

Appendix D

Comparability of MECS Estimates with Other Series

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The Energy Information Administration (EIA) collects data from two distinct sources that, in their entirety, provide a comprehensive picture of energy production, marketing, and consumption in the United States.⁴⁵ One set of surveys is directed to the suppliers and marketers of specific fuels (including electricity). The second group of surveys collects comprehensive energy consumption and related data directly from end-use consumers.

Because there is a seeming correspondence between energy supplied and energy consumed, it is tempting to compare or merge their results. However, there are important differences between the supplier and end-user surveys that need to be taken into account in doing such comparisons or other analyses. This appendix discusses the relationship of the supplier surveys and the Manufacturing Energy Consumption Survey (MECS).

An Overview of EIA Surveys

The End-User Surveys

The overall purpose of the end-user surveys is to provide comprehensive baseline data on energy consumption and related characteristics for major sectors of the U.S. economy. Accordingly, the end-user surveys are conducted for the manufacturing sector, commercial buildings, residential households, and residential transportation. These surveys collect data directly from samples of the energy-consuming units comprising those sectors. The results of these end-user surveys are available in a variety of EIA publications (see Appendix I). The end-user surveys are:

- **Form EIA-457A/G, Residential Energy Consumption Survey (RECS)**—The RECS collects information on energy consumption, energy expenditures, and housing and demographic characteristics for residential households in the United States. The survey is conducted triennially using a complex area sample of residential housing units.
- **Form EIA-846A/D, Manufacturing Energy Consumption Survey (MECS)**—The MECS collects information on energy consumption, end-uses of energy, fuel-switching capabilities, energy management activities, and technology penetration for manufacturing establishments in the United States. The survey was conducted triennially beginning in 1985, and will become a biennial survey beginning with data year 1994. The MECS uses complex list sampling techniques to develop its sample of manufacturing establishments.
- **Form EIA-871A/H, Commercial Buildings Energy Consumption Survey (CBECS)**—The CBECS provides comprehensive information on the consumption of energy, energy expenditures, and energy-consuming characteristics of the commercial buildings in the United States. The survey is conducted triennially using a complex area sample of commercial buildings.
- **Form EIA-876A/E, Residential Transportation Energy Consumption Survey (RTECS)**—The RTECS collects information on the number and types of vehicles per household, annual vehicle miles traveled, Vehicle Identification Number (VIN), and vehicle characteristics. Fuel consumption, expenditures, and fuel efficiency are estimated using data from the Environmental Protection Agency, Bureau of Labor Statistics, and Lundberg Survey, Inc. The survey is conducted triennially, as a companion survey to the RECS.

⁴⁵Descriptions of all EIA data collection activities are included in Energy Information Administration, *Directory of Energy Data Collection Forms*, DOE/EIA-0449(90) (Washington, DC, January 1991).

The Supplier Surveys

The EIA conducts numerous supplier surveys. The overall purpose of these surveys is to measure the quantity of a specific fuel produced and/or supplied to the market, along with other information related to the fuel's production and supply. The results of these surveys are published in several EIA reports.⁴⁶ Among the supplier surveys⁴⁷ are:

- **Form EIA-3, Quarterly Coal Consumption Report, Manufacturing Plants**—This form collects information about coal consumption, stocks, and receipts (quantity and price) directly from manufacturing establishments and could be classified as an end-user survey. Because it collects information only on coal consumption and does not collect characteristics data, it is typically viewed as a supplier survey.
- **Form EIA-5, Quarterly Coke Plant Report**—This form provides information on the production, transfers, consumption, sales, and stocks of coal, coke, and breeze. Respondents include all establishments operating coke plants.
- **Form EIA-6, Coal Distribution Report**—Form EIA-6 surveys all U.S. companies (producers and/or distributors) that own or purchase and distribute more than 50,000 short tons of coal annually. Quarterly data are collected on coal production and purchases, distribution by consumer category, and method of transportation. At present, there are approximately 1,300 respondents to the EIA-6. The data are collected on a quarterly basis.
- **Form EIA-176, Annual Report of Natural and Supplemental Gas Supply and Disposition**—Form EIA-176 provides annual data on the consumption of natural gas as reported by natural gas and synthetic gas producers, processors, distributors, and pipeline operators. Data are collected on the consumption, disposition, movement, and supply of natural and synthetic gas.
- **Form EIA-810, Monthly Refinery Report**—Form EIA-810 provides information regarding the balance between supply (beginning stocks, receipts, and production) and disposition (input, shipments, fuel use and losses, and ending stocks) of refined petroleum products. Data are provided by all refineries and blending plants.
- **Form EIA-821, Annual Fuel Oil and Kerosene Sales Report**—Form EIA-821 provides annual data on the sales by petroleum distributors of distillate and residual fuel oil and kerosene to end-use sectors and State of destination. The survey is sent to a sample of fuel oil dealers in the 50 States and the District of Columbia.
- **Form EIA-861, Annual Electric Utility Report**—Form EIA-861 is used to survey all electric utilities in the United States. The survey collects annual data on power production and sales of electricity from approximately 3,250 electric utilities.
- **Form EIA-867, Annual Nonutility Power Producer Report**—Form EIA-867 collects annual data from nonutility power producers who own or plan to install electric generation equipment with a total capacity of five megawatts or more at an existing or proposed site. This survey collects information from the nonutility power producer on electricity generation, installed capacity, and energy consumption devoted to power production.

