Comparability of Supply- and Consumption-Derived Estimates of Manufacturing Energy Consumption

by John L. Preston*

The Energy Information Administration tracks U.S. energy flows by gathering data on both energy supply and energy consumption. While it might seem that those tallies should be equivalent, there are important differences between the supplier and end-user surveys that must be considered when comparing their respective results. This article explores some of those differences by disaggregating and comparing two estimates of industrial-sector total energy consumption, one derived from supplier surveys that are compiled and published in the State Energy Data Report *and the other from the Manufacturing Energy Consumption Survey (an end-use survey).*

The Energy Information Administration (EIA) collects data from two distinct sets of sources that, in their entirety, provide a comprehensive picture of energy production, marketing, and consumption in the United States.[1] One set of surveys is directed to the suppliers and marketers of specific fuels (including electricity). These surveys are designed to measure the quantities of specific fuels produced and/or supplied to the market, as well as other information related to the fuels' production and supply. Supplier surveys are conducted to collect data on coal, coke, natural gas, petroleum refinery products, and electricity.

The second group of surveys collects energy consumption and related data directly from end-use consumers. The end-user surveys collect comprehensive baseline data on energy consumption and related characteristics for the manufacturing sector, commercial buildings, residential households, and residential transportation.

Because there is a seeming correspondence between energy supplied and energy consumed, it is tempting to compare or

merge the results of these two survey sets. However, there are important differences between the supplier and end-user surveys that can yield contrasting estimates for the same parameters. Those differences need to be taken into account when making comparisons or performing other analyses. This article illustrates some of the differences by discussing the relationship of the industrial-sector consumption estimates presented in EIA's *State Energy Data Report* (SEDR), which are derived from supplier surveys, to those derived from EIA's Manufacturing Energy Consumption Survey (MECS), one of the end-use surveys.

Comparing the MECS and SEDR Estimates

The MECS produces four separate estimates of manufacturing energy consumption: (1) total primary consumption of energy for all purposes; (2) total primary consumption of energy for nonfuel purposes; (3) total inputs of energy for heat, power, and electricity generation; and (4) total consumption of offsite-produced energy for heat, power, and electricity generation. 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 fuel consumption for energy and as a raw material or feedstock.

Definitional irregularities contribute to the need for caution when making comparisons between the estimates from the two survey groups. For example, the industrial sector is defined in general to consist of manufacturing, mining, construction, agriculture, fisheries, and forestry. The approximate Standard Industrial Classification (SIC) equivalent of the industrial sector includes major group codes 01 through 39.[2] However, a perfect mapping of the supplier surveys to that range of SIC codes is not possible:

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Although the 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. Because agricultural use of natural gas cannot be identified separately, it is included in the commercial sector... [rather than the industrial sector.][3]

The allocations to the industrial sector are discussed in more detail in the following sections on individual energy sources, which explain (when they are known) the reasons for the differences between the MECS and SEDR estimates.

Coal. The 1991 estimate of coal consumption from the MECS is 2,006 trillion Btu and the combined estimate published in SEDR for the industrial sector is 2,600 trillion Btu (Table 1). 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.

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 (1,693 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).[4]

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."[5] 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's 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 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 plants[6] 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

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Glossary

Miscellaneous Energy Sources. Includes sources such as rice hulls, used tires, and floor sweepings.

Net Steam and Hot Water. The sum of purchases, generation, and transfers in of steam and hot water used in industrial processes, minus transfers out, for all industrial establishments.

Other Oils. Oils with a boiling range of 401°F or greater intended for use as petrochemical feedstocks.

Pulping Liquor. The alkaline spent liquor removed from the digesters in the process of chemically pulping wood. After evaporation, the liquor is burned as a fuel in a recovery furnace that permits the recovery of certain basic chemicals.

Special Naphthas. All finished products within the naphtha oiling range that are used as paint thinners, cleaners, or solvents.

Still Gas and Waste Gas. Still gas is any form or mixture of gas produced in refineries by distillation, cracking, reforming, and other processes, the principal constituents of which are methane, hydrogen, ethane, ethylene, propane, propylene, butanes, butylene, and others. Waste gas is typically such things as blast furnace gas, coke oven gas, and other waste-combustible gases produced by industrial processes.

Unfinished Oils. Includes all oils requiring any further processing other than mechanical blending.

Waxes. Solid or semisolid materials derived from petroleum distillates or residues by such treatments as chilling, precipitating with a solvent, and de-oiling.

