ENERGY SECTOR CURRENT STATUS, RECENT DEVELOPMENTS AND ENERGY POLICIES IN MONGOLIA

REPORT OF THE MONGOLIA WORKING GROUP TO THE NAUTILUS INSTITUTE REGIONAL ENERGY SECURITY (RES) PROJECT

OYUNCHIMEG CH, TUYA N, ZORIGT D, SUKHBAATAR TS, BAYARKHUU CH

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I. INTRODUCTION

In this Special Report, Oyunchimeg, Tuya, Zorigt, Sukhbaatar and Bayarkhuu provide an update on the current status and recent trends and challenges in Mongolia's energy sector, including changes to the Mongolian energy sector and economy as a result of the COVID-19 pandemic. The report provides the results of future energy demand and supply paths for Mongolia prepared by the Working Group. The future paths include "business as usual" projections, and paths in which Mongolia becomes a major electricity exporter. Mongolia's energy policies and the status of discussions with nations in the region regarding infrastructure for energy sharing are also updated and summarized.

Oyunchimeg Chogdon, is an Independent Energy Analyst; Tuya Nyamosor is a Professor at the School of International Relations, National University of Mongolia; Zorigt Dashdorj, is Executive Director of the Mongolia Development Strategy Institute; Sukhbaatar Tsegmid is Managing Director and CEO of Clean Energy LLC; and Bayarkhuu Chinzorigt is Business Development Manager at Akuo Energy.

Banner image: Salkhit Wind Farm, December 2019. Photo by D. von Hippel.

II. NAPSNET SPECIAL REPORT BY OYUNCHIMEG, TUYA, ZORIGT, SUKHBAATAR AND BAYARKHUU

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Abstract

This report is an updated version of the Mongolia Working Group's Year 1 Regional Energy Security (RES) project report, and as such includes updates of information on the Mongolian energy sector and economy for the years 2018 and 2019. It also provides energy sector and related economic data for January through December 2020 to enable comparisons with previous years and thus to indicate how the COVID 19 pandemic has influenced the economy of Mongolia during 2020. In addition, this update describes amendments approved since 2017 that relate to key Energy and Renewable Energy laws and policies in Mongolia. Additional recent relevant studies and information have been included in the Regional Energy Cooperation section of this report. Information on the recent status of proposed Russian gas transfers though Mongolia, and the construction of the new oil refinery plant in Mongolia have been updated as well, and these updates appear in section 6 of this Report.

In Mongolia, total primary energy supplies continue to be dominated by coal, and electricity generation is largely provided by coal-fired power plants, particularly combined heat and power plants. In 2018, 93% of all electricity was produced by thermal power plants, and 98% of all district heat was provided by coal-fired systems. Mongolia's renewable energy resources, including wind, solar, geothermal, and hydro, are estimated to be able to provide as much as 2,600 GW of electricity, far exceeding Mongolia's current generation capacity of about 1 GW. The Gobi Desert in particular has tremendous renewable energy potential and has favorable climatic and weather conditions to allow the effective use of wind and solar resources. Mongolia has modest oil reserves, but exports crude oil and imports oil products, as it lacks refining capacity.

Although Mongolia has abundant resources to produce electricity, it currently lacks sufficient generation capacity to meet its needs, and thus imports power from Russia and China. Power is imported across the northern border to compensate for shortfalls of electricity in the northern central area during winter peak periods. Also, in order to meet the electricity demand of the Oyu Tolgoi copper mine in the south, electricity is imported from China. As a result, Mongolia has been heavily dependent on electricity imports in recent years.

To ensure the reliability and stability of the energy sector, currently operating thermal power plants, district heating plants, and transmission and distribution networks are prioritized for investment, and expansion of capacity, technical and technological rehabilitation and upgrades are ongoing step by step in the energy sector. Also, development of renewable energy sources

with limited capacities for domestic use is underway, and the share of renewable generation is increasing slowly from year to year. Local air pollution from power and heating plants located in urban areas, as well as from direct use of heating fuels by households, is a significant concern to be addressed by energy policy.

The government of Mongolia has set targets to increase the share of generation capacity from renewable energy sources to 20% by 2023 and 30% by 2030, and to build export-oriented power plants. The goal of these policies is that Mongolia will become an energy exporting country in the future by utilizing its rich renewable energy resources with efficient and environmentally-friendly technologies while establishing mutually beneficial cooperation with neighboring and regional countries.

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1 Introduction

1.1 Mongolia's Physical, Demographic, and Economic setting

Mongolia is one of the largest landlocked countries in the world, with a territory extending over 1.6 million square kilometers on a plateau averaging 1,580 meters above sea level. It is bordered by the Peoples' Republic of China on three sides, to the East, South and West, and by the Russian Federation to the North.

Population

Mongolia is a sparsely populated country, with a population of around 3.3 million (Table 1-1) meaning an average population density of about 2 persons per square kilometer. More than 67 per cent of the population, however, lives in urban areas (Table 1-2).

Table 1-1: Population Growth, 2012-2019

Population	2012	2013	2014	2015	2016	2017	2018	2019
Total	2,867,744.	2,930,277.	2,995,949.	3,057,778.	3,119,935.	3,177,899.	3,238,479.	3,296,866.
Male	1,393,453.	1,425,843.	1,466,455.	1,503,612.	1,533,983.	1,562,370.	1,591,848.	1,619,573.
Female	1,474,291.	1,504,434.	1,529,494.	1,554,166.	1,585,952.	1,615,529.	1,646,631.	1,677,293.

Source: Mongolian Statistical Yearbook 2019, NSO (Mongolian National Statistical Office)

Table 1-2: Population and Population Growth in Mongolia by Region, 2000, 2010 and 2020

Region	Population (thous)			%	%		Percentage	
	2000	2010	2020	2010/2000	2020/2010	2000	2010	2020
TOTAL	**2373.5**	**2647.5**	**3197.0**	**11.5**	**20.8**	**100.0**	**100.0**	**100.0**
Western	421.6	352.3	404.7	-16.4	14.8	17.8	13.3	12.6
Khangai	545.7	514.7	597.8	-5.7	16.1	23.0	19.4	18.7
Central	443.7	440.7	506.2	-0.7	14.9	18.7	16.6	15.8
Eastern	202.5	185.3	222.2	-8.5	19.9	8.5	7.0	7.0
Ulaanbaatar	760.1	1154.3	1466.1	51.9	27.0	32.0	43.6	45.9

Source: 2020 Population and housing by-census of Mongolia, NSO of Mongolia

Internal migration: the population in the aimags (outlying provinces) has been decreasing in recent years while the population of Ulaanbaatar has been increasing, as shown in Table 1-2. Since 2000, natural hazards, including drought and dzud (winter weather disasters), have negatively affected herders and rural populations, triggering mass migration towards Ulaanbaatar and other cities. Urbanization is driven by the desire for easier access to health services, education, consumer and social services, and particularly, employment.

Economy

Mongolia's economic performance improved dramatically in 2017-19 relative to previous years, with the annual GDP growth rate increasing from 1.2 percent in 2016 to 5.1 percent in 2017, 6.4 percent in 2018 and 5.1 percent in 2019 from the previous year and reached 19.0 trillion tugrug, or just under USD 14 billion (see **Error! Reference source not found.**).

Table 1-3: Mongolia Economic Data, 2013-2019

	2013	2014	2015	2016	2017	2018	2019
Population (million)	2.9	2.9	3.0	3.0	3.1	3.2	3.3
GDP per capita (USD)	4,598	4,165	3,996	4,075	3,903	4,051	4,211
GDP (USD bn)	13.3	12.2	11.9	12.3	11.9	13.1	13.9
Economic growth (GDP, annual variation in %)	11.6	8.1	2.5	1.4	5.1	7.0	4.9
Exports (USD billion)	4.3	5.8	4.7	4.9	6.2	7.0	7.6
Imports (USD billion)	6.4	5.2	3.8	3.4	4.3	5.9	6.1
Electricity consumption per capita, kWh	1526.5	1,664.10	1,704.30	1756.7	1,928.7	2068.8	2163.1

Source: Mongolian Statistical Database; www.1212.mn; https://www.focus-economics.com/countries/mongolia

An increase in foreign trade revenue, particularly from sales of resources such as coal and copper, helped to drive the expansion of the economy, and coal and copper generated almost 70 percent of Mongolia's total export revenues. Most of Mongolia's output in these sectors is sold to neighboring China.

As reported in a Mongol Bank Report for 2019,[1] in 2019, exports increased 9 percent or USD 608 million from the previous year. The increase was due to increases in volume and prices of the following commodities: coking coal (with an increase in total value of USD 288 million), gold (an increase of USD 274 million) and iron ore (an increase of USD 234 million).

Based on the latest statistics as of late 2020 (Monthly Bulletin of December 2020) from the National Statistic Office of Mongolia (NSO), in 2020 Mongolia traded with 146 countries from all over the world and the total trade turnover reached USD 12.9 billion, of which USD 7.6 billion were exports and USD 5.3 billion were imports. Total foreign trade turnover decreased relative to the same period in 2019 by USD 876.1 million (6.4 %), of which exports decreased by USD 43.3 million (0.6 %) and imports decreased by USD 833.6 million (13.6 %) compared to the same period of the previous year (see Figure 1-1, Table 1-4, and Table 1-5).

[1] *The Bank of Mongolia* (2019), *Annual Report*. https://www.mongolbank.mn/documents/annualreport/2019e.pdf

Figure 1-1: Exports of Mongolia's Main Mineral Products, million USD, in 2018, 2019 and 2020

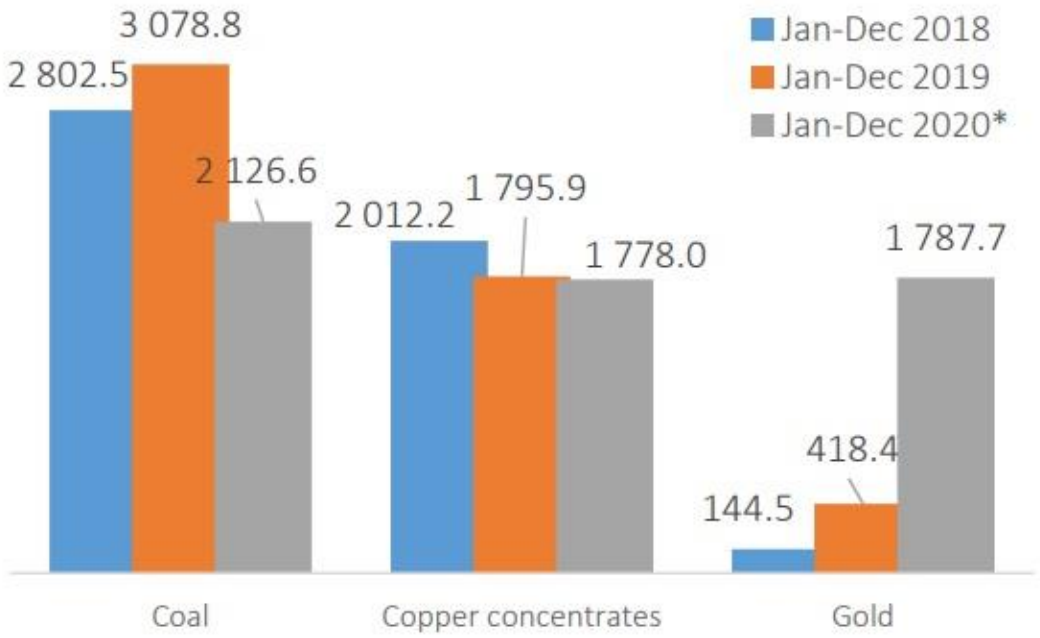


Table 1-4: Exports from Mongolia to Key Partner Countries in 2018, 2019 and 2020

Countries	2018		2019		2020*	
	Total amount, million US dollars	Share to total	Total amount, million US dollars	Share to total	Total amount, million US dollars	Share to total
Total	**7 011.8**	**100.0**	**7 619.6**	**100.0**	**7 576.3**	**100.0**
China	6 542.8	93.3	6 789.7	89.1	5 493.6	72.5
Switzerland	0.7	0.0	75.0	1.0	1 681.6	22.2
Singapore	30.0	0.4	154.5	2.0	151.3	2.0
United Kingdom	172.9	2.5	291.1	3.8	84.1	1.1
Russia	85.9	1.2	68.1	0.9	57.3	0.8
Others	179.4	2.6	241.2	3.2	108.6	1.4

Source: National Statistic Office, Monthly Bulletin

Trade with China reached USD 7.4 billion in 2020., which is 57.5 % of the total trade turnover. Bituminous coal and copper concentrates accounted for 36.6 % and 32.4 % of total exports to China, while gold accounted for 99.9%, 39.7 % and 57.4 % of goods exported to Switzerland, Singapore, and the United Kingdom, respectively.

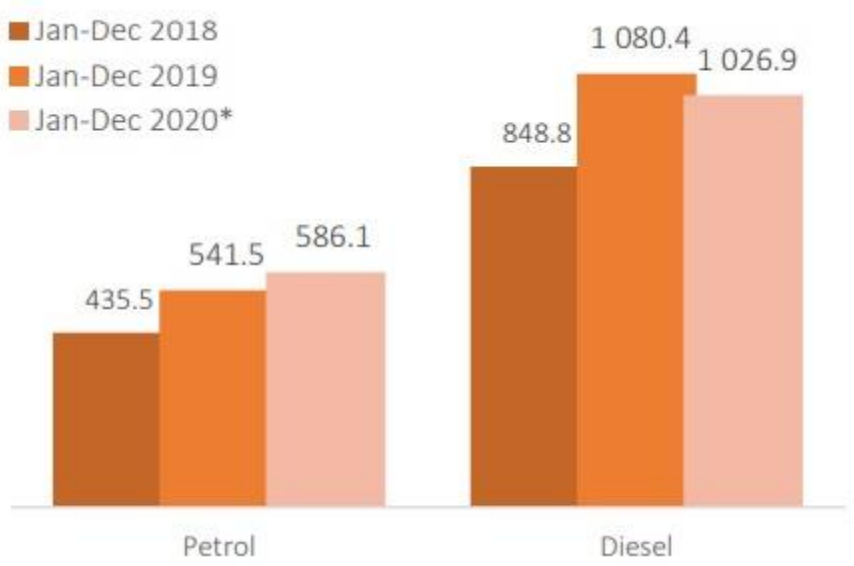
Table 1-5:: Imports to Mongolia from key partner countries in 2018, 2019 and 2020

Улс орон	2018		2019		2020*	
	Total, amount million US dollars	Share to total	Total, amount million US dollars	Share to total	Total, amount million US dollars	Share to total
Total	**5 874.8**	**100.0**	**6 127.5**	**100.0**	**5 293.9**	**100.0**
China	1 994.8	34.0	2 060.8	33.6	1 910.2	36.1
Russia	1 710.3	29.1	1 729.9	28.2	1 400.0	26.4
Japan	561.0	9.5	585.5	9.6	406.7	7.7
Republic of Korea	211.5	3.6	289.6	4.7	245.4	4.6
USA	262.4	4.5	267.0	4.4	235.8	4.5
Germany	168.7	2.9	188.9	3.1	184.8	3.5
Others	966.0	16.4	1 005.9	16.4	911.2	17.2

Source: National Statistic Office, Monthly Bulletin

In 2020, 36.1 % of total value or imports to Mongolia was from China, 26.4 % was from Russia, 7.7% was from Japan, 4.6 % was from the USA and 4.5 % was from Republic of Korea, between them accounting for 79.3 % of total imports. 51.8 % of the total value of imports from Russia was for petroleum products (see Figure 1-2), 59.8 % of the total import value of goods imported from Japan was for cars, and 6.4 % of the total imports from China was electricity, 7.8% was trucks and 85.8 % was imports of other products.

Figure 1-2: Imports of Major Petroleum Products, in Thousand Tonnes, during 2018, 2019 and 2020



Source: National Statistic Office, Monthly Bulletin

The USD 833.6 million decrease in imports in 2020 from the previous year was mainly due to a USD 82.7 million decrease in petrol (gasoline) imports, a USD 237.0 million decrease in diesel fuel imports, a USD 121.4 million decrease in car imports and a USD 152.1 million decrease in truck imports.

1.2 Energy Demand and Supply in Mongolia

In Mongolia, total primary energy supply is dominated by coal, and electricity production is largely from coal-fired power plants. In 2019, 91% of total domestic electricity output was produced by thermal power plants, and 98% of district heat was provided by coal-fired plants.

Mongolia has estimated total coal resources of approximately 173 billion tons. Based on an ADB Sector Assessment Report on the energy sector (dated 2017),[2] use of those resources could potentially generate a total of nearly 300,000 terawatt–hours of electricity, an amount that could meet the total electricity requirements of the People's Republic of China, Japan and the Republic of Korea combined for the next 20 years. In 2019, coal production in Mongolia reached 64.7 million tons, of which 47.0 million tons were sold and 36.8 million tons were exported, with the remainder placed in storage. Based on the coal balance of 2019, a total of 0.6 million tons of coal were registered as wasted during transportation and storage.

The total potential of Mongolian renewable energy including wind, solar, geothermal, and hydro resources is estimated to be as high as 2,600 GW. The Gobi Desert in particular has tremendous renewable energy potential and has favorable climatic and weather conditions to use these resources effectively.

The electricity consumption of customers connected to the Central Regional Energy System (CRES) reached 6,846.4 million kWh in 2019, with a peak load of 1153 MW. The annual average growth rate of electricity use in the CRES has been about 5-5.5% in recent years. Electricity consumption per capita is increased rapidly, from 1,314 kWh to 2,163 kWh, over the period from 2012-2019.

1.3 Key Energy Policy Issues for Mongolia

Based on the document "State Energy Policy for 2015-2030" the priorities and objectives set for the Mongolian energy sector are separated into two phases. The first covers 2015 to 2023, and the second spans 2023 to 2030. These stages correspond to two main key energy strategic goals: (1) to build a reliable and secure energy system, including doubling the existing installed coal-fired generation capacity using supercritical technology and ensuring at least 10 percent of installed capacity is from hydropower plants as a base for adding more renewables to the grid, and (2) exporting electricity to neighboring countries and developing further renewable capacity up to 30 percent of total installed capacity.

The priority areas and key energy policy issues are:

- Reliable supply and energy security
- Energy efficiency

[2] ADB (2017), *Sector Assessment: Energy Sector; Ulaanbaatar Air Quality Improvement Programme* (RRP MON51199). https://www.adb.org/sites/default/files/linked-documents/51199-001-sd-01.pdf.

- Environmental sustainability and green development
- Commercialization and tariff reform[3]

As stated in the State Energy Policy document, in the 2nd stage Mongolia will become an electricity exporting country using efficient and environmentally-friendly technologies while establishing mutually beneficial cooperation on energy issues with neighboring countries and with other countries in the region.

2 Energy Demand in Mongolia – Current Status and Recent Trends

2.1 Current Status

As a result of population and economic growth, as well as the ongoing expansion of the mining industry, overall electric energy demand has increasing by around 6-9% annually in recent years.