⁴⁶For a complete list of publications see Energy Information Administration, *EIA Publications Directory 1992*, DOE/EIA-0149(92) (Washington, DC, June 1993).

⁴⁷In order to be consistent with the 1991 MECS, the descriptions of the supplier surveys are of the 1991 versions.

Combined Results of the Supplier Surveys

In addition to supporting fuel-specific publications of EIA, the results of the supplier surveys are combined to produce estimates of total energy consumption by consuming sector. The consuming sectors consist of the commercial, residential, industrial, transportation, and electric utilities sectors. The resulting combined estimates are published by EIA in the *Monthly Energy Review* (MER), the *State Energy Data Report* (SEDR), and the *Annual Energy Review* (AER). Table D1 presents the 1991 combined industrial estimates as they appear in the MER and SEDR.

Table D1. Combined Industrial Energy Consumption Estimates and Sources of Information, 1991

Description of Energy Source	Combined Estimates (Trillion British Thermal Units)		Relevant Supplier Surveys, Publications, and Notes
	SEDR	MER	
Coal	2,600.4	2,601	Form EIA-3, "Quarterly Coal Consumption Report, Manufacturing Plants"; Form-EIA-5, "Quarterly Coke Plant Report"; Form EIA-6, "Coal Distribution Report"
Bituminous Coal and Lignite ..	2,592.3	NP	
Anthracite	8.1	NP	
Natural Gas	8,657.1	8,641	Form EIA-176, "Annual Report of Natural and Supplemental Gas Supply and Disposition"
Petroleum	8,057.7	8,057	<i>Petroleum Supply Annual 1991</i> , DOE/EIA-0340
Asphalt and Road Oil	1,076.5	NP	<i>Petroleum Supply Annual 1991</i> , DOE/EIA-0340
Distillate Fuel Oil	1,139.2	NP	<i>Fuel Oil and Kerosene Sales, 1991</i> , DOE/EIA-0535(91)
Kerosene	11.4	NP	<i>Fuel Oil and Kerosene Sales, 1991</i> , DOE/EIA-0535(91)
LPG	1,749.2	NP	American Petroleum Institute, <i>1991 Sales of Natural Gas Liquids and Liquefied Refinery Gases</i>
Lubricants	166.7	NP	Bureau of the Census, <i>Current Industrial Reports</i> , "Sales of Lubricating and industrial Oils and Greases, 1977"
Motor Gasoline	193.3	NP	Federal Highway Administration, <i>Highway Statistics</i>
Residual Fuel Oil	335.9	NP	<i>Fuel Oil and Kerosene Sales, 1991</i> , DOE/EIA-0535(91)
Other	3,385.5	NP	<i>Petroleum Supply Annual 1991</i> , DOE/EIA-0340
Industrial Hydropower	32.7	33	Estimates of hydroelectric power represent the average generation over the 6-year period of 1974-1979, the last period for which data are available.
Net Imports of Coal Coke	8.9	9	Bureau of the Census, U.S. Department of Commerce, "Monthly Report IM 145."
Electricity	3,229.7	3,230	Form EIA-861, "Annual Electric Utility Report"
Net Energy	22,586.6	22,570	Total estimated end-use energy consumption.
Electrical System Energy Losses	7,014.1	7,022	Electrical system energy losses represent the amount of energy lost during generation, transmission, and distribution of electricity. These losses are calculated as the difference between the total heat content of energy input at electric utilities and the total heat content of electricity sold to end-use consumers.
Total Consumption	29,600.7	29,592	Total consumption including electrical system energy losses.

NP=Not published. Estimate is included in higher-level totals.

Note: Slight differences between the SEDR and MER estimates are attributable to rounding differences and to the fact that the SEDR Btu estimates are developed from State-level Btu conversion factors while MER Btu estimates are developed from national-level Btu conversion factors.

Sources: Energy Information Administration, *State Energy Data Report 1991*, DOE/EIA-0214(91) (Washington, DC, May 1993), Table 15 and Appendices A and C, and *Monthly Energy Review September 1993*, DOE/EIA-0035(93/09) (Washington, DC, September 1993), Table 2.4 and pp. 40-45.

Defining the Industrial Sector

In general, the "industrial sector" is defined as consisting of manufacturing, mining, construction, agriculture, fisheries, and forestry. The approximate SIC equivalent of the industrial sector includes major group codes 01 through 39.⁴⁸ There are a few definitional irregularities, however, that preclude a perfect mapping of the supplier surveys to that range of SIC codes. As pointed out in the MER,

although end-use allocations are made according to [the sector definitions] as closely as possible, some data are collected by using different classifications. For example, data on agricultural use of natural gas are collected and reported in the commercial sector rather than the industrial sector. Since agricultural use of natural gas cannot be identified separately, it is included in the commercial sector....[rather than the industrial sector.]⁴⁹

The allocations to the industrial sector will be discussed in more detail in the subsequent sections on individual energy sources.

