

Chapter 6

Industrial Sector

January 2021

This chapter should be cited as

Study team (2021), 'Industrial Sector', in Mongolian Energy Institute and ERIA (eds.), *Mongolia's Energy Efficiency Indicators 2019*. ERIA Research Project Report FY2020 no. 17, Jakarta: ERIA, pp.57-68.

Chapter 6

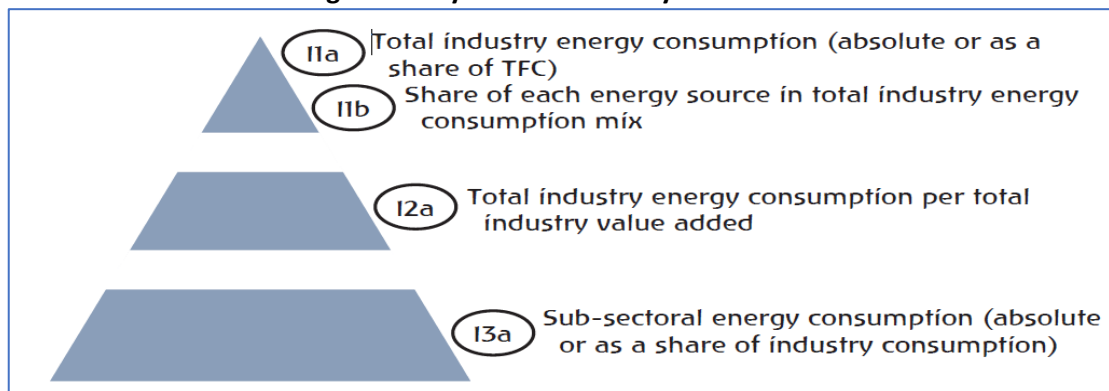
Industry Sector

1. Energy Efficiency Indicators in the Industry Sector

In principle, energy efficiency indicator (EEI) is the ratio of energy consumption per activity. In other words, it is the amount of energy required to conduct an activity. In the industry sector, activity is the process of producing an output. Thus, it can be measured in quantity produced or its value. Since the industry sector is very complex, a detailed understanding of the various processes or product types would be necessary to monitor energy efficiency.

The Manual on Energy Efficiency Indicators (IEA, 2014b) of the International Energy Agency differentiates the aggregate indicators and the disaggregate indicators. The aggregate indicators (Figure 6-1) refer to the overall energy consumption of industry expressed either in absolute terms or as the share in total final consumption and to the share of each energy source in the total industry consumption mix. These two indicators are enough to provide a high-level picture of the sectoral consumption and allow a first comparison across countries, as well as a preliminary assessment of the importance of the various sub-sectors and energy sources.

Figure 6-1 Pyramid of Industry Indicators



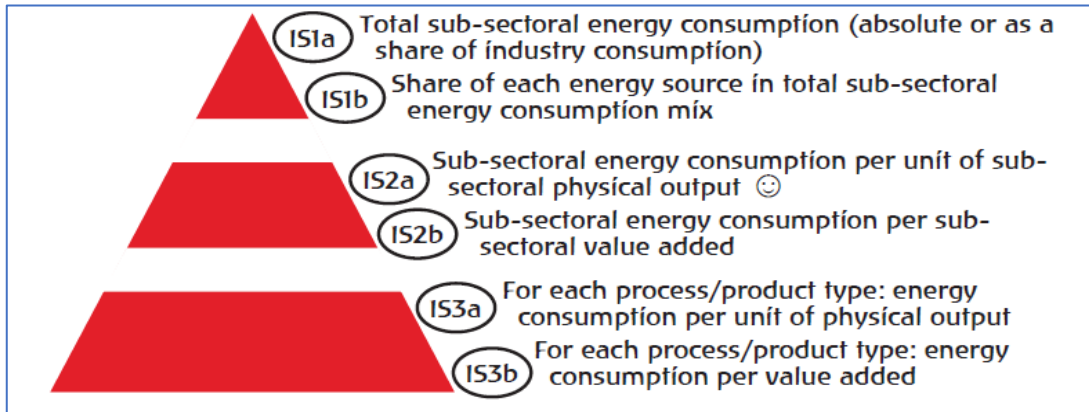
Note: TFC = total final consumption.

