure for each fuel type by the unit price used in calculating residential consumption.

By this method, estimates for consumption of electricity by rented residential units paid directly by the landlord or realty agent were derived and allocated to the real estate sector. They represent, however, only a first approximation, since residential, rather than commercial, price series were used. A more appropriate price series will be developed for the final report.

Retail Trade--I-O 69020; Hotels and Lodging Places--I-O 72000
Amusements--I-O 76000; Medical, Educational, Non-Profit--I-O 77000

No firm data on commercial consumption of electricity for refrigeration were available. However, based on a Stanford Research Institute study entitled Patterns of Energy Consumption in the United States, estimates for the food service industry and for supermarkets were derived for two years--1966 and 1967. For food service establishments, SRI relied heavily on data compiled by the U.S. Department of Agriculture in its study of the food service industry in 1966. (The published portion of this information can be found in The Food Service Industry: Its Structure and Characteristics, Statistical Bulletin No. 416, USDA Economic Research Service, Marketing Economics Division.)

Within each of 24 sector groupings used by USDA, SRI obtained information on the number of establishments with walk-in refrigerators; the number with reach-in refrigerators, and the number with freezers. Also available was the average number of cubic feet per place of such equipment. By multiplying the average cubic footage per place by the number of places, the total sector cubic footage by type of equipment was obtained.

Through conversations with manufacturers of refrigeration equipment, average kilowatt-hour consumption per cubic foot of refrigerator and freezer space was estimated and multiplied by the cubic footage in each sector. The result was a sector-by-sector KWH consumption for refrigeration.

In the present report, the SRI consumption estimates for 18 of the 24 sectors were allocated unadjusted to one of the four I-O sectors listed above. In

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some instances, however, SRI sector classifications did not fall in the commercial
industries, or were not clearly enough defined so that the data could be utilized.
This was the case for SRI sectors "Other Public", "Other Institutional", "Colleges
and Professional Schools", "Fraternity and Sorority Houses", and "Civic Social
and Fraternal Organizations". Thus, the total shown for refrigeration will not
correspond completely to that contained in the SRI study. (For the final report,
an attempt will be made to determine the precise coverage of these sectors.)

Total consumption of electriticy for supermarket refrigeration for 1966 was also
taken directly from the SRI study, and added to the consumption allocated to the
retail sector. This estimate is considered to be less reliable than that for the
food service industry, but was used for 1966 in order to provide a measure of the
magnitude of total retail consumption.

To bring these data to a benchmark year, consumption estimates were made for 1967.
For the SRI classifications within I-O sectors 69020, 72000 and 76000, estimates
of the 1966 sales were made based on data for 1963 and 1967 sales published in the
1967 Census of Retail Trade and Selected Services. A KWH per dollar of sales figure
was derived for that year, and multiplied by the 1967 sales figure.

For IO-77000, the major consuming sectors in the SRI report were hospitals,
convalescent and other homes (85 percent of total consumption). Lacking sales
data comparable to that for the other sectors, the 1966 consumption figure was
trended in relation to the number of patients in hospitals.

Treatment of Residual Electricity

The individual sector allocations discussed above, i.e., those for communi-
cations (excluding radio and television broadcasting), radio and television
broadcasting, real estate and rental, and commercial refrigeration were
summed, and deducted from the FPC "Commercial Sales" control total. The
remainder was a residual kilowatt-hour figure which could not readily be

distributed to specific sectors covered by the control, i.e., the commercial sector and the construction industry.

Given the insufficiency of existing information, it was felt to be of little analytical utility to attempt a detailed sector by sector distribution of this residual. The only further adjustment made was to estimate the portion of the residual consumed by the Commercial industries.

This estimation was based on the annual distribution of employment between the commercial and contract construction sectors. For the commercial sector, data on the "number of persons engaged in production" in each of the benchmark years, published in the Survey of Current Business, was used. These annual (revised) totals were felt to be the best measure of total employment, since they account not only for employees, but self-employed as well. For the contract construction industries, figures for supervisory personnel were developed, based on information on total employees and construction workers published in the Bureau of Labor Statistics' Employment and Earnings, United States, 1909-72. It was believed that the use of the "number of persons engaged in production" series would tend to overstate consumption by the construction sector, and that a more suitable distribution could be obtained by utilizing supervisory employment only (i.e., that the average per capita consumption of electricity by construction workers was well below the average per capita consumption of those employed in the commercial sector).

The final distribution by employment was made across all sectors within the construction and commercial industries, except I-O 66000 and I-O 11010 (Oil and Gas Well Drilling). As mentioned, data provided by AT&T allowed an estimation of total consumption by communications excluding radio and television broadcasting. As for I-O 11010, sales of electricity to that sector were not originally included in the "Commercial Sales" control.

This method produced two figures--total undistributed aggregate commercial consumption, and total consumption of electricity by the construction industry

excluding oil and gas well drilling. The aggregate commercial figure was allocated to Sector 00600. That for construction was added to JFA estimates for oil and gas well drilling in order to obtain an estimate of total electricity consumed for Sector 00003.

NATURAL, MIXED AND MANUFACTURED GAS

Development of the Control Totals

The control totals for natural, mixed and manufactured gas are taken directly from the American Gas Association's "Commercial Sales" figures published in annual volumes of <u>Gas Facts</u>. The data are compiled from an annual independent survey conducted by AGA. Representatives believe that approximately 98 percent of total gas utility sales are directly covered by this survey, with the aggregated results expanded 2 percent to obtain total national sales.

AGA's "Commercial Sales" cover a broad range of activities not included under the strict definition of "commercial" used in the present report. Besides trade, communications and services, the total also includes sales to agriculture, forestry, and fisheries (I-O 01000-04000), the transportation sectors (I-O 65010-65070), and construction excluding oil and gas well drilling (I-O 11020 and I-O 12000). There is also a discrepancy between AGA's definition of sales to real estate and the standard input-output definition. As is the case with electricity, sales to rented units of less than five households are considered residential rather than commercial sales.

Individual Sector Allocations with the Control Sectors

Hotels, Lodging Places, Personal and Repair Service, Excluding Auto Repair--
IO-72000

Sector allocations to IO-72000 were made for all three gases for 1954, 1958,

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1962, and 1967. For 1971, an estimate for natural gas only was obtained since there were no reported sales of either mixed or manufactured gas in that year. These data were derived from annual figures on total "Gas Utility Industry Large Volume Sales" published for the period 1950-1972 in Gas Facts. This information was not available for 1947, and estimates were consequently not made for that year.

Large volume sales are defined as all gas sales to customers using more than fifty million cubic feet of gas annually, and are reported for 27 sector groupings spanning IO-01000-77000. Utilities reporting information on these sales accounted for approximately 90% of all non-residential sales between 1960 and 1972, and between 80% and 90% from 1950 to 1960.

It was first necessary to determine which of these 27 sector groupings, when summed, corresponded to the total sector coverage of the "Commercial Sales" control. Of the 27, 6 were isolated: Agriculture, Forestry and Fisheries; Other Transportation, Communications and Public Utilities; Hotels, Rooming Houses and Camps; Laundries, Cleaning and Dyeing establishments; Other Services, and Other Non-Manufacturing.

For each of the benchmark years except 1947, a total large volume sales figure for these six sectors was calculated, and a percentage distribution of this total among the six sectors was obtained. The percentages (for "Hotels, Rooming Houses, and Camps" and "Laundries, Cleaning, and Dyeing Establishments",) were then applied to the controls for the five years, resulting in absolute sales for the two sectors by type of gas.

The use of this procedure was based on two premises. First, it was assumed that the distribution of total large volume sales sufficiently reflected the distribution of total sales as to allow estimates of relative consumption among sectors. Secondly, since large volume sales were presented only on an aggregated basis, and not by type of gas, it was also assumed that the

composition of sector sales is comparable to that of total commercial sales (as defined by AGA).

The results, however, were not entirely satisfactory. A level change in sales to laundries, cleaning, and dyeing establishments occurred between 1962 and 1963, which could not be explained by economic factors. Personnel at AGA believed that this change most likely resulted from a shift in the reporting procedures of survey respondants. The pre-1963 series was subsequently adjusted by calculating the sector's 1963 share of total large volume sales, applying this percent to the 1962 control, and trending that figure back to 1950 on the basis of year to year percentage changes in the sector's large volume sales.

The resulting estimates were combined with those for "Hotels, Rooming Houses and Camps" to arrive at the allocation for I-0 72000. It is believed these estimates provide a useful gauge of the magnitude of total sector consumption; though there is no means to determine their quality.

Communications Excluding Radio and Television Broadcasting—I-0 66000

Consumption of natural gas only for I-0 66000 was estimated in a manner similar to that employed for determining electricity consumption. Information provided by AT&T for non-manufacturing use by the Bell System in 1972 was used to determine natural gas consumption per Bell telephone. This estimate was multiplied by the number of telephones in the United States in each year from 1947 to 1971.

It is believed that these estimates approximate total sector consumption, but suffer from the same lack of information on fuel efficiency and fuel mix as those for electricity.

Real Estate and Rental—I-0 71000

To obtain estimates of consumption of natural, mixed, and manufactured gas by rented residential units which is paid for directly by the owner

or realty agent, the same procedure used to determine consumption of electricity was employed. Utility expenditures by real estate as a percentage of contract rent were derived from data in the 1970 Census of Population and Housing Fourth Count Summary Tape for the Total United States. Absolute expenditures were calculated by applying this percentage to the adjusted contract rent figures from the Survey of Current Business.

These expenditures were then distributed across fuel types on the basis of JFA estimates for the percentage distribution of residential energy expenditures. Dollar values were then converted to physical units by dividing the total expenditure for each gas by the unit price used in calculating residential consumption. As noted earlier, these estimates serve only as a first approximation of consumption given the use of residential rather than commercial prices.

Treatment of the Residual

The individual sector allocations just examined (i.e., those for hotels and personal services, communications excluding radio and television broadcasting, and real estate and rental, were summed and deducted from the AGA's "Commercial Sales" control for each year the allocations were made. The remainder comprised all unallocated sales by gas utilities to agriculture, forestry and fisheries, transportation, construction (excluding oil and gas well drilling) and the commercial industries.

For all years except 1947, one further deduction for sales to agriculture, forestry, and fisheries was made. Estimates of these sales were derived in the same manner as the estimates for hotels and laundries, i.e., on the basis of the percentage distribution of large volume sales. These data are not, however, those which appear in this report as consumption by I-O 01000-04000. These latter estimates were derived independently, and include not only sales to agriculture, but also gas siphoned by farmers in exchange for pipeline rights-of-way.

After the above deductions were made, the unallocated residual was distri-
buted (except in 1947) to each of the transportation sectors except rail-
roads, and to each of the commercial sectors except I-O 66000 and I-O 72000.
The reason for excluding construction (an activity which falls within the
control's sector coverage) was the belief that an allocation based on
supervisory personnel alone would still greatly overstate sectoral con-
sumption. As for railroads, Interstate Commerce Commission annual reports
show no gas consumption for this sector, and it was therefore assumed to be
zero. I-O 01000-04000, I-O 66000 and I-O 72000 were also excluded on the
belief that the individual allocations to these sectors approximated total
consumption, and that additional allocations based on employment would over-
state total sectoral energy use.

The Survey of Current Business and the Bureau of Labor Statistics' Employ-
ment and Earnings, United States, 1909-1972, were again used to derive
employment estimates for those sectors to which the final residual was dis-
tributed. For the transportation sectors, a series on non-operating per-
sonnel was developed as the most suitable gauge of relative consumption. For
the commercial sectors, the Survey of Current Business data on "Number of
Persons Engaged in Production" was used.

For 1947, allocations to I-O 72000 and I-O 01000-04000 were not developed due
to the lack of information on large volume sales. Consequently, employment to-
tals for these sectors were included in the distribution of the residual for 1947.

This method produced allocations for each of the transportation sectors
(excluding railroads), and total undistributed consumption by the commercial
industries. The latter total was allocated to I-O 00600. Since transportation
use of energy by the transportation sector was available, the allocations
to the disaggregated transportation industries were left distributed so as
to provide estimates for total consumption by these sectors.