Comparing the MECS and Industrial Sector Estimates

The MECS produces four separate estimates of manufacturing energy consumption, which are: (1) Total Primary Consumption of Energy for All Purposes (Table A1), (2) Total Primary Consumption of Energy for Nonfuel Purposes (Table A3), (3) Total Inputs of Energy for Heat, Power, and Electricity Generation (Table A4), and (4) Total Consumption of Offsite-Produced Energy for Heat, Power, and Electricity Generation (Table A5). The differences among those estimates are discussed in detail elsewhere in Appendix B of this report.

The combined estimates for the industrial sector published in SEDR are conceptually similar to the MECS estimates of Total Primary Consumption of Energy For All Purposes, because both series measure energy consumption as a fuel and as a raw material or feedstock. Table D2 presents a comparison of those MECS estimates and the combined industrial estimates appearing in SEDR.

Coal Consumption

The 1991 estimate of coal consumption from the MECS is 2,006 trillion British thermal units (Btu) (Table A1, Part 2) and the combined estimate published in SEDR for the industrial sector is 2,600 trillion Btu (Table D1). It is tempting to attribute that difference to the disparate coverage of the manufacturing and industrial sectors and to conclude that the difference of approximately 594 trillion Btu is due to additional consumption in the construction, mining, agriculture, forestry, and fisheries sectors. That interpretation is only partially correct, however.

Table D2 shows that the SEDR estimate of coal consumption consists of two basic components—coal consumption by coke plants, 907 trillion Btu and coal consumption by other industrial, 1,694 trillion Btu. The consumption by coke plants can be further disaggregated into consumption by furnace coke plants, 787 trillion Btu, and consumption by merchant coke plants, 120 trillion Btu.⁵⁰

The inclusion of merchant coke plants represents a major departure from the MECS. A merchant coke plant is one whose coke is produced for sale on the commercial market. According to the SIC Manual, these coke plants are classified in SIC 4925, "Mixed, Manufactured, or Liquefied Petroleum Gas Production and/or Distribution." They are classified in that industry because they produce coke oven gas as a primary product and coke as a byproduct. Since the MECS covers only the manufacturing sector (SIC 20 - 39), the merchant coke plants are excluded from the estimates of coal consumption. Deducting the quantity of coal consumed by those plants from the SEDR estimate

⁴⁸See Office of Management and Budget, *Standard Industrial Classification Manual 1987*, (Washington, DC, 1987).

⁴⁹Energy Information Administration, *Monthly Energy Review September 1993*, p. 40.

⁵⁰Energy Information Administration, *Quarterly Coal Report October-December 1992*, DOE/EIA-0121(92/4Q), (Washington, DC, May 1993), Table 48. Short tons converted to British thermal units using standard EIA conversion rates.

Table D2. A Comparison of the Components of MECS and SEDR Estimates of Energy Consumption
(Trillion British Thermal Units)

1991 Manufacturing Energy Consumption Survey Total Primary Consumption of Energy for All Purposes		1991 State Energy Data Report Industrial Sector Energy Consumption Estimates	
Energy Source Description	Estimate	Energy Source Description	Estimate
Coal	2,006	Coal	2,600.4
		<i>Coke Plants</i>	907.3
		<i>Other Industrial</i>	1,693.2
Natural Gas	6,095	Natural Gas	8,657.1
		<i>Industrial</i>	7,470.6
		<i>Lease and Plant Fuel</i>	1,186.5
Net Electricity	2,370	Electricity	3,229.7
<i>Purchased Electricity</i>	2,380	<i>Electricity Sales</i>	3,229.7
<i>Transfers In</i>	71		
<i>Generation from Nonrenewable Combustible Resources</i>	15		
<i>Electricity Sales/Transfers Out</i>	- 96		
Coke and Breeze	308	Net Imports of Coal Coke	8.9
		<i>Coke Imports</i>	27.3
		<i>Coke Exports</i>	18.4
Residual Fuel Oil	454	Residual Fuel Oil	335.9
Distillate Fuel Oil	146	Distillate Fuel Oil	1,139.2
Liquefied Petroleum Gases	1,574	Liquefied Petroleum Gases	1,749.2
Other	7,304	Asphalt and Road Oil	1,076.5
<i>Asphalt and Road Oil</i>	1,078	Lubricants	166.7
<i>Lubricants</i>	380	Kerosene	11.4
<i>Kerosene</i>	48	Finished Motor Gas	193.3
<i>Finished Motor Gas</i>	81	Other Petroleum	3,385.5
		<i>Naphtha < 401 Degrees</i>	298.9
<i>Naphtha < 401 Degrees</i>	299	<i>Other Oils ≥ 401 Degrees</i>	827.3
<i>Other Oils ≥ 401 Degrees</i>	795	<i>Special Naphthas</i>	88.0
<i>Special Naphthas</i>	134	<i>Waxes</i>	35.1
<i>Waxes</i>	41	<i>Miscellaneous Fuel & Nonfuel Products</i>	152.6
<i>Miscellaneous Nonfuel Products</i>	141	<i>Crude Oil</i>	38.9
<i>Crude Oil</i>	0	<i>Pentanes Plus</i>	294.0
<i>Pentanes Plus</i>	--	<i>Unfinished Oils</i>	- 450.2
<i>Unfinished Oils</i>	--	<i>Motor Gas Blending Compounds</i>	- 25.9
<i>Motor Gas Blending Compounds</i>	--	<i>Aviation Gas Blending Compounds</i>	- 0.1
<i>Aviation Gas Blending Compounds</i>	--	<i>Petroleum Coke</i>	700.3
<i>Petroleum Coke</i>	617	<i>Still Gas</i>	1,426.6
<i>Still Gas/Waste Gas</i>	1,399	<i>Pulping Liquor</i>	--
<i>Pulping Liquor</i>	857	<i>Wood Chips, Bark, Wood Waste</i>	--
<i>Wood Chips, Bark, Wood Waste</i>	666	<i>Net Steam/Hot Water</i>	--
<i>Net Steam/Hot Water</i>	239	<i>Miscellaneous</i>	--
<i>Miscellaneous</i>	529		
Total	20,257	Net Energy¹	22,553.9
		Electrical System Energy Losses	7,014.1
		Total¹	29,568.0