Currently, domestic power is supplied by a total of 24 generation facilities (9 combined heat and power plants --CHPPs, 3 Wind power plants, 7 hydroelectric power plants—HPPs, and 8 Solar power plants) with a total installed capacity of 1475 MW (as of 2019). This mix of renewable energy and conventional (mostly coal-fired) plants are currently providing power to meet 80 percent of the total national electricity demand. The total electricity consumption for the Central Region Energy System (CRES), the largest grid in Mongolia, reached 6,846.4 million kWh in 2019, with a peak load of 1153 MW. Mongolia imports electricity from Russia and China, which accounted about 20% of total supplies (1,722.7 million kWh) in 2019 to fill the gaps caused by the national demand/supply mismatch. Table 2-1 shows the evolution of the electricity balance in Mongolia in recent years, and ***Figure 2-1*** shows the trend in peak demand growth in Mongolia since 2001.

[3] A key recent document on government energy policy, "Parliament of Mongolia 2015 Annex to Resolution 63 GOVERNMENT POLICY ON ENERGY / 2015-2030 /", includes as item 3.14 "Transfer the energy sector to a private sector-based, regulated and competitive market system". Document (in Mongolian) available as https://www.legalinfo.mn/annex/details/6812?lawid=11130.

Table 2-1: Mongolia Electricity Balance, 2012-2019; (Unit: million kWh)

Indicators	2012	2013	2014	2015	2016	2017	2018	2019
Resources- Total	**5,181.6**	**6,215.0**	**6,725.0**	**6,930.0**	**7,113.6**	**7,601.7**	**8,201.0**	**8,623.1**
Gross generation	4,815.6	5,019.5	5,375.8	5,513.2	5,667.1	6,027.3	6,535.3	6,900.4
Imports	366.0	1,195.5	1,349.2	1,416.8	1,446.3	1,574.3	1,665.7	1,722.7
Distribution -Total	5,181.6	6,215.0	6,756.8	6,895.0	7,047.5	7,601.7	8,201.0	8,623.1
Consumption	**3,772.6**	**4,732.1**	**5,158.4**	**5,283.5**	**5,445.7**	**5,948.7**	**6,449.7**	**6,846.4**
Industry and construction	2,338.9	2,930.7	3,171.6	3,261.4	3,356.3	3,692.0	4,003.0	4,249.2
Transport and communication	156.8	196.9	211.4	216.5	222.9	247.5	268.3	284.8
Agriculture	39.8	49.9	63.7	54.8	56.6	62.8	68.1	72.3
Household,housing and community amer	906.7	1,139.2	1,251.4	1,277.5	1,321.3	1,426.6	1,546.7	1,641.9
Other	330.4	415.4	460.4	473.3	488.6	519.8	563.6	598.3
Losses in transmission and distribution	675.4	739.5	792.6	782.6	817.1	810.9	875.3	891.6
Station internal use	712.4	725.3	772.4	778.2	748.7	816.4	849.3	860.9
Export	21.2	18.2	33.4	50.8	36.0	25.7	26.7	24.1
Electricity produced per capita, kW.h	1,762.3	1,797.9	1,866.2	1,860.0	1,872.2	1,945.8	2,068.8	2,163.1

Source: Mongolian Statistical Yearbook 2019, National Statistics Office of Mongolia (NSO)

Figure 2-1: Peak Demand Growth in CES, 2012-2019, MW (Excluding Oyu Tolgoi Mining)

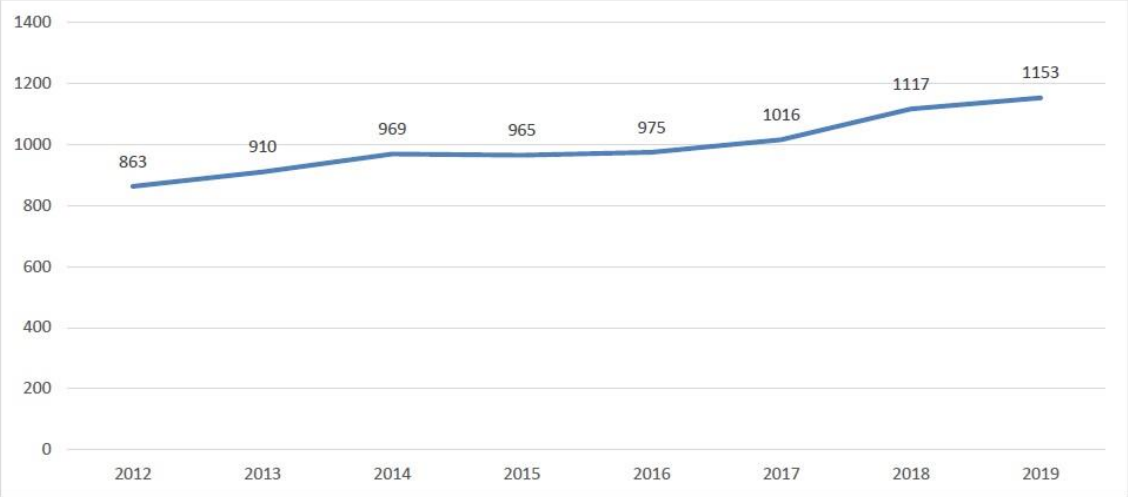
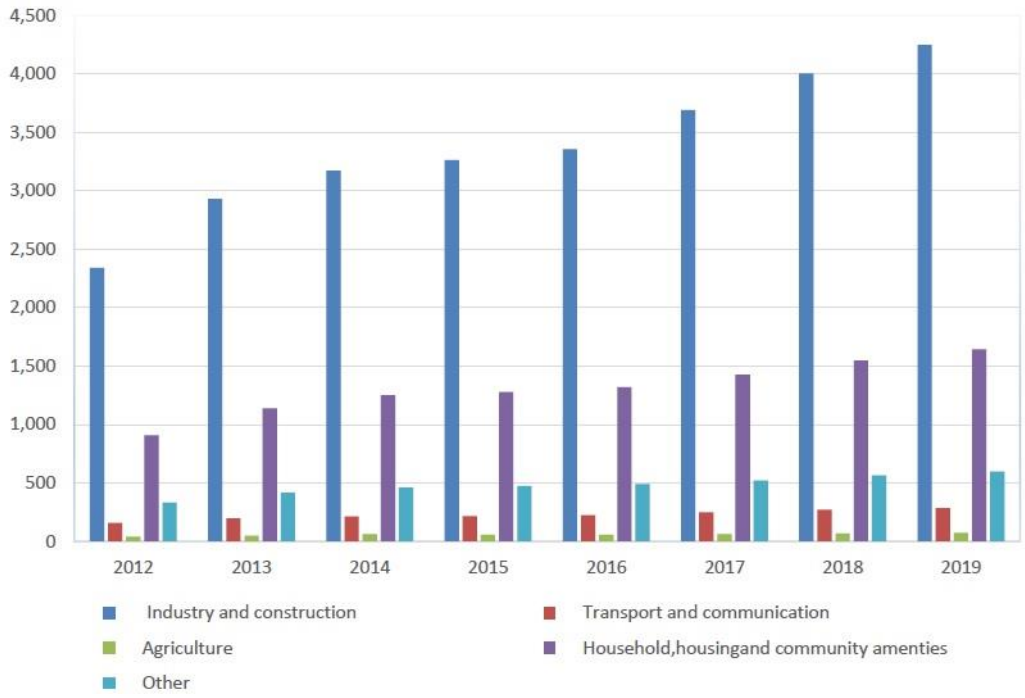
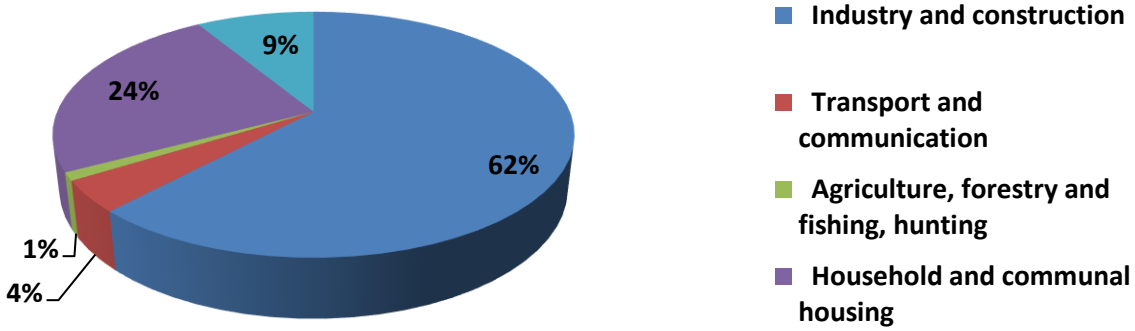


Figure 2-2: Electricity Consumption by Sectors, (GWh), 2012-2019



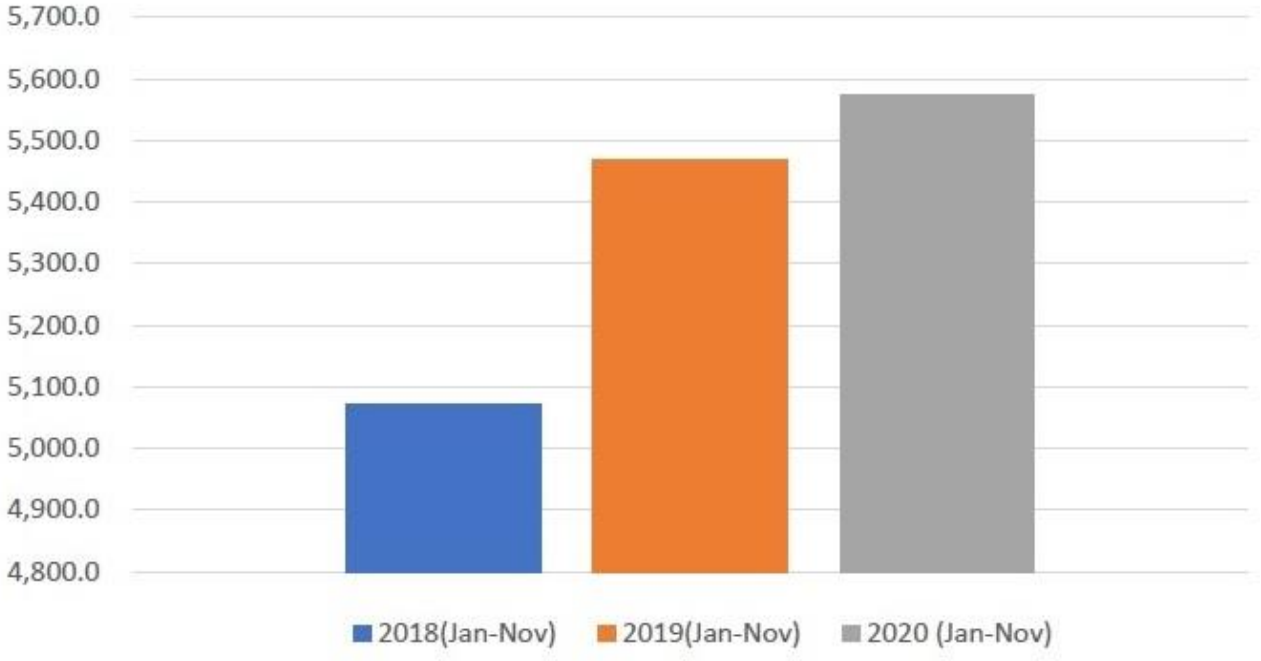
The highest-volume electricity consuming sector in Mongolia is the industrial sector, as shown in Figure 2-2 and Figure 2-3, which accounts for 62% of electricity use and consumed 4,249 million kWh in 2019, while the Household and communal housing sector accounted for 24% of demand with consumption of 1,641 million kWh in 2019.

Figure 2-3: Electricity Consumption Share for 2019 by Sectors, by percentage



Preliminary statistics for the energy sector show that in the first 11 months of 2020 electricity generation increased from 5,467.7 million kWh to 5574.8 million kWh and by about 2 percent compared to the same period in 2019 (see Figure 2-4).

Figure 2-4: Electricity generation by million kWh, in the first 11 months of 2018, 2019 and 2020 (units: GWh)



Source: Energy Statistic, Ministry of Energy

2.2 Energy Demand Trends

Recently, several sets of energy sector projections have been developed for Mongolia in the context of various studies and projects. In this report, Energy projections were used and taken from two widely used studies: (*ADB Updating Energy Sector Development Plan 2013* (the "ADB study"[4]), and the ADB Energy Sector Assessment prepared in 2017 (referenced above as ADB 2017).

Energy Demand Forecasts by ADB Updating Energy Sector Development Plan:

In the *ADB study*, energy demand was analyzed in three forecast cases, the first being a *low or "organic"* forecast that includes growth associated with existing domestic, commercial and industrial consumers. A 2nd forecast presents a *Medium or "bear"* industrial forecast that includes an industrial growth forecast added to the organic forecast; and in which it is assumed that industrial development takes place over a 30-year period (from 2013) in 3 central zones: the Northern Zone (Erdenet/Darkhan), the Central zone (Choir/Sainshand), and the Southern zone

[4] E. Gen Consultants and Mon-Energy Consult (2013), *Mongolia: Updating Energy Sector Development Plan* (TA No.7619-MON): Final Report. Prepared for ADB and The Mongolian Ministry of Energy, dated September 2013, Executive Summary available as https://www.adb.org/sites/default/files/project-document/81826/43079-012-tacr-01a.pdf.

(Dalanzadgad/TT/OT). The 3rd Forecast presents a *high or "Bull"* industrial forecast that assumes that the industrial development described above takes place over a 20-year period in accordance with mineral and mineral processing expectations.)

The following forecast is for electricity demand for the whole of Mongolia, including and excluding Oyu Tolgoi Copper and Gold Mining (OT) and Tavan Tolgoi Mining (TT). In accordance with the ADB study, in the *low scenario* the electricity demand for the whole of Mongolia including energy demand for the OT and TT Mining concerns is projected to reached at 4,073 MW in 2030. (Table 2-2, Low scenario)

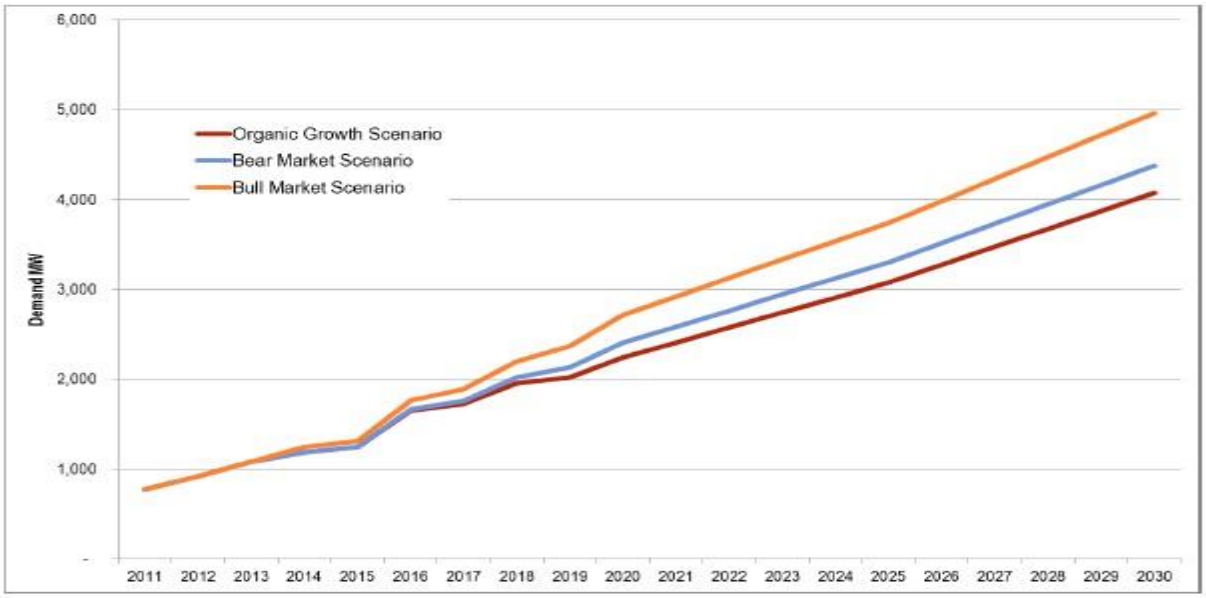
Table 2-2: Whole of Mongolia Electricity Demand Forecast (including and excluding OT and TT)

Year	Electricity demand including OT&TT						Electricity demand excluding OT&TT					
	LOW		Medium		High		LOW		Medium		High	
	MW	AGR MW	MW	AGR MW	MW	AGR MW	MW	AGR MW	MW	AGR MW	MW	AGR MW
2011	774		774		774		689		689		689	
2015	1,246	5.2%	1,247	5.3%	1,311	5.4%	935	7.0%	936	7.1%	985	7.3%
2020	2,240	10.8%	2,404	12.7%	2,717	14.8%	1,253	4.1%	1,416	7.9%	1,680	11.5%
2025	3,075	5.7%	3,302	5.8%	3,741	5.8%	1,756	6.1%	1,984	6.1%	2,357	6.1%
2030	4,073	5.2%	4,377	5.2%	4,961	5.2%	2,517	6.4%	2,821	6.3%	3,327	6.2%
GAGR		9.3%		9.8%		10.5%		7.1%		7.7%		8.7%
Aver. MW added pa	174		190		220		96		112		139	

Source: ADB Updating Energy Sector Development Plan (TA No.7619-MON)

The demand growth rates shown in Table 2-2 can be understood as representing a need to add 200 MW of supply capacity every year for the next 20 years. Based on the study, excluding OT and TT, the estimated annual future growth rate of demand (7.1%) is consistent with average growth rates in Mongolia over the past decade (see Figure 2-5).

Figure 2-5: Mongolia-wide Electricity Demand Forecast (including OT and TT)



Source: ADB, Updating Energy Sector Development Plan (TA No.7619-MON),

The ADB Study shows that strong growth in electricity demand is expected in the Central Regional Energy System (CRES), and the average projected growth rates for demand in the CRES (see Table 2-3) are considered reasonable by authorities in Mongolia. Population growth in the CRES area is expected to continue at a high rate, increasing 17% by 2020 relative to 2017, mostly due to in-migration to Ulaanbaatar.

Table 2-3: Electricity Demand Forecast for CRES

	LOW		Medium		High	
Year	MW	AGR MW	MW	AGR MW	MW	AGR MW
2011	640		640		640	
2015	815		872		873	
2017	1,010	6.5%	1,032	7.9%	1,059	9.6%
2018	1,074	6.3%	1,117	8.30%	1,169	10.4%
2019	1,124	4.6%	1,194	6.9%	1,282	9.7%
2020	1,169	4.0%	1,275	6.8%	1,407	9.7%
2025	1,628	7.9%	2,016	11.6%	2,500	15.5%
2030	2,309	8.4%	3,161	11.4%	3,734	9.9%
GAGR		7.2%		8.6%		9.8%
Aver. MW added pa	88		133		163	

In the ADB study, electricity demand for the CRES increases at an average growth rate of 7.2 % in the low scenario, reaching 2,309 MW by 2030.