FUEL OIL (DISTILLATE AND RESIDUAL)

Development of the Control Total

As was the case with electricity and gas, it was not possible to develop a
control total for strictly commercial consumption. However, a control
covering the commercial industries, transportation, construction (excluding
oil and gas well drilling) and non-military government use was calculated
based on information from a number of sources.

The starting point chosen was Bureau of Mines data on total sales of distillate
and residual fuel oil published annually in the Mineral Industry Survey
Fuel Oil and Kerosine Sales. This information is compiled from Form No.
6-1337-A "Fuel Oil and Kerosine Sales and Inventories".

The sum of total sales of distillate and residual fuel oil was taken as
reflecting total consumption of fuel oil for each of the six years. Sector
use, however, could not be determined relying solely on information published
in this survey. Its insufficiency was due principally to the sales classi-
fication employed on Form No. 6-1337-A.

More specifically, the Bureau of Mines requests that reporting companies
distribute their total final sales across ten different categories: heating
oils; industrial use (excluding oil company use); oil company use (in-
cluding own use); railroad use; vessel bunkering; military use; use by
electric utilities; on-highway use; off-highway use; and all other uses.
A particular problem is that the "heating oils" figure includes heating oil
consumption by all sectors, even though sales for non-heating uses are
collected for individual sectors.

Thus, to arrive at a control with the narrowest possible sector coverage,
estimates from various sources which reflected total sector use (heating

plus non-heating consumption) were compiled and deducted from the Bureau of Mines total sales figure. For agriculture, on-highway, railroad, vessel, pipeline and residential use, the estimates shown in the present report were used. For mining and oil and gas well drilling, Census of Mineral Industry data were utilized. For manufacturing, Census of Manufacturing estimates were taken. Finally, Bureau of Mines figures were used for sales to electric utilities and to the military.

After these deductions, there remained non-transportation use in the commercial industries, all transportation sectors except railroads, construction (excluding oil and gas well drilling) and civilian government. From this figure, the following two sector allocations were deducted.

Individual Sector Allocations within the Control

Communications (Excluding Radio and Television Broadcasting)--I-O 66000

Consumption by I-O 66000 was again estimated on data for 1972 consumption by the Bell System provided by AT&T. Average consumption of fuel oil per Bell Telephone in 1972 was calculated, and multiplied by the number of telephones in the United States in each year from 1947 to 1971. Again, the problems of fuel efficiency and fuel mix consumed over time leave the quality of the data uncertain.

Real Estate and Rental--I-O 71000

The procedure for estimating fuel oil consumption by rented residential units which is paid for directly by the owner or realty agent was the same as that used for electricity and gas. Utility expenditures as a percentage of contract rent were calculated from Bureau of Census information. Absolute utility expenditures were determined from Survey of Current Business data, and distributed on the basis of JFA estimates of residential expenditures. Again residential prices were used to determine physical quantity.

Treatment of the Residual

The derived control totals, less the individual sector allocations for
I-O 66000 and I-O 71000 were distributed by employment across construction
(excluding oil and gas well drilling), the transportation sectors (excluding
railroads), the commercial industries (excluding I-O 66000), and civilian
government. Railroads were excluded from the distribution because information
collected by the ICC reflected total sector use. I-O 66000 was also ex-
cluded because estimates based on data supplied by AT&T were believed to
approach total sector consumption.

For the remaining sectors, employment data for construction, transportation
and the commercial industries were once more taken from the Survey of
Current Business and Employment and Earnings. Figures for civilian govern-
ment were also added, derived from the Survey of Current Business series on
"Number of Persons Engaged in Production".

Distribution of the residual across these sectors yielded a total
undistributed consumption figure for the commercial industries. This
estimate was allocated to I-O 00600. Data for contract construction,
each transportation sector except railroads, and civilian governments were
also derived and allocated to the appropriate I-O.

COAL

Development of the Control Total

The control totals which served as the base for determining commercial con-
sumption of coal were the "derived retail delivery" data calculated in
determining residential consumption, less residential consumption itself.

These derived retail deliveries were obtained by subtracting from total
apparent consumption (production plus imports minus exports minus change
in stocks) available data on sales to individual sectors. From the derived
retail deliveries, estimates of residential consumption were made based
on personal consumption expenditure data. This residential consumption was

then deducted from the retail deliveries figure to leave a control which
could be used in gauging commercial consumption.

The coverage of this control included three major industries--transportation,
commercial and civilian government.

Individual Sector Allocations

The only individual sector allocation deducted from the above controls was
for consumption by residential rented dwellings which was paid for directly
by the owner or realty agent. These allocations were obtained in the same
manner as that for the other energy types. Utility expenditures as a per-
centage of contract rent were derived from data on the 1970 Census of
Population and Housing Fourth County Summary Tape for the Total United States.
Absolute expenditures were determined by multiplying this percentage by the
contract rent figures (adjusted) published in the Survey of Current Business,
and distributed across fuel types on the basis of JFA estimates for resi-
dential consumption. These expenditures by fuel type were translated to
physical units by using residential unit prices.

Treatment of the Residual

After the deduction of the above allocation, distribution by employment to
each transportation sector except railroads, the commercial industries ex-
cluding I-0 66000, and civilian government was made. Railroads were again
excluded due to the comprehensive nature of Interstate Commerce Commission
data. Communications excluding radio and television broadcasting was not
included because the AT&T information on fuel consumption for 1972 reported
no consumption of coal. It is very probable that in earlier years, some
coal was consumed by this sector, but to add an allocation for coal to total
energy consumption would tend to overstate the actual energy requirements of
the industry.

The data on employment was again based on estimates published in the Survey
of Current Business and Employment and Earnings.

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LIQUIFIED PETROLEUM GAS (LPG)

Development of the Control Totals

Data for commercial consumption of LPG was drawn from the Bureau of Mines'
Mineral Industry Survey Sales of Liquified Petroleum Gas Form No. 6-1435-A.

Two classes of service reported by the Bureau of Mines included sales of LPG
for commercial use. The first of these two, "Residential and Commercial
Uses", is defined as sales for "use in private households, and non-manufacturing
establishments such as motels, restaurants, retail stores, laundries, etc.,
primarily for use in space heating, water heating and cooking". By sub-
tracting JFA estimates of residential LPG consumption, a residual was
obtained, which, based on discussions with Bureau of Mines personnel, is
believed to correspond quite well to consumption by the commercial sector.

The second sales classification, "internal-combustion engine fuel", includes
sales for "use in tractors, irrigation engines, highway vehicles, fork lifts,
oil field drilling and production equipment, etc,". Within this total would be
some amount of commercial consumption such as that for use in the wholesale
trade sector. Due to the lack of sufficient information, however, these
sales, less a deduction of the JFA estimate for on-highway use, were left
undistributed. The only available data on off-highway internal-combustion
engine consumption are Liquefied Petroleum Gas Association estimates for farm
tractor, industrial tractor and stationary engine use in 1969. These esti-
mates, though, were not utilized, due to the limited coverage and low
response rate of the survey from which they were derived.

Individual Sector Allocations

Communications Excluding Radio and Television Broadcasting--I-O 66000

Allocations of LPG to I-O 66000 were based on the information supplied by
AT&T. Average consumption for Bell telephone in 1972 was calculated and

multiplied by the number of telephones in the United States in each of the benchmark years.

Real Estate and Rental—I-O 71000

Estimates for LPG consumption by rented residential units which is paid for by the owner or realty agent were made in the manner used for deriving estimates for the other energy types. The Fourth Count tape, combined with the Survey of Current Business data on contract rent, yielded absolute utility expenditures by real estate. These expenditures were distributed across fuel types on the basis of JFA estimates for residential consumption, and converted to physical units using residential unit price data.

Treatment of the Residual

After deduction of the above two allocations from the adjusted "Household and Commercial Uses", the residual was allocated to I-O 00600, "Commercial Industries—Total".

COKE

No overall control total for coke was developed, due to the lack of sufficient information. However, an allocation to I-O 71000, real estate and rental, were independently arrived at in the same manner used to determine consumption of other fuel types by rented residential units.

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PERSONAL CONSUMPTION EXPENDITURES

This section presents a detailed description of energy consumed by the personal consumption component of final demand. Included in this sector is energy used in all household operations, i.e., space heating, water heating, cooking, refrigeration, appliances and lighting, etc. However, it does not include fuels consumed for personal transportation, discussed in the transportation section. Only energy expenditures by households and individuals residing in individually-metered dwellings are measured in this sector. All other residential consumption, such as apartment housing and dormitories have been categorized as commercial uses.

Personal Consumption Expenditures (PCE) for each energy type have been calculated on a national annual basis without regard to functional uses. The primary data were obtained from Table 2.5 "Personal Consumption Expenditures by Type of Product" in the July issues of the Survey of Current Business published by the Bureau of Economic Analysis. Expenditures are reported in millions of dollars for electricity, gas, and "other fuels and ice" for each year covered by the Historical Energy Flow Accounts (see Table 4-15).

Gas consumption expenditures were further disaggregated by type of gas-- natural, mixed, and manufactured. Estimates were based on residential sales data compiled by the American Gas Association.

Using the Bureau of Labor Statistics' Consumer Expenditure Surveys (CES) of 1950, 1960, and 1972 (unpublished detail) the "other fuels and ice expenditures" were disaggregated into separate figures for coal, coke, fuel oil, kerosine, liquefied petroleum gas (LPG), and fuelwood for those benchmark years. Residential coal and coke consumption was then estimated for the remaining years using the Bureau of Mines' Minerals Yearbooks, and Census of Mining. Coal and coke expenditures were deducted from the "other fuels" component of PCE leaving fuel oil, kerosine, LPG, and wood to be distributed according to the Consumer Expenditure Survey.

TABLE 4-15.–PERSONAL CONSUMPTION EXPENDITURES FOR FUELS USED IN THE HOUSEHOLD[a]

(Dollars, Million)

	Electricity	Gas	Other Fuel and Ice
1972	12250	6174	7829000
1971	10936	5699	6876000
1970	9824	5262	6752000
1969	8905	4938	6358000
1968	8141	4613	6145000
1967	7496	4432	5981000
1966	7027	4242	5770000
1965	6608	4075	5391000
1964	6294	3939	4950000
1963	5960	3770	4770000
1962	5688	3644	4422000
1961	5340	3415	4278000
1960	5071	3211	4176000
1959	4721	2901	4201000
1958	4381	2685	4153000
1957	4097	2403	4058000
1956	3802	2259	3887000
1955	3496	2027	3751000
1954	3213	1800	3491000
1953	2932	1589	3416000
1952	2652	1469	3439000
1951	2395	1345	3496000
1950	2138	1185	3374000
1949	1879	1038	3055000
1948	1668	963	3446000
1947	1473	865	2950000

[a]*Excludes fuels used for transportation and non-individually metered dwelling units.*

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Retail price series for each energy type were developed and applied to the annual expenditures to arrive at quantities of energy consumption. Natural, mixed, and manufactured gases and LPG prices were calculated from sales and revenue statistics published in the American Gas Association's Gas Facts and Historical Statistics of the Gas Industry, Minerals Yearbook and the Bureau of Labor Statistics' Consumer and Wholesale Price Indexes were used to determine average retail prices of coal, coke, fuel oil, and kerosine. Since no sources are available for residential fuelwood prices, consumption is given in dollar values only.

A more detailed discussion of Personal Consumption Expenditures for each energy type follows.

ELECTRICITY

The value and quantity of electric energy consumption were obtained directly from federal government published documents. The Survey of Current Business, Table 2.5 (July issues) provides the dollar amounts spent annually for electicity by the personal consumption sector. Volume figures were found in the Federal Power Commission, Annual Reports, Table entitled "Kilowatt-hour Sales in Millions". These tables are compiled from the FPC's monthly publications Electric Power Statistics, Table entitled "Sales of Electric Energy to Ultimate Consumers." The primary data covers both privately and publicly owned utilities filing mandatory FPC survey forms. The residential sales classification includes use on farms and in rural areas but does not include irrigation included in the sales classification "Rural (district and rural rates)." The FPC data cover certain classes of publically owned plants excluded from the Edison Electric Institute (EEI) statistics on electric energy sales, therefore FPC data were used rather than those from EEI. Table 4-16 illustrates the difference between these two sources.