¹Excludes Industrial Hydropower.

--=Not applicable. Energy source is not included in series.

Note: Totals may not equal sum of components due to independent rounding.

Sources: The MECS estimates of major energy sources (boldface) are from Table A1 of this report. The components of the MECS estimates (italics) are from Tables A6, A16, and unpublished sources. The SEDR estimates of major energy sources (boldface) are from Energy Information Administration, *State Energy Data Report 1991*, DOE/EIA-0214(91) (Washington, DC, May 1993), Table 15. The components are from *Quarterly Coal Report October-December 1992*, DOE/EIA-0121(92/4Q) (Washington, DC, October 1992), Tables 2, 48, and 49; *Natural Gas Annual 1991*, DOE/EIA-0131(91) (Washington, DC, October 1992), Tables 16 and 17; and *Petroleum Supply Annual, Volume 1*, DOE/EIA-0340(92)/1 (Washington, DC, May 1993), Table 2. Where necessary, physical units were converted to British thermal units using the thermal conversion factors in Energy Information Administration, *Monthly Energy Review September 1993*, DOE/EIA-0035(93/09) (Washington, DC, September 1993), Appendix B.

yields 2,480 trillion Btu. The SEDR estimate of coal consumption by other industrial plants, 1,694 trillion Btu, can also be further disaggregated. Of that total quantity, 1,494 trillion Btu was consumed by manufacturing plants⁵¹ and 199 trillion Btu by the nonmanufacturing portion of the industrial sector. The nonmanufacturing portion of the industrial sector is, of course, excluded from the MECS estimate. Subtracting that quantity from the adjusted SEDR estimate results in 2,281 trillion Btu.

The remaining difference between the MECS and SEDR estimates of coal consumption (275 trillion Btu) can be accounted for by two factors. First, Form EIA-3, "Quarterly Coal Consumption Report, Manufacturing Plants," collects coal consumption information from coal gasification plants and classifies those plants in SIC 29, "Petroleum and Coal Products." The coal gasification plants are excluded from the MECS sample.⁵² Second, Form EIA-3 collects coal consumption information from electricity generating plants that are owned by manufacturing companies but are not co-located with a manufacturing establishment. Those generating facilities are defined as being a part of the manufacturing sector by Form EIA-3, but are excluded from the MECS because, according to the SIC Manual, they should be classified in SIC 4911, "Electric Services." For reasons of confidentiality, the exact values included in the SEDR estimates of coal consumption for the coal gasification plants and electricity generating plants not co-located with a manufacturing establishment cannot be shown. Suffice it to say, however, that the total of these values account for virtually all of the remaining difference of 275 trillion Btu between the MECS estimate and the adjusted SEDR estimate.

Natural Gas

The 1991 estimates for natural gas consumption for the MECS and the combined industrial estimates published in SEDR are, respectively, 6,095 and 8,657 trillion Btu. Since the SEDR estimates of natural gas come directly from estimates produced from Form EIA-176, "Annual Report of Natural and Supplemental Gas Supply and Distribution," most of that discrepancy can be accounted for by the differences in the coverage of the industrial sector as defined for the EIA-176 and manufacturing sector as defined for the MECS.

- Both the 1988 and 1991 MECS samples excluded very small establishments. While it was possible to adjust the 1988 MECS estimates for that exclusion, such a procedure was not feasible for the 1991 MECS (see Appendix B). However, the 1988 adjustments indicate that the excluded small establishments would account for roughly 200 trillion Btu of natural gas consumption that was excluded from the 1991 MECS. Deducting that quantity from the SEDR estimate leaves 8,457 trillion Btu.
- The estimates of the industrial consumption included in SEDR include lease and plant fuel. Lease and plant fuel is defined as "Natural gas used in well, field, and lease operations (such as gas used in drilling operations, heaters, dehydrators, and field compressors) and as fuel in natural gas processing plants."⁵³ The SIC Manual classifies those establishments in the mining sector and, as a result, they are excluded from the MECS. Lease and plant fuel consumption accounted for 1,187 trillion Btu in 1991 (Table D2), and is self-provided (i.e., not purchased). The SEDR estimate, excluding lease and plant fuel, is 7,271 trillion Btu.
- The SEDR estimate of industrial natural gas consumption also includes purchased natural gas by the mining sector. The *1987 Census of Mineral Industries*⁵⁴ indicates that the mining sector consumed 459 trillion Btu of purchased natural gas. As noted, the mining sector is excluded from the MECS. Excluding purchased natural gas by the mining sector from the SEDR estimate results in 6,812 trillion Btu.