Energy Demand Forecasts by ADB, 2017 Sector Assessment: Energy sector; Ulaanbaatar Air Quality Improvement Programme (RRP MON51199)

In projections prepared for the *ADB Sector Assessment Report 2017*, the compound annual demand growth rates (despite the recent economic slowdown) are forecasted to be 4.4 % for electricity and 3.4% for heat through 2030. It was concluded that growth of electricity and heat demand at those rates will result in a generation capacity shortage by 2023.

The increasing population influx and economic concentration in urban areas, particularly Ulaanbaatar, raises urban electricity and heat load demand growth further. Heat load demand in Ulaanbaatar grew by 35% between 2006-2016 and is projected to grow to 8,096 Teracalories (thousand billion, or 10^{12} calories) in 2030 from 5,059 Teracalories in 2017 (see Table 2-4). The central grid system, which covers Ulaanbaatar and other major cities, also is projected to undergo 42% growth in electricity load demand during the same period, with electricity demand projected to grow to 8,225 gigawatt-hours by 2030, up from 4,607 gigawatt-hours in 2016. The updated demand forecast includes a projection of generation capacity at 1,703 MW by 2030 for electricity, while maintaining heat output of 3,093 Teracalories by 2030 are essential to meet growing demand, while maintaining an adequate reserve margin, which the Government of Mongolia targets as a 20% reserve margin for electricity and 15% for heat by 2030.

Table 2-4: Medium –and Long-term Demand Projections, ADB 2017 Study

	CES Electricity Demand Forecast (GWh)	Ulaanbaatar Heat Demand Forecast (kGcal per hour)	CES Necessary Electrical Capacity (MW)	Ulaanbaatar Necessary Heat Capacity (kGcal)
2016	4,607	5,059	823	2,313
2020	4,411	5,811	910	2,313
2025	6,471	6,914	1,349	2,833
2030	8,225	8,086	1,703	3,093

CES = clean energy system, GWh = gigawatt hour, kGcal = kilo giga calorie, MW = megawatt.
Notes: Numbers may not sum precisely because of rounding.
Source: ADB staff estimates

2.3 Key Demand Sectors for Economic Growth and Energy Consumption

2.3.1 Industry

As can be seen from the structure of industrial production in Mongolia (Table 2-5) the largest share of output belongs to the Mining and quarrying (extraction) industries (57.5% as of 2019) while manufacturing industries make up 32.8% of total industrial output.

Table 2-5: Gross Industrial Output, by sub-sectors

Sector/Divisions	2012	2013	2014	2015	2016	2017	2018	2019
	Unit: percentage							
Mining and quarrying	58.9	58.4	64.4	55.1	55.6	57.7	57.9	57.5
Manufacturing	30.7	30.8	28.1	35.9	33.3	32.3	32.6	32.8
Electricity, gas,steam and air conditioning supply	8.4	8.7	5.9	7.1	9.1	8.4	8.2	8.4
Water supply; sewerage, waste activities	2	2.2	1.7	1.9	2	1.7	1.3	1.2

Source: Mongolian Statistical Yearbook 2019, NSO

As Mongolia is a country with a natural resource based economy, Mongolia exports mostly raw products, such as coal and copper concentrate and gold, and imports finished products (see Table 2-6 and Table 2-7).

Table 2-6: Coal Production and Exports, tonnes, 2014-2019

	Stripping /ths.m3/	Coal production /ths.tons/	Coal sale /ths.tons/	Coal export /ths. tons/
2014	95,600.0	24,449.0	27,305.0	19,513.0
2015	92,975.0	23,979.0	22,125.0	14,468.0
2016	102,374.3	35,096.5	33,831.7	25,809.3
2017	197,240.8	49,480.3	41,904.6	33,400.1
2018	244,861.2	54,572.3	45,741.9	36,671.4
2019	292,181.7	57,128.8	47,047.8	36,809.1

Source: Mineral Resources and Petroleum Statistics 2020, Mineral Resources and Petroleum Authority of Mongolia,

As shown in Table 2-6 coal production in Mongolia reached 57.1 million tonnes in 2019, of which 47.1 million tons were sold by coal mines, with the remainder-unsold coal totaling about 10.1 million tonnes–stored as mining stock. 36.8 million tons of coal were exported, with the remainder, amounting to 10.3 million tonnes, used by local consumers (see Table 3-3). Among local consumers, a total of 7.5 million tonnes were consumed by combined heat and power plants (CHPP) and heat-only thermal plants for electricity and heat generation (see Table 3-4), while the remaining 2.1 million tonnes of coal supplies were used by households during winter periods as fuel to heat their houses and gers. Based on the coal balance, losses during transportation and storage were estimated at 0.7 million tonnes in 2019.[5]

[5] Data confirmed through personal communications with Coal Department of the Mineral Resources and Petroleum Authority of Mongolia in early 2021, as well as comparison with the Coal Balance for 2019 from the Statistics Office of Mongolia.

Table 2-7: Main Mining Product Exports, 2012-2019

	2012	2015	2016	2017	2018	2019
by Volume, (tonnes and thousand tonnes)						
Gold in semi-manufactured forms (t)	2.8	11.3	19.2	14.55	3.4	9.1
Copper concentrates (thous.t)	574.3	1,477.8	1,562.	1,447.22	1,436.7	1,403.6
Molybdenium concentrates (thous.t)	4.3	5.	5.8	6.5	6.	5.7
by Value, (thousand USD)						
Gold in semi-manufactured forms (t)	122,293.8	420,567.6	758,408.7	595,354.08	144,499.1	418,394.4
Copper concentrate (thous.t)	838,579.3	2,280,135.3	1,607,754.3	1,613,117.29	2,012,194.4	1,795,868.4
Molybdenium concentrates (thous.t)	38,173.7	29,473.8	26,446.8	37,358.65	49,939.4	49,012.2

Source: National Statistical Database, www.1212.mn

Preliminary results for the output of the mining and quarrying sector for the first 11 months of 2020 show that extraction of brown coal, fluor spar, copper concentrate, hard coal and crude oil had decreased by 3.9 to 43.6% relative to the first 11 months of 2019 (Table 2-8).

Table 2-8: Production of Main Industrial Commodities, in the First 11 Months of 2019 and 2020

Commodities	Measurement unit	2019		2020*		Jan-Nov 2020* / Jan-Nov 2019 %
		Nov	Jan-Nov	Nov	Jan-Nov	
Mining and quarrying						
Hard coal	thousand t	4 133.8	41 894.5	5 242.4	29 206.5	69.7
Brown coal	thousand t	740.0	5 998.3	740.0	5 764.2	96.1
Crude oil	thousand barrels	579.9	6 318.0	545.0	3 562.4	56.4
Copper, concentrate	thousand t	96.3	1171.4	111.8	1 162.9	99.3
Gold	kg	1 687.4	14 820.0	1 528.4	18 766.4	126.6
Iron ore	thousand t	644.9	8 105.2	904.5	8 718.2	107.6
Fluor spar	thousand t	10.7	131.5	8.8	118.2	89.8

Source: National Statistic Office, Monthly Bulletin

In the manufacturing sector, production of alcoholic beverages, bottled water, soft drink, juice, alcohol, cement, milk and wheat flour increased by 1.7-13.9% in 2020 compared to the same period of the previous year. Also, production of coal briquettes and face masks increased by factors of 2.3 and 12 compared to the same period in 2019, the results, respectively, of continued enforcement of laws against raw coal burning in urban areas and of the increase in mask use because of the COVID-19 pandemic.

In the manufacturing sector, production of lime, combed cashmere, copper cathode material, meat, concentrated coal, cashmere products, steel, and cigarettes decreased by 7.5 to 53.8% in the first 11 months of 2020 compared with the same period in the previous year.

Energy use in the industrial sector

In the Energy balance for 2019, the electricity consumption share for the industry and construction sector in the CRES accounted for 62 % of total electricity use on the system (Figure 2-1), while Household and communal housing accounted for 24% of the total. For the period 2012-2019, electricity consumption increased from 2,338.9 million kWh to 4,249.0 million kWh in the industrial sector alone. Some of the largest electricity consumers on the CRES grid are Darkhan Steel and Erdenet Copper Mining. Based on the last 5 years of historical electricity consumption, the average annual electricity use has been 60.0 million kWh for Darkhan Steel Industry and 980.0 million kWh for Erdenet Copper Industry.[6]

With the exception of electricity use, the most important fuels for the Mining sector are petroleum products such as diesel and gasoline, and the Mining sector is the largest user of diesel in Mongolia. Diesel is used for heavy machinery at mining sites and is also used in the trucks that are used to export mining products to China, with an average of 750-800 trucks used daily for mining products transportation. Based on accordance with NSO statistical data, more than 70 percent of the total national use of diesel (23516.3 TJ out of 33031.5 TJ) was used by Mining sector in 2019. The Oyu Tolgoi copper and gold mine is a large electricity user and is located in the South Gobi region. Power demand in the South Gobi region was projected by both of the ADB studies (see Table 2-9) to grow rapidly as a result of both existing and new mining development. Oyu-Tolgoi and Tavan Tolgoi plan to build power plants to service their own needs. (Currently, the Oyu Tolgoi Mining is using electricity imported from China.)

Table 2-9: Historical and Projected Energy Demand for OT and TT Mines

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Tavan Tolgoi											
GWh	184	184	184	184	1,104	1,104	1,104	1,104	1,104	2,208	2,208
MW	30	30	30	30	180	180	180	180	180	360	360
Load Factor	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Oyu Tolgoi											
GWh	858	1,717	1,717	1,717	2,759	2,759	3,679	3,679	4,599	4,599	4,599
MW	140	280	280	280	450	450	600	600	750	750	750
Load Factor	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total GWh	1,042	1,901	1,901	1,901	3,863	3,863	4,783	4,783	5,703	6,807	6,807
Total MW	170	310	310	310	630	630	780	780	930	1,110	1,110

Source: ADB, Updating Energy Sector Development Plan (TA No.7619-MON),

[6] Personal communications with factory personnel in early 2021.

Energy Demand Forecasts for the Industrial Sector

As forecasted in the *ADB study*, in accordance with the *CRES Electricity "Low" forecast scenario,* annual electricity consumption for the Industrial Large sector of CRES (Darkhan Steel and Erdenet Copper are considered as "Heavy Industry-Large Consumers") was projected to reach 2,638 GWh, while electricity demand for heavy industry was projected to reach 434 MW in 2030.

An energy demand forecast for the industries located in the South Gobi region, including Oyu-Tolgoi and Tavan-Tolgoi, was prepared separately in the *ADB study*, as those industries are not supplied with electricity from the CES and as at present OT is importing electricity from China. ADB's energy demand forecast including the South Gobi industries is shown in Figure 2-5: Mongolia-wide Electricity Demand Forecast (including OT and TT)".

2.3.2 Buildings

The buildings sector in Mongolia is divided into the household subsector and the "commercial & other" subsector. Buildings, including both buildings hosting residential housing and businesses (or both, in some cases), consume a large quantity of energy, especially for heating during Mongolia's long winter months. Energy demand in the buildings sector increased strongly over the last decade.

Based on the 2020 Population and Housing By-census for Mongolia, 38.2 % of households live in traditional Mongolian dwellings (gers), 60.9 % percent live in buildings and the remaining 0.9 % live in other types of housing (see Table 2-10). Since the last full census (in 2010), the percentage of households living in gers has decreased by 7 %, while the percentage of households living in buildings increasing by 6.3%.

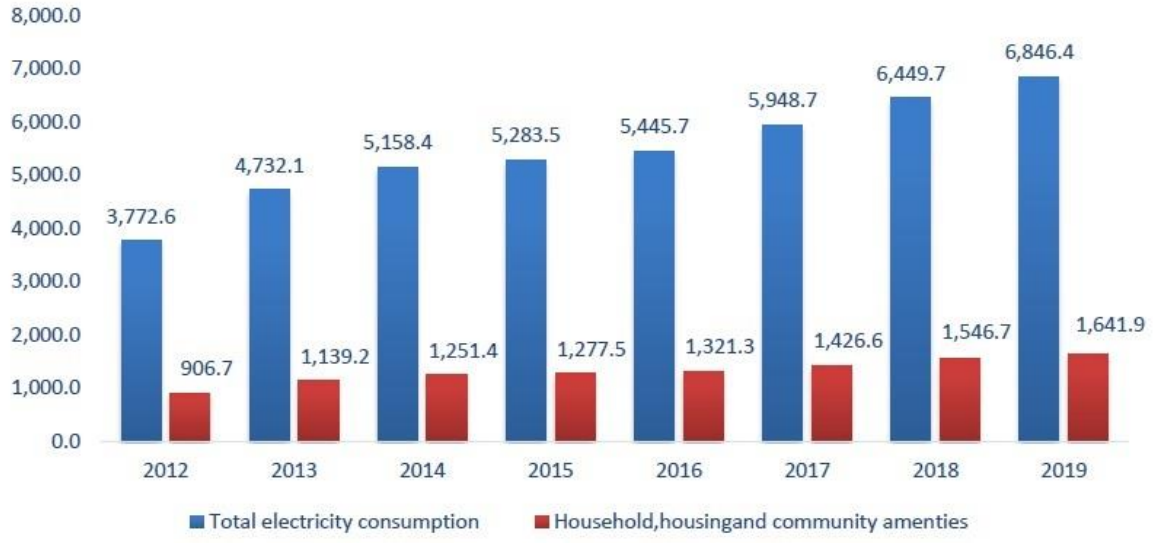
Table 2-10: Households (HH) by Housing Type, 2010, 2020

Housing Type	2010		2020	
	thous. HH	%	thous. HH	%
TOTAL	713.8	100	897.4	100
Ger	322.8	45.2	342.4	38.2
Building (apartment, single family home, public dwellings)	382.8	53.6	546.9	60.9
Other housing	8.2	1.1	8.1	0.9

Energy use by households

Electricity consumption by the buildings sector for the period between 2012-2019 increased from 906.7 million kWh to 1,641.9 million kWh (see Figure 2-6).

Figure 2-6: Electricity Consumption for the Households, Housing and Community Amenities Sector, 2012-2019, million kWh



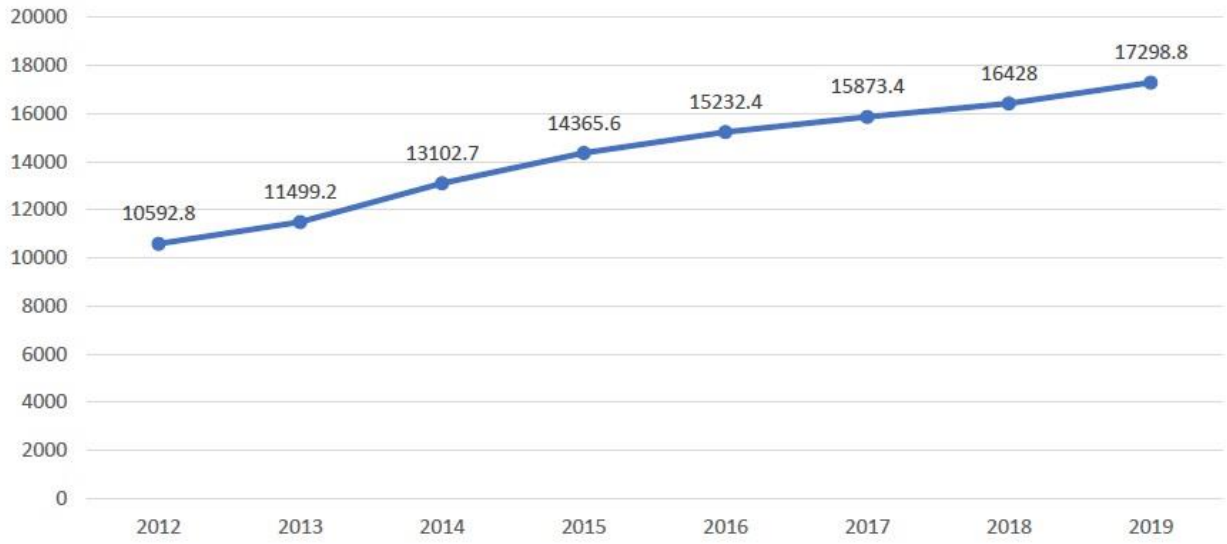
Electricity consumption for households in the Historical Energy balances (Table 2-1), is calculated together with commercial and community amenities as a single category.

As energy use in households is driven by population growth, and as per Population UN Medium Variant, Mongolia's population is expected to grow from 3.3 million in 2019 to 4.3 million in 2045, an increased demand for housing will be created, as well as an increase in household energy use. Figure 2-7 shows the increase in housing stock over the five years from 2012 through 2019.

In connection with city planning, the development of housing, as well as commercial and institutional buildings, is expected to increase in urban areas, especially in Ulaanbaatar. In the Buildings sector, energy-efficient buildings with special insulation and energy efficient appliances are starting to be introduced. In the framework of the Green Development Policy (2014-2030), the heat loss rate in buildings will be reduced by 20 percent in 2020 and 40 percent in 2030, relative to 2013.[7]

[7] Government of Mongolia (2014), "Annex to Government order No 43 of 2014", available as www.Legalinfo.mn - Хуулийн нэгдсэн портал сайт

Figure 2-7: Housing Stock Floor Space, Thousand Square Meters, 2012-2019



Energy demand forecasts in the buildings sector:

Based on the results of the *ADB study* (the CES Electricity "Low" Forecast scenario), electricity consumption for the household sector will reach 1,094 GWh, with peak demand of 250 MW, in 2030.

2.3.3 Transport sector

Transport services in Mongolia are provided by road vehicles, railways, and civil aviation. Passenger and freight transportation activity has been expanding in Mongolia for the last decade and more.

In 2019, the freight carried by all types of transport reached 69.0 million tonnes and the number of passengers (individual departures) reached 173.0 million. Compared to the previous year, the amount of freight carried in 2019 increased by 1.2 million tonnes (1.8%) and the number of passengers carried decreased by 24.0 million passengers (12.2%). (see Table 2-11).

Table 2-11: Carried Freight, Thousand Tonnes and Passengers Carried, million passengers, 2010-2019

	2010	2015	2016	2017	2018	2019
Road Transport						
Carried freight, thousand tonnes	12610.23	13043.7	20406.2	31212.9	42033.78	40848.8
Freight turnover, million tonnes km	1833.95	2374	4236.2	5661.3	6640.61	6203.8
Passengers carried, million passengers	246.7	256.5	260.7	212.2	193	168.44
Passenger turnover, million passengers km	1480.18	1940.5	1959.9	2040.9	2919.9	2925.1
Air Transport						
Carried freight, thousand tonnes	12610.23	13043.7	20406.2	31212.9	42033.78	40848.8
Freight turnover, million tonnes km	1833.952	2374	4236.2	5661.3	6640.61	6203.8
Passengers carried, million passengers	246.7	256.5	260.7	212.2	193	168.44
Passenger turnover, million passengers km	1480.182	1940.5	1959.9	2040.9	2919.9	2925.1
Rail Transport						
Carried freight, thousand tonnes	16804	19150.79	19989.14	22765.1	25763.33	28143
Freight turnover, million tonnes km	10286.7	11462.59	12371	13493.2	15315.29	17384.1
Carried passengers, thousand persons	3516.3	2794.7	2645.52	2630.3	2572.46	2948
Passenger turnover, million passengers km	1220	996.74	955.5	973.2	993.69	1111.5

Source: NSO, Statistical Yearbook 2019

During the last decade, the amount of freight carried by road has increased from 12,610.23 to 40,848.75 thousand tonnes. Crude oil and coal transport almost completely rely on road transport, whereas iron ore and copper concentrate exports use rail to some extent. As most of the mining is located in the southern part of Mongolia, which is close to the Chinese border, most exports of mineral product are carried out by trucks from mining sites to China.