TABLE 4-16.-CONSUMPTION OF ELECTRIC ENERGY BY THE
HOUSEHOLD SECTOR[a]

(KWH, Millions)

	Federal Power Commission Data	Edison Electric Institute Data
1971	499,615	479,080
1967	340,332	331,525
1963	250,753	241,692
1958	169,492	164,839
1954	116,228	113,065
1947	49,418	NA

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[a]*Excludes dwellings which are not individually metered.*

GAS

The amount of gas consumed by households includes three types: natural gas (dry--residue), manufactured gas, and mixed gas. Although natural gas has been the dominant gas type in recent years, accounting for close to 100% in 1971 and 1972, in the earlier years of our time series it accounted for about 75% of sales and 53% of revenues in the residential market.

In order to allocate expenditures by type of gas for the 1947-1972 period, utility industry revenues for each type of gas were calculated as a percent of total residential revenues. The data were obtained from Gas Facts, Tables 79 in the 1973 edition, Tables 82, 83, and 84 in the 1971 edition and from Historical Statistics of the Gas Industry, Tables 110, 111 and 112, both published by the American Gas Association. The percentages were then applied to the PCE data to estimate natural, mixed, and manufactured gas expenditures in millions of dollars.

Prices were calculated for each gas type by dividing residential sales by A.G.A. residential revenues. Sales statistics were found in the same source used above; on Table 64 in the 1973 edition and Tables 69, 70, and 71 in the 1971 edition of Gas Facts and on tables 90, 91, and 92 in Historical Statistics of the Gas Industry. Most data were reported in millions of therms and converted to trillions of BTU on the basis of one therm equals 100,000 BTUs. Prices were computed in thousands of BTUs per dollar for each type of gas. The estimated PCE were divided by the price to determine the physical quantities of natural, mixed, and manufactured gas consumed in billions of BTUs. BTU conversion factors were applied to obtain the cubic feet of each type of gas. (See BTU Conversion Table for factors used)

ALL OTHER FUELS

The basis for distributing the "other fuels and ice" item reported in the Survey of Current Business is the Bureau of Labor Statistics" Consumer Expenditure Survey (CES) for 1950, 1960, and 1972. The CES measures the average

expenditures by families (including one-person families) for fuel during that year. This information was used as benchmarks from which the "other fuels" purchases were developed for the complete time series.

In 1950 the BlS surveyed 91 cities of various sizes and geographic locations. Table A in the CES provides the list and characteristics of each city including the number of families in the sample. Table 1, Part 1 in Volume XIII of the "Study of Consumer Expenditures, Incomes, and Savings" contains detailed information on average family expenditures for fuel, light, and refrigeration for each urban area. The tabulations present specific fuel expenses for coal , coke, wood, kerosine, and No. 1 fuel oil, No. 2 fuel oil, LPG, and ice used for heating, cooking and refrigeration purposes which are not covered by contract rent. Aggregate expenditures by city were calculated for the individual fuel types by multiplying the average expenditures by the total number of sample families in that city. Having computed aggregate expenditures for the families in the sample for each city in this manner, a grand total was tabulated by summing the 91 cities by individual fuel, and ice outlays. A percent distribution of expenditures by type of fuel was finally calculated (Table 4-17).

The 1960 CES was published in a more convenient format for our purpose. BLS findings were published in a number of separate reports in "Consumer Expenditures and Income, Detail of Expenditures and Income," one covering urban areas only and another covering the total U.S. Table 29A in each shows in detail the average expendtiure for fuel, light, and refrigeration by families and single consumers. Included are data on coke and coal, wood, kerosine, fuel oil LPG, and ice.

Although the CES for 1972 has not yet been published, preliminary estimates of fuel expenditures were gathered from personal conversations with BLS. Average expenditures per household are available in four breakdowns: "Coal and wood", "Fuel oil and kerosine", LPG, and ice. In order to achieve

TABLE 4-17.-PERCENT DISTRIBUTION OF PERSONAL CONSUMPTION
EXPENDITURES OF "OTHER FUELS AND ICE" FOR CONSUMER EXPENDITURE
SURVEY BENCHMARK YEARS

	1950 Urban	1960 Urban	1960 Total U.S.	1972 Total U.S.
Coal and Coke	45.46	14.46	16.46	8.05
Fuel Oil	28.79	64.64	57.47	55.66
Kerosine	14.08	15.42	19.82	18.55
LPG	1.19	1.93	1.53	16.49
Wood	5.64	2.31	3.76	0.73
Ice	4.84	1.24	0.96	0.52
Total	100.00	100.00	100.00	100.00

further disaggregation, the 1972 residential fuelwood expenditure was esti-
mated from the sharply declining consumption pattern shown in the two previous
CES reports as well as conversations with staff members of the U.S. Department
of Agriculture, Forest Service. Fuel oil and kerosine expenditures were
broken down using the Bureau of Mines' Mineral Industry Surveys, "Sales
of Fuel Oil and Kerosine in 1972." Total U.S. sales of kerosine, excluding
jet fuel (Table 2), plus No. 1 distillate heating oil (Table 6) were divided
by the total U.S. sales of No. 2 fuel oil (Table 6). The ratio, about one
to three, was applied to the 1972 CES to derive separate expenditure figures
for fuel oil and kerosine. Having done this, all three CES were now on
a comparable basis, except for the fact that the 1950 CES measured only
urban family expenditures, while the 1960 and 1972 data also compiled expen-
ditures for all families. The procedure used to adjust the 1950 data will
be discussed below.

Coal

The method used to estimate PCE for coal over the 1947-1972 time period
is based on a determination of the proportion of retail deliveries of coal,
as reported by the Bureau of Mines, which make up residential coal consumption.
This excludes coal consumed in rented dwellings in which the occupant is
not directly billed for the coal.

The first step was to arrive at an estimate of residential coal consumption
for 1947. This was done by calculating coal as a percent of "other fuel
and ice" expenditures from the 1950 urban CES and the 1960 urban and total
U.S. CES data. During that period urban coal expenditures dropped from
43.60% to 14.32%, an annual decrease of 2.93 percentage points. This negative
rate was applied to the coal share of 16.30% in the 1960 total U.S. CES
and trended back to 1947. The resultant estimated proportion of "other
fuel and ice" accounted for by coal was 54.50% for all families in the U.S.
in 1947. Multiplying this percent by the "other fuels and ice" expenditures
in PCE produces the dollar amount of residential coal consumption. A quantity
figure was computed in thousands of short tons by dividing by the retail

price in 1947. (Coal prices will be discussed later).

A similar procedure was repeated to arrive at an estimate of 1971 coal consumption. According to the average expenditures data in the 1972 CES coal accounted for only 8.49% of household "other fuels and ice" expenditures, compared to the 16.30% in 1960. The coal share declined 0.65 percentage points per year. From this it was estimated that coal accounted for 9.14% of the "other fuels and ice" outlays in 1971. Again prices were applied to get a physical quantity in thousands short tons.

The next step was to derive an estiamte of retail coal delieries for the census benchmark years 1947, 1954, 1958, 1962, 1967, and 1971. Apparent consumption was calculated by adding domestic production plus imports minus exports minus inventory change. After deducting the amounts of coal used for manufacturing, mining, electric utilities, coke plants, railroads, briquets, and bunker fuel, the residual represented "derived" retail delieries. Supply and demand data came from Minerals Yearbook chapters on anthracite and bituminous coal and lignite in the "Fuels" volume, the Census of Manufactures, and estimates produced by JFA based on the Census of Mineral Industries.

To complete the rest of the time series, a comparison was made with the retail deliveries data published in the Minerals Yearbooks. Retail deliveries of anthracite (estimated for 1947-1972) were added to those of bituminous coal and lignite and the totals were divided by the derived deliveries in the census years. The quotients are correction factor which were applied to the Bureau of Mines' retail deliveries data. The values of the correction factors were interpolated for the non-benchmark year and applied to the BOM data. This adjustment was made to the Bureau of Mines retail deliveries data since it was considered to be understated when compared to the consumption data for coal as measured by the 1950 and 1960 Consumer Expenditure Surveys. Estimates of retail deliveries of coal were thus generated. (See Table 4-18).

TABLE 4-18.—PERSONAL CONSUMPTION EXPENDITURES FOR COAL

(Short Tons, Thousand)

	BOM Retail Deliveries	"Derived" Retail Deliveries	Residential Consumption
1972	14708	29416	19485
1971	15201	31206	20632
1970	16114	34140	22529
1969	16875	36845	24268
1968	19983	45007	29588
1967	22134	51445	33756
1966	25185	50370	32987
1965	25676	44654	29188
1964	22949	35306	23034
1963	27603	38073	24791
1962	32955	41314	26850
1961	32805	39053	25331
1960	37180	43741	28318
1959	36700	42924	27735
1958	45005	52952	34149
1957	46382	55547	35753
1956	62143	76249	48982
1955	66781	83476	53521
1954	66243	83976	53736
1953	76017	98723	63049
1952	86820	114993	73296
1951	95845	130401	82955
1950	107432	149211	94734
1949	109978	155997	98847
1948	115951	168045	106272
1947	124323	184666	116552

Note: Anthracite portion of Bureau of Mines deliveries was estimated from the 1947-1972 period.

Next the personal consumption expenditures for coal were estimated.

Going back to the amount of coal consumed by households in 1947 and 1971, the proportion of residential sales to derived retail deliveries increased from about 63% to about 66% over the period. A linear trend line from 1947 and 1971 was used to estimate the residential share of the retail market for the intervening years and 1972. These percentages were then multiplied by the derived retail deliveries to obtain a complete series of residential consumption in thousands of tons. Multiplying by the price per ton gives the amount of PCE for coal.

Coal prices used here were an average of bituminous and anthracite retail prices weighted by retail sales. The retail price of bituminous is published in the Minerals Yearbook for 1947-1963. The remaining years were estimated from the year-to-year change in the BLS wholesale price indexes (WPI) for domestic large size and domestic stoker bituminous coal. Retail anthracite prices were based on the BLS consumer and wholesale price indexes with 1958 as the base year, the prices of the two dominant residential anthracite types, stoker and buckwheat No. 1 were averaged. For 1947-1963 the CPI was used and for 1964-1972 the WPI.

The market shares of bituminous and lignite and of anthracite were calculated as a percent of the Bureau of Mines' figures on coal deliveries for each year. These percentages were then used as weights in averaging the retail price of two types of coal. (See Table 4-19 for retail prices).

<center>COKE</center>

The quantity and value of coke included in PCE was very small relative to other household fuels over the 1947-1972 period. Estimated coal consumption was based on ratios of retail coke sales to retail coal deliveries from data found in the Minerals Yearbook's chapters on coal (bituminous and anthracite) and coke for each year. By multiplying the estimated residential coal consumption discussed above by this ratio, an estimate of the quantity of coke consumed by the residential sector was obtained. Unit prices were reported

TABLE 4-19.–RETAIL PRICES OF "OTHER FUELS" COMPONENT OF PERSONAL CONSUMPTION EXPENDITURES

	Bituminous & Lignite ($/Ton)	Anthracite ($/Ton)	Coke ($/Ton)	Fuel Oil #2 ($/BBL.)	Kerosine (¢/Gal.)
1974	-	-	-	-	34.50
1973	-	-	-	-	19.32
1972	31.09	36.86	27.06	8.68	16.04
1971	29.31	35.36	21.46	9.60	15.88
1970	25.04	32.02	20.19	10.99	15.40
1969	19.15	28.54	18.67	10.55	15.71
1968	18.11	26.75	17.96	10.47	15.87
1967	17.63	24.39	17.35	11.08	15.71
1966	17.33	24.28	17.02	11.12	14.61
1965	17.08	24.60	16.45	10.90	14.17
1964	17.13	25.78	15.91	10.45	13.32
1963	17.46	24.34	15.25	10.50	14.52
1962	17.30	23.63	14.10	10.67	14.52
1961	17.12	23.41	17.12	10.50	14.52
1960	17.06	22.92	17.24	10.04	13.94
1959	16.89	23.44	17.22	9.67	14.22
1958	16.53	23.67	17.12	9.91	13.65
1957	16.28	23.86	17.10	9.75	14.74
1956	15.65	21.97	16.27	9.87	14.30
1955	15.10	20.88	15.08	9.79	13.44
1954	14.94	21.26	14.83	10.56	13.17
1953	14.95	22.09	15.24	10.59	12.91
1952	16.27	20.65	14.74	10.59	12.91
1951	15.96	20.34	14.43	10.26	12.65
1950	16.48	18.54	13.60	8.36	12.02
1949	15.83	17.86	13.49	11.69	11.42
1948	15.40	16.72	13.15	11.62*	13.25
1947	12.99	14.88	11.17	11.38*	9.94

*Estimated

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in the Minerals Yearbook's "Coke and Coal Chemicals" chapters in dollars per ton and were applied to the quantity to obtain the personal consumption expenditures for coke in thousands of dollars.