⁵¹Energy Information Administration, *Quarterly Coal Report October - December 1992*, Table 50.

⁵²There is some question about the appropriate SIC code for coal gasification plants. According to the SIC Manual, coal gasification plants located at the mine site should be classified in SIC 1311, crude petroleum and natural gas. There is no SIC code for coal gasification plants located at sites other than the mine site. The most logical classification for such plants would be SIC 2999, products of petroleum and coal, not elsewhere classified, although a case could be made for classifying them in SIC 4925, mixed, manufactured, or liquefied petroleum gas production and/or distribution.

⁵³Energy Information Administration, *Natural Gas Annual 1991*, DOE/EIA-0131(91) (Washington, DC, October 1992), p. 250.

⁵⁴U.S. Bureau of the Census, *1987 Census of Mineral Industries, Fuels and Electric Energy Consumed*, MIC87-S-2, (Washington, D.C., December 1990), Table 2. The *Census of Mineral Industries* is conducted only every five years. The estimates for 1992 are not yet available.

The remaining difference of 717 trillion Btu between the MECS and the adjusted SEDR estimate of industrial natural gas consumption is more difficult to explain. The difference cannot be attributed to the agriculture, forestry, and fishing division (SIC 01 through 09) because those industries are excluded from both the MECS and the SEDR estimates of natural gas consumption. Specifically,

Industrial consumers are establishments engaged in a process which creates or changes raw or unfinished materials into another form or product. Generation of electricity, other than by electric utilities, is included. In general, industrial establishments would be those in Standard Industrial Classification major group codes 10 through 39.⁵⁵

The SEDR estimate of industrial natural gas consumption does include the construction industries (SIC 15 through 17), and these estimates are excluded from the MECS. The Bureau of the Census estimates that, in 1987, the total cost of natural gas and manufactured gas for the construction division was only \$303.5 million,⁵⁶ or the equivalent of approximately 100 trillion Btu. Excluding the construction industries from the SEDR estimates leaves 6,712 trillion Btu.

Finally, as noted in the above definition, the SEDR estimate (as taken from Form EIA-176) also includes the natural gas consumed in the generation of electricity by generating facilities *other than electric utilities*. Some of those generating facilities are co-located with manufacturing plants, others are owned by manufacturing operations, but not co-located with manufacturing plants, and still others are totally independent of manufacturing. In general, these generating facilities are known as nonutility power producers (NPP), and EIA collects electricity generation and related information from them using Form EIA-867, "Annual Nonutility Power Producer Report."

Many of the NPP's use natural gas as an input fuel to generate electricity. According to the results of the EIA-867, all NPP's generated 131 billion kWh⁵⁷ of electricity using 1,617 trillion Btu of natural gas as an input fuel⁵⁸ in 1991, for an efficiency rate of 28 percent.⁵⁹ All of that natural gas consumption would be included in the SEDR estimate of industrial natural gas consumption. However, the MECS includes only the natural gas consumed by those NPP's co-located with manufacturing plants. Thus, to check the comparability of the MECS and SEDR estimates of natural gas consumption, it is necessary to deduct from the SEDR estimate the quantity of natural gas consumed as a generating fuel by independent NPP's and those NPP's owned by manufacturers but not co-located with a manufacturing plant.

In 1991, manufacturers generated 125,584 million kWh of electricity from nonrenewable energy sources (Table A16). The MECS does not provide information on the quantities of input fuels consumed to generate that electricity, so it cannot be determined precisely how much of the natural gas-produced electricity reported for NPP's originated in the manufacturing sector. However, some speculation is possible.

Manufacturers consumed 3,311 trillion Btu of selected energy sources as a boiler fuel in 1991, of which 2,098 trillion Btu (63 percent) was natural gas (Table A36, Part 2). Clearly, not all of that boiler output was used to generate electricity. However, if electricity was generated in proportion to the quantities of boiler fuel, then natural gas would have accounted for 63 percent of the electricity generated, or approximately 79,800 million kWh (272 trillion Btu). That quantity of electricity would have required 982 trillion Btu of natural gas as an input fuel (assuming an efficiency rate of 28 percent). Thus, of the 1,617 trillion Btu of natural gas input for nonutility power generation reported by the EIA-867 and captured in the SEDR, 982 trillion would be accounted for by facilities covered by the MECS. The remaining 635 trillion Btu would have been consumed in facilities outside the scope of the MECS. Deducting that amount from the adjusted SEDR estimate of 6,712 trillion Btu yields 6,077 trillion Btu of natural gas, an estimate that is quite close to the MECS estimate of 6,095 trillion Btu.

⁵⁵Form EIA-176, "Annual Report of Natural and Supplemental Gas Supply and Disposition," p. 7.

⁵⁶U.S. Bureau of the Census, *1987 Census of Construction Industries*.

⁵⁷Energy Information Administration, *Electric Power Annual 1991*, DOE/EIA-0348(91), (Washington, DC, February 1993), Table 70.

⁵⁸Unpublished 1991 estimate of natural gas consumption obtained by telephone from EIA's Office of Coal, Nuclear, Electric and Alternate Fuels.