Note: See the glossary in the back of this publication for terms not listed here.

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Table 1. MECS and SEDR Estimates of Coal Consumption, 1991
(Trillion Btu)

MECS Total Primary Consumption of Energy for All Purposes		SEDR Industrial Sector Energy Consumption Estimates	
Energy Source	**Estimate**	**Energy Source**	**Estimate**
Coal	**2,006**	**Coal**	**2,600.4**
		Coke Plants	907.3
		Other Industrial	1,693.2

Note: Total does not equal sum of components due to independent rounding.

Source: Energy Information Administration, *Manufacturing Consumption of Energy 1991*, DOE/EIA–0512 (91) (Washington, DC, prepublication copy), Table D2.

Products." The coal gasification plants are excluded from the MECS sample.[7] 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. However, the total of these values accounts for virtually all of the remaining difference of 275 trillion Btu between the MECS estimate and the adjusted SEDR estimate.

Natural gas. The natural gas consumption estimates for 1991 for the MECS and the combined industrial estimates for 1991 published in SEDR are, respectively, 6,095 trillion Btu and 8,657 trillion Btu (Table 2). 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 the manufacturing sector as defined for the MECS.

Specifically, the 1991 MECS sample excluded very small establishments. EIA estimates that those establishments accounted 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.

Further, 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."[8] 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 and is self-provided (i.e., not purchased). The SEDR estimate, excluding lease and plant fuel, is 7,270 trillion Btu.

The SEDR estimate of industrial natural gas consumption also includes purchased natural gas used by the mining sector. The *1987 Census of Mineral Industries*[9] 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 used by the mining sector from the SEDR estimate results in 6,811 trillion Btu.

The remaining difference of 716 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's 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.[10]

The SEDR estimate of industrial natural gas consumption does include the construction industries (SIC's 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,[11] or the equivalent of approximately 100 trillion Btu. Excluding the construction industries from the SEDR estimates leaves 6,711 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; still others are totally independent of manufacturing. In general, these generating facilities are known as nonutility power producers (NPP's). 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, NPP's with generating capacities of 5 megawatts or more generated 131 billion kWh[12] of electricity using 1,617 trillion Btu of natural gas as an input fuel[13] in 1991, for an efficiency rate of 28 percent.[14] All of that natural gas consumption would be included in the SEDR estimate of industrial natural gas consumption. However, the MECS includes only the

Table 2. MECS and SEDR Estimates of Natural Gas Consumption, 1991
(Trillion Btu)

MECS Total Primary Consumption of Energy for All Purposes		SEDR Industrial Sector Energy Consumption Estimates	
Energy Source	Estimate	Energy Source	Estimate
Natural Gas	**6,095**	**Natural Gas**	**8,657.1**
		Industrial	7,470.6
		Lease and Plant Fuel	1,186.5

Note: The 1992 SEDR contained revised estimates of natural gas consumption. However, the differences were not large enough to affect the analyses.
Source: Energy Information Administration, *Manufacturing Consumption of Energy 1991*, DOE/EIA–0512 (91) (Washington, DC, prepublication copy), Table D2.

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, according to MECS data, manufacturers generated 125,584 million kWh of electricity from nonrenewable energy sources. 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. Clearly, not all of that boiler output was used to generate electricity. However, if electricity were 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 Btu 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 6,711 trillion Btu yields 6,076 trillion Btu of natural gas, an estimate that is quite close to the MECS estimate of 6,095 trillion Btu.

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 3).[15]

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. 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. The estimate included in SEDR represents electricity sales to SIC's 01 through 39, while the MECS estimate of purchased electricity is for SIC's 20 through 39 only.

Specifically, 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,[16] or roughly 190 trillion Btu.[17] 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.

Finally, 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,[18] 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 the remaining SIC's in the agriculture, forestry, and fishing division for which estimates are not available and by increased consumption in the mining and construction divisions between 1987 and

Table 3. MECS and SEDR Estimates of Net Electricity Consumption, 1991
(Trillion Btu)

MECS Total Primary Consumption of Energy for All Purposes		SEDR Industrial Sector Energy Consumption Estimates	
Energy Source	Estimate	Energy Source	Estimate
Net Electricity	**2,370**	**Electricity**	**3,229.7**
Purchased Electricity	2,380	Electricity Sales	3,229.7
Transfers In	71		
Generation From Nonrenewable Combustible Resources	15		
Electricity Sales and Transfers Out	-96		

Source: Energy Information Administration, *Manufacturing Consumption of Energy 1991*, DOE/EIA–0512 (91) (Washington, DC, prepublication copy), Table D2.