Source: IEA (2014b).

Another indicator at the aggregate level refers to intensity, which is the total industry energy consumption divided by total industry value added. This indicator provides a first assessment of the overall intensity of the sector and its trends. The total output of the sector at the overall industry level is represented by the sector's value added because the physical output across the subsectors is not homogeneous. The value added should be in constant currency to avoid bias induced by fluctuations in the monetary market.

The last level of the pyramid refers to the energy consumption of each sub-sector, as a total or as a share of industry consumption. This level corresponds to the top level of the sub-sectoral pyramid (Figure 6-2).

Figure 6-2 Pyramid of Freight Transport Indicators



Source: IEA (2014b).

As in the aggregate pyramid, the next level refers to the intensity of the sub-sectors. These can be consumption per unit of physical output or consumption per value added. The first indicator is meaningful only when the output is homogeneous, such as crude steel or cement. If the output is heterogeneous production output, such as in textile or petrochemical facility, the latter indicator, which is the intensity per value added, can be used or moved to the next level of disaggregation with data per individual type of product.

At the last level, the indicators refer to a specific production process or product type, instead of the sub-sector as a whole. These will either be the consumption per unit of physical output or per value added for each sub-sectoral process or product type. The difficulty for the energy efficiency analysis at this level is the lack of availability of data or the difficulties in allocating energy consumption to specific physical output values when outputs are heterogeneous in the same establishment.

Conducting the survey on the energy consumption of the industry sector is an attempt to obtain the energy consumption data at the sub-sector level. The result of the industry survey will describe how energy is being consumed by the sub-sectors surveyed. The unit consumption per product output or value can be derived from the survey result.

The accuracy of the sub-sector energy intensity is limited to the samples. In this regard, preparation of the industry sector EEI of Mongolia will require larger samples of the different sub-sectors and must be inflated to the national level using the national statistics on industrial production output in physical unit or monetary value.

2. Effective Samples

The Mongolian industry sector is divided into three main sub-sectors: (i) mining and quarrying; (ii) manufacturing; and (iii) electricity, thermal energy, and water supply (ETEWS).

During the research work, 120 sample surveys were conducted from the industry sector. The collected data was summarised and 89 of them were counted as useful samples.

3. Main Indicators of the Industry Sector

The industry sector survey collected the energy consumption of the sector from six different areas of the country. Fuel consumption was classified as coal, diesel, wood, liquefied petroleum gas (LPG), lubricants, and motor gasoline.

Although the industries provided detailed information on their electricity consumption, they provided limited information on their thermal power consumption. Thus, thermal energy consumption cannot be calculated.

3.1. Mining and quarrying Sector

The mining and quarrying sector plays a major role in Mongolia's industry sector. The study classified this as the coal and others sub-sector.

The coal sub-sector covers nine mining factories located in the western, eastern, southern, and northern regions of Mongolia. Information on energy consumption, sources, and fuel consumption was collected and analysed.

Samples for the energy consumption survey of this sector were taken from factories such as zinc, tungsten, iron, and copper concentrate. The LPG factory of Oyu-tolgoi was not included in this sector because its energy consumption was too high for the energy consumption structure (outlier).

3.2. Manufacturing sector

The manufacturing sector covers the factories in Ulaanbaatar, eastern, southern, western, and northern Mongolia. The study analysed the energy consumption data by fuel source of 75 entities as follows:

- Food – 31
- Construction materials – 13
- Basic metals – 5
- Other – 26
-

During the survey, detailed information on electricity and fuel consumption was collected; however, information on heat energy consumption was insufficient. The energy consumption of the subsector was calculated for three fuel types: coal, electricity, and wood. Fuel used in vehicles was excluded from the survey.