⁵⁹In a perfect world, the heating value of the quantity of energy consumed to generate electricity would exactly equal the heating value of the quantity of electricity produced. Such a relationship would be 100 percent efficient. In fact, however, electricity generation is not 100 percent efficient. For example, in 1991, electric utilities consumed 29.70 quadrillion Btu of input fuels to produce 10.14 quadrillion Btu of electricity. The difference of 19.56 quadrillion Btu represents the conversion loss due to the inefficiencies inherent in the generation process. Thus, the efficiency rate for utilities is approximately 35 percent. See Energy Information Administration, *Annual energy Review 1991*, DOE/EIA-0384(91), (Washington, DC, June 1992). p. 207.

Net Electricity

The MECS provides an estimate of "net electricity," defined as the sum of purchases (2,380 trillion Btu), transfers in (71 trillion Btu), and generation from noncombustible renewable resources (15 trillion Btu), minus quantities of electricity sold or transferred out (96 trillion Btu). Thus, the MECS estimate of net electricity is 2,370 trillion Btu (Table D2).⁶⁰

The combined estimate of industrial electricity consumption published in SEDR is based on industrial sales data as reported on Form EIA-861, "Annual Electric Utility Report." The SEDR estimate is 3,230 trillion Btu. Assuming that sales by utilities equal consumption by customers, the appropriate MECS measure for comparative purposes is purchased electricity, 2,380 trillion Btu (Table A22, converted to British thermal units). Thus, the initial difference between the two estimates of purchased electricity is 850 trillion Btu.

Most of that difference can be explained by the differences in the definitions of the manufacturing and industrial sectors. Specifically, the estimate included in SEDR represents electricity sales to SIC 01 through 39, while the MECS estimate of purchased electricity is for SIC 20 through 39 only.

- The agriculture, forestry, and fishing division is represented by SIC's 01 through 09. Energy consumption estimates are not available for the entire division, but the U.S. Department of Agriculture does collect farm expenditure data for electricity. For 1991, total expenditures for electricity for agricultural production (SIC's 01 and 02) were \$2,567 million,⁶¹ or roughly 190 trillion Btu.⁶² Deducting that quantity from the SEDR estimate yields 3,040 trillion Btu of electricity.
- The mining division is represented by SIC's 10 through 14. According to the *1987 Census of Mineral Industries*, the mining division purchased 68,176 million kWh (233 trillion Btu) of electricity in 1987, the latest year for which data are available. Subtracting that quantity from the SEDR estimate of electricity results in 2,807 trillion Btu of electricity.
- The construction division is represented by SIC's 15 through 17. According to the *1987 Census of Construction Industries*, total expenditures for electricity were \$1,089 million,⁶³ or approximately 80 trillion Btu. Deducting that quantity from the SEDR estimate yields 2,727 trillion Btu.

Thus, the final difference between the MECS estimate of 2,380 trillion Btu of electricity consumption and the adjusted SEDR estimate of 2,727 trillion Btu is 347 trillion Btu. It is reasonable to hypothesize that most of that remaining difference could be accounted for by: (1) the remaining SIC's in the agriculture, forestry and fishing division for which estimates are not available, and (2) increased consumption in the mining and construction divisions between 1987 and 1991. Moreover, the estimates of electricity sales to the industrial sector do not strictly follow SIC classification criteria. The instructions for Form EIA-861 provide the following definition of the industrial sector:

The industrial sector is generally defined as manufacturing, construction, mining, agriculture, fishing, and forestry establishments, Standard Industrial Classification (SIC) codes 01-39. [For the purpose of reporting, the] utility may classify industrial service using the SIC codes or based on demand or annual usage exceeding some specified limit. The limit may be set by the utility based on the rate schedule of the utility.⁶⁴

⁶⁰The MECS uses "net electricity" as a measure of electricity consumption in order to avoid double counting. See Appendix X.

⁶¹Unpublished estimate obtained by telephone from U.S. Department of Agriculture, National Agricultural Statistics Service, Agricultural Statistics Board.

⁶²Conversion based on \$13.486 per million Btu. See Table A25.

⁶³Cost information obtained by telephone.

⁶⁴Form EIA-861, "Annual Electric Utility Report for the Reporting Period 1991," p. xi.

This situation is potentially troublesome when making comparisons between the MECS and SEDR industrial estimates of electricity. The extent to which the respondents to Form EIA-861 classify their industrial customers based on SIC codes or their industrial rate schedules is unknown. Moreover, because the industrial rate schedule may be established by the utility, the criteria are likely to be inconsistent from utility to utility. Therefore, a customer receiving an industrial rate from a utility does not guarantee that the customer is, in fact, an industrial facility. Many commercial buildings are sufficiently large to qualify for an industrial rate, and, conversely, many small industrial facilities, while not large enough to qualify for an industrial rate, would qualify for a commercial rate. Unfortunately, there is no way to quantify the impact of these alternative methods of classifying industrial customers.

Coke and Breeze

Coke and breeze are produced by heating bituminous coal in the absence of air. That process drives off the volatile constituents of the coal and produces a porous residue consisting of carbon and mineral ash, known as coal coke. Breeze is the residue from the fine screenings of coke. Coke and breeze are used primarily as a fuel in blast furnaces.