In accordance with Monthly Bulletin issued by NSO, In the first 11 months of 2020, 27.5 million tonnes of freight were carried by railway transport. Compared to the same period of the previous year, the freight carried increased by 1.9 million tonnes (7.3%). 82.8% of freight carried by railway transport was mining freight, with 10.4% of freight was accounted for by construction materials and other products. In the first 11 months of 2020, 439.0 thousand passengers (arrivals plus departures) were carried by air transport. The number of carried passengers decreased by 1.1 million (70.8%) compared to the same period of the previous year.

In particular, there has been a strong trend towards increases in the number of private passenger vehicles in Mongolia (Table 2-12), to the point where one of every three people living in Ulaanbaatar owns a vehicle. As a result, traffic jams and toxic emissions resulting from motor fuel consumption by vehicles have increased significantly in the capital city. Out of all imported vehicles, only 14% are new; the remaining 86% are secondhand vehicles, most imported from nations such as Japan and the Republic of Korea. As a result of this import pattern, most of the vehicles currently used in Mongolia are over 10 years old (see Figure 2-8). A substantial fraction of the vehicles imported in recent years are hybrid gasoline/electric vehicles (mostly used Toyota Prius models imported from Japan), following a government program of tax reduction for such vehicles (see Figure 2-9).

Table 2-12: Number of Vehicles in Mongolia

	2012	2013	2014	2015	2016	2017	2018	2019
Total number of vehicles	608255	673106	739589	789720	841552	900125	925850	935510
Number of vehicles that passed technical inspection	386881	428020	437677	482049	499152	536399	585363	614753

Source: Road transport sector 2019 statistic, Ministry of Road and Transport development of Mongolia, http://mrtd.gov.mn/single/88/item/1485

Figure 2-8: Vehicles Usage in Mongolia, by Vintage, 2012-2019

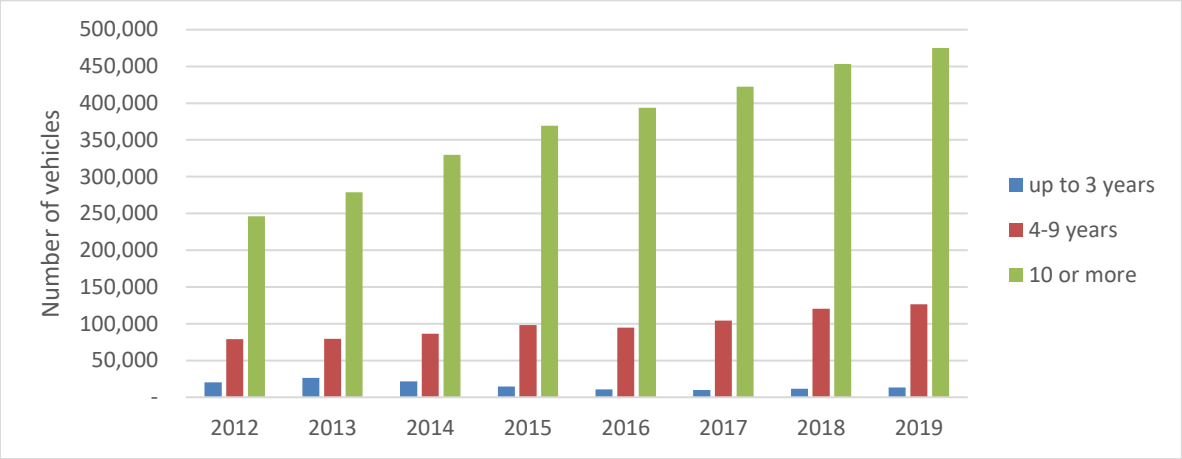
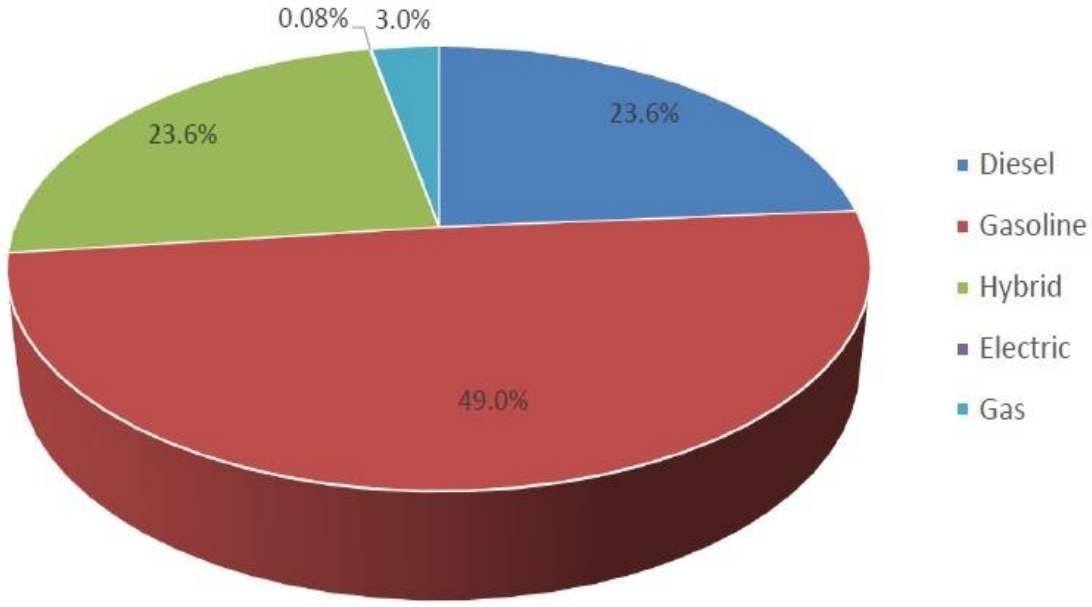


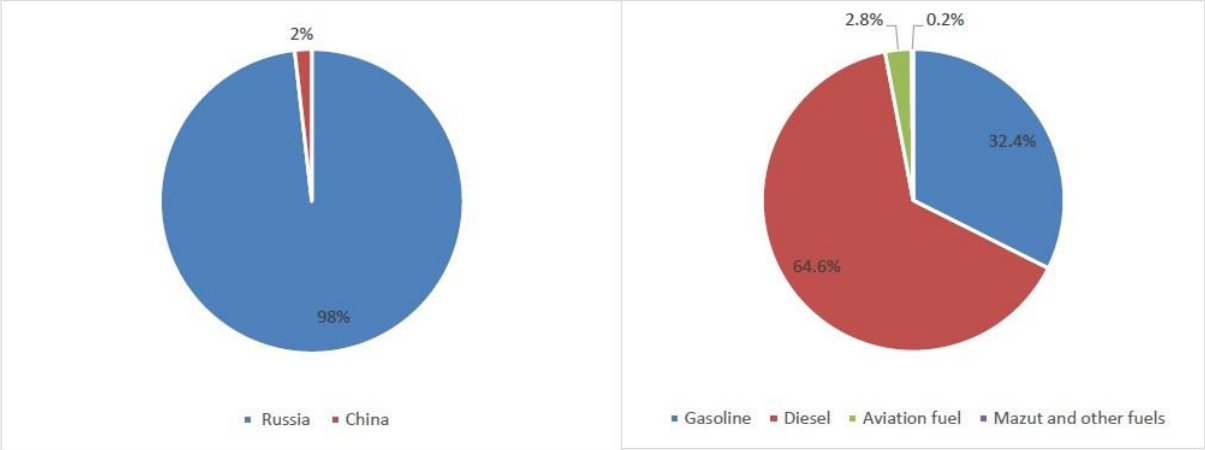
Figure 2-9: Share of Vehicles, by Engine and Fuel Type, 2019



Energy use in the transport sector

In the transportation and storage industries, transport diesel and aviation fuels accounted for 84.4 percent of the industry's total energy use in 2019. Mongolia imports all of the petroleum products it uses. In 2019, Mongolia imported a total of 541.5 kilotonnes of gasoline and 1080.4 kilotonnes of diesel fuel. The sources and types of Mongolia's fuel imports in 2019 are shown in Figure 2-10.

Figure 2-10: Shares of Petroleum Products Imports and Use in Mongolia, 2019



In accordance with NSO's new estimates, the total energy use for the Transportation and Storage sector was 10075.2 TJ in 2018 and 11451.9 TJ in 2019.

2.3.4 Agriculture Sector

In Mongolia, Agriculture is still vital to the country's economy and animal husbandry is part of the lives of Mongolians. In 2019 a total 71.0 million head of livestock were counted in the annual livestock census. Animal husbandry accounts for over 80% of the value of the country's agricultural production.

Mongolia has enormous potential to boost its meat production, dairy food processing, and other value-added activities. Cashmere wool and animal skin products are a particular potential growth area. Accessing export markets is critical for Mongolia's economic growth and to lift rural populations out of poverty.

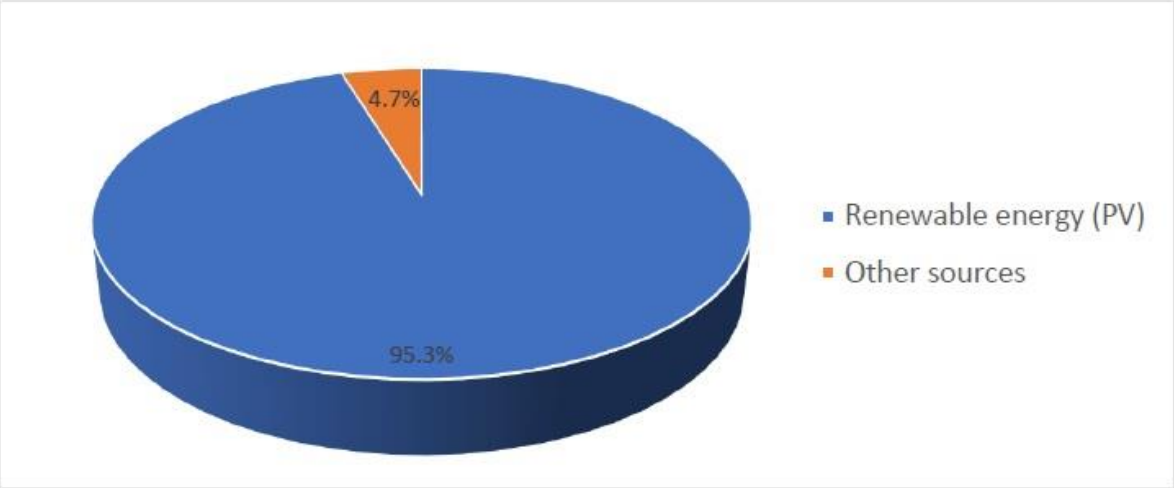
The number of herding households reached 171.6 thousand in 2019, showing a 1.1 percent increase relative to the previous year.

Energy use in the Agriculture Sector

Traditionally, livestock production used limited amounts of commercial energy (oil products, coal and electricity), although in recent years most herding households have adopted greater use of gasoline-powered vehicles, including motorcycles, for herding of animals, and are also using more renewable energy sources such as solar PV (photovoltaic) and wind power systems, as well as gas-

and diesel-fueled generators. In total, out of 141.7 thousand herder households in Mongolia in 2019, 95.3% of herding families used small-scale renewable energy electricity sources (mostly solar PV systems) while 4.37% used other electricity sources, as shown in Figure 2-11.

Figure 2-11: Herders Households with Electricity Systems, by Source Types



Based on the NSO's most recent estimates, the Agriculture and Forestry sector's total energy use amounted to 987.4 TJ in 2019, which represented only 0.1 percent of Mongolia's total use of energy.

Energy Demand Trends in the Agriculture Sector:

For herders' households, small-scale independent renewable energy sources (wind turbines and PV systems) will continue to be used by herders as those systems become even more affordable, reliable, and convenient.

3 Primary Energy Supply in Mongolia –Current Status and Recent Trends

The total primary energy supply in Mongolia is dominated by coal, and electricity production is largely from coal-fired power plants. As such, coal is the dominant energy resource used in Mongolia, accounting for 74.8% of primary energy as of 2019 (Table 3-1), and it is the sole available resource that is easy to transport and use in CHPPs to meet electricity and district heating needs in the country. In 2019, 90.6% of all electricity generated was produced by thermal power plants, and 98% of district heat was provided by burning coal.

As Mongolia does not have a petroleum refinery and lacks natural gas facilities, it is 100% dependent on imported petroleum products from Russia and China. Table 3-1 shows the structure of Primary Energy Supply by product in Mongolia, in units of Terajoules (TJ).

Table 3-1: Primary Energy Supply, by Product, (TJ), 2018-2019

	2018	2019	2018	2019
			%	%
TOTAL SUPPLY of primary energy, by product	**1 574 920.6**	**1 715 265.5**	**100.0**	**100.0**
Hard coal	1 155 088.3	1 282 196.3	73.3	74.8
Brown coal	148 612.4	141 811.1	9.4	8.3
Coke and semi-coke of coal	126 856.9	121 716.2	8.1	7.1
Crude oil	37 820.7	49 982.4	2.4	2.9
Motor spirit	20 080.7	24 298.3	1.3	1.4
Kerosene	4 788.4	2 297.1	0.3	0.1
Transport diesel	36 582.1	46 564.5	2.3	2.7
Jet fuel for aircrafts	1 775.8	2 054.8	0.1	0.1
Fuel Oils	120.1	120.2	0.0	0.0
Lubricants	850.1	930.8	0.1	0.1
Other petroleum and oil products	4 029.9	3 637.7	0.3	0.2
LPG	2 736.7	1 571.1	0.2	0.1
Petroleum Jelly, paraffin waxes and Bitumen and asphalt, natural products	1 884.3	2 238.2	0.1	0.1
Wood, wood waste & other solid biomass, charcoal	33 694.2	35 846.8	2.1	2.1

Source: Statistical Data base, National Statistic Office of Mongolia, http://www.1212.mn/tables.aspx?TBL_ID=DT_NSO_3600_007V1

3.1 Coal

Mongolia has estimated total coal resources of approximately 173 billion tons, which could potentially be used to generate nearly 300,000 terawatt –hours of electricity, enough to meet the total electricity demands in the People's Republic of China, Japan and the Republic of Korea combined for the next 20 years.

About one-third of the nation's coal resources are in Gobi region in the south, one third in the eastern region and the balance distributed through the rest of the country, of which the central region accounts for about half. Bituminous coal is found in the South Gobi and in the western basins. Most of the resources in the central, north and western regions of Mongolia are sub-bituminous or lignite coal. Coal deposits in Mongolia are typically suitable for open cast mining because of their geological condition.

Coal production and sales

In 2019, coal production in Mongolia reached 57.1 million tons, of which 47.1 million tons were sold and 36.8 million tons were exported, with the remainder being stored as stocks. Table 3-2 shows the export destinations for Mongolia's coal, and Table 3-3 shows the types and disposition of coal mined in Mongolia.

Table 3-2: Mongolia's Coal Exports in 2014-2019, by Importing Country

		2014	2015	2016	2017	2018	2019
1	China	19,461,343.22	13,965,736.78	25,317,322.77	32,291,706.23	35,360,684.61	35,798,266.42
2	Russia	19,937.33	76,761.13		3.74		
3	Japan						
4	Korea	36.24	1,092.94				
5	England		161,501.80	316,604.45	489,821.49	98,305.25	333,166.11
6	Singapore		221,220.10		91,631.75	164,391.55	335,331.30
7	India						
8	Kong hong			79,959.00	117,764.85	134,817.60	
9	USA						
10	Other	1.00					
	Total	**19,481,317.79**	**14,426,312.75**	**25,713,886.22**	**32,990,928.06**	**35,758,199.01**	**36,466,763.83**

Source: Customs Statistics 2019, Customs' Authority of Mongolia

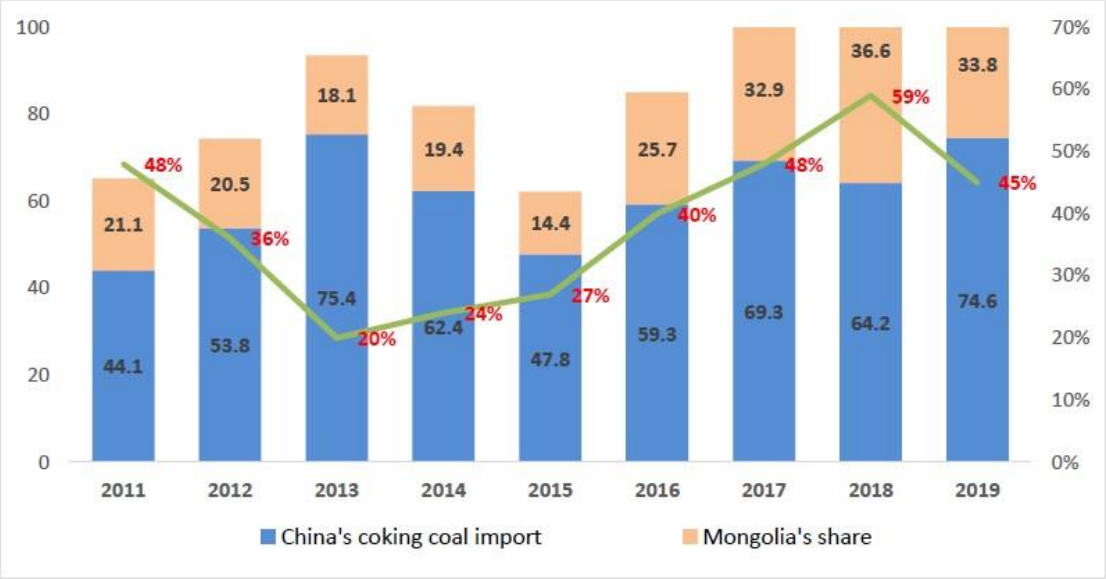
Table 3-3: Coal Sales and Exports, by Coal Type, Thousand Tons, 2019

	Total	Export	Local
TOTAL	**47,047.8**	**36,809.1**	**10,238.7**
Washed coking coal	6,846.0	6,846.0	
Raw coking coal	16,797.1	16,797.1	
Weak coking coal	8,699.30	8,699.3	
Thermal coal	4,466.7	4,466.7	
Brown coal	10,238.7		10,238.7

Source: Coal Research Division, The Implementing Agency of Mongolian Government, Mineral Resources and Petroleum Authority (MRPAM)

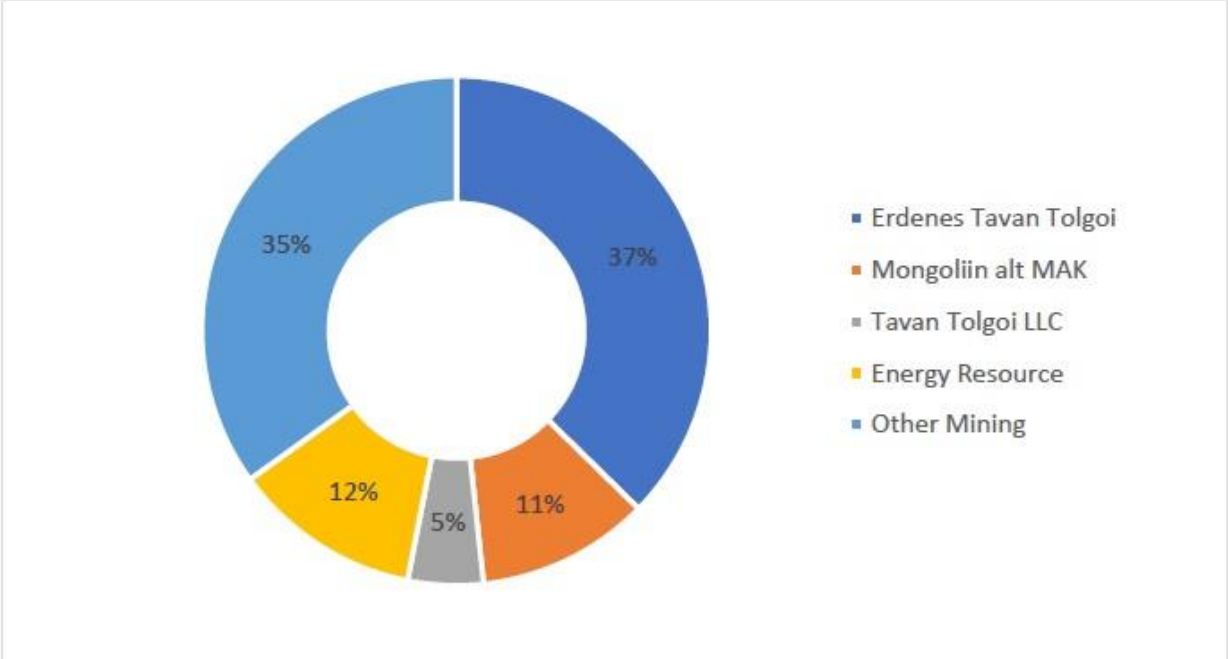
Mongolia is the largest export coal supplier to China. In 2019, China's coking coal imports were 74.6 Mt of which 45% or 33.8 Mt was supplied by Mongolia. In 2018, China imported 64.2 Mt of coking coal, of which 59% or 36.6 Mt came from Mongolia. Figure 3-1 shows recent trends in Chinese coal imports from Mongolia, and Figure 3-2 shows the export shares of Mongolia's major coal mining companies.