The food sub-sector included meat products, flour, fresh water, beverage, and candy companies; the units are in cube, cubic metre, and so on. The energy intensities, defined as

consumption per output, were calculated based on the sales revenue rather than the physical quantities.

The construction sub-sector included windows, bricks, blocks, and wood production companies with outputs measured in metre, cubic metre, ton, etc. The energy intensities were calculated by comparing sales with physical quantities.

Copper, cathode copper, iron-enriched steel products, and steel ball bearers were included in the basic metals sub-sector. Although it was possible to quantify the intensities by quantity, these could not be accounted for in the manufacturing sector compared to sales revenue.

Other sub-sector includes a wide variety of business entities, such as clothing, textile products, leather products, shoes, and furniture, and are measured in terms of unit quantities, such as set, unit, and bill because they are calculated based on sales rather than physical quantities.

4. Energy Consumption in the Manufacturing and Mining and Quarrying Sectors

Industry sector energy consumption was estimated for four types of fuels – coal, electricity, diesel, and wood – for both the mining and quarrying and manufacturing plants (Table 6-1).

Table 6-1. Energy Consumption in the Industry Sector (toe)

Energy Type	Manufacturing	Mining and Quarrying	Total
Coal	19,358.42	27,304.81	46,663.24
Electricity	8,668.75	13,194.61	21,863.36
Diesel (for generators)	0.00	86.47	86.47
Wood	12.16	7.93	20.09
Total	28,039.33	40,593.82	68,633.15

Source: Elaboration and calculation of MEEI authors.

The energy consumption of manufacturing plants was 28,039 toe whilst that of mining and quarrying was almost 40,600 toe. The main fuel used in both sectors was coal. Coal share in the total energy consumption of the manufacturing sector was 69% whilst for mining and quarrying, the share was 67.3% (Table 6-2). The electricity share was 30.9% in the manufacturing sector and 32.5% in the mining and quarrying sector. Diesel was only consumed by the mining and quarrying sector for generators. The share in the total mining and quarrying consumption was 0.21%. Only a small amount of wood is consumed by the manufacturing and mining and quarrying sectors, 0.04% and 0.02%, respectively.

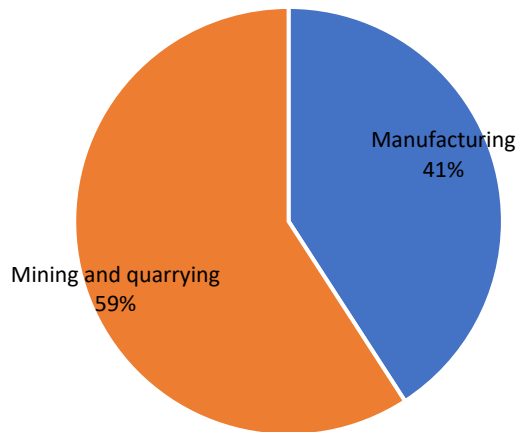
Table 6-2. Energy Consumption in the Industry Sector (%)

Energy Type	Manufacturing	Mining and Quarrying	Total
Coal	69	67.3	68
Electricity	30.9	32.5	31.9
Diesel (for generators)	0	0.21	0.13
Wood	0.04	0.02	0.03
Total	100	100	100

Source: Elaboration and calculation of MEEI authors.

Overall, the total energy consumption of the industry sector was 68,633 toe; 41% of this was consumption of the manufacturing plants and 59%, that of the mining and quarrying sector (Figure 6-3).

Figure 6-3 Industrial Energy Consumption , by Sector



Source: Elaboration and calculation of MEEI.

5. Energy Consumption and Intensities of Sectors

5.1 Manufacturing sector

Business entities in the manufacturing sector are classified into four sub-sectors: food, construction materials, basic metals, and others. In terms of consumption structure, diesel fuel is excluded, and calculations of three types of energy – coal, electricity, and wood – are made.