The MECS reports that 308 trillion Btu of coke and breeze was consumed by manufacturers during 1991. The SEDR combined estimate for the industrial sector reports that the net imports of coal coke (imports minus exports) was 8.9 trillion Btu.

Both of these estimates represent attempts to avoid double counting energy sources. The MECS estimates of the primary consumption of energy and the SEDR industrial estimates include the quantity of bituminous coal used to produce the coke and breeze. Therefore, including both the coal consumed as a raw material to produce coke and the resulting coke and breeze would result in double counting. Accordingly, the SEDR industrial estimates include only net imports of coal coke.

The MECS approach also attempts to avoid the double counting that would result from including coke and breeze and the bituminous coal used to produce them. The MECS consumption estimate of 308 trillion Btu of coke and breeze excludes the quantities of those energy sources that were produced and consumed on the establishment site, and, therefore, the estimates are free of *intraestablishment* double counting.⁶⁵ However, the MECS estimate still *includes* all offsite-produced (purchased and transferred in) coke and breeze, whether produced domestically or imported. Because of these different approaches, the MECS and SEDR estimates of the consumption of coke and breeze are totally incomparable.

The MECS estimate of coke and breeze consumption can be verified by reference to other EIA series. The *Quarterly Coal Report* includes estimates of the quantity of coke and breeze sold by coke plants. In 1991, total commercial sales of coke and breeze were 9,503 thousand short tons.⁶⁶ Coke and breeze are heavy-duty energy sources, and would thus be expected to be consumed primarily within the industrial sector, by manufacturers. The MECS reports the quantity of coke and breeze that was purchased by manufacturers. In 1991, those total purchases were 9,340 thousand short tons (Table A22), a value that is quite close to the sales estimate.

Residual Fuel Oil

The MECS estimate of the primary consumption of residual fuel oil for 1991 is 454 trillion Btu. The estimate appearing in SEDR for the industrial sector is 335.9 trillion Btu. The difference in these two is not only substantial, it is in the opposite direction from what would be expected. The reason for that difference is not understood.

⁶⁵For more details on removing *interestablishment* duplication from the estimates in Table A1, see Appendix B.

⁶⁶Energy Information Administration, *Quarterly Coal Report, January - March 1991, April - June 1991, July - September 1991, October - December 1991*, Table A6.

Distillate Fuel Oil

The MECS estimate of the primary consumption of distillate fuel oil for 1991 is 146 trillion Btu. The estimate for the industrial sector published in SEDR was 1,139 trillion Btu. It is reasonable to attribute the difference between the estimates (993 trillion Btu) to the additional consumption in the construction, mining, agriculture, forestry, and fisheries sectors. For example, agricultural production (SIC's 01 and 02) accounted for approximately 400 trillion Btu of diesel fuel in 1991⁶⁷, and the mining division (SIC's 10 - 14) accounted for approximately 170 trillion Btu in 1987⁶⁸. Accounting for these sectors reduces the difference between the estimates to 423 trillion Btu. The remaining discrepancy could be accounted for by the construction sector, the remainder of the agricultural sector, and growth in the mining sector between 1987 and 1991.

Liquefied Petroleum Gases (LPG)

The 1991 MECS estimate of the primary consumption of LPG was 1,574 trillion Btu. The estimate published in SEDR was 1,749 trillion Btu. In the case of LPG, the difference of approximately 175 trillion Btu reasonably may be attributed to additional consumption in the construction, mining, agriculture, forestry, and fisheries sectors.

Nonenergy Products

The MECS estimates of primary consumption include an estimate of the quantity of energy consumed to produce nonenergy products at refineries. Those products are asphalt and road oil, lubricants, naphtha < 401 degrees, other oils ≥ 401 degrees, special naphthas, waxes, and miscellaneous nonfuel products. (See Appendix B for a discussion of the rationale for including estimates of nonenergy products in the MECS.) The total energy consumption to produce those products included the MECS in 1991 was 2,868 trillion Btu. That estimate was taken from an annual summary of shipments data adjusted for inventory change as reported by petroleum refineries on Form EIA-810, "Monthly Refinery Report." The estimate appearing in SEDR for these products is 2,640 trillion Btu, or 222 trillion Btu less than the MECS estimate. That estimate is taken directly from *Petroleum Supply Annual 1991*.

The difference in the estimates is attributable to slightly different estimating approaches between the MECS and those employed to derive the estimate that appears in the *Petroleum Supply Annual*. Specifically, the MECS estimate, as noted, represents sales of the products adjusted for inventory change. These estimates are derived to show only the quantities of the nonenergy products produced and shipped from petroleum refineries. The estimates in the *Petroleum Supply Annual*, however, are specifically designed to estimate the quantities of these products supplied to the market, regardless of their origin. Thus, the estimates are derived as refinery production, plus imports, minus stock change, minus exports. Except for net imports, the estimates of nonenergy products reported in the *Petroleum Supply Annual* and those included in the MECS are comparable.

Kerosene

The MECS estimate of the primary consumption of kerosene is 48 trillion Btu, and the estimate published in SEDR is 11.4 trillion Btu. Reasons for this difference are unknown.