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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 codes 01 through 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.[19]

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 one utility to another. 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 were consumed by manufacturers during 1991 (Table 4). The SEDR combined estimate for the industrial sector reports that the net imports of coal coke (imports minus exports) were 8.9 trillion Btu.

Both 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. The estimates are therefore free of *intraestablishment* double counting.[20] 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.[21] 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, a value that is quite close to the sales estimate.

Fuel oils and liquefied petroleum gases. The MECS estimate of the primary consumption of residual fuel oil for 1991 is 454 trillion Btu (Table 5). 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.

The MECS estimate of the primary consumption of distillate fuel oil for 1991 is 146 trillion Btu (Table 5). 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 1991,[22] and the mining division (SIC's 10 through 14) accounted for approximately 170 trillion Btu in 1987.[23] Accounting for these sectors reduces the difference

Table 4.   MECS and SEDR Estimates of Coke and Breeze Consumption, 1991
(Trillion Btu)

MECS Total Primary Consumption of Energy for All Purposes		SEDR Industrial Sector Energy Consumption Estimates	
Energy Source	**Estimate**	**Energy Source**	**Estimate**
Coke and Breeze	**308**	**Net Imports of Coal Coke**	**8.9**
		Coke Imports	27.3
		Coke Exports	18.4

Source: Energy Information Administration, *Manufacturing Consumption of Energy 1991*, DOE/EIA–0512 (91) (Washington, DC, prepublication copy), Table D2.

Table 5. MECS and SEDR Estimates of Fuel Oil and Liquefied Petroleum Gases Consumption
(Trillion Btu)

MECS Total Primary Consumption of Energy for All Purposes		SEDR Industrial Sector Energy Consumption Estimates	
Energy Source	**Estimate**	**Energy Source**	**Estimate**
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**

Note: The 1992 SEDR contained a revised estimate of consumption of liquefied petroleum gases. However, the difference was not large enough to affect the analysis.
Source: Energy Information Administration, *Manufacturing Consumption of Energy 1991*, DOE/EIA–0512 (91) (Washington, DC, prepublication copy), Table D2.

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.

The 1991 MECS estimate of the primary consumption of liquefied petroleum gases (LPG) was 1,574 trillion Btu (Table 5). 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.

Other components of the MECS and SEDR estimates (Table 6).

- 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, other oils, special naphthas, waxes, and miscellaneous products. The total energy consumed to produce those products included in 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

Table 6. MECS and SEDR Estimates of Other Primary Consumption
(Trillion Btu)

MECS Total Primary Consumption of Energy for All Purposes		SEDR Industrial Sector Energy Consumption Estimates	
Energy Source	**Estimate**	**Energy Source**	**Estimate**
Other	**7,304**		
Asphalt and Road Oil	1,078	**Asphalt and Road Oil**	**1,076.5**
Lubricants	380	**Lubricants**	**166.7**
Kerosene	48	**Kerosene**	**11.4**
Finished Motor Gasoline	81	**Finished Motor Gasoline**	**193.3**
		Other Petroleum	**3,385.5**
Naphtha < 401 Degrees	299	Naphtha < 401 Degrees	298.9
Other Oils $\geq$ 401 Degrees	795	Other Oils $\geq$ 401 Degrees	827.3
Special Naphthas	134	Special Naphthas	88.0
Waxes	41	Waxes	35.1
Miscellaneous Products	141	Miscellaneous Products	152.6
Crude Oil	0	Crude Oil	38.9
Pentanes Plus	—	Pentanes Plus	294.0
Unfinished Oils	—	Unfinished Oils	-450.2
Motor Gasoline Blending Compounds	—	Motor Gasoline Blending Compounds	-25.9
Aviation Gasoline Blending Compounds . . .	—	Aviation Gasoline Blending Compounds . . .	-0.1
Petroleum Coke	617	Petroleum Coke	700.3
Still Gas and Waste Gas	1,399	Still Gas	1,426.6
Pulping Liquor	857	**Pulping Liquor**	**—**
Wood Chips, Bark, Wood Waste	666	**Wood Chips, Bark, Wood Waste**	**—**
Net Steam and Hot Water	239	**Net Steam and Hot Water**	**—**
Miscellaneous	529	**Miscellaneous**	**—**

Note: Totals may not equal sum of components due to independent rounding.
— = Not applicable. Energy source is not included in series.
Source: Energy Information Administration, *Manufacturing Consumption of Energy 1991*, DOE/EIA–0512 (91) (Washington, DC, prepublication copy), Table D2.

by petroleum refineries on Form EIA-810, "Monthly Refinery Report." The estimate appearing in SEDR for these products is 2,645 trillion Btu, or 223 trillion Btu less than the MECS estimate. That estimate is taken directly from *Petroleum Supply Annual 1991*.