The EEIs are calculated for each fuel used by each sector, and the fuel consumption is expressed in tonne of oil equivalent (toe) (Table 6-3).

Table 6-3. Energy Consumption in the Manufacturing Sector (toe)

Type of Fuel	Food	Construction Materials	Basic Metals	Other	Total
Coal	374.87	298.06	18,470.77	214.73	19,358.42
Electricity	1,579.16	66.44	5,622.88	1,400.27	8,668.75
Wood	9.69	0.35	0.00	2.11	12.16
Total	1,963.72	364.85	24,093.65	1,617.11	28,039.33

Source: Elaboration and calculation of MEEI authors.

The total energy consumption of the manufacturing sector reached 28,039 toe which was mainly the consumption of the basic metals sub-sector (24,094 toe). The remaining energy consumption of the industry was that of food (1,964 toe), construction materials (365 toe), and others (1,617 toe).

As earlier mentioned, coal share is the highest, at 69%, of the total energy consumption of the manufacturing sector. This was due to coal consumption in construction materials and basic metals plants. Coal share in the total consumption of construction materials was 81.7% whilst that in the total basic metal consumption it was 76.7% (Table 6-4).

As to the energy consumption of the total food industry and the other industry, the share of coal was not dominant, only 19.1% and 13.3%, respectively. Electricity has the dominant share in these two sectors, i.e. 80.4% for food industries and 86.6% for the other sub-sector. Wood is consumed in the food, construction materials, and other sub-sector. No wood is consumed in the basic metals sub-sector. Wood share was 0.49% in the food subsector, 0.1% in the construction materials sub-sector, and 0.13% in the other sub-sector.

Table 6-4. Energy Consumption in the Manufacturing Sector (%)

Specification	Food (31)	Construction Materials (13)	Basic Metals (5)	Other (26)	Percentage
Coal	19.09	81.69	76.66	13.28	69.04
Electricity	80.42	18.21	23.34	86.59	30.92
Wood	0.49	0.10		0.13	0.04
Total	100	100	100	100	100

Source: Elaboration and calculation of MEEI authors.

The basic metal sub-sector accounted for 95.4% of the total coal consumption of the manufacturing industry. The remaining shares are that of the food (2%), construction materials (1.5%), and other (1.1%) manufacturing industries (Table 6-5).

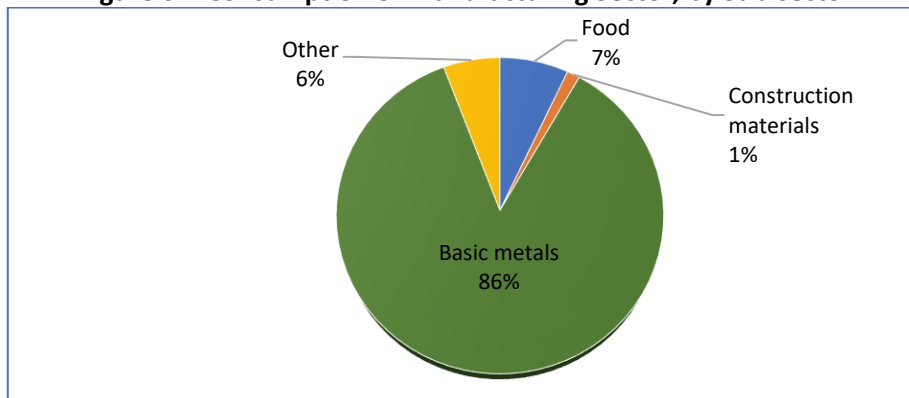
Table 6-5. Energy Consumption of the Manufacturing Sector (%)

Sub-sector	Coal	Electricity	Wood	Total
Food (31)	1.94	18.22	79.71	7.00
Construction materials (13)	1.54	0.77	2.90	1.30
Basic metals (5)	95.41	64.86		85.93
Other (26)	1.11	16.15	17.39	5.77
Total (75)	100	100	100	100

Source: Elaboration and calculation of MEEI authors.