FUEL OIL, KEROSINE, LPG, AND WOOD

Personal consumption expenditures for "other fuels and ice" as reported in the Survey of Current Business were adjusted to cover only fuel oil, kerosine, LPG, wood, and ice by deducting the estimates of coal and coke. The Consumer Expenditure Survey was then used to distribute expenditures for each of these fuels and ice. Each energy type was computed as a percent of the adjusted "other fuels and ice" for the 1950, 1960 urban, 1960 total U.S., and 1972 CES. The differences between 1950 and 1960 in the proportion of the expenditures of the urban family for each fuel was determined. The average annual percnetage point changes in the percent of expenditures for each fuel were than applied to the distribution for total U.S. in 1960 and worked backward to fill in the distributions for 1959 expenditures by fuel for the 1960 and 1972 benchmark years so that the intervening years may be interpolated.

The dollar value of each fuel consumed by year was determined by multiplying the percent shares of fuel oil, kerosine, LPG, and wood and ice by the adjusted "other fuels and ice" in PCE. Physical quantities were calculated by dividing the estimated personal consumption expenditures by the appropriate retail prices.

Fuel oil prices were obtained from the BLS consumer price index for fuel oil No. 2.

Retail kerosine prices had to be estimated from the movement of a comparable energy product--light distillate. The federal Energy Adminsitration furnished an average retail kerosine price for 1974. Since no CPI or WPI for kerosine is available, the 1974 retail price of kerosine was extended back to 1947 on the basis of the movement of the WPI for light distillates.

The retail prices of LPG were based on gas utility industry sales and revenues from residential service. The American Gas Association reports residential sales in millions of therms and residential revenues in thousands of dollars in Historical Statistics of the Gas Industry, Table 93 and 113 (1947-1955) and in the 1971 Gas Facts, Tables 72 and 85 (1955-1970). Quantities were converted to thousands of barrels at 40.11 therms per barrel. The ratios of revenues to volume of sales were computed for 1947 to 1970 to obtain an average residential price (dollars per barrel). 1971 and 1972 prices were estimated based on the percent change in the WPI for LPG, since AGA discontinued its sales and revenues series.

As mentioned earlier, a retail price for fuelwood for residential use is not available in any reliable form for the 1947-1972 period. Only personal consumption expenditures in current dollars and BTUs are shown for fuelwood in this report.

SECTION 9

GOVERNMENT

The government sectors are divided between final demand and government enter-
prises. Both are further disaggregated between federal, state and local
activities. Government enterprises are activities of agencies with separate
accounting records that cover more than half of their operating costs from
the sale of goods and services to the public. In the Energy Flow Accounts,
the activities of publicly owned electric and gas utilities have been trans-
ferred to the Electric and Gas Utilities Industries. Public transportation
systems operated by government have been transferred to the Transportation
Sectors.

Data measuring fuel consumption by the Government Sectors are particularly
lacking over the 1947-1972 period. Electric power consumed by the former
Atomic Energy Commission (now the U.S. Energy Research and Development Adminis-
tration [ERDA]) at major facilities associated with the production of reactor
products and the enrichment of uranium was measured over the historical period.
In addition, the information on consumption of several energy products by the
U.S. Department of Defense is also available. Where data measuring the consump-
tion of specific fuels by the individual government sectors are not directly
available, control totals obtained from the U.S. Department of the Interior,
Bureau of Mines, as well as the Federal Power Commission, Federal Highway Admin-
istration, and the Amrican Gas Association were used to estimate government fuel
consumption.

The control totals were distributed using the U.S. Department of Commerce,
Bureau of Economic Analysis employment data as well as U.S. Department of
Defense personnel information. Domestic consumption of energy products
for transportation and non-transportation functions by the military was based
on the proportions of personnel stationed in the U.S. These proportions were
calculated for the 1953-1972 period from the number of personnel based in

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other countries and afloat. The proportions for earlier years were esti-
mated from the difference between total U.S. population and resident U.S.
population.

Fuels consumed for transportation purposes by the non-military component
of Federal Government final demand are discussed in the transportation section
of this chapter since the control totals for the transportation function
include the non-military on-road use of fuels.

The following section provides detailed documentation of the data sources
and procedures used to estimate the consumption of energy products by the
Government Sectors.

DETAILED DESCRIPTIONS

Electric Power

The control total measuring the amount of electric energy consumed by all
segments of government including military was obtained from the Federal Power
Commission, Annual Report, table entitled "Kilowatt-Hour Sales in Millions" in
column headed "Other". These totals were adjusted to remove electricity con-
sumed by the transportation sector. This was done by deducting electric power
use by railroads and railways as reported in Edison Electric Institute (EEI),
Statistical Yearbook of the Electric Utility Industry. Table 19s "Energy
Sales--Total Electric Utility Industry". (See Table 4-20.) The resulting total
government consumption was distributed by employment to the following sectors:

- Federal Civilian Government

- Federal Government--Military

- Federal Government Enterprises (Excluding ERDA installations
  and government operated transportation systems.)

TABLE 4-20.—GOVERNMENT CONSUMPTION OF GAS AND
ELECTRICITY

	Gas (BTUs, Billions)			Electric Power (KWH, Millions)
	Natural	Manufactured	Mixed	
1972	882500	0	0	50326
1971	840900	0	0	46536
1970	670640	240	3110	43819
1969	554070	240	3010	41325
1968	617150	190	2340	37531
1967	529190	180	1740	34523
1966	565950	130	1490	32222
1965	488630	130	1260	28928
1964	534720	100	1210	27563
1963	522170	100	1300	29027
1962	503540	120	1180	27039
1961	492360	240	1650	27707
1960	468760	130	1490	26701
1959	425150	770	1310	31379
1958	372440	1120	1160	27675
1957	355690	1710	1040	26864
1956	262660	1690	950	25603
1955	278780	2130	980	23601
1954	246510	1840	1020	22628
1953	264770	3300	570	21368
1952	206140	5680	640	18966
1951	188520	4520	510	18220
1950	120680	4620	710	16246
1949	122510	2450	960	14483
1948	118170	2310	1090	13727
1947	85820	2420	1310	13015

- State and Local Government

- State and Local Government Enterprises

These data do not include electric power consumed by ERDA installations for processing use. Electricity used for processing to AEC installations was obtained from communication with Samuel Hack, Director of Construction for ERDA. The fiscal year data were adjusted to calendar year for consistency.

Gas

Control totals measuring the purchase of natural, manufactured, and mixed gases by government as a whole were obtained from American Gas Association (AGA) publications. Government purchases, including those of the military, were reported in terms of volume and revenues to the class of service described as "Other" in the AGA publications. The volumes of natural gas sold over the 1960-1972 period are reported in the 1971 and 1973 editions of Gas Facts, Table 69. The data prior to 1960 are published in Historical Statistics of the Gas Industry, Table 90 for volume of sales, and Table 110 for revenue. The volumes of manufactured gas and mixed gas purchased over the 1947-1959 period by government are reported on Tables 92 and 91, respectively, in the Historical Statistics of the Gas Industry. Corresponding revenue data appear on Tables 112 and 111. Data for the more recent years are found in the 1971 edition of Gas Facts, Tables 71 and 70 for the volume of manufactured and mixed gases, and Tables 84 and 83 for corresponding revenue information. (See Table 4-20.) All volume data were reported in either millions of therms (100,000 BTUs per therm) or trillions of BTUs. These data were converted to BTUs (see conversion factor table).

Employment data were used to distribute the controls for each of the three types of gas to the Government sectors.

The data for non-highway use represents motor gasoline only and does not include special fuels such as diesel and LPG. (See Table 4-21.) The control total was then distributed between final demand for state and local governments and state and local government enterprises.

Information on motor gasoline delivered for all purposes was obtained from Mr. W.F. Vance, Directorate of Energy, Office of the Secretary of Defense. Since data were not available on the change in the stock of motor gasoline held by the military, deliveries were considered a measure of consumption. Data were provided in thousands of barrels per day by fiscal year and converted to annual totals by calendar year. Using the same procedures noted above, domestic use was estimated by the proportion of personnel based in the United States.

<center>Aviation Gasoline</center>

Military consumption of aviation gasoline was determined from data compiled by the Bureau of Mines and Defense Department. The Bureau of Mines, Mineral Industry Surveys, "Annual Petroleum Statement" provided data on shipments for military use in the United States over the 1961-1972 period. The earlier years were obtained from Mr. Vance. As with motor gasoline, the data was converted to annual totals for calendar years and adjusted for the number of personnel stationed in the U.S. The data were further adjusted by multiplying 1.097 since this was the average error between the data from the Bureau of Mines and the Department of Defense for years in which these two sources overlapped.

<center>Jet Fuel</center>

Jet fuel consumption by the military was reported by Bureau of Mines in the Mineral Industry Surveys, "Annual Petroleum Statement" for 1964 through 1972. Department of Defense supplied data for total military deliveries for the earlier years in thousands of barrels per day by fiscal year. To determine

TABLE 4-21.-CONSUMPTION OF MOTOR GASOLINE FOR NON-HIGHWAY USE
BY STATE AND LOCAL GOVERNMENT

(Barrels, Thousand)

1972	10553
1971	10044
1970	9754
1969	10357
1968	9979
1967	9561
1966	9198
1965	8827
1964	8501
1963	8041
1962	7852
1961	7554
1960	7185
1959	6872
1958	6640
1957	6253
1956	5819
1955	5519
1954	5300
1953	4870
1952	4632
1951	4398
1950	4251
1949	4020
1948	3849
1947	3559

domestic military consumption of jet fuel, the same procedure used for aviation gas was followed. Jet fuel consumption in the U.S. was then adjusted for the difference between Bureau of Mines and the Department of Defense by multiplying by a correction factor of 0.783 for 1947 to 1963.

Lubricating Oils and Greases

No data were available from public or private sources on the amount of lubricating oil and grease consumed by the government. Partial information was found on total military procurement for 1947 through 1963 from the Military Petroleum Supply Agency. From these data an estimate of domestic military use was derived on the basis of military personnel stationed in the U.S.

Fuel Oil and Coal

While no firm data were available for non-transportation use of fuel oil and coal by the civilian government industries, estimates were derived in conjunction with those for consumption by commercial industries. For fuel oil, Bureau of Mines data on total domestic sales of fuel oil, adjusted by information on consumption from the Bureau of the Census and in-house estimates, yielded a figure for non-transportation consumption in the construction, transportation, and civilian government industries, except oil and gas well drilling, railroads, and communications other than radio and television broadcasting. This estimate was distributed on the basis of employment in these sectors, and the allocations for the civilian government sectors were assigned to the appropriate I-O sector.

For coal, available data on coal consumption for individual sectors was deducted from Bureau of Mines data on total domestic sales of coal. This procedure produced a derived retail deliveries estimate which was comprised of non-transportation use in the transportation, commercial, and civilian government industries except railroads and communications other than radio and television broadcasting. This estimate was then distributed across the above sectors on the basis of employment, and the allocations for the civilian government sectors were assigned to the relevant I-O sector.

A more detailed description of these estimating procedures can be found in Section 8 (Commercial Industries).

SECTION 10

EXPORTS

Exports of Primary and Converted Energy Products are classified in the National Energy Flow Accounts framework. Viewed in terms of the BTU content, energy exports represent a "loss" of energy to the economy although, of course, from a dollar value point of view they are not a "loss" in term of employment, income, etc. The geographical region which has been adopted for the National Energy Flow Accounts (NEFA) is the same as that used by the Bureau of Mines and consists of the 48 contiguous states plus the District of Columbia Alaska and Hawaii. The exclusion of Puerto Rico causes data, if not conceptual, problems since both export and import data reported by the Census Bureau include Puerto Rico. A detailed description of the procedures for geogaphical adjustment of the Census export data will be discussed later in this section.