The discrepancy in the estimates is attributable to slight differences in estimating approaches between the MECS and those employed to derive the estimate that appears in the *Petroleum Supply Annual 1991*. 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 1991*, 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 1991* and those included in the MECS are comparable.

- The MECS estimate of the primary consumption of kerosene is 48 trillion Btu and the estimate published in SEDR is 11 trillion Btu. The reasons for this difference are unknown.

- 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.

- Crude oil inputs to refineries are excluded from the MECS except when the 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.

- In general, the MECS excludes all inputs to the refinery process in order to avoid double counting. Pentanes plus, unfinished oils, and blending compounds used in motor gasoline and aviation gasoline are among those inputs that are excluded. The estimates appearing in SEDR are taken directly from the *Petroleum Supply Annual 1991*, 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]."[24]

- The MECS estimates of the primary consumption of petroleum coke and still gas and waste gas for 1991 were 617 trillion Btu and 1,399 trillion Btu, respectively. The estimates appearing in SEDR for these energy sources were 700 trillion Btu 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 are all included in the MECS but are 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 used, 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.[25] These values vary from one utility to another.

Electrical system energy losses include all losses (Table 7) 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.[26]

Table 7. MECS and SEDR Estimates of Total Energy Consumption
(Trillion Btu)

MECS Total Primary Consumption of Energy for All Purposes		SEDR Industrial Sector Energy Consumption Estimates	
Energy Source	Estimate	Energy Source	Estimate
Total	20,257	Total	29,568.0
		Net Energy[a]	22,553.9
		Electrical System Energy Losses	7,014.1

[a]Net energy total does not include industrial hydropower.

Source: Energy Information Administration, *Manufacturing Consumption of Energy 1991*, DOE/EIA–0512 (91) (Washington, DC, prepublication copy), Table D2.

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 at 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 x 2,380 = 4,765.

A Final Observation

This article shows 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, particularly the SEDR, 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 paying careful attention to the origins and purposes of the different estimates.

Notes

[1]Descriptions 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).

[2]Office of Management and Budget, *Standard Industrial Classification Manual 1987* (Washington, DC, 1987), pp. 21–263.

[3]Energy Information Administration, *State Energy Data Report 1992, Consumption Estimates,* DOE/EIA–0214 (92) (Washington, DC, May 1994), p. 4.

Coal

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

[5]*Standard Industrial Classification Manual 1987*, p. 284.

[6]Energy Information Administration, *Quarterly Coal Report,* October–December 1992, Table 50.

[7]There 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.

Natural Gas

[8]Energy Information Administration, *Natural Gas Annual 1991*, DOE/EIA–0131(91) (Washington, DC, October 1992), p. 250.

[9]U.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 every 5 years and the estimates for 1992 are not yet available.

[10]Form EIA–176, "Annual Report of Natural and Supplemental Gas Supply and Disposition," p. 7.

[11]Cost information obtained by telephone from the Industry Division of the U.S. Bureau of the Census.

[12]Energy Information Administration, *Electric Power Annual 1991*, DOE/EIA–0348(91) (Washington, DC, February 1993), Table 70.

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

[14]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

[15]The MECS uses "net electricity" as a measure of electricity consumption in order to avoid double counting.

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

[17]Conversion based on $13.486 per million Btu.

[18]Cost information obtained by telephone from the Industry Division of the U.S. Bureau of the Census.

[19]Form EIA–861, "Annual Electric Utility Report for the Reporting Period 1991," p. xi.

Coke and Breeze

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

[21]Energy Information Administration, *Quarterly Coal Report,* January–March 1991, April–June 1991, July–September 1991, and October–December 1991, Table A6.

Fuel Oils and Liquefied Petroleum Gases

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

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

Other Components of the MECS and SEDR Estimates

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

Electrical System Energy Losses

[25]Energy Information Administration, *State Energy Data Report 1991*, Appendix D, p. 475.

[26]Energy Information Administration, *State Energy Data Report 1991*, Appendix A, p. 396.