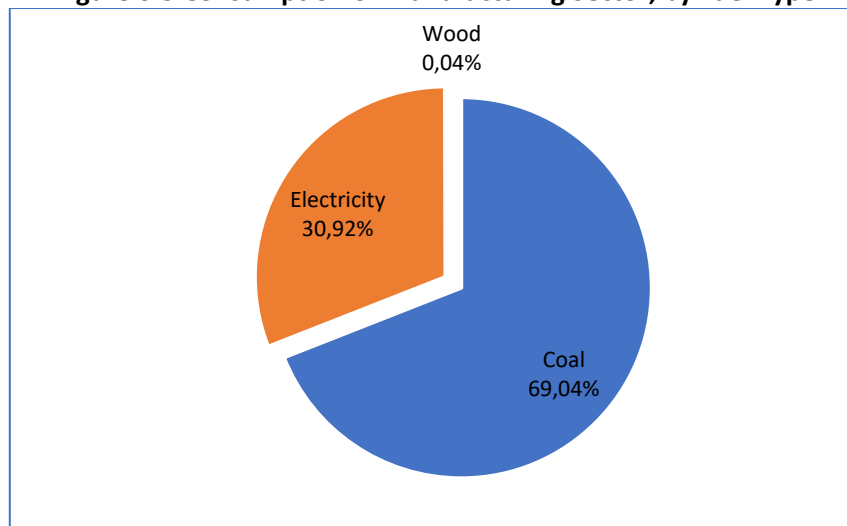
Electricity is also mainly consumed by the basic metals sub-sector (64.9%) whilst wood consumption is the highest in the food sub-sector (79.7%). Figure 6-4 shows the energy consumption of the manufacturing sector by sub-sector, and Figure 6-5 by energy type.

Figure 6-4 Consumption of Manufacturing Sector, by Sub-sector



Source: Elaboration and calculation of MEEI authors.

Figure 6-5 Consumption of Manufacturing Sector, by Fuel Type



Source: Elaboration and calculation of MEEI authors.

Energy intensity of the manufacturing sector is determined by comparing the total energy consumed to the size of the sales revenue. The result is shown in Table 6-6 with different units. Per ₮1 million output, the average energy intensity of the manufacturing sector was 0.0096 toe. By sub-sector, the energy intensity was 0.0007 toe for the food industries; 0.065 toe for the basic metal industries; 0.037 for the building materials; and 0.00097 for the other manufacturing industries. These results indicate that for the manufacturing sector, more energy efficiency measures will be needed on the construction materials and basic metals sub-sectors.