Figure 3-1: Mongolia's Share of China's Coking Coal Imports



Source: Data based on Mongolian coal statistics (China total coal import amounts are taken from https://www.spglobal.com/platts/en/market-insights/latest-news/metals/012819-china-imports-6423-mil-mt-of-coking-coal-in-2019-down-8-from-2017https:/ /www.argusmedia.com/en/news/2064083-chinese-coking-coal-imports-rise-by-153pc-in-2019?backToResults=true

Figure 3-2: Major Coal Mining Companies in Mongolia, Export Shares 2019, by Company



Coal supplies to power plants in the CES are dominated by three mines: Baganuur, Shivee Ovoo and Shariin gol. These three mines are connected by railways to the cities where coal-fired power plants are located. Table 3-4 summarizes coal use by power and heating plants in Mongolia over the period from 2012 through 2019.

Table 3-4: Coal Consumption by Power Generation and Heating Plants in Mongolia

Name of Plant	2012	2013	2014	2015	2016	2017	2018	2019
	Thousand tonne							
CHPP-2	192.6	189.3	204.6	225.4	236.7	241.5	261.6	254.1
CHPP-3	1,128.1	1,111.2	1,238.8	1,277.6	1,267.4	1,275.4	1325.1	1305.4
CHPP-4	3,104.1	3,302.6	3,381.0	3,305.4	3,286.6	3,451.2	3409.3	3495.5
Darkhan CHPP	394.9	367.1	405.2	342.1	371.2	400.8	401.1	433.5
Erdenet CHPP	247.5	287.2	306.8	285.6	269.4	326.2	318.4	290.1
Erdenet Mining CHP							435.9	375.7
Dornod CHPP	322.9	381.5	413.4	425.3	482.7	500.6	487.4	531.4
Dalanzadgad CHPP	35.9	30.9	21.4	20.1	24.8	25.8	37.1	34.8
Baganuur Thermal plant	65.6	60.9	59.4	57.3	61.9	57.8	60.8	61.4
Nalaikh Thermal Plant	55.1	53.3	51.9	53.6	57.5	48.9	44.4	43.1
Amgalan TP				39.9	109.7	159.0	226.5	229.8
Other HOBs- in rural areas				242.8	333.4	330.5	385.5	396.5
Total consumption	**5,546.7**	**5,784.0**	**6,082.5**	**6,275.1**	**6,501.3**	**6,817.7**	**7393.3**	**7451.4**

Source: Energy Statistic 2019, Energy Regulation Commission

There are also some small mines within the CES area that serve the fuel needs of small boilers, HOB (heat-only district heating boilers) and households living in the ger districts. The calorific and moisture contents of coals are different for different mines depending on their locations.

3.2 Oil Reserves

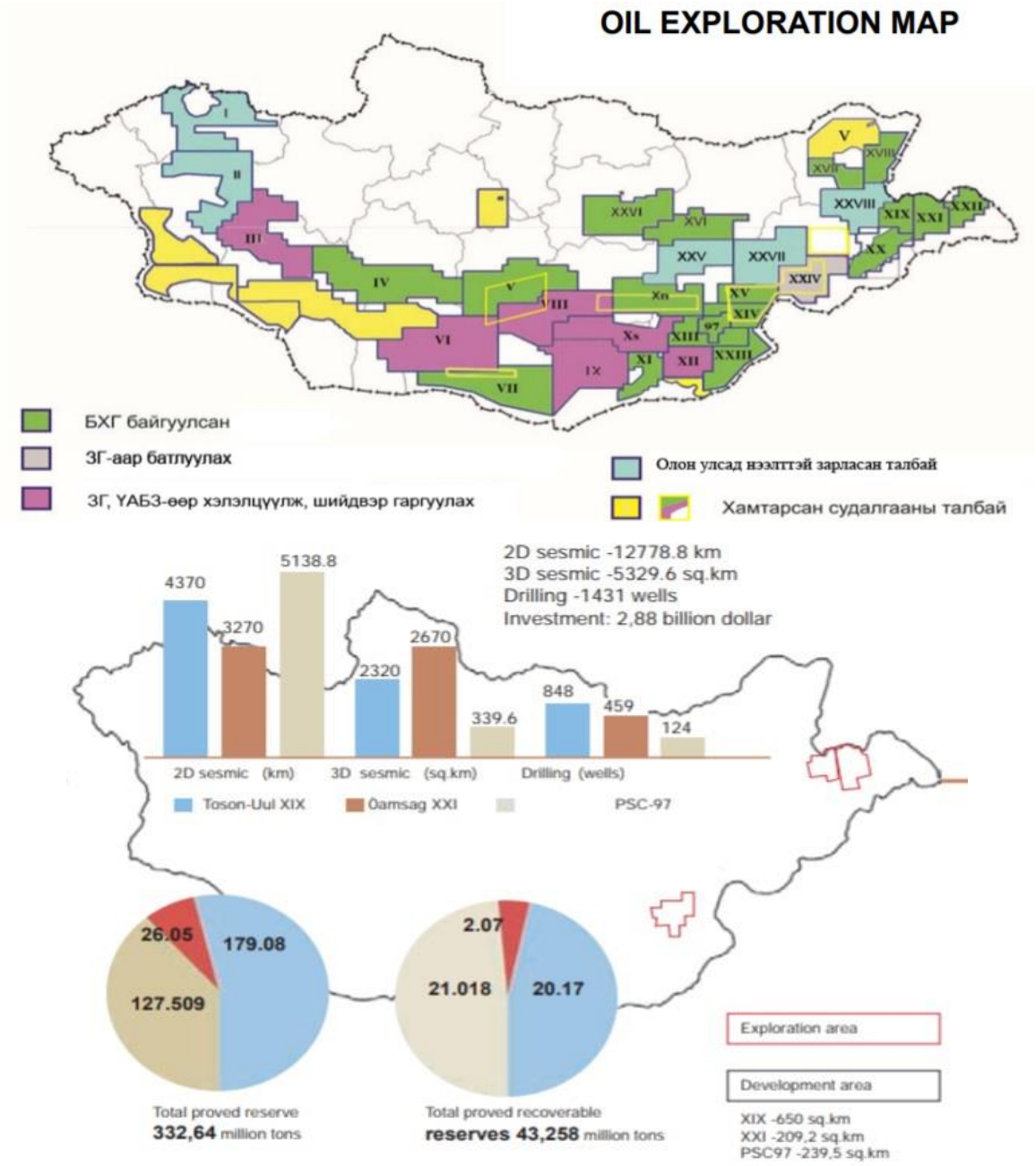
There are 31 exploration blocks for crude oil defined in Mongolia, and the country's current proven oil reserves are about 332.64 million tons.

As reported in the Annual Report 2016, prepared by the Mineral Resources and Petroleum Authority of Mongolia, the companies "Petro China Daqing Tamsag LLC" and "Dongsheng Petroleum (Mongol) LLC" drilled 1465 wells for exploration between 1993 and 2016, and the Mineral Resources Professional Council issued a revised report on the estimated reserves of the Toson-Uul XIX block in 2011. Based on the estimate of reserves carried out in 2011, the overall block reserves were estimated at 179.08 million tonnes, of which 20.17 million tonnes were proved recoverable reserves. A subsequent resource evaluation report for the Tamsag XXI block was discussed by the Mineral Resources Professional Council. Conclusion No. 01/02 (March 2, 2012) of the Council led to the Mineral Resources and Energy Minister's Decree 41 (dated May 16, 2012) approving the block's proved reserves at 127.509 million tonnes, with proved

recoverable reserves based on use of natural well pressure at 14.01 million tonnes and proved recoverable reserves using wells pressurized by pumping water into deposits at 21.018 million tonnes. These reserves were then registered in the Mongolian Mineral Resources Reserve Fund.

Reserves for the PSC-97 block were estimated at 26.05 million tonnes (186.3 million barrels) in total, and the proved recoverable reserves were estimated at 2.07 million tonnes (14.86 million barrels). The reserve estimation report was for this block was discussed by the Mineral Resources Professional Council of the Mineral Resources and Energy Ministry. The reserves are registered in the Mongolian Mineral Resources Reserve Fund as a part of Resolution 137 (June 8, 2011) of Mineral Resources and Energy Minister on the basis of Conclusion 3 of the Mineral Resources Professional Council (April 18, 2010). Figure 3-3 provides an oil exploration map and a summary of oil statistics for Mongolia.

Figure 3-3: Oil Reserves in Mongolia

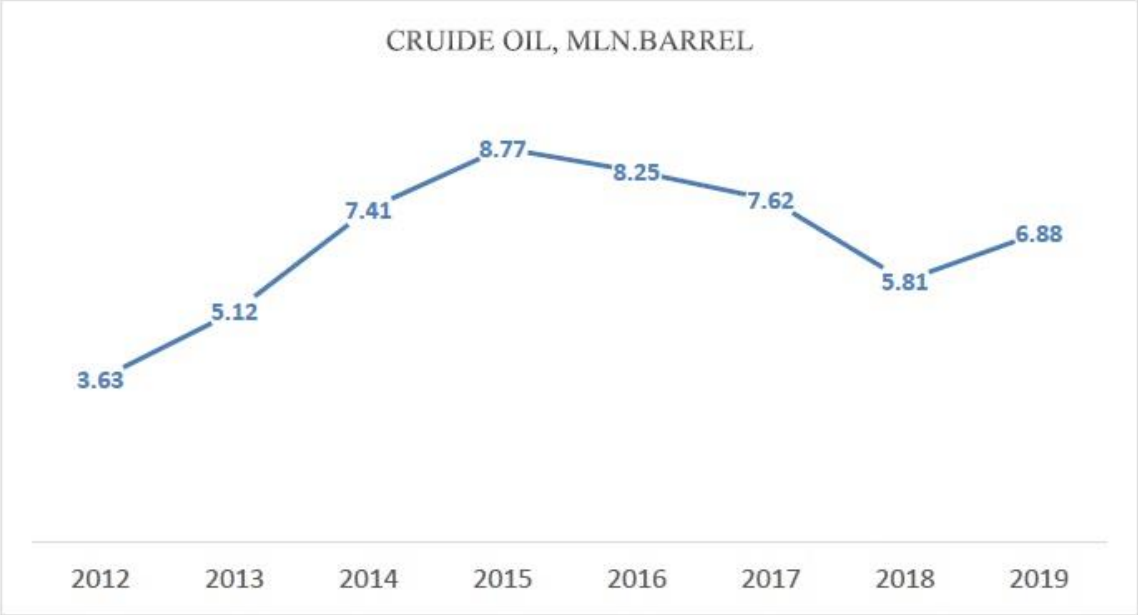


Oil production, imports and exports:

There is some extraction of crude oil from conventional deposits in Mongolia, but all crude oil produced is currently exported to China, while Mongolia imports all its refined petroleum products, mostly petrol and diesel, from Russia. Imported oil products are used mostly in the transportation, construction, and mining sectors, as well as to fuel off-grid electricity generators in various regions of Mongolia, especially in some mining areas.

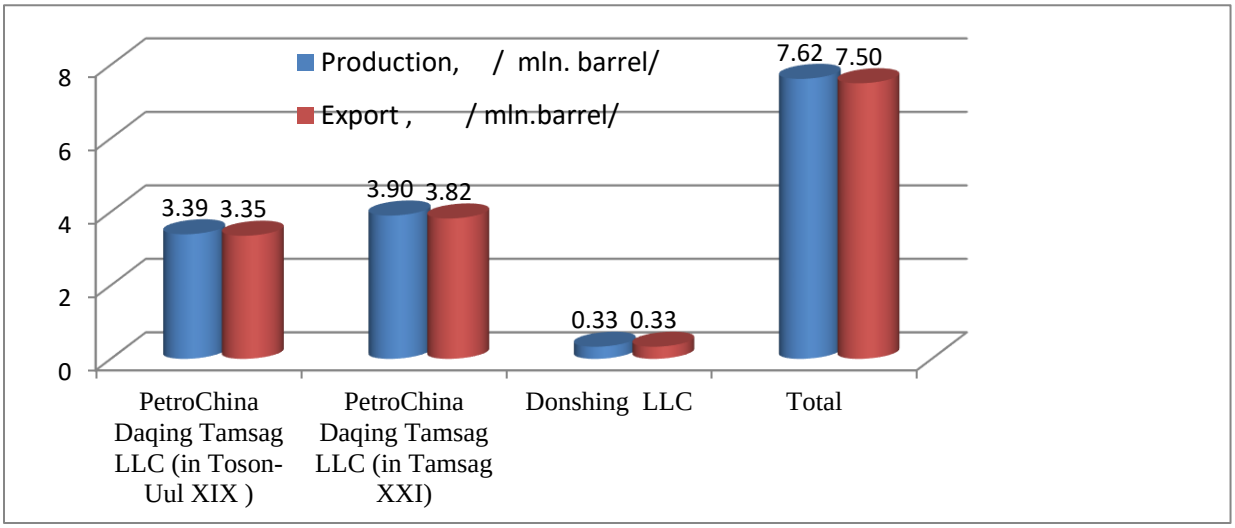
Approximately 72.39 million barrels (10.14 million tonnes) of oil were produced in total Mongolia between 1996 and 2019. In 2017, 6.88 million barrels (0.96 million tonnes) of oil were produced and 6.55 million barrels of oil were exported. Figure 3-4 shows crude oil production in Mongolia over the period 2012 through 2019.

Figure 3-4: Crude Oil Production for 2012-2019, million barrels



Exports of crude oil in 2019 were estimated at 6.55 million barrels, with a value of 366.7 million USD. Compared to results from the previous year, exports in 2019 had increased by 0.36 million barrels and the total value decreased by 25.3 million USD. The average price per barrel crude oil received by Mongolia decreased from 63.3 USD in 2018 to 55.9 USD in 2019. Figure 3-5 shows the production and exports of oil by the three major oil-producing companies in Mongolia, and Table 3-5 shows national imports of oil products by type over the period 2012 through 2019.

Figure 3-5: Crude Oil Production and Exports in 2017 in Mongolia, by 3 Main Supplier Companies



Source: Statistical Report 2017 on minerals, Ministry of Mining; Mineral Resources and Petroleum Authority

Table 3-5: Petroleum imports, 2012-2019

	2012	2013	2014	2015	2016	2017	2018	2019
Petrol (thou.t)	389.1	380.1	416.	433.5	385.3	410.86	435.5	541.5
Diesel (thous.t)	715.5	772.9	685.9	655.	548.1	805.34	848.8	1,080.4
Jet fuel (thous.t)	36.2	38.8	26.2	27.3	24.8	30.66	40.3	46.6
Mazut (thous.t)	3.9	2.6	3.1	3.2	2.6	2.2	2,973.1	2,974.2

Source: National Statistical Database, www.1212.mn

3.3 Natural Gas

Currently, no significant gas deposits have been found in the territory of Mongolia, and there is almost no consumption of any gaseous fuels in Mongolia, except for some small amounts of liquefied petroleum gas (LPG), which are imported from Russia for use either as a vehicle fuel or for cooking purposes in household and restaurants.

3.4 Uranium

The territory of Mongolia was classified into four uranium-bearing metallogenic provinces: Mongol-Priargun, Gobi-Tamsag, Khentei-Daur and Northern Mongolian. Each of these provinces has different geology and hosts different deposit types. Mineral associations and ages of mineralization also vary. Within these provinces, 12 uranium deposits, about 100 uranium occurrences and 1,400 showings and radioactive anomalies have been identified.

Based on *Uranium 2018- Resources, Production and Demand Report* (a Joint report by the Nuclear Energy Agency and the International Atomic Energy Agency), identified recoverable conventional resources of uranium in Mongolia (reasonably assured and inferred resources) as of 1 January 2017 were estimated at 113,357 tU (tonnes of elemental uranium).

As of January 2017, undiscovered conventional resources (prognosticated and speculative resources) for Mongolia were estimated at 1,390,000 tU.[8]

3.5 Renewable Energy Resources

The total electricity generation potential of renewable energy in Mongolia, including wind, solar, geothermal, and hydro resources, has been estimated by the National Renewable Energy Laboratory (NREL) of the United States Department of Energy to be as high as 2,600 GW. The Gobi Desert in particular has tremendous renewable energy potential and has favorable climatic and weather conditions to allow the effective use of these resources.

Wind:

More than 160,000 square-kilometers (km^2) of land area in Mongolia, or 10% of the total land area, has been estimated to have good-to-excellent wind potential for utility-scale applications (power densities of 400-600 W/m^2). Based on conservative assumptions prepared by the National Renewable Energy Laboratory (NREL) of the United States Department of Energy, at a capacity rate of 7 MW per km^2, this area of Mongolia has the potential to support more than 1,100,000 MW of installed capacity, and potentially to deliver over 2.5 trillion kWh per annum, equivalent to 14% of global electricity consumption in 2017.