Exports of primary and converted energy products are accounted for in general, if they are used or produced by domestic fuel producing industries: coal, mining, petroleum refining, etc.). While this distinction is suitable for domestic production in accounting for energy flows since double counting of BTUs is avoided, it does cause some incompleteness in the import and export section of the accounts. Specifically, in the trade sector we count disembodied energy types such as crude, petrochemical feedstock, coal, etc. but we do not account for the BTU content of products which contain or embody energy. We do not for example account for the energy contained or embodied in a product such as styrene. Clearly the exclusion of such products involve only a loss of detail in the domestic energy flow accounts but since products like these are substitutes for the energy products required in their manufacture, their exclusion leads to understatement of the BTU value of energy flows into the economy in terms of imports and corresponding understatement of the energy outflow when such products are exported.

In terms of international energy dependence, consideration might be given
to expanding the NEFA framework to include these products with embodied
energy which are, in effect, substitutes for energy. Conceptually, imports
and exports of all products which involve energy either as a material input
or fuel in their production could be included in a system of energy accounts.
It is not clear, however, that such an exhaustive scope is analytically
necessary but some consideration should be given to evaluation of an ex-
tension of the accounts to include products which require relatively large
amounts of energy in their production such as styrene and chemicals but no
doubt stopping short of the energy content in an imported or exported auto-
mobile both for analytical and measurement reasons.

<center>EXPORT PRODUCTS INCLUDED</center>

Subject to the general comments on the scope of the National Energy Flow
Accounts (NEFA), exports have been included for all primary and converted
energy products where data are available. Table 4-22 contains a list of
the products for which export data are available.

In general, the level of export product detail found in Census data is
greater than or equivalent to the product classification used in the NEFA.
For example, NEFA product 15711, Lubricating Oils, consists of exports of
ten different classes of lubricating oils reported by the Bureau of the
Census.

The concordance used between the NEFA level of product detail and the detail
reported on exports (and imports) is shown in Table 4-23.

The Bureau of Mines (BOM) publishes export data derived from the Census trade
data adjusted when necessary to conform to their geographic definition of the
U.S. Table 4-24 is a concordance between BOM export product groups for petro-
leum products only and the appropriate Census Schedule B export classification
codes which can be used to compare NEFA and BOM export product definitions for
petroleum products.

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TABLE 4-22.-EXPORT PRODUCTS

NEA Code	Product Name	NEA Code	Product Name
00100	Electricity	14510	Special Naphtha
10002	Crude Petroleum	15711	Lubricating Oils
10100	Gasoline--Total	15712	Lubricating Grease
10101	Gasoline and Special Naphtha	16540	Petroleum Asphalt
10110	Motor Gasoline	16560	Petroleum Wax
10120	Aviation Gasoline	17100	Coal Anthracite
10300	Kerosine	17200	Coal Bituminous
10500	Jet Fuel	17401	Lignite & Coal & Lignite Briquettes
10700	Liquefied Petroleum Gases	17510	Coke of Coal
10710	Butane	17734	Pitch of Tar
10720	Propane	17720	Mineral Tar
10730	Butane Propane Mixes	18510	Solvent Naphtha
11100	Distillate Fuel Oil	18900	Petrochemical Feedstocks
11300	Residual Fuel Oil	18910	Benzene
11700	Petroleum Coke	18920	Toluene
13500	Natural Gas	18930	Xylene

TABLE 4-23.--EXPORTS OF ENERGY PRODUCTS--CONCORDANCE OF THE
ENERGY FLOW ACCOUNTS PRODUCT CLASSIFICATION
AND SCHEDULE B CENSUS PRODUCT CLASSIFICATION

NEA Code	Name	Census Schedule B Numbers	Years
00100	Electricity	NA	1947-72
10002	Crude Oil	331.0100 50110	1965-72 1947-64
10003	Natural Gas	331.1010 50520	1965-72 1947-72
10110	Motor Gasoline	332.1030 50120 } 50170 }	1965-72 1947-64
10120	Aviation Gasoline	332.1010 } 332.1020 } 332.1040 } 50150 } 50140 } 50161 } 50163 } 50165 }	1965-72 1947-64
10300	Kerosine	332.2010 50270	1965-72 1947-64
10500	Jet Fuel	332.2020 50180	1965-72 1954-64
10700	Liquified Gases	341.1020 50435	1965-66 1947-64
10710	Butane	341.1025	1967-72
10720	Propane	341.1030	1967-72
11100	Distillate Fuel Oil	332.3000 } 331.0200 } 50300	1965-72 1947-64
11300	Residual Fuel Oil	332.4000 } 332.9520 } 50310	1965-72 1947-64

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TABLE 4-23   (Continued)

NEA Code	Name	Census Schedule B Numbers	Years
11700	Petrol. Coke	332.9410 ⎫ 332.9420 ⎭ 50480	1965-72 1947-64
14510	Special Naptha	332.9110 501900	1965-72 1947-63
15711	Lubricating Oils	332.5005 ⎫ 332.5010 332.5015 332.5020 332.5025 332.5030 ⎬ 332.5034 332.5040 332.5045 332.5050 ⎭ 50330 ⎫ 50340 50351 50352 50390 ⎬ 54000 54003 54005 54007 ⎭	1965-72 1947-64
15712	Lubricating Greases	332.5055 50410	1965-72 1949-64
16540	Petrol. Asphalt	332.9220 ⎫ 332.9510 ⎭ 50470	1965-72 1947-64
16560	Waxes	332.6210 ⎫ 332.6220 ⎬ 332.6230 ⎭ 50440 50455 ⎫ 50465 ⎭ 50450 ⎫ 50460 ⎭	1965-72 1947-64 1958-64 1947-57
17100	Anthracite	321.4040 500100	1965-72 1947-64

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TABLE 4-23 (Continued)

NEA Code	Name	Census Schedule B Numbers	Years
17200	Bituminous Lignite	321.4020 50020	1965-72 1947-64
17510	Coke	321.8000 50040	1965-72 1947-64
17720	Crude Tar	521.1000 845.8005	1965-72 1947-64
17734	Pitch of Tar	332.9210 332.9220 } 332.9230 80070	1965-72 1947-64
17401	Coal & Coke Briquettes	321.9000 50030	1965-72 1947-64
18900	Finished Petrochemicals	332.9150 332.9160 } 332.9180	1965-72
18910	Benzene	521.4010 } 521.0222 80060	1965-72 1947-64
18920	Toluene	521.4020 } 512.0224 80110	1963-72 1947-64
18930	Xylene	521.4027	1968-72
18510	Solvent Naptha	521.4022	1968-72

TABLE 4-24.--EXPORTS OF PETROLEUM PRODUCTS--CONCORDANCE OF BUREAU OF
MINES PRODUCT CATEGORIES AND CENSUS SCHEDULE B EXPORT PRODUCT CLASSIFICATION[a]

BOM Product Name	Census Schedule B Numbers	Years
Crude Petroleum	331.0100	1965-72
	50110	1947-64
Distillates	332.3000 331.0200 }	1965-72
	50300	1947-64
Residual Fuel Oil	332.4000 332.9520 }	1965-72
	50310	1947-64
Kerosine	332.2010	1965-72
	50270	1947-72
Jet Fuel	332.2020	1965-72
	50180	1954-65
Motor Gasoline	332.1030	1965-72
	50120 50170 }	1947-64
Aviation Gasoline	332.1010 332.1020 332.1040 }	1965-72
	50150 50161 50163 50165 50140 }	1947-64
Special Napthas	332.9110	1965-72
	50190	1947-62
Liquid Petroleum Gases Butane Propane B-P Mixes LPG	341.1025 341.1030 341.1040 } 50435	1967-72 1967-72 1967-72 1947-64
Petrochemical Feedstocks	332.9150 332.9160 332.9180 }	1965-72

[a]*Bureau of Mines figures are based on Census data but are geographically adjusted by exclusion of Puerto Rico's exports and addition of shipments to Puerto Rico and other U.S. Possessions. Bureau of Mines source: James Dithel, (703) 557-0443.*

TABLE 4-24   (Continued)

BOM Product Name	Census Schedule B Numbers	Years
Lubricating Oils	332.5005 332.5010 332.5015 332.5020 332.5025 332.5030 332.5035 332.5040 332.5045 332.5050	1965-72
	50330 50340 50351 50352 50390 50400 50403 50405 50407	1947-64
Lubricating Greases	332.5055 50410	1956-72 1947-64
Wax	332.6210 332.6220 332.6230	1965-72
	50440 50450 50460	1947-64
Coke	332.9410 332.9420 332.9400	1965-72
	50480	1947-64
Asphalt	332.9220 332.9510	1965-72
	50470	1947-64
Misc. Petroleum Products	332.6100 332.9120 332.9130 332.9140	1965-72
	50325 50380 50408 50420	1947-64

Principal Data Sources and Adjustment Procedures

Data Sources

The export trade statistics published by the Census Bureau are the primary source for the reported export data on energy products. The exceptions are the quantity and value figures for exports of electricity which are obtained from the Federal Power Commission (and excluded, by Census definition from both export and import statistics) and additional data, not available at this time, on exports and imports of uranium ore and products.

Export data derived from Census figures and adjusted for geographic definition by the Bureau of Mines are available for most of the energy products used in the National Energy Flow Accounts. For most products data are published by the Bureau of Mines for only quantities and these export quantities have been valued using Census data.

Valuation represents the value of the seaport, airport or border point and is usually the selling price unless it is not sold, then the cost is used, and includes inland freight, insurance and other charges. Sometimes valuation includes estimated freight charges from an inland point to the seaport.

A description of the procedure used to value BOM quantities is contained in a later section. The primary adjustments to export data relate to geographic and valuation procedures.

Other adjustments required for the export data are detailed in the individual product documentation and most of these involve conversions of the units in which export data are reported. These include shifts from one volumetric measure to another (e.g. gallons to barrels) and shifts from weight to volume or the reverse (pounds to gallons). Conversion rates used are included in the product documentation.

For some of the reported products, export data had to be converted to a common unit to get a consistent time series, and for others, export data had to be converted before a total figure could be aggregated in order to correspond to an NEFA product classification.

The whole problem of weight-volume conversions and the ratio used in this study should receive a careful review aimed either towards standardizing data collection or developing better conversion procedures. For some products exports are reported in pounds while imports of the same product are in gallons. Since some of the reported trade data are aggregates of products with varying specific gravities, it is quite impossible to do much more than make educated guesses as to the appropriate weight or volume conversion.

Geographical Adjustment and Valuation Procedures

Export data when available have been obtained (usually only for quantities of exports) from the Bureau of Mines, Mineral Yearbooks. Export data are derived from Commerce form 7525 V "Shippers Export Declaration" and are processed by the BOM from the Census Bureau compiled data to conform to the BOM geographic definition of the U.S.

The BOM export figures are obtained by adding to the Census export figure shipments from the U.S. tc Puerto Rico and to U.S. outlying possessions, and excluding exports shipped from the Puerto Rico customs area to foreign countries. These separate trade figures are obtained from Census publication FT 800 and tabulations, EA 694 and EA 644.

In order to obtain valuations of export data we applied a geographic adjustment procedure to Census export data. After adjusting the Census export data, unit valuations were obtained which were then applied to BOM export figures. In addition, the geographic adjustment procedure was appied to obtain quantity and value figures for those products not reported separately by the BOM.

The adjusted figures were obtained in the following manner.

1) Obtain Census export data (FT 410)

2) Include shipments from the U.S. to Puerto Rico and other U.S. possessions (EA 694 or FT 800)

3) Exclude exports from Puerto Rico to foreign countries (EA 644 or EA 622)

Due to the extensive calculations and data acquisition required for the geographical adjustment procedure, it will not normally be carried out where adjusted quantity control numbers for exported products are available from the BOM. In these cases unadjusted Census quantity and value figures will be used to calculate a unit value figure which should be sufficient for the valuation of these exports.[1] The entire procedure will be used to obtain quantity and value figures for these products not available from the BOM.