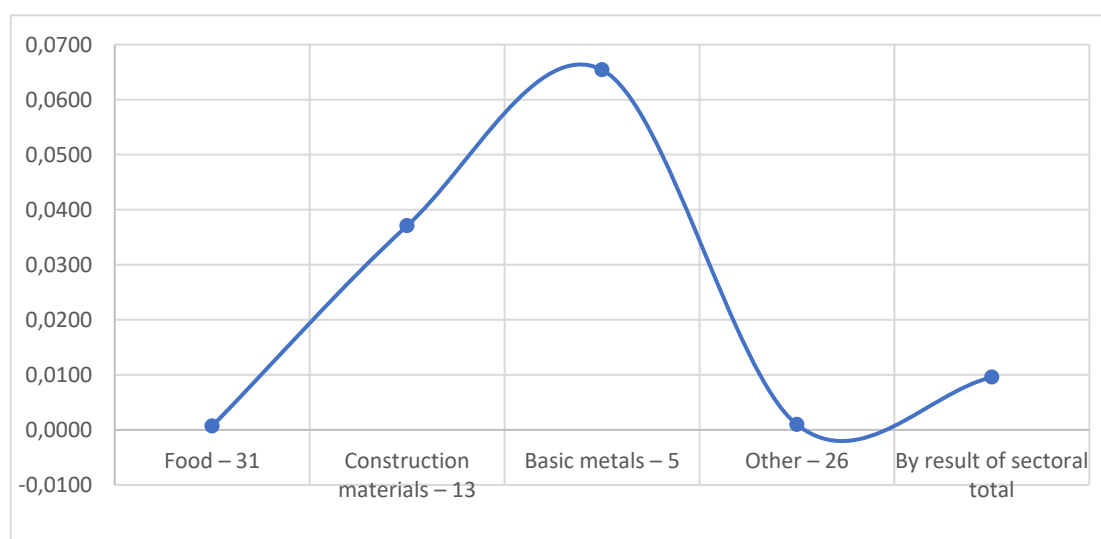
Table 6-6. Energy Intensity

Energy Type	Unit	Food	Building Materials	Metals	Other	Total
Energy intensity	toe/million tugrik (₮)	0.00067	0.03708	0.06542	0.00097	0.00959
	toe/'000 US\$	0.00178	0.09803	0.17294	0.00256	0.27531
	kWh/million ₮	7.8	431.3	760.8	11.3	111.5
	kWh/thousand US\$	20.6	1,140.1	2,011.3	29.8	3,201.8

Source: Elaboration and calculation of MEEI authors.

Figure 6-6 is the graphic form of energy intensity of the manufacturing sector in toe/ million ₮.

Figure 6-6 Energy intensity of the Manufacturing Sector (toe/million tugrik [₮])



Source: Elaboration and calculation of MEEI authors.

Table 6-7 shows the total sales of the various manufacturing sub-sectors – food, construction materials, basic metals, and other sub-sectors.

Table 6-7. Sales of Manufacturing Sector (million *tugrik* [₮])

Specification	Food	Construction Materials	Basic Metals	Other	Total
Sales revenue	876,806.4	9,839.2	368,318.7	1,669,082.5	2,924,046.7

Source: Elaboration and calculation of MEEI authors.

5.2 Mining and quarrying sub-sector

The business entities of the mining and quarrying sector are classified into coal and other. In terms of consumption structure, the types of energy considered are diesel, coal, electricity, and wood. Diesel is basically for generators.

Similar to the manufacturing sector, this sector's EEIs are calculated for each sub-sector by fuel usage in tonne of oil equivalent (toe). The resulting energy consumption of the mining and quarrying sector is shown in Table 6-8.

Table 6-8. Energy Consumption in Mining and Quarrying Sub-sector (toe)

Type of Fuel	Coal-9	Other-5	Total
Coal	1,108.60	26,196.22	27,304.81
Electricity	2,417.62	10,776.99	13,194.61
Diesel generator	71.34	15.13	86.47
Wood	0.00	7.93	7.93
Total	3,597.55	36,996.27	40,593.82

Source: Elaboration and calculation of MEEI authors.

The sector's total energy consumption was almost 40,600 toe; the consumption was mainly that of the other mining and quarrying sub-sector (around 37,000 toe). The energy consumed by this sub-sector is mainly coal (70.8%) and electricity (29.1%). The remaining fuel consumed is diesel for generators and wood.

In the coal mining and quarrying sub-sector, the main fuel is electricity, not coal, with share accounting for 67.2% of the total sub-sector consumption. The other fuel share is that of coal (30.82%) and diesel generator (1.98%). The energy consumption share of the sub-sector is shown in Table 6-9.

Table 6-9. Energy Consumption Shares of the Mining and Quarrying Sub-sector (%)

Type of Energy	Coal-9	Other-5	Total Amount
Coal	30.82	70.81	67.26
Electricity	67.20	29.13	32.50
Diesel generator	1.98	0.04	0.21
Wood	0.00	0.02	0.02
Total	100	100	100

Source: Elaboration and calculation of MEEI authors.