Finished Motor Gasoline

The MECS estimate of the primary consumption of finished motor gasoline is 81 trillion Btu and the estimate published in SEDR is 193 trillion Btu. That substantial difference may be attributable to the additional consumption in the construction, mining, agriculture, forestry, and fisheries sectors, which are excluded from the MECS estimates.

⁶⁷Unpublished estimate obtained by telephone from U.S. Department of Agriculture, National Agricultural Statistics Service, Agricultural Statistics Board.

⁶⁸U.S. Bureau of the Census, *Census of Mineral Industries, Fuels and Electric Energy Consumed*, Table 2.

Crude Oil

Crude oil inputs to refineries are excluded from the MECS except when that crude oil is consumed as a fuel. In general, the consumption of crude oil as a fuel is an extremely rare occurrence, and the MECS sample was too small to provide a reliable estimate. Accordingly, the MECS estimate of the primary consumption of crude oil is given as zero. The 1991 estimate appearing in SEDR for crude oil is 39 trillion Btu. Therefore, the two series are not comparable, but the difference is so small that it is inconsequential.

Pentanes Plus, Unfinished Oils, Gasoline Blending Compounds

In general, the MECS excludes all inputs to the refinery process in order to avoid double counting. Pentanes plus, unfinished oils, and motor gas/aviation gas blending compounds are among those inputs that are excluded. The estimates appearing in SEDR are taken directly from the *Petroleum Supply Annual*, which is specifically designed to reflect petroleum balance. Unfinished oils and blending compounds appear as negatives in the estimates included in SEDR because these products "... have entered the primary supply channels with their production not having been reported [elsewhere]."⁶⁹

Petroleum Coke and Still Gas/Waste Gas

The MECS estimates of the primary consumption of petroleum coke and still gas/waste gas for 1991 were 617 and 1,399 trillion Btu, respectively. The estimates appearing in SEDR for these energy sources were 700 and 1,427 trillion Btu. Thus, the MECS and SEDR estimates of these energy sources are quite close and judged to be comparable.

Pulping Liquor; Wood Chips, Bark, Wood Waste; Net Steam and Hot Water; and Miscellaneous Energy Sources

All of these energy sources are included in the MECS, but excluded from the industrial estimates appearing in SEDR. In the MECS, these energy sources account for 2,291 trillion Btu. These estimates are excluded from the SEDR because of a lack of consistent historical data.

Electrical System Energy Losses

The heat content of a kilowatthour of electricity, regardless of the generation process, is 3,412 Btu. That quantity represents the amount of *useful* energy contained in a kilowatthour of electricity, and is used as a conversion factor to produce the MECS estimates of end-user consumption.

Electricity production, on the other hand, is typically measured as the heat value of the energy sources that were consumed by utilities to produce electricity. On the average, fossil-fueled generating plants require about 10,352 Btu of energy to produce one kilowatthour of electricity. Nuclear steam generating plants require 10,760 Btu per kilowatthour, and geothermal generating plants require 20,997 Btu per kilowatthour.⁷⁰ These values vary from one utility to another.

Electrical system energy losses include all losses incurred in the generation, transmission, and distribution of electricity, including plant use and unaccounted for quantities. These losses are estimated in SEDR as the difference between the total of all energy input at electric utilities and the total electricity sold to end users.⁷¹

⁶⁹Energy Information Administration, *Petroleum Supply Annual 1991 Volume 1*, DOE/EIA-0340(91)1 (Washington, DC, June 1992), p. 140.

⁷⁰Energy Information Administration, *State Energy Data Report 1991*, Appendix D, p. 475.

⁷¹Energy Information Administration, *State Energy Data Report 1991*, Appendix A, p. 396.

The 1991 industrial estimates, as reported in SEDR, include electrical system energy losses of 7,014 trillion Btu. End-use consumption for the industrial sector was estimated as 3,230 trillion Btu. Thus, electric utilities consumed 10,244 (7,014 + 3,230) trillion Btu of energy to produce the 3,230 trillion Btu of electricity consumed by the industrial sector.

The MECS does not include, nor does it require an estimate of electrical system energy losses because it is designed to produce estimates of end-use consumption. However, electrical system energy losses that would be associated with manufacturing end-use consumption can easily be estimated for the MECS by multiplying the end-use consumption of purchased electricity (in Btu) by 2.0023, i.e., $(10,244 - 3,412) / 3,412 = 2.0023$. Thus, electrical system energy losses associated with the consumption of purchased electricity by the manufacturing sector would be 4,765 trillion Btu, i.e., $2.0023 \times 2,380 = 4,765$.

A Final Observation

This appendix has shown that many of the substantial differences between the MECS estimates of the primary consumption of energy and the combined estimates resulting from the supplier surveys can be reconciled by carefully reviewing the coverage and definitions of the data series involved. It should be emphasized that the differences are not an indication of the relative strengths or weaknesses of either series. Rather, the differences in the estimates simply reflect the differences in the *intents* of the end-user surveys and the supplier surveys. The overall purpose of the end-user surveys is to provide baseline energy consumption and related characteristics data for various groups of end users (manufacturers, residential housing and transportation, and commercial buildings). The overall purpose of the supplier surveys, on the other hand, is to provide baseline data on the production and supply of various fuels. To reiterate, data users should be extremely wary of attempting to compare or combine the results of the end-user and supplier surveys without careful attention to the origins and purposes of the different estimates.