It should be noted that magnetic tapes are available for both annual and monthly export figures and therefore offer a less labor intensive approach to reconcile BOM and Census export figures, at least for more recent years. Quantity and value figures compiled, as well as unit values are being stored on the computer in order to enable others to make further adjustments when it is found that unit valuation on steps 2 and 3 are sufficiently different to cause over or understatement of export value and/or the data are being used for purposes which require more accuracy. The section on Detailed Data Source and Estimating Techniques will indicate whether the geographic adjustment procedure was applied to each energy product.

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[1] _In order to assist the user in identification of value figures derived by this method, a quantity code of B has been used exclusively to identify valuation by this method. These codes appear in columns 33, 52 and 71 of the coding format 7 where functional use (cols. 12-15) is coded 7000 for exports._

Quality of Data

The quality code definitions used for other functional use categories and described elsewhere, are not used for exports or imports. Since almost all of the data are derived from Census figures and little information is available to test these data the reader is referred to the Census Bureau FT 410 and related publications. The same code meanings are used for imports.

Since the geographic and valuation procedures have the major observable impact on the export data and it was decided that it was important to be able to improve or modify procedures used in a relatively easy manner, the quality codes have been given the following meanings for export data.

Code A   Used where both Census and Bureau of Mines quantity
          data exist and are equal or BOM publishes both
          quantity and value data or BOM publishes only quan-
          tity data. Code A is also used for FPC exports
          (value and quantity).

Code B   Used only on a quantity code for value when value
          is determined by Census unit values applied to
          published BOM export figures.

Code C   Used for quantity figures obtained from Census
          when a geographic adjustment has been made and
          no Bureau of Mines quantity figure is available.
          Value will also be coded C in this case.

Code D   Used for quantity figures obtained from Census
          when a geographic adjustment has not been made and
          no Bureau of Mines quantity figure is available.
          In this case, value will also be coded D.

One final note about the Census quantity and value information is that revisions published, in the June issue of FT 410 for the year after the release of the annual FT 410 data, were not taken into account in calculation of unit values unless noted in the documentation for specific products. However, these adjustments for data revisions are or will be made for all products where a BOM quantity figure is not available.

Detailed data sources and estimating techniques used in compiling export data are discussed below.

Electricity

Export figures for electricity were obtained from the Annual Federal Power Commission (FPC) news releases for the years 1947-1972. Wheeled energy, i.e., energy shipped through the U.S. on route from one point in Canada to another point in Canada, was excluded from the trade statistics. Included in the export statistics, however, are quantities for which no values are given. These include net interchanges, inadvertent flows, returnable energy and exchanges of energy which are required by contract to be balanced to zero as of June 30 each year. For this reason the value figure for exports may be somewhat low in regard to the quantity figure.

Crude Petroleum

Quantities were obtained from BOM figures. Unit values from Census figures have been applied to the BOM quantities. No geographic adjustment was necessary.

Gasoline--Total

Quantity obtained from BOM for 1964-1972. Prior to 1964 special naphthas were included with gasoline in one category by BOM. Unit values obtained from Census data were applied to BOM figures to obtain values for 1964-1972.

Quantities and values for 1947-1963 were obtained from Census. Geographic adjustment is being made.

Gasoline and Special Naphtha

Quantities obtained from BOM figures. The figures for 1964-1972 are an aggregate of gasoline--total and special naphtha each of which is reported separately for these years. Unit values obtained from Census figures have been applied to the BOM quantities. Geographic adjustment is being made.

Motor Gasoline

Quantities for 1964-1972 were obtained from BOM figures. Prior to 1964 BOM includes motor gas with aviation gas in a single category. Unit values from Census figures have been applied to the BOM quantities for 1964-1972. Quantities and values were obtained from Census figures for 1947-1963. A geographic adjustment is being made.

Aviation Gasoline

Quantities for 1964-1972 were obtained from BOM figures. Prior to 1964 BOM includes aviation gas with motor gas in a single category. Unit values from Census figures have been applied to the BOM quantities for 1964-1972. Quantities and values were obtained from Census figures for 1947-1963. The BOM includes the census category, Gas Blending Agents and Hydrocarbon Compounds, in the export statistics on aviation gasoline. We have therefore included this category to derive export figures for 1947-1963. A geographic adjustment is being made.

Kerosine

Quantities were obtained from BOM figures. Unit values obtained from Census figures have been applied to BOM quantities. No geographic adjustment is necessary.

Jet Fuel

Quantity figures obtained from BOM. Unit values obtained from unadjusted Census export figures and applied to BOM quantity figures. Adjustment of Census data is being made. No data available prior to 1954.

Liquefied Petroleum Gases

Quantities reported by BOM and Census were identical. Value figures were reported by BOM for 1967-1972. Prior to 1967 value figures were obtained from Census. No geographic adjustment was necessary.

Butane

Quantities reported by BOM and Census were identical. Value figures were reported by BOM. No data were available prior to 1967. No geographic adjustment was necessary.

Propane

Quantities reported by BOM and Census were identical. Value figures were reported by BOM. No data were available prior to 1967. No geographic adjustment was necessary.

Butane Propane Mixes

Quantities reported by BOM and Census were identical. Value figures were reported by BOM. No data were available prior to 1967. No geographic adjustment was necessary.

Distillate Fuel Oil

Quantities were obtained from BOM figures. Unit values obtained from Census figures have been applied to BOM quantities. A geographic adjustment is being made.

Residual Fuel Oil

Quantities were obtained from BOM figures. Unit values obtained from Census figures have been applied to BOM quantities. A geographic adjustment is being made.

Petroleum Coke

Quantities obtained from BOM. Unit values obtained from unadjusted Census figures and applied to BOM quantities. No geographic adjustment necessary.

Natural Gas

Quantities were obtained from BOM figures. Unit value from Census figures have been applied to BOM quantities. A geographic adjustment is being made.

Special Naphtha

Quantities for 1964-1972 obtained from BOM. Prior to 1964 special naphtha was included with gasoline in BOM statistics. Quantities for 1947-1972 were obtained from Census figures for the category Naphtha, Mineral Spirits, Solvents and Other Finished Light Petroleum Products, nec. Unit values were obtained from Census export figures and applied to BOM quantities 1964-1972; Census values used for 1947-1963. Adjustment of Census data is being made. No data were available in 1964 and 1965.

Lubricating Oils

Quantities were obtained from BOM figures. Unit values obtained from Census figures have been applied to the BOM quantities. No geographic adjustment is necessary.

Lubricating Grease

Quantities were obtained from BOM figures. Unit values obtained from Census figures have been applied to BOM quantities. No geographic adjustment is necessary.

Petroleum Asphalt

Quantities were obtained from BOM figures. Unit values from Census figures have been applied to the BOM quantities. No geographic adjustment is necessary.

Petroleum Was

Quantities were obtained from BOM figures. Unit values from Census figures have been applied to the BOM quantities. No geographic adjustment is necessary.

Coal Anthracite

Quantities were obtained from BOM figures. Unit values obtained from Census figures have been applied to the BOM quantities. No geographic adjustment is necessary.

Coal Bituminous

Quantities were obtained from BOM figures. Unit values obtained from Census figures have been applied to the BOM quantities. No geographic adjustment is necessary.

Lignite and Coal and Lignite Briquettes

Quantities and values were obtained from BOM figures for 1947-1965. This series was discontinued in the Minerals Yearbook after 1965. Quantities and values were obtained from Census figures for 1966-1972. No geographic adjustment is required.

Coke of Coal

Quantities and values were obtained from BOM figures. No geographic adjustment is necessary.

Pitch of Tar

No data are available from BOM. Quantities and values were obtained from Census figures. A geographic adjustment is being made.

Mineral Tar

No data are available from BOM. Quantities and values were obtained from Census figures. A geographic adjustment is being made.

Solvent Naphtha

Quantities and values were obtained from Census figures for 1968-1972. No data were available from the BOM. No data were available prior to 1968. A geographic adjustment is being made.

Petrochemical Feedstocks

Quantities were obtained from BOM figures for 1965-1972. Unit values obtained from Census figures have been applied to the BOM quantities for 1965-1972. No data were available prior to 1965. No geographic adjustment is necessary.

Benzene

No quantity or value figures were available from BOM. Quantity and value figures used were obtained fom Census. A geographic adjustment is being made.

Toluene

No quantity or value figures are available from BOM. Quantity and value figures for 1953-1972 were obtained from Census. No data were available prior to 1953. A geographic adjustment is being made.

Xylene

No quantity or value figures were available from BOM. Quantity and value figures for 1968-1972 were obtained from Census. No data were available prior to 1968. A geographic adjustment is being made.

SECTION 11

ENERGY MATERIAL INPUTS TO CONVERSION PROCESSES

Energy material inputs to conversion processes are those inputs which are not used as fuel. The products of these material inputs, once they are processed, are finished energy products and conversion losses. The finished products are discussed in Section 2 of the Sources Account chapter, while losses are examined in the next section of this chapter.

Material inputs will be discussed in terms of the conversion processes involved; therefore this section will consider: petroleum refining, electric utilities, coke-oven plants, natural gas processing plants, and other conversion processes.

PETROLEUM REFINING

Material inputs in petroleum refining include crude petroleum (including lease condensate), unfinished oils reruns, natural gas liquids, finished petrochemicals and other hydrocarbons. These data are published by the Bureau of Mines in the <u>Mineral Industry Survey</u>, "Crude Petroleum, Petroleum Products, and Natural Gas Liquids--Annual Petroleum Statement". Data are available for the 1947-72 period for most of the energy products noted above. Also for the more recent years, measures of natural gas liquids have been published in a more disaggregated form.

The liquefied petroleum gas portion of natural gas liquids used as material inputs in petroleum refining is published by the Bureau of Mines over the 1965-72 period. Estimates of LPG were made for earlier years by subtracting the production and additions to inventory of natural gasoline, isopentane and plant condensate from the total natural gas liquids used as material inputs at refineries. This was done since almost all of natural gasoline,

isopentane, and plant condensate used in the economy are used as inputs to refineries.

Benzol (benzene) is the only finished petrochemical for which data are available measuring petrochemicals used at refineries. These data were published for the 1962-67 period.

ELECTRIC UTILITIES

Fossil fuels were the only material inputs for the generation of electric power for which data were available. Information on nuclear fuel assemblies used in electric generation could not be obtained.

Fossil fuel data were collected from worksheets provided by the Federal Power Commission. Fuel inputs include anthracite, bituminous coal, lignite, fuel oil, and gas. In order to develop estimates of the amount of each of these fuels used by federal, state, and local, and private electric utilities, each of the fossil fuels was distributed by the KWH generated in fossil fuel generating plants operated by each class of ownership of utility. Table 4-25 presents the quantities of fossil fuel by type used at utilities to generate electric energy.

Data measuring the amount of nuclear fabricated products consumed in the process of generating electric energy is not readily available. Based on conversations with experts in the area, it was determined that there is an approximate heat loss of two-thirds in the generating process at nuclear facilities. Therefore, an estimate was made of the nuclear inputs by expanding the net BTU value of the KWH generated by a factor of 67 percent.

COKE-OVEN PLANTS

Bituminous and anthracite coal are the two material inputs which are available to coal carbonization at coke-oven plants. Measures of the consumption of each of these energy products are published by the Bureau of Mines in the Minerals Yearbook.

TABLE 4-25.–FOSSIL FUELS USED BY UTILITIES TO GENERATE ELECTRIC ENERGY

Year	Coal (1000 Tons)				Fuel Oil (1000 BBLs)	Natural Gas (MMCF)
	Bituminous	Lignite	Anthracite	Total		
1972	341125	8336	1584	351045	493930	3978700
1971	320637	5643	1646	327926	396240	3993000
1970	314187	4734	1897	320818	335503	3931996
1969	304854	3937	1850	310641	251027	3487642
1968	291667	3909	2203	297779	188642	3147909
1967	268579	3419	2186	274184	161278	2746352
1966	261555	2730	2192	266477	140949	2609949
1965	240757	1873	2158	244788	115203	2321101
1964.	221316	1870	2239	225425	101141	2322896
1963	207535	1658	2139	211332	93313	2144473
1962	189090	1852	2297	193239	85768	1965974
1961	177800	1813	2509	182122	85736	1825117
1960	172321	1561	2751	176633	85340	1724762
1959	164431	1363	2629	168423	88263	1628509
1958	151756	1183	2785	155724	77668	1372853
1957	156055	1351	3363	160769	79693	1336141
1956	153492	1491	3296	150279	72711	1239311
1955	138883	1667	3209	143759	75274	1153279
1954	113660	1558	3166	118384	66745	1165498
1953	110774	1509	3614	115897	88238	1034272
1952	101795	1514	3762	107071	67218	910116
1951	100378	1520	3870	105768	63944	763898
1950	86855	1407	3609	91871	75420	628919
1949	79397	1213	3354	83964	66301	550121
1948	94470	1151	3965	99586	42645	478097
1947	85033	976	3522	89531	45309	373054.