In terms of energy type consumed by the mining and quarrying sector, coal consumption in the other sub-sector accounted for 95.9% of the total coal consumption of the mining and quarrying sub-sector (Table 6-10). The other sub-sector also consumed most of the electricity (81.7%) and wood (100%) used by the mining and quarrying sector. In terms of diesel for generator, the coal sub-sector consumption represented 82.5% of the total sector consumption.

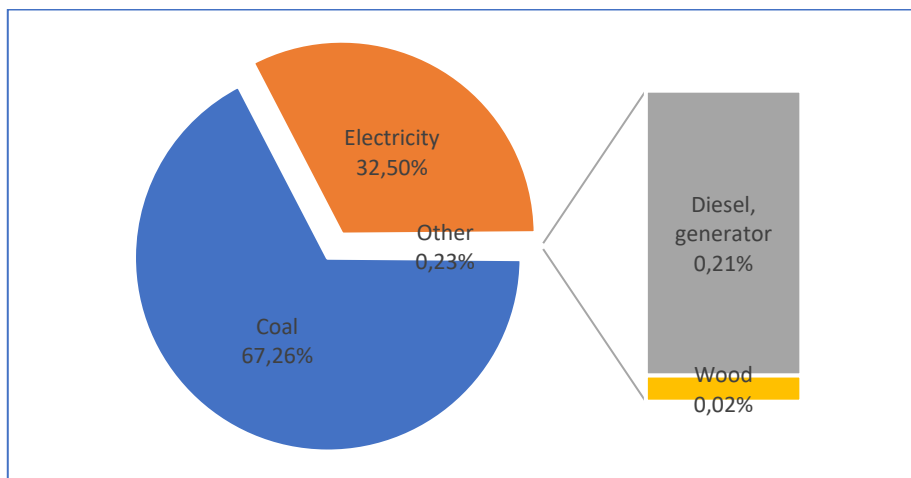
Table 6-10. Energy Consumption in Mining and Quarrying Sector, by Sub-sector (%)

Specification	Coal	Electricity	Diesel, Generator	Wood	Total
Coal-9	4.1	18.3	82.5	0.0	8.9
Other-5	95.9	81.7	17.5	100.0	91.1
Total-14	100	100	100	100	100

Source: Elaboration and calculation of MEEI authors.

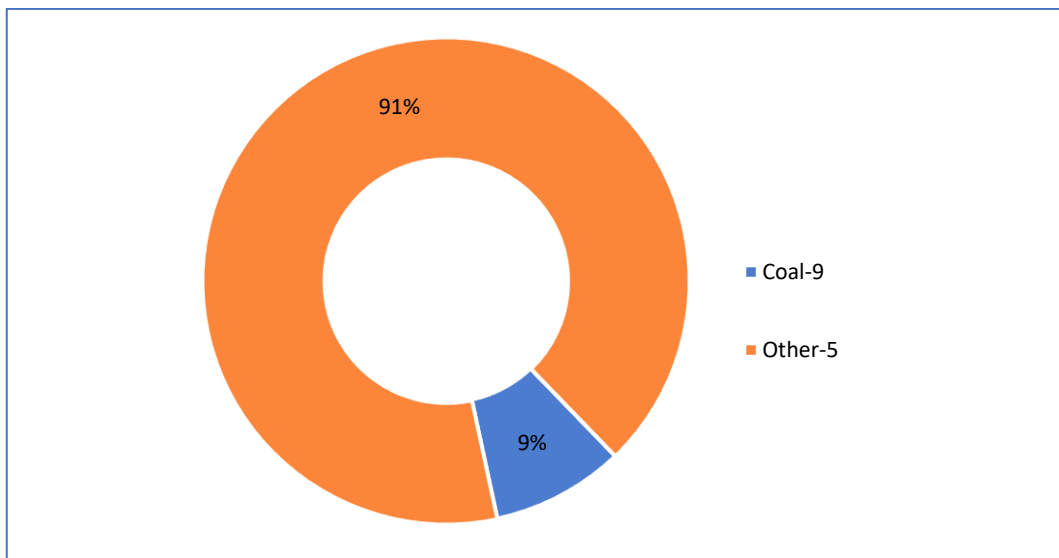
Figure 6-7 shows the total mining and quarrying energy consumption by fuel type whilst Figure 6-8 by sub-sector.