NREL also developed a wind energy resource map for Mongolia in co-operation with NREC (the National Renewable Energy Center) and the National Institute of Meteorology, which is summarized in Table 3-6, below.

Table 3-6: Wind Power Resources in Mongolia

Category	Wind at 30 m height		Total area coverage		Total potential capacity, MWe	Potential annual power production, GWh
	Power , W/m^2	Speed, m/s	km^2	%		
3	300–400	6.4–7.1	130,665	81.3	905,500	1,975,500
4	400–600	7.1–8.1	27,165	16.9	188,300	511,000
5	600–800	8.1–8.9	2,669	1.7	18,500	60,200
6	800–1000	8.9–9.6	142	0.1	1,000	3,400
Total			160,641	100	1,113,300	2,550,100

[8] *Uranium 2018 Resources, Production and Demand*, Joint Report by the Nuclear Energy Agency and IAEA, available from https://www.oecd-nea.org/ndd/pubs/2018/7413-uranium-2018.pdf.

It is estimated that 13 aimags have more than 20,000 megawatts of wind potential each, an additional 9 aimags each have more than 50,000 megawatts of wind potential, and the Omnogobi aimag alone has wind energy potential of over 300,000 megawatts.

Solar:

Based on calculations by NREL, on average, Mongolia has 270-300 sunny days annually and an estimated 2250-3300 hours of direct sun in a typical year. This indicates that the availability of solar radiation in Mongolia is fairly reliable. With average daily solar energy at the range of 3.4-5.4 kWh/m² and solar generation installed over a total area of 23,461 (about 1.5 percent of the overall 1.56 million km² territory of the nation), Mongolia could yield 4774 TWh of solar electricity per year, as shown in Table 3-7. With an estimated average solar electricity generation potential of 5.4kWh/m² / day, over an area of 5542 km², NREL calculations rank the Gobi Desert as the third highest on the list of the world's deserts with high solar electricity generation potential.

Table 3-7: Solar Resources in Mongolia

Solar radiation (kWh/m²/day)	Land area (km²)	Total solar resource (TWh/year)
3.4	5269	654
3.8	3924	544
4.1	4210	630
4.5	4515	742
5.4	5542	1092
Total	**23461**	**4774**

Source: US National Renewable Energy Laboratory, National Renewable Energy Centre of Mongolia

Hydropower:

There is significant potential in Mongolia for hydropower generation. In 1994, the Institute of Water Policy of Mongolia estimated the gross theoretical hydropower production capacity for all rivers with a runoff of more than 1 cubic meter per second (m^3/s) at 6,400 MW, delivering a potential 56.2 million MWh of electricity per year at full capacity. The actual hydropower potential is between 20% to 60% of this estimate, meaning between 1,280 MW and 3,840 MW.

Geothermal (thermal resources and ground-source heat pumps application):

A researcher in 2015 described the status of geothermal energy use in Mongolia as follows:

"There are 43 geothermal areas in Mongolia, with many utilized for heating, bathing and medicinal purposes…. National Sanatoriums utilize thermal waters via shallow (typically <100

m deep) wells at Tsenkher, Hujirt, Shargaljuut, Zart, Shivert, Khalzan uul, Eruu and Tsagaan tal."[9]

There have recently been several pre-feasibility studies for geothermal energy projects in Mongolia conducted by government and private companies. The National Renewable Energy Centre of Mongolia has completed a number of surveys of geothermal resources. Two types of geothermal applications have been well developed in Mongolia during the last decade. These are the traditional sanatorium concept and a newer technology called ground source heat pumps. Ground source heat pump applications started from 2008 in Mongolia.

1. Traditional sanatorium and tourist camps: The traditional sanatorium and bathing- are continuously being developing in the country and are designed to attract local and foreign tourists.
2. Shallow geothermal heat pumps: In the last decade, a several ground source heat pumps (GSHP) were installed in Mongolia.

At present, there is no geothermal resource utilization in Mongolia for electricity (power) generation. In the foreseeable future, most geothermal resource utilization is anticipated be for direct use applications, which are expected to include district heating schemes, cashmere and wool processing, horticultural applications, balneological and therapeutic purposes, and development of the country's tourism industry. Ground source heat pump utilization is promising for development among rural communities as an efficient means of electric heating, as well as for individual space heating, and will replace the use of coal burning heat-only boilers, resulting in a reduction in GHG emissions.

As reported in ADB's (2018) *Proposed Loan and Administration of Grants Mongolia: Upscaling Renewable Energy Sector Project* document, within the project scope: "In selected targeted regions, 500 kilowatts-thermal of shallow-ground heat pump capacity will be installed in public buildings in three batches. (The subproject will be implemented in three batches, starting with a 100-kilowatt installation in the Uvs aimag center (core subproject), followed by a rollout in four aimag centers in the western Mongolia). This will supply air pollutant-free space heating for 10,000 square meters of floor area. The subprojects will demonstrate the performance of the heat pump systems and increase experience in design, installation, operation, and maintenance for future scale-up". As of 2018, there are only about 3 MW of ground source heat pumps installed in Mongolia (New Climate Institute 2020).

Biomass:

In Mongolia, there are four major types of biomass resources: (1) wood from forests, (2) crop wastes, (3) animal husbandry residues, and (4) industrial and domestic wastes. Table 3-8 summarizes forest land areas by type and by region in Mongolia.

[9] Purevsuren Dorj (2015), "Geothermal Development in Mongolia: Country Update 2015", Proceedings World Geothermal Congress 2015 Melbourne, Australia, 19-25 April 2015, available as https://pangea.stanford.edu/ERE/db/WGC/papers/WGC/2015/01078.pdf.

Table 3-8: Land with Forest Resources, 2019, (Thousand hectares)

Region and Capital city	Total	Forest land	Clearcut area	Tree nursery	Forest land under regeneration	Other areas of forest land
Total	**14341.2**	**12188.8**	**142.8**	**64.9**	**743.4**	**1201.1**
Western region	2312	2084.6	15.9	13.6	33.5	164.4
Khangai region	7490.3	6103.8	57.3	0.4	538.7	790.1
Central region	3160.1	2858.3	26.2	47.5	59.7	168.3
Eastern region	1304.8	1077.5	43.4	1.2	111.5	16.1
Ulaanbaatar	74.1	64.7		2.1	0.2	7.2

The forest resources of Mongolia are described as follows in *Mongolia's Forest Reference Level submission to the UNFCCC*: [the] country supports two major forest biomes, boreal forests in the north accounting for 14.2 million hectares (87%), dominated by larch and birch; and 2.0 million of saxaul forests (13%), a dryland woodland ecosystem in the southern arid regions of Mongolia that is considered under national definitions as 'forest'".[10]

Based on forest taxation inventories conducted by the Forest Research and Development Center (FRDC), larch, birch and saxaul trees account for more than 60%, 10% and 15% of forest areas, respectively. In terms of growing stock, larch contributes close to 80%, while all other trees are below 10%. The average growing stock amounts to 113.9 m^3/ha. (Source: Mongolia's Forest reference level submission to the UNFCCC, 2018).

In the Gobi Desert area, widespread usage of saxaul (the only tree-like plant that grows in the Gobi Desert) and shrubs is resulting in extinction of forests and green zones in the desert area, consequently increasing sand movement/spread. Thus, using different types of biomass, including dung, for fuel and for generating biogas, will help to reduce the loss of plants in the Gobi Desert.

Resources of agricultural waste and livestock (dung): As of 2017 Mongolia had 70.9 million head of livestock, which means that Mongolia has a considerable biomass resource in manure from livestock. The forms of these resources include dried cow dung, sheep pellets, horse-dung, and "khurzun" (the hardened dung and urine of sheep and goats), which are produced continuously by livestock and serve as a source of renewable energy. All forms of dung are considered high quality compact fuel.

The thermal energy contents of the different dung types and forms depend on the season and the region where the dung is collected.[11] The minimum amount of thermal energy capacity: from cow

[10] Ministry of Environment and Tourism (2018), Mongolia's Forest Reference Level submission to the UNFCCC, dated June 6 2018, available as http://reddplus.mn/eng/wp-content/uploads/2018/08/2018-Mongolia-FRL-modified-2.pdf, and referring to CCPIU, (2018).Forestry land use, land use change assessment report 1986-2016.Ulaanbaatar, Mongolia: Climate Change Project Implementing Unit under Environment and Climate Fund of the Ministry of Environment and Tourism.

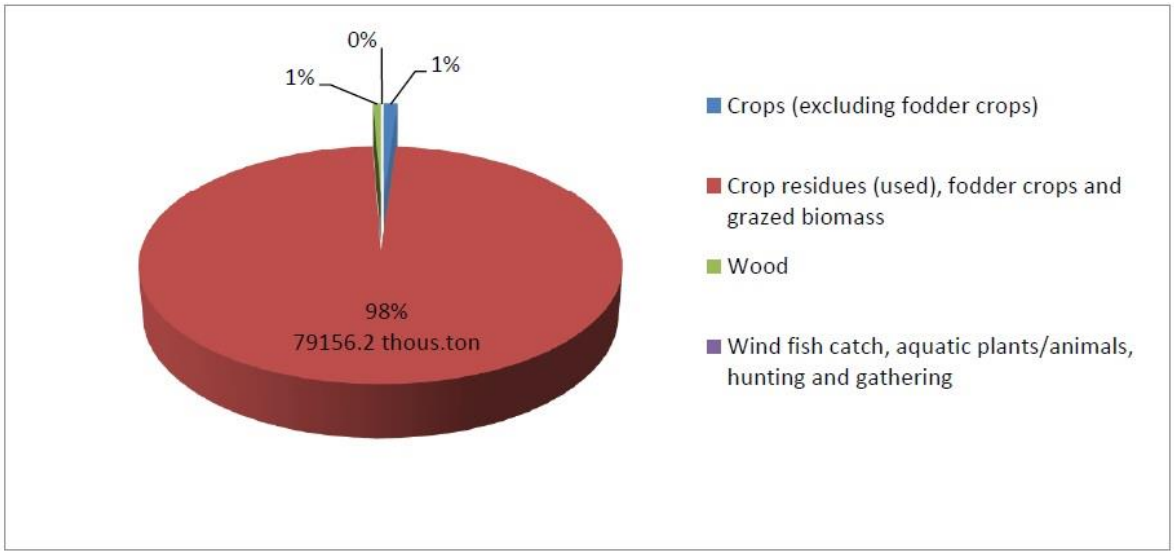
[11] See, for example, "Combustion of dung", https://energypedia.info/wiki/Cooking_with_Dung#Combustion_of_Dung.

dung is 10800-13300 kJ/kg, from sheep pellets is 8800-16700 kJ/kg, and from "khurzun" is 12500-14600 kJ/kg

As a part of the study summarized by JCM in *Feasibility Study in Mongolia (FS) 2015 – Final Report*, cattle manure from dairy farmers in Tuv aimag and dewatered sludge from the UB City central sewage treatment plant were collected, and were analyzed at Bureau Veritas. Based on the analysis results, the calculated lower heating value (LHV) based on moisture content of ≤30% was at least 2,800 kcal/kg.[12]

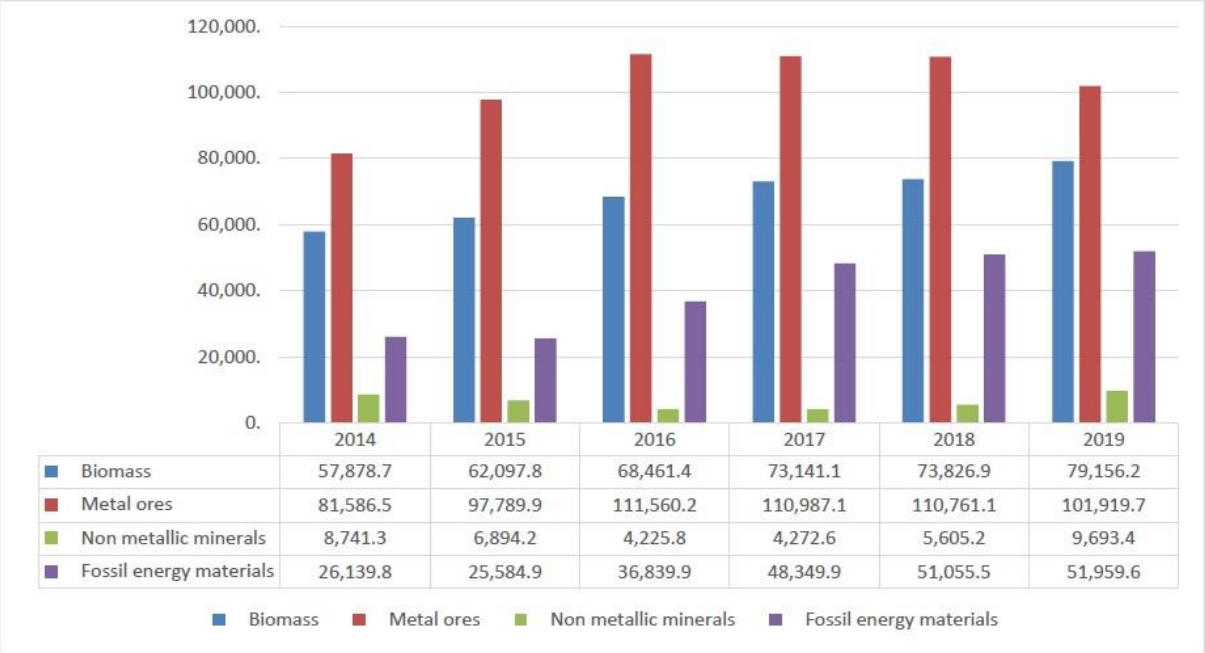
Based on available data in Mongolia, biomass production and use are as summarized in Figure 3-6 and Figure 3-7.

Figure 3-6: Biomass Production Domestically Used in 2019, thousand. ton



[12] JCM Feasibility Study (FS) (2015), *Summary of the Final Report "Distributed heat supply system using biomass and coal mixture combustion type boiler"* available as http://gec.jp/jcm/en/wp-content/uploads/2017/05/2015FS201_sum_en.pdf.

Figure 3-7: Biomass Domestically Used, 2014-2019, million tons



	2014	2015	2016	2017	2018	2019
Biomass	57,878.7	62,097.8	68,461.4	73,141.1	73,826.9	79,156.2
Metal ores	81,586.5	97,789.9	111,560.2	110,987.1	110,761.1	101,919.7
Non metallic minerals	8,741.3	6,894.2	4,225.8	4,272.6	5,605.2	9,693.4
Fossil energy materials	26,139.8	25,584.9	36,839.9	48,349.9	51,055.5	51,959.6

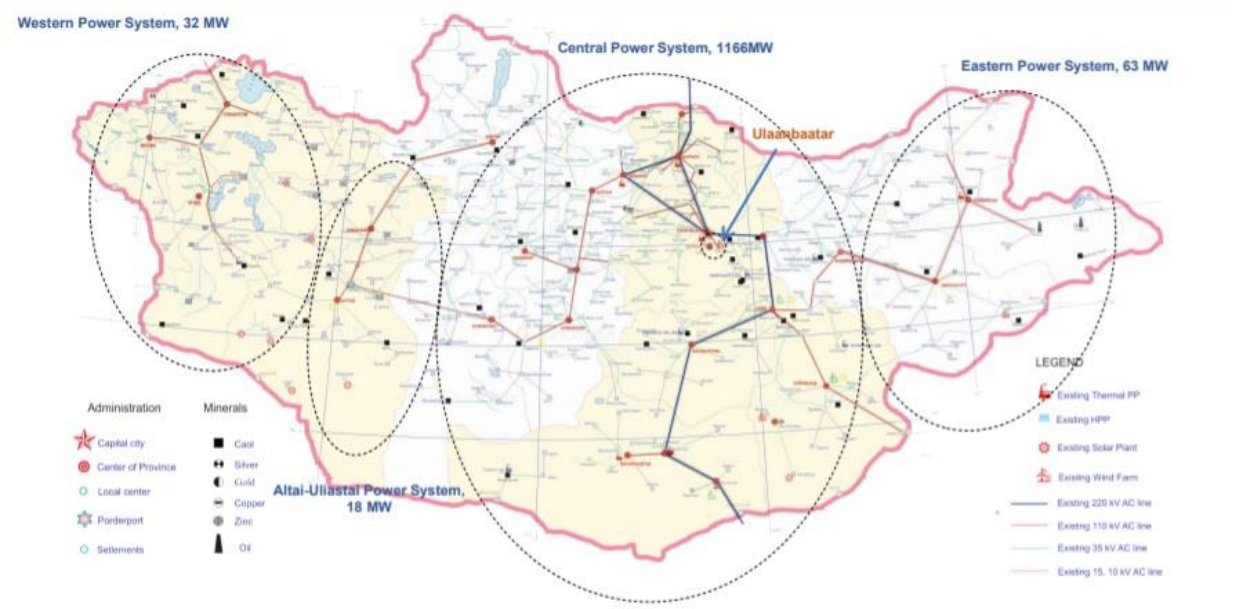
Source: Mongolian Statistical Database, http://www.1212.mn/tables.aspx?TBL_ID=DT_NSO_3600_001V1

4 Electricity Supplies in Mongolia

4.1 The Mongolian Power System

The electric power network of Mongolia consists of five independent electric power systems: the Central Region Energy System (CRES or CES), the Southern Region Energy System (SRIES), Eastern Region Energy System (ERES), Altai–Uliastain Energy System (AUES) and Western Region Energy System (WRES). There are also small-scale off-grid renewable energy sources and diesel stations in rural remote areas. The Mongolian power systems include around 1500 km of 220 kV (kilovolt), 5650 km of 110 kV and 9400 km of 35 kV overhead transmission lines, and about 24,540 km of 0.4-20 kV distribution lines. Figure 4-1 provides a map of the Mongolian power system.

Figure 4-1: Mongolian Power System



The Central Region Energy System (CRES) is the largest of the five independent energy systems and covers the main cities of Ulaanbaatar, Darkhan, Erdenet and 13 provinces. The CRES supplies electricity in total to 83% of consumers throughout the country, as shown in Table 4-1.

Table 4-1: Peak load and Number of Electricity Consumers, by Grid (as of 2019)

	Grid	Peak load , MW	Electricity consumers
1	Central Region Energy System (CRES)	1153	83.8%
2	Western Region Energy System (WRES)	36.5	6.4%
3	Southern Region Energy Supply (SRIES)	190.9	4.2%
4	Eastern Region Energy System (ERES)	49.05	2.3%
5	Altai-Uliastain Energy System (AUES)	19.47	3.2%

Source: NDC Report, Energy Statistic 2019, ERC

In Mongolia, there are six types of energy sources used for electricity generation: coal (lignite), diesel, hydro, wind, solar, and imported electricity.