NATURAL GAS PROCESSING PLANTS

Natural gas is the only material input to the conversion process at
natural gas processing plants. These data are presented in the <u>Minerals</u>
<u>Yearbook</u>.

OTHER PROCESSES

Manufacture of gas by gas utilities is accomplished through the carbon-
ization of bituminous coal. These data are published by the American
Gas Association over the 1947-69 period.

The specific processes noted above are the only ones for which material
inputs to conversion processes have been collected. There are additional
conversion processes which may warrant investigation.

Inputs to each phase of the nuclear fuel cycle, i.e., milling, conversion
to uranium hexafloride, enrichment, fabricating, and reprocessing, would
be useful in extending our knowledge of the disposition of energy. These
data were not available.

In addition, the material inputs to the distillation of coal chemicals resulting
from coal carbonization may be examined so as to more completely develop an
Energy Balance Account. This was not done at this time, since this was a
phase of coal carbonization which is distinctly removed from the production
of energy.

SECTION 12

LOSSES

Losses are generally defined as the "final use of an energy type in which neither an intermediate input, nor a final good or service is produced." In the Energy Balance Accounts, losses in the conversion processes at petroleum refineries, electric utilities, coke-oven and natural gas processing plants are presented, as well as losses in storage and distribution.

The following is a discussion of each loss shown, including an evaluation of each conversion loss estimate in the light of independently derived controls.

LOSSES IN THE CONVERSION PROCESS

Petroleum Refining

Losses in the conversion process at petroleum refineries were calculated by deducting the total BTU value of output from the total BTU value of the material inputs. The residual was recorded as the total loss.

The results of this procedure were not entirely satisfactory. First, the negative entry for 1971 is unrealistic, since no positive energy gain (as opposed to the volumetric processing gain) occurs during the refining process. Second, totals shown for other years are somewhat inconsistent with an independently derived control.

This control is an estimate by industry spokesmen of average material balance losses in recent years at refineries. (A material balance, though based on the difference between the total weight of input and output, is believed to reflect net energy loss.) This material loss was estimated at between 0.5 percent and 1 percent, but was felt to have been higher in earlier years due to lower refinery efficiency.

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Based on this estimate, absolute losses shown for 1954, 1958 and 1962 would appear reasonable, except for the fact that refinery efficiency would have had to decline between 1954 and 1958. It is felt, therefore, that while these data reflect approximate magnitudes, they should not be considered precise measurements.

For the final report, input and output data will be re-examined in an attempt to obtain more accurate estimations.

Electric Utilities

Estimates of conversion losses at electric utilities are the sum of losses at fossil fuel, hydroelectric and nuclear installations. Losses at fossil fuel installations were determined by deducting the BTU content of total output from the total BTU input. At hydroelectric plants, losses were assumed to be zero.

Information on material inputs to nuclear generating plants was not available. A percentage loss of 67 percent is generally accepted by experts in the area. The absolute losses were therefore estimated as the difference between the net BTU value of the electric energy generated and the estimated BTU value of the nuclear inputs, which are 67 percent greater than the net BTU value of the electric energy generated. These estimates are considered quite firm, except for nuclear electric generation, particularly in relation to losses in other processes.

Coke-Oven Plants

Losses in the conversion process at coke-oven plants were calculated by deducting the total BTU content of finished output from the BTU content of the coal carbonized. The residual was taken as the total loss.

Again, the results were not entirely satisfactory. Based on material balance data published in the Bureau of Mines' Coal Carbonization in the United States,

1900-1962, coupled with JFA estimates for subsequent years, the anticipated
energy loss was at least 4 percent of BTU input. This 4 percent is estimated
weight loss in the coal carbonization process, but is believed to reflect the
magnitude of energy loss. The 4 percent figure, however, does not include
losses in the refining process at coke plants. Total loss, then, is likely
to be somewhat higher, although measurements of the additional magnitude were
not available.

Consequently, the positive losses shown for 1947, 1954 and 1958 are considered
below actual loss, and the negative entries for 1962, 1967, and 1971 are not
realistic. As for petroleum refineries, data on inputs and outputs will be re-
examined for the final report.

Natural Gas Processing Plants

The total loss at natural gas processing plants was taken as the sum of
the BTU content of gas vented or flared, and the difference between total
BTU output and input adjusted for the quantity vented or flared.

Data on gas vented or flared is published for 1962, 1967 and 1971 in the
Bureau of Mines, Minerals Yearbook. Estimates for the other benchmark years
were derived by calculating the volume of gas vented or flared in each year
from 1962 to 1971 as a percentage of total natural gas processed. This per-
centage was then applied to the volume of gas processed in 1947, 1954 and 1958.

Based on estimates provided by two major processing companies, anticipated
losses at gas plants were in the range of 0.5 percent to 1 percent in recent
years, and somewhat higher in the earlier years. Except for 1967, then,
estimates shown in the Energy Balance Accounts appear slightly on the low
side, particularly in earlier years. The 1967 estimate, however, appears
to overstate loss. Again, these data will be re-examined for the final report.

TABLE A-4.—BTU CONVERSION FACTORS

Year	Coal 10001	Crude Oil (incl. lease condensate) 10002	Natural Gas 10003	Total Gasoline 10100	Motor Gasoline 10110	Aviation Gasoline 10120
1972	23500000	5800000	1113.8	5248000	5248000	5248000
1971	23700000		1115.1			
1970	23800000		1115.2			
1969	24200000		1116.3			
1968	24300000		1153.1			
1967	24400000		1150.7			
1966	24500000		1132.4			
1965	24900000		1143.7			
1964	24700000		1115.0			
1963	24500000		1118.2			
1962	24600000		1119.7			
1961	24600000		1136.8			
1960	24600000		1133.0			
1959	24800000		1134.6			
1958	24900000		1132.8			
1957	24800000		1128.4			
1956	24800000		1119.6			
1955	24900000		1145.9			
1954	24600000		1137.2			
1953	24600000		1141.6			
1952	24900000		1133.4			
1951	24800000		1137.8			
1950	24900000		1152.9			
1949	24800000		1130.7			
1948	24700000		1142.8			
1947	24400000		1153.1			
Source[a]	3L	1	3G	1,13	1,13	1,13
Units	BTU/S.Ton	BTU/BBL	BTU/CF	BTU/BBL	BTU/BBL	BTU/BBL

[a]Detailed citations are noted at the end of the table.

	Kerosene (ex. Jet Fuel) 10300	Kerosene (in. Jet Fuel 10310	Total Jet Fuel 10500	Kerosinic Jet Fuel 10510	Naphthenic Jet Fuel 10520	Liquefied Gases 10700
1972	5670000	5670000	5592219	5670000	5355000	4009798
1971			5581769			4011219
1970			5582270			4021112
1969			5567422			4018544
1968			5548538			4020131
1967			5543518			4024495
1966			5539175			4030008
1965			5533981			4027892
1964						4025997
1963						4027799
1962						4031162
1961						4033075
1960						4067086
1959						4045966
1958						4040242
1957						4031707
1956						4026657
1955						4040965
1954						4027179
1953						4021929
1952						4024165
1951						4032529
1950						4046601
1949						4073219
1948						4061338
1947						4093140
Source	1,13	1,13	3A	1,13	1,13	3C
Units	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL

TABLE A-4 (Continued)

	Butane 10710	Normal Butane 10711	Iso- Butane 10712	Other Butanes 10713	Propane 10720	Butane- Propane 10730	Ethane 10730
1972	4298160	4358610	4189233	4298193	3847806	4009798	3082380
1971	4298227			4297973		4011219	
1970	4298087			4298888		4021112	
1969	4318489			4298351		4018544	
1968	4312542					4020131	
1967	4311070					4024495	
1966	4311898					4030008	
1965	4310514					4027892	
1964	4310281					4025997	
1963	4310752					4027799	
1962	4310709					4031162	
1961	4315540					4033075	
1960	4316091					4067086	
1959	4317824					4045966	
1958	4316933					4040242	
1957	4319950					4031707	
1956	4320444						
1955	4315941						
1954	4315979						
1953	4317853						
1952	4317491						
1951	4323927						
1950	4324531						
1949	4319610						
1948	4307883						
1947	4305322						
Source	3B	6	6	3B	6	3C	13
Units	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL

	Total Fuel Oil 11000	Distillate Fuel Oil (in. Diesel) 11100	Residual Fuel Oil 11300	Other LG Mixtures 10740	Total Natural Gas Liquids 10600	Still Gas 11500
1972	5933466	5825000	6287000	4036967	4053283	6000000
1971	5933134				4093756	
1970	5929288				4113716	
1969	5936578				4134331	
1968	5940370				4165507	
1967	5943998				4181726	
1966	5942247				4208295	
1965	5946165			4027892	4218318	
1964	5948277			4025997	4230745	
1963	5948393			4027799	4218540	
1962	5960553			4031162	4236661	
1961	5970180			4033075	4268866	
1960	5979609			4067086	4274611	
1959	5983510			4045966	4283657	
1958	5996718			4036967	4384079	
1957	6005359				4384444	
1956	6006714				4443589	
1955	6016019				4498214	
1954	6027053				4454547	
1953	6038514				4488911	
1952	6041708				4469483	
1951	6055152				4536412	
1950	6064008				4542828	
1949	6081727				4566117	
1948	6011960				4592425	
1947	6102499				4617051	
Source	3D	1,13	1,13	3C	3F	7
Units	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL

TABLE A-4 (Continued)

	Petroleum Coke 11700	Dry Natural Gas 13500	Natural Gas Liquids,NEC 13700	Natural Gasoline 13710	Iso-pentane 13720	Plant Condensate 13730
1972	6024000	1031	4609553	4620000	4556034	4556034
1971			4609764			
1970			4608571			
1969			4607887			
1968		1032	4605941			
1967			4605612			
1966			4605845			
1965			4607123			
1964		1035	4609170			
1963			4608544			
1962			4606094			
1961			4607153			
1960			4608438			
1959			4608943			
1958			4612948			
1957			4615236			
1956		1050	4614043			
1955			4614335			
1954			4613887			
1953			4613395			
1952			4612927			
1951			4612734			
1950			4612246			
1949			4612146			
1948			4611644			
1947			4608505			
Source	7	7	3E	1,13	8	8
Units	BTU/BBL	BTU/CF	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL

	Other Natural Gas Liquids,NEC 13790	Naphtha (ex. Solvent Naphtha) 14500	Special Naphtha 14510	Naphtha 400° 14520	Absorption Oil 14700
1972	4609553	5248000	5248000	5248000	6065000
1971	4609764				
1970	4608571				
1969	4607887				
1968	4605941				
1967	4605612				
1966	4605845				
1965	4607123				
1964	4609170				
1963	4608544				
1962	4606094				
1961	4607153				
1960	4608438				
1959	4608943				
1958	4612948				
1957	4615236				
1956	4614043				
1955	4614335				
1954	4613887				
1953	4613395				
1952	4612927				
1951	4612734				
1950	4612246				
1949	4612146				
1948	4611644				
1947	4608505				
Source	3E	1,13	1,13	1,13	2
Units	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL

TABLE A-4 (Continued)