Figure 6-7 Type of Energy Consumption of the Mining and Quarrying Sector



Source: Elaboration and calculation of MEEI authors.

Figure 6-8 Energy Consumption for Mining and Quarrying, by Sub-sector



Source: Elaboration and calculation of MEEI authors.

As for the manufacturing sector, the energy intensity of the mining and quarrying sub-sector is determined by comparing the energy consumed by the mining and quarrying sector to the size of the sales revenue. Table 6-11 shows the resulting energy intensity by the different units.

Table 6-11. Energy Intensity

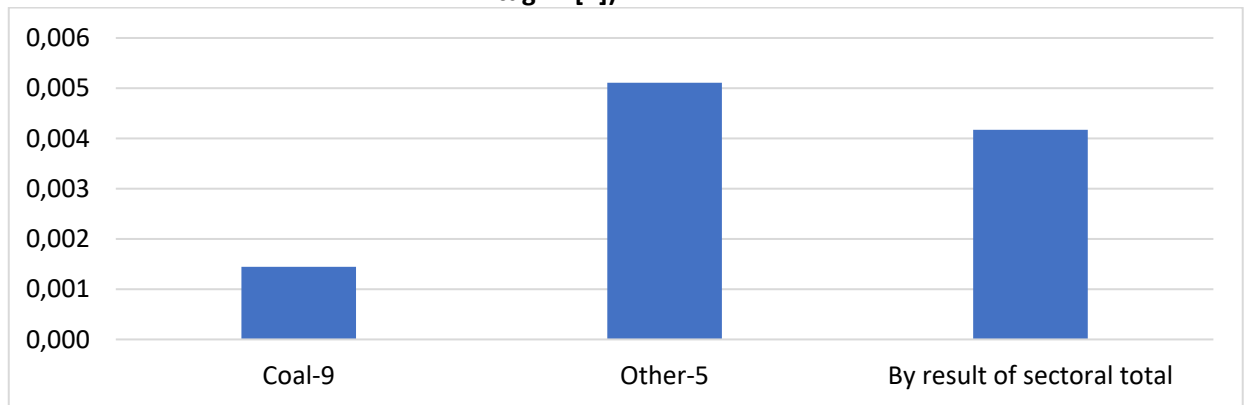
Type of Energy	Unit	Coal-9	Other-5	Total
Energy intensity	toe/million <i>tugrik</i> (₮)	0.0014	0.0051	0.0042
	toe/thousand US\$	0.0038	0.0135	0.0110
	kWh/million ₮	16.82	59.43	48.53
	kWh/thousand US\$	44.45	157.11	128.30

Note: US\$1 = ₮2,643.69.

Source: Elaboration and calculation of MEEI authors.

In terms of toe/million ₮, the energy intensity of mining and quarrying was on average 0.0042. The energy intensity for the coal mining and quarrying sub-sector is lower at 0.0014 toe/million ₮ whilst for the other sub-sector, it was higher at 0.0051 toe/million ₮. These results indicate that energy efficiency measures will be needed more for the other mining and quarrying sub-sector compared to the coal sub-sector. Figure 6-9 shows the energy intensity of the mining and quarrying sector and its sub-sectors in toe/million ₮.

Figure 6-9 Energy Intensity of the Mining and Quarrying Sector, by Sub-sector (toe/million tugrik [₹])



Source: Elaboration and calculation of MEEI authors.

Total sales of the mining and quarrying sector (coal and other) is shown in Table 6-12.

Table 6-12. Mining and Quarrying Sales (million tugrik [₹])

Specification	Coal-9	Other-5	Total
Sales revenue	2,488,202.960	7,240,022.850	9,728,225.810

Source: Elaboration and calculation of MEEI authors.