As of 2019, generators with a combined installed capacity 1416.61 MW, including renewable electricity systems, were operating and supplied 80.3 percent of national electricity demand. (The remaining 19.7 % of electricity, totaling 1,715.8 million kWh, was imported from Russia and China.) Table 4-2 shows historical electricity generation from 2013 to 2019 by each of the

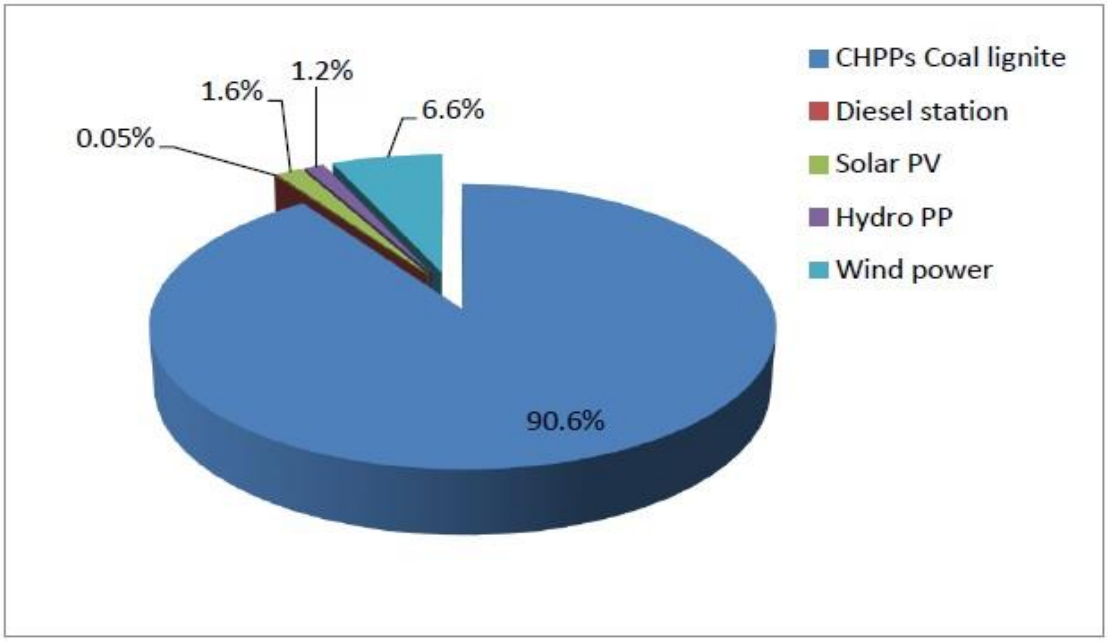
domestic sources. A majority of the total electricity supply is provided by plants burning lignite coal, accounting for 90.6% of output in 2019. Electricity generation from renewable and distributed energy sources accounted as 9.3% of the total in 2019, of which 6.6 % came from wind, 1.2% from hydro, 0.05% from diesel, and 1.6% from solar, as shown in Figure 4-2.

Table 4-2: Electricity Generation by Sources, 2019

Sources	2013	2014	2015	2016	2017	2018	2019
	GWh						
CHPPs Coal lignite	5,014.0	5,191.3	5,415.8	5,555.9	5,826.9	6,152.4	6,346.6
Diesel station	5.4	8.2	6	3.8	3.7	3.7	3.0
Solar PV		0.6	0.5	0.3	19.7	51.1	109.0
Hydro PP	59.9	66.3	59.3	84.7	84.5	78.7	85.4
Wind power	52.9	125.4	152.5	157.5	154.4	339	459.3
Total generation	5,132.20	5,391.80	5,634.10	5,802.20	6,089.20	6,624.80	7,003.3

Source: Energy Statistics, Energy Regulation Commission

Figure 4-2: Electricity Generation Share by Sources, 2019



4.2 Coal-Fired Power Plants (CHPPs)

The current energy mix in Mongolia is very coal-intensive, with nine thermal power plants, some built decades ago, using older coal combustion technology, and with total capacity of 1162.8 MW as of 2019 (Table 4-3). The majority of these power plants are operating in the central

region of the country where the power grid has the most interconnections, and supply electricity to both urban and rural areas.

Table 4-3: Installed Capacity of CHPPs, 2019

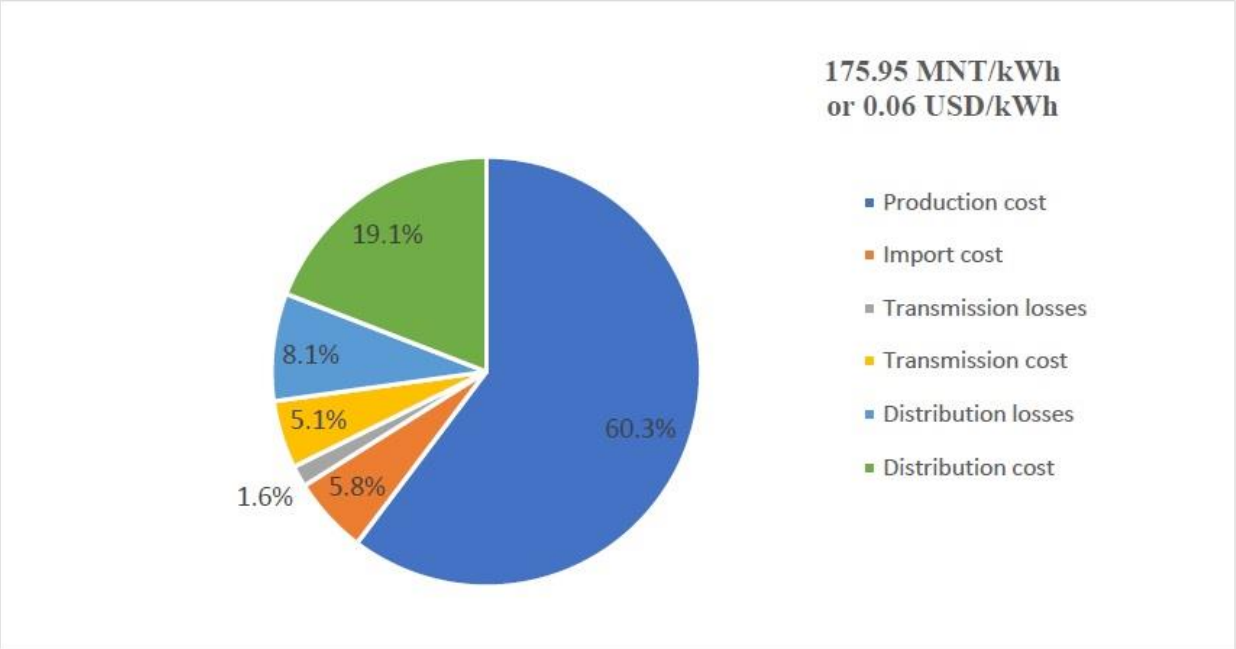
Name of Plant	Installed capacity (MW)	Electricity own use %	Commissioning year
CHPP-2	24	12.58	1961
CHPP-3	186	16.44	1968
CHPP-4	749	12.09	1983
Darkhan CHPP	59	16.38	1965
Erdenet CHPP	28.8	18.16	1986
Erdenet Mining CHP	53	17.86	(1976) 2017
Dornod CHPP	36	14.0	1967
Dalanzadgad CHPP	9	39.76	2000
Ukhaa Khudag CHPP	18	10.0	2011
Total by CHPPs	1162.8		

The capital, Ulaanbaatar City, has three Combined heat power plants located inside the city area with a total installed capacity of 959 MW. Of the three, the largest is Combined Heat and Power Plant 4 (CHPP4) with a capacity of 749 MW, with the others being CHPP 3 (186 MW) and CHPP 2 (24 MW). As such, the Central Energy System, which includes Ulaanbaatar, represents approximately 80 per cent of the total electricity generation of Mongolia. The total capacity for the CRES was 1070 MW in 2017, 1166 MW in 2018 and 1243 MW in 2019.

Electricity cost

The unit costs for electrical energy generated by the CHPPs are comprised of 6 groups of costs, as shown in Figure 4-3. These include production costs, transmission and distribution costs, transmission and distribution losses, and import costs. The actual unit cost of electric energy per kWh totaled 155.85 MNT, or approximately 0.06 USD in 2018, and 175.95 MNT (also equal to about 0.06 USD) in 2019.

Figure 4-3: Electricity Price Structure for CES Coal-fired Plants



In accordance with the Energy Law, the electricity selling price and tariff to consumers is set by the Energy Regulation Commission. The tariff for 2019 included a renewable energy levy (23.79 MNT per kWh, which equals 0.008 USD/kWh) and an entities capacity charge (9,000 MNT/kWh/month, which equals about 3.21 USD/kWh/month based on USD/MNT conversions as of 2019). Electricity tariffs in Mongolia in 2018 and 2019 are shown in Table 4-4. Note that in comparison with the costs of coal-fired generation as described above, tariffs in Mongolia only exceed costs for electricity sold to the mining and minerals processing industries.

Table 4-4: Electricity and End-user tariff, 2018-2019

CONSUMER CATEGORY	Tariff for 2018		Tariff for 2019	
	MNT/kWh	USD/kWh	MNT/kWh	USD/kWh
Industrial				
Mining, processing industry	167.78	0.066	179.69	0.066
Other industries, entities	140.38	0.055	164.38	0.06
Residential				
Monthly consumption below 150 kWh	110.28	0.044	134.28	0.049
Monthly consumption above 150 kWh	130.08	0.051	154.08	0.056

Source: Energy Statistics 2018,2019, Energy Regulation Commission

4.3 Renewable Energy Sources

As of 2019, as shown in Table 4-5, below, a total of 20 renewable energy (RE) electricity sources were operating in Mongolia, of which three were wind, seven were hydro, and ten were solar, with capacities ranging between 0.1-15 MW. The 10 MW Darkhan solar PP was connected to the Central grid in 2017, and the 15 MW "Gegeen" Solar PP, which is located in Zamiin-Uud soum of Dornogobi, was commissioned in November 2018.

The first wind farm in Mongolia, the 50 MW "Salkhit" plant, located in Sergelen soum, Tuv aimag, was built in 2013. The second, the 50 MW Tsetsii Wind Park in Tsogttsetsii soum of South Gobi, was commissioned in Dec of 2017, and the 55 MW Sainshand Wind Farm with a total capacity of 55 MW was commissioned at the end of 2018.

Table 4-5: Installed Capacity of Renewable Electricity Sources in Mongolia, 2019

	Wind Power Plants, MW		Hydro Power Plants, MW		Solar Power Plants, MW	
1	Salkhit WP	50	Tosontsengel HPP	0.375	Bugat Solar PP	0.14
2	Tsetsii WP	50	Taishir HPP	11.2	Urgamal Solar PP	0.15
3	Sainshand WP	55	Guulin HPP	0.4	Buyantooroi Solar PP	0.1
4			Hungiin HPP	0.115	Altai Solar PP	0.3
5			Gauutain HPP	0.12	Mandakh Solar PP	0.2
6			Bogd River HPP	2	Bukhug Solar PP	15
7			Durgun HPP	12	Darkhan Solar PP	10
8					Monnaran Solar PP	10
9					Gegeen Solar PP	15
					Sumber PP	10
	Wind Total	155	Hydro Total	26.21	Solar Total	60.89

Costs of Renewable Energy

Feed-in-Tariffs (FiT) were initiated based on Article 11 ("Renewable energy tariffs and Prices") of the Renewable Energy Law of 2015 and are applicable to RE generators. The renewable FiT acts as a subsidy to encourage the production of electricity from renewable energy sources. According to the law, the Energy Regulatory Commission (ERC) sets the tariffs and prices of energy generated and supplied by renewable energy power sources connected to the transmission network (grid-connected). In addition, the ERC is responsible for annually setting and monitoring the tariffs and prices of energy generated and supplied by renewable energy power sources (off-grid) by households and companies (this section of the Renewable Energy Law, "Article 5.6.5", was added on 06 June of 2019 by Amendment).Table 4-6 shows the ranges, as updated through the Law passed on 06 June of 2019, for the FiTs applicable to renewable energy sources.

Table 4-6: Ranges of FiTs for Renewable Energy Sources in Mongolia, (unit: USD/kWh)

Renewable energy sources /costs	Hydropower Up to 5000 kW	Wind	Solar
Cost per kWh	0.045-0.06	0.085	0.12

4.4 Electricity Exports and Imports

As mentioned above, electricity imports to Mongolia make up around 20 percent of its power supply. Although in the southern region it is mostly the mining sector, namely the Oyu Tolgoi mine, that imports electricity via the transnational power transmission line from China. The CES also imports electricity from Russia via the Western parts of Mongolia (see Table 4-7 and Table 4-8). The maximum imports from Russia are limited- depending on the contacted amount in Mongolia's Power Purchase Agreements (PPA) with Russian sellers in each year, although power imports to meet nightly peaks in Mongolia during winter can exceed contracted totals by a limited margin.

Table 4-7: Electricity Imports and Exports in Central Region Integrated Power Grid

Indicators	2014	2015	2016	2017	2018	2019
Imported electricity, GWh	288	176.3	201.4	270.6	304.1	250.8
Exported electricity, GWh	30.3	54.3	33.9	34.1	26.9	26.5
Average price of imports, US$	0.084	0.072	0.082	0.08	0.08	0.09
Payment, thous.US$	24,149.7	12,628.7	16,441.6	21,352.2	22,695.8	21,541.9

Table 4-8: Total Electricity Import Overview, 2014-2019 (million kWh)

	2014	2015	2016	2017	2018	2019
Import from Russia to CES, mln kWh	288	176.3	201.4	270.6	304.1	250.8
Import Western, others border points, mln kWh			103	0.9	110.98	120,50
Import from China to OT, mln kWh	987.7	1090.1	1095.5	1130.7	1241.8	1315.0

As for the numerous mines around the country—with the exception of the Oyu Tolgoi mine that purchases power from Inner Mongolia, China—the majority of the smaller mines are either connected to the grid, have their own small power plant (such as the Energy Resources plant serving the Tavan Tolgoi coal deposit) or have diesel generators.

To cover the crucial electricity demand of the Oyu Tolgoi (OT) and Tavan Tolgoi (TT) projects, the Government of Mongolia and Oyu Tolgoi LLC signed a Power Source Framework

Agreement (PSFA) in 31 Dec 2018 to construct the 450 MW Tavan Tolgoi Power Plant (TTPP) and thus to secure a long-term domestic power solution for OT and the wider South Gobi region. The project will also consider how to utilize renewable power sources as part of an overall solution to regional power needs.

Heat supply

In 2019, the total heat energy production in Mongolia reached a volume of 10,310.9 thousand Gcal (gigacalories), an increase of 9.4%, or 885.8 thousand Gcal, compared to 2018. Heat supply in Mongolia is mostly provided by centralized heat supply systems, especially for consumers living in cities and aimag centres. Many small Heat Only Boilers (HOBs), independent boilers, and water heaters are used in the Mongolian countryside for space heating and for domestic hot water use, and to provide steam to industry.

4.5 Recent Challenges with Power Sector

At present, the following challenges exist in the Mongolian power sector:

- Capacity shortages in domestic power generation due to rapid GDP growth and growth in demand by the mining sector
- Aging of key equipment at coal-fired power stations and of transmission and distribution network infrastructure
- High rates of electricity losses in the transmission and distribution network
- Load regulation as renewable energy generation increases
- Subsides and tariffs

Existing coal power plants are aging (see Figure 4-4)–with most of the main power plants having been operating for over 40 years as of 2021 (the red line in the figure)—and have relatively low utilization rates. In addition, major electricity losses are occurring along the transmission and generation network. Mongolia experienced losses of approximately 14 percent in transmission and distribution in 2019, greatly exceeding the international best practice benchmark 5 percent (

Figure 4-5).

Figure 4-4: Utilization of the Existing Main Power Plants, by Age

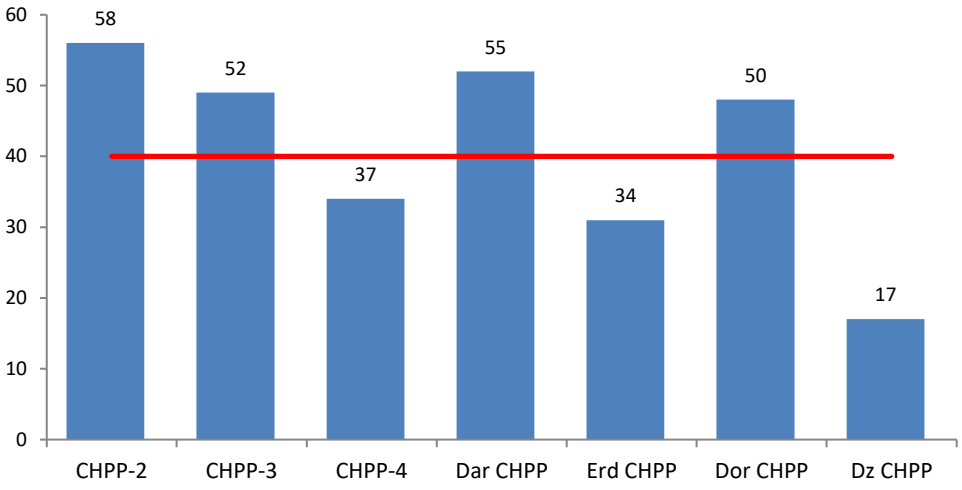
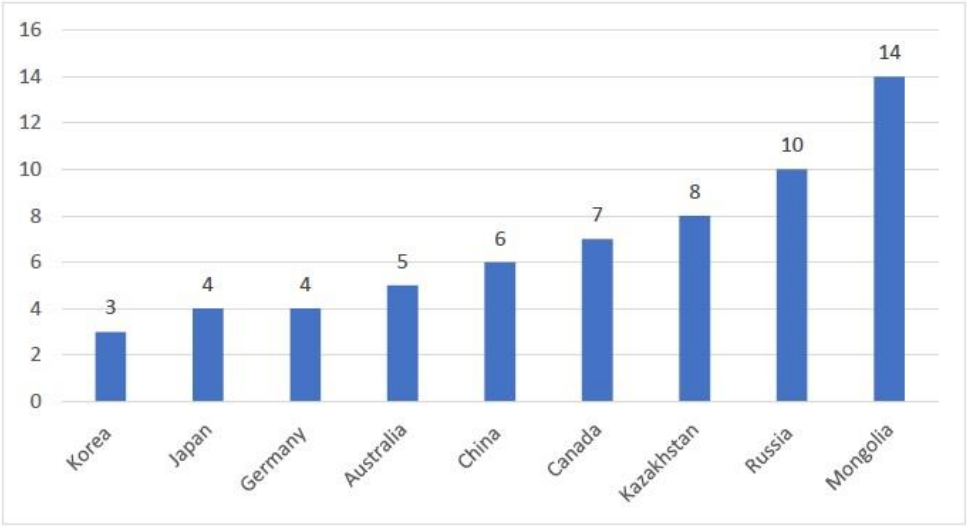


Figure 4-5: Transmission and Distribution Losses by Country. 2019 (percent)



Electricity Subsides and tariffs in Mongolia

Detailed information about cost and tariffs are provided in the previous subsections of section 4 of this Report (4.2 Coal-Fired Power Plants (CHPPs), including costs for electricity generated by CHPPs shown in Figure 4-3 and the tariffs shown in Table 4-4, and subsection 4.3 Renewable Energy Sources, including the FIT levels shown in Table 4-6.