	Lubricating Oils, Greases,and Related Products 15700	Lubricants 15710	Lubri- cating Oils 15711	Greases 15712	Insulating Oil 15720	Hy- draulic Fluid 15730
1972	6065000	6065000	6065000	6065000	6065000	6065000
1971						
1970						
1969						
1968						
1967						
1966						
1965						
1964						
1963						
1962						
1961						
1960						
1959						
1958						
1957						
1956						
1955						
1954						
1953						
1952						
1951						
1950						
1949						
1948						
1947	↓	↓	↓	↓	↓	↓
Source	1,13	1,13	1,13	1,13	2	2
Units	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL

	Other Lubricating Products NEC 15790	Other Finished Petroleum Products NEC 16500	Medicinal Oil 16510	Petrolatum 16520	Spray Oil 16530	Asphalt 16540
1972	6065000	6591367	6065000	6065000	6065000	6636000
1971		6588082				
1970		6585034				
1969		6598102				
1968		6586091				
1967		6585656				
1966		6586183				
1965		6584542				
1964		6581396				
1963		6583709				
1962		6580426				
1961		6567655				
1960		6568641				
1959		6575268				
1958		6575061				
1957		6572038				
1956		6575322				
1955		6571154				
1954		6563323				
1953		6565740				
1952		6571775				
1951		6559963				
1950		6558957				
1949		6570328				
1948		6566919				
1947		6570085				
Source	2	3H	2	2	2	1,13
Units	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL

	Road Oil 16550	Waxes 16560	Un-finished Oils 16900	Total Petroleum Products 19000	Anthracite Coal 17100	Bituminous Coal and Lignite 17200
1972	6636000	5537000	5800000	5503200	25400000	23500000
1971				5505600		23700000
1970				5506000		23700000
1969				5508100		24200000
1968				5519000		24300000
1967				5526200		24400000
1966				5530600		24500000
1965						24900000
1964						24600000
1963						24400000
1962						24500000
1961						24500000
1960						24500000
1959						24700000
1958						24800000
1957						24700000
1956						24700000
1955						24800000
1954						24600000
1953						24500000
1952						24800000
1951						24700000
1950						24800000
1949						24700000
1948						24600000
1947						24400000
Source	1,13	1,13	4	1,13	1,13	3I
Units	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/S.Ton	BTU/S.Ton

TABLE A-4 (Continued)

	Bituminous Coal-Total 17300	Bituminous Coal -used for metal-lurgical purposes and for export 17300-2600 & 17300-7000	Bituminous Coal -used for all other purposes 17300-2400, 17300-1000 & 17300-1001	Lignite 17400	Coke and Breeze 17500
1972	23700000	26800000	22700000	13340562	24484313
1971	23800000	26800000	22700000	13340562	24482927
1970	23800000	26800000	22700000	13666229	24485181
1969	24300000	26800000	23300000	13757429	24493336
1968	24400000	26800000	23600000	13817365	24510497
1967	24500000	26900000	23600000	13650311	24518099
1966	24600000	26800000	23700000	13806492	24528698
1965	25000000	27000000	24200000	13735923	24524506
1964	24700000	26800000	23900000	13807306	24515633
1963	24500000	26800000	23700000	13661551	24500654
1962	24600000	26700000	23800000	13670453	24500378
1961	24600000	26700000	23800000	13683829	24503648
1960	24600000	26600000	23800000	13775313	24476809
1959	24800000	26600000	24000000	13721212	24494962
1958	24900000	26800000	24000000	13716129	24489262
1957	24800000	26500000	23800000	13748284	24509052
1956	24800000	26500000	23900000	13654587	24505884
1955	24900000	26600000	23900000	13898018	24503757
1954	24700000	26700000	23900000		24503726
1953	24600000	26000000	23900000		24496227
1952	24900000	26000000	24300000		24490802
1951	24800000	25800000	24300000		24504375
1950	24900000	25900000	↓	↓	24475569
1949	24800000	26100000			24449326
1948	24700000	25700000			24449191
1947	24400000	24600000	↓	↓	24458956
Source	3J	15	14	16	3K
Units	BTU/S.Ton	BTU/S.Ton	BTU/S.Ton	BTU/S/Ton	BTU/S.Ton

TABLE A-4   (Continued)

	Coke 17510	Breeze 17520	Total Gas (Natural and other) 13000	Total Other Gas 13600	Manu-factured Gas 13610	Coke Oven Gas 13611
1972	24800000	20000000	1089.05	967	540	550
1971			1090.89			
1970			1086.43			
1969			1087.04			
1968			1119.46	↓		
1967			1114.66	962		
1966			1098.24	956		
1965			1102.76	938		
1964			1077.23	931		
1963			1079.79	850		
1962			1077.12	815		
1961			1088.93	822		
1960			1080.94	837		
1959			1078.92	781		
1958			1072.51	757		
1957			1053.73	742		
1956			1046.16	760		
1955			1062.94	779		
1954			1062.34	783		
1953			1052.97	855		
1952			1041.00	712		
1951			1028.67	665		
1950			1029.04	650		
1949			1008.03	651		
1948			1000.63	646		
1947	↓	↓	1002.55	657	↓	↓
Source	7	10	3M	3N	7	7
Units	BTU/S.Ton	BTU/S.Ton	BTU/CF	BTU/CF	BTU/CF	BTU/CF

	Mixed Gas 13620	Crude Tar 17720	Sodium Phenolate or Carbolate 17731	Naphtha-lene 17732	Road Tar 17733	Pitch of Tar 17734
1972	992	6300000	164960	19852	160000	27518428
1971						
1970						
1969						
1968						
1967	970					
1966	966					
1965	960					
1964	954					
1963	866					
1962	829					
1961	835					
1960	847					
1959	781					
1958	758					
1957	742					
1956	769					
1955	795					
1954	809					
1953	955					
1952	811					
1951	818					
1950	899					
1949	924					
1948	894					
1947	885					
Source	3P	10	12	9	7	7
Units	BTU/CF	BTU/BBL	BTU/Gal.	BTU/lbs.	BTU/Gal.	BTU/Ton

	Other Tar Derivatives NEC 17739	Inter- mediate Light Oil 18100	Crude Light Oil 18300	Light Oil Derivatives NEC 18500	Solvent Naphtha 18510	Other Light Oil Derivatives 18590
1972	6808719	6930000	5460000	5838000	5838000	5838000
1971	6806154					
1970	6803948					
1969	6800833					
1968	6781658					
1967	6804682					
1966	6799109					
1965	6791401					
1964	6799426					
1963	6791413					
1962	6773749					
1961	6775888					
1960	6778405					
1959	6778724					
1958	6780948					
1957	6768443					
1956	6772810					
1955	6763245					
1954	6760445					
1953	6752037					
1952	6762255					
1951	6757920					
1950	6753050					
1949	6756310					
1948	6745778					
1947	6741861					
Source	3Q	5	10	5	5	5
Units	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL

TABLE A-4   (Continued)

	Ammonia 18700	Benzene 18910	Toluene 18920	Xylene 18930	Liquified Gases (in. Butylene and Propylene) 10800	Butane (in. Butylene) 10810
1972	2610930	5565798	5565924	5634552	4009798	4298160
1971					4011219	4298227
1970					4021112	4298087
1969					4018544	4318489
1968					4020131	4312542
1967					4024495	4311070
1966					4030008	4311898
1965					4027892	4310514
1964					4025997	4310281
1963					4027799	4310752
1962					4031162	4310709
1961					4033075	4315540
1960					4067086	4316091
1959					4045966	4317824
1958					4040242	4316933
1957					4031707	4319950
1956					4026657	4320444
1955					4040965	4315941
1954					4027179	4315979
1953					4021929	4317853
1952					4024165	4317491
1951					4032529	4323927
1950					4046601	4324531
1949					4073219	4319610
1948					4061338	4307883
1947					4093140	4305322
Source	5	8	8	8	3C	3B
Units	BTU/S.Ton	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL	BTU/BBL

	Normal Butane (in. Butylene) 10811	Propane (in. Propylene) 10820	Ethene (in. Ethylene) 10990	Elec- tricity 10100	U_3O_8 (Yellow Cake) 30110	Enriched Uranium 30000
1972	4358610	3847806	3082380	3412.193	399,750,000,000	1,040,036,300
1971						
1970						
1969						
1968						
1967						
1966						
1965						
1964						
1963						
1962						
1961						
1960						
1959						
1958						
1957						
1956						
1955						
1954						
1953						
1952						
1951						
1950						
1949						
1948						
1947						
Source	6	6	13	7	11	11
Units	BTU/BBL	BTU/BBL	BTU/BBL	BTU/KWH	BTU/S.Ton	BTU/lb.

Sources:

1. *Bureau of Mines, <u>Mineral Industry Surveys</u>, "Annual Petroleum Statements," Supplement, (appropriate years).*

2. *Assumed to be identical to the value given for lubricants, based on discussion with BOM personnel.*

3. *Derived by averaging BTU factors, weighted by quantities produced in each year, of products nested within.*

3A. *Weighted average of kerosinic and naphthenic jet fuel factors.*

3B. *Weighted average of normal butane and iso-butane factors.*

3C. *Weighted average of butane and propane factors.*

3D. *Weighted average of distillate fuel oil and residual fuel oil factors.*

3E. *Weighted average of natural gasoline, isopentane, and plant condensate factors.*

3F. *Weighted average of motor gasoline, kerosene, liquefied gas, ethane, distillate oil, natural gas liquids (NEC), jet fuel, and special naphtha (produced from natural gas only) factors.*

3G. *Weighted average of dry natural gas and total natural gas liquids factors.*

3H. *Weighted average of medicinal oil, petrolatum, spray oil, asphalt, road oil and wax factors.*

3I. *Weighted average of bituminous coal and lignite factors.*

3J. *Weighted average of two different bituminous coal factors:*
       1) used for metallurgy and exports
       2) other uses.

3K. *Weighted average of coke and breeze factors.*

3L. *Weighted average of bituminous/lignite and anthracite factors.*

3M. *Weighted average of total natural gas, total other gas and coke-oven gas (only production not used as input to total other gas) factors.*

3N. *Weighted average of manufactured gas and mixed gas factors.*

Sources: (continued)

3P. *Weighted average of natural gas, manufactured gas and liquefied gases (only quantities used as inputs to mixed gas production) factors.*

3Q. *Weighted average of sodium phenolate (carbolate), naphthalene, road tar and pitch of tar factors.*

4. *Assumed to be identical to the values given for crude oil. No other information is available.*

5. *Values given are based on telephone conversations with authorities at U.S. Steel Corporation. No other information is available on these products.*

6. *Nelson, W.L., Petroleum Refinery Engineering, Chemical Engineering Series, New York, McGraw-Hill, 1958 (4th edition), pp. 184-185.*

7. *National Coal Association, Bituminous Coal Facts and Figures, Table entitled, "Conversion Factors for Fuel and Power," (appropriate years).   (Note: This data was originally compiled by Bureau of Mines.)*

8. *Bland, William F. and Robert L. Davidson, Petroleum Processing Handbook, New York, McGraw-Hill, 1967, p. 12-15.   (Note: Plant condensate is assumed to have the same heat content as isopentane.)*

9. *Values given are based on telephone conversations with authorities at the American Petroleum Institute.*

10. *Bureau of Mines, Minerals Yearbook, Chapter on "Coke and Coal Chemicals," Table 34, 1970 (used for all years).*

11. *Values given are based on telephone conversations with experts at the Federal Energy Administration, Nuclear Data Division.*

12. *Value derived as the average of naphthalene and road tar factors. No other information is available.*

13. *Bureau of Mines, Department of Interior News Release on Total Energy Production and Consumption, March 13, 1974 (used for all years).*

14. *Derived by examination of physical quantity and heat content of bituminous coal used in electric generation. Both types of data were obtained from the National Coal Association publication, Steam Electric Plant Factors, Table 2. (Note: This data comes originally from FPC Forms 1 and 1-M.)*

Sources: (continued)

15. *Derived by obtaining a weighted average of conversion factors of the principal output components of coal carbonization, including coke, light oils, coke-oven gas and tars. The basic data needed to drive this method was obtained from BOM Minerals Yearbooks, the chapters entitled, "Coke and Coal Chemicals."*

16. *Derived by examination of physical quantity and heat content of lignite coal used in electric generation. Both types of data were obtained from the National Coal Association publication, Steam Electric Plant Factors, Table 2. (Note: This data comes originally from FPC Forms 1 and 1-M.)*