Subsidies for electricity prices in Mongolia are linked to the tariff-setting process. In accordance with the Energy Law (those provisions of the Energy Law regulating the principles of setting

tariffs), the ERC reviews and approves the tariffs of the electricity supply licensees, and the tariffs are expected to be based on the real costs of operation. The law states that tariffs shall be determined separately for each licensed activity, including generation, transmission, distribution, dispatching and supply of electricity and heat. In the CES, the electricity transaction market is operated with a Single Buyer Model (SBM) in which one organization (the National Power Transmission Grid Company) buys electricity from generators and sells to distributors. (Please see the discussion of energy market principles regarding the Single Buyer Model provided in section 4.6, below).

A discussion of some of the challenges faced in setting and applying tariffs in Mongolia was provided in a recent World Bank project document, and included the following:[13]

"In some years the generation, transmission and distribution companies have been unable to cover even their operating costs because of delayed tariff adjustments to match inflation or exchange rate fluctuations."

Another source noted "In practice, however [during this time], the tariffs are kept lower for political reasons and cost-covering tariffs would not be approved by the authorities if suggested by a licensee."[14]

Although in recent years tariffs have frequently been adjusted in Mongolia, often as a response to inflationary pressure related to currency exchange rate fluctuations, tariffs are still intended to be based on the real cost of operation. This approach has not always been followed, however. For instance, CHPPs have sold electricity at tariffs lower than real generation costs based on the guidance of the government. (As of the 2019 tariff adjustment, the actual costs of generationg by CHPPs is 175.95 MNT/kWh or about 0.06 USD/kWh (see Figure 4-3), while end user tariffs ranged between 134.28 -179.69 MNT/kWh or 0.049-0.06 USD/kWh (see Table 4-4) . The electricity tariff for the mining sector only started to cover real operational costs in 2019. Because of these low tariffs, the energy sector has suffered financial losses. In 2012, for example, "aggregate operating losses of the CES power companies were 7 percent of total revenues, or about US$30 million dollars . The following year the Government compensated the shortfall of the zero-balance account based on losses incurred in the energy sector in the previous year, this translated to government subsidies of US$36 million (inclusive of coal subsidies) in the 2013 budget".[15] In the 2015 Government Budget, subsidies amounted to 200.5 billion MNT which was equivalent to 46.8% of the total expenditures in the energy sector (428.5 billion MNT).

[13] World Bank (undated, but probably 2015 or 2016), *Mongolia –Capacity Building and Regulatory Support Technical Assistance Project Document*, available as http://pubdocs.worldbank.org/en/259441531555593596/4106-XSREMN057A-Mongolia-Project-Document.pdf,

[14] Energypedia (2020) "Mongolia Energy Situation", available aa https://energypedia.info/wiki/Mongolia_Energy_Situation#Tariffs_and_Subsidies

[15] Electricite de France (EDF, 2020), *Technical Assistance Consultant's Report, Project Number: 48030-001, Mongolia: Strategy for Northeast Asia Power System Interconnection*, dated February 2020, and available as https://www.adb.org/sites/default/files/project-documents/48030/48030-001-tacr-en_2.pdf.

In a pair of interviews in 2019 and 2020, Teleikhan, the Director of the ERC, reported that the financial and economic situation of the energy sector has improved compared with past years.[16] In 2018 alone, sales revenue in the energy sector reached 952 billion MNT, an increase of 97.2 billion MNT from the previous year, and increased to 1.1 trillion MNT in 2019. The energy sector paid a total of 289.1 billion MNT to the Tax Office in 2018, and 335.0 billion MNT in 2019. The energy sector has become an active sector that pays taxes and makes contributions to the tax creation fund rather than taking subsidies from the Government. Although the energy sector of Mongolia had an operating loss amounting to 69.6 billion MNT in 2009, by 2019 there was no operating loss for the Central Regional Energy System as a result of measures implemented to improve economic efficiency and reduce losses. Only in some local areas, including 5 provinces in the Western region and 2 provinces in the South Region, as well as the South Gobi Regional Energy System, had operating losses amounting to 28.2 billion MNT in 2019, and therefore, these regions received subsides from the Government totalling 17.1 billion MNT in 2019. Operating losses were incurred in these regions because electricity tariff were lower than actual operational costs.

As of 2019, the Central and Eastern Regional Energy Systems operated without subsidies from the Government.

It was mentioned in both interviews that despite rate adjustments, in Mongolia electricity tariffs remain low by regional standards. This is especially the case for residential tariffs (for example, the average CES household tariff is around 168.14 MNT/kWh, which equals about 0.06 USD/kWh as shown in Table 4-4), which are still sufficiently low as to not be covering real operational costs. (The Government provides "subsides" to household tariffs). Compared to its neighboring two countries, the electricity tariff in Mongolia is half that in both Russia and China, and if compared with developed countries (such as Japan and some nations in Europe), Mongolia's tariffs are in some cases just 20 to 25 percent of those in other countries. Further tariff reform and ensuring of financial sustainability for companies in the electricity sector are still required in Mongolia.[17]

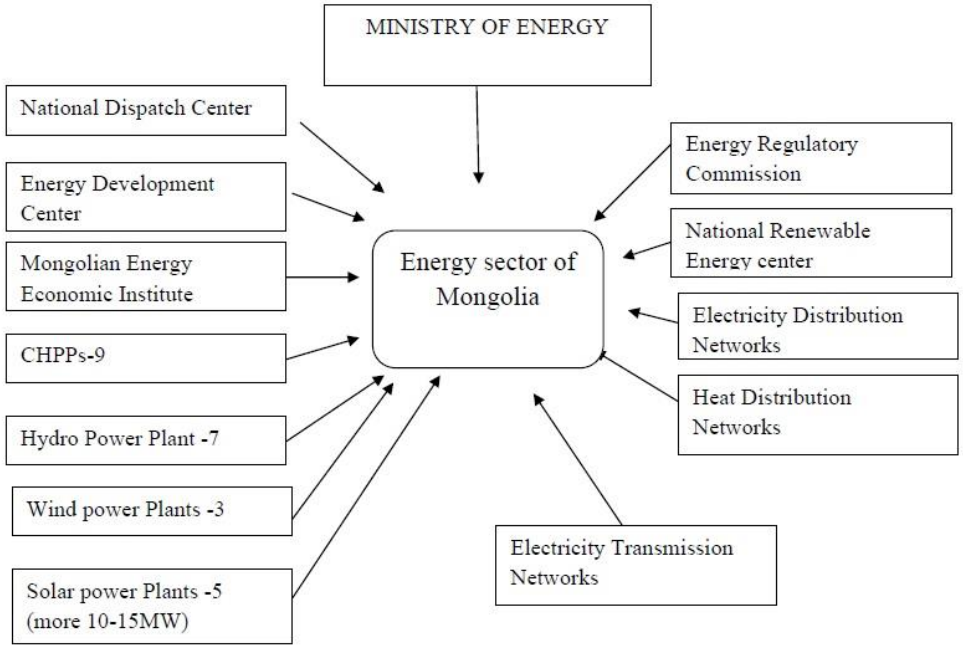
4.6 Structure of Energy Sector and Market Principles

As of 2019, the electricity sector of Mongolia was comprised of 9 thermal power plants, 3 wind farms, 7 hydro power plants, 5 solar PV plants, the transmission system, and distribution networks. Figure 4-6 shows the structure of the sector, and the key institutions overseeing the sector are as follows.

[16] Interview with Tleikhan, Head of Energy Regulation Commission of Mongolia, 12 September 2019, published at https://erc.gov.mn/web/mn/print/337?date=true, in Mongolian language; and Interview with Tleikhan, Head of Energy Regulation Commission of Mongolia, dated 04 May 2020, and available as https://erc.gov.mn/web/mn/print/410?date=true.

[17] Interview with Tleikhan, Head of Energy Regulation Commission of Mongolia, dated 04 May 2020, ibid.

Figure 4-6: The Structure of the Mongolian Energy Sector and its Key Institutions



The Ministry of Energy (MOE): The Ministry of Energy (MOE) is a line ministry in charge of policymaking for the sector. The policy areas under the Ministry of Energy include the development of energy resources, energy use, the import and export of energy, the construction of power plants, transmission lines and networks, energy conservation, the use of renewable energy sources, the monitoring of the sector, the approval of rules and regulations for the sector, and international cooperation.

The Energy Regulatory Commission (ERC) is an independent regulation authority, nominated by the government and self-funded by license fees, in charge of regulation of the generation, transmission, distribution, dispatching and supply of energy. The ERC's main powers are: setting terms and conditions for licensing, issuing, voiding, dismissing, amending and changing licenses; establishing conditions and requirements for attaining a license and the activities of licenses; controlling licensees' performance; elaborating tariff design methods, and settling disputes arising between consumers and licensees.

The Commission' objectives are to issue operational licenses, to review and approve the tariffs of the licensees, to protect equally the rights of the consumers and licensees as well as to create condition for fair competition among the generators and suppliers in accordance with the Law on Energy.

The National Renewable Energy Corporation (NREC) is a state-owned enterprise that has been managing scientific research, experimental and construction works, trade and the production of renewable energy equipment activities for the purposes of assessing renewable energy resources such as solar, wind, hydro, biomass and geothermal energy in Mongolia and their efficacious utilization. The NREC has been operating since 1989. The mission of the NREC is to ensure

sustainable, smooth and balanced economic and energy development through the utilization of secologically clean renewable energy.

The National Dispatch Center (NDC) of Power Systems is responsible for the safe, reliable and efficient operation of the interconnected electric power system. The NDC's responsibility under certain network codes is to comply with dispatch arrangements for the reliable and stable operation of the network and electricity and heat supply 24 hours per day using a least-cost-to-consumers principle. NDC is responsible for grid operations that meet standards and also maintain the required balances between electricity and heat supply and demand.

The Electricity Generation Companies, are a combination of state-owned and private entities, the main activities of which are to generate electricity and heat for consumer needs using energy resources. In accordance with License Holders' Registrations issued by Energy Regulation Commission of Mongolia (ERC), as of 01 Nov of 2020, there were 24 electricity generation companies which of 11 out of the 24 companies have licenses to generate electricity from traditional coal-fired power plants, all of which are state owned except for the privately-owned 18 MW Ukhaa Khudag CHPP, while 13 companies have licenses to generate electricity from renewable energy sources, all which are license holders from the private sectors.[18]

The National Electricity Transmission Company is a state-owned entity, the main activities of which are to transmit safe and reliable electricity from generation companies to distribution networks and also to designated consumers. Its main duties include responsibility for operation and maintenance of the 35-220 kV Substations and the 35-220 kV overhead transmission lines (OHTL).

The Electricity Distribution Companies, including state-owned and private distribution companies, are responsible for reliable and uninterrupted electricity distribution to consumers. In accordance with the License Holders' Registrations issued by the Energy Regulation Commission, as of 3 Dec of 2020, about 1/3 of distribution companies were privately held, with more than 10 private companies out of the 30 distribution companies doing business in this subsector.[19]

Energy Market Principles

One of the main objectives of the ERC is to transform the energy sector of Mongolia into a market-oriented system. Currently, the Single Buyer model, which is in use in the Central Energy System, is regulated by an automatic cash flow mechanism. Spot and auction markets are also in use for the Central Energy System.

The Single Buyer purchases electricity from the Power Plants operating in the Central region and imports power from Russia, then sells electricity to the electricity distribution companies. The

[18] Energy Regulation Commission (2021), *ЭРЧИМ ХУЧ ҮЙЛДВЭРЛЭХ ТУСГАЙ ЗӨВШӨӨРӨЛ ЭЗЭМШИГЧИД [Energy License Owners]*, listing as of March 2021, available as http://admin.erc.gov.mn/uploads/files/tusgai/erchimhuchuild.pdf (table in Mongolian language).
[19] Energy Regulation Commission (2021), *ЭРЧИМ ХУЧ ТҮГЭЭХ, ХАНГАХ ТУСГАЙ ЗӨВШӨӨРӨЛ ЭЗЭМШИГЧИ [ENERGY DISTRIBUTION AND SUPPLY LICENSE OWNERS]*, dated March 2021, available as http://admin.erc.gov.mn/uploads/files/tusgai/erchimtugeehkhangah.pdf; table in Mongolian language.

National Power Transmission Grid Company (NPTG) has been operating as a Single Buyer in Mongolia since September 2002.

A spot market is based on the differences between the amount of scheduled electricity generation and the amount of real-time electricity supply is also in operation.

An auction organized among the generators based on their offered generation tariffs and their expected electricity outputs is defined as the competitive market. As explained by the ERC of Mongolia, based on the experiences of competitive markets in foreign countries, usually the right to supply electricity is awarded to the generator based on the lowest offered price.

However, in the Mongolian case, the lowest generation tariff will not necessarily be ranked in first place. Instead, the generators who offer to reduce their generation tariff by a higher percentage will be ranked first. This affords an opportunity for the power plants with significantly different tariffs to have an equal right to participate in the auction market. In addition, due to the specific nature of the electricity market in Mongolia, the auction market is designed to serve only the growth in electricity demand. In the competitive market, electricity is purchased through a competition between producers in the event of an increase in electricity consumption. In the case of the Central Energy System (CES), priority is given to producers that have reduced their energy tariffs by the largest percentage, rather than to those offering the lowest selling price, providing equal access to the market to power plants (producers) with very different tariffs.

The auction market commenced operation on 1 August 2007. According to the "Electricity Auction Market Temporary Rule" approved by the ERC, the "National Dispatching Center" (NDC) LLC developed and approved an "Auction organization rule for the electricity competitive market".

For example: In accordance with statistics reported by the NDC, in 2019, planned electricity supplies from Power Plants (Producers) were 4,350 million kWh, while actual production was 4,274 million kWh (provided to the CES) which represented electricity consumption lower by 76.5 thousand kWh relative to planned supplies during the first 9 months of the year. As a result, an auction was not organized for that period.

In October of 2019, in order to reduce electricity imports, an auction to provide a total of 6.7 million kWh was announced, and increased to 10.0 million kWh because of the need indicated by an increase electricity demand in the CES in November (please see Table 4-9). Among the producers participating in the market, CHP 4 offered the lowest tariff and as per auction regulations, the producer offering the lowest tariff is awarded the sale.

In 2019 in total, 36,7 million kilowatt-hours of electricity auctions were announced and 30,6 million kWh were traded at a cost of 1,590.0 million MNT in the auction market. Power plants participated in the auction market by decreasing their offered energy tariffs.

Table 4-9: The Electricity Auction Market in Mongolia in 2019

Months	Power Plants (Producers)	Auction announcement, electricity amount	Traded electricity amount
		thousand kWh	
October	CHP 3	744.00	744.00
	Erd CHP	120.00	120.00
November	CHP 4	10,000.00	10,000.00
	CHP 3	4,512.00	4,512.00
December	CHP 4	10,000.00	10,000.00
	Dar CHP	4,838.00	4,838.00
	Sumber Solar PP	300.00	68.00
	Gegeen Solar PP	350.00	350.00
Total		30,864.00	30,632.00

5 Energy Projections and Energy Policy

5.1 Energy Projections

In this report, electricity generation and demand projections have been taken from the studies presented in the ADB document *Updating Energy sector Development Plan 2013 (Ta No.7619-MON)* and GGGI's *Strategies for Development of Green Energy Systems in Mongolia 2013.*[20]

As a part of the ADB *Updating Energy sector Development Plan*, electricity generation forecasts have been prepared for low, medium (bear) and high (bull) economic growth scenarios (Table 5-1 and Table 5-2).

In accordance with ADB's "medium" scenario, electricity generation in 2030 is projected to reach 23,820 GWh (Including OT&TT) and 14,279 GWh (excluding OT&TT), respectively.

[20] e.gen and Mon Energy Consult (2013), *ADB Updating Energy Sector Development Plan (TA No.7619-MON): Final Report*. Prepared for ADB and The Mongolian Ministry of Energy, dated September 2013, with the *Executive Summary* available as https://www.adb.org/sites/default/files/project-document/81826/43079-012-tacr-01a.pdf; and Global Green Growth Institute (GGGI, 2015), *Strategies for Development of Green Energy systems in Mongolia (2013-2035), Extended Executive Summary*, dated February, 2015, and available as http://gggi.org/site/assets/uploads/2017/11/2015-02-Strategies-for-Development-of-Green-Energy-Systems-in-Mongolia-2013-2035.pdf.

Table 5-1: Mongolia National Electricity Generation Projection (including OT& TT)

Year	LOW			Medium			High		
	MW	GWh	AGR MW	MW	GWh	AGR MW	MW	GWh	AGR MW
2011	774	3,846		774	3,846		774	3,846	
2015	1,246	6,586	5.2%	1,247	6,594	5.3%	1,311	7,264	5.4%
2020	2,240	12,335	10.8%	2,404	13,336	12.7%	2,717	15,803	14.8%
2025	3,075	16,817	5.7%	3,302	18,213	5.8%	3,741	21,643	5.8%
2030	4,073	21,955	5.2%	4,377	23,820	5.2%	4,961	28,343	5.2%
GAGR			9.3%			9.8%			10.5%
Aver. MW added pa	174			190			220		

Source: ADB Updating Energy Sector Development Plan (TA No.7619-MON)

Compound annual growth rates by scenario are Low (9.3%), Medium (9.8%) and High (10.5%).

Table 5-2: Mongolia National Electricity Generation Projection (excluding OT and TT)

Year	LOW			Medium			High		
	MW	GWh	AGR MW	MW	GWh	AGR MW	MW	GWh	AGR MW
2011	689	3,417		689	3,417		689	3,417	
2015	935	4,683	7.0%	936	4,690	7.1%	985	5,170	7.3%
2020	1,253	6,282	4.1%	1,416	7,283	7.9%	1,680	9,145	11.5%
2025	1,756	8,734	6.1%	1,984	10,130	6.1%	2,357	12,752	6.1%
2030	2,517	12,414	6.4%	2,821	14,279	6.3%	3,327	17,848	6.2%
GAGR			7.1%			7.7%			8.7%
Aver. MW added pa	96			112			139		

Source: ADB Updating Energy Sector Development Plan (TA No.7619-MON)

Compound annual growth rates by scenario are Low (7.1%), Medium (7.7%) and High (8.7%).

5.2 Energy Policies

The main objectives of energy policies of Mongolia are to build the energy security of the country, assure sustainability of energy sector development, create the basis for faster deployment of renewable energy, and become an energy exporter in the future.

In the energy sector of Mongolia, at present, the following six energy-related laws and three energy policy documents guide the development and regulation of the sector.

5.2.1 Legal environment and Laws, its recent amendments

Law of Mongolia on Energy: Approved -2001.02.01. (Last amendments on June 2015); - Enhances legal environment for investors in the energy sector of Mongolia (including

independent power producers—IPP—and their regulation, and power purchase agreements—PPAs—and their regulation).

The purpose of this law is to regulate matters relating to energy generation, transmission, distribution, dispatching and supply activities, as well as construction of energy facilities and energy consumption that involves utilization of energy resources.

Law of Mongolia on Licensing: Approved on 01 February 2001, the objective of this Law is to regulate the issuing, suspending, and revoking of licenses to conduct certain business activities that may negatively affect the public interest, human health, the environment, and/or national security, and that require specific conditions and expertise.

Law of Mongolia on Renewable Energy: Approved on 01 November 2007 (amendment made in June 2015). This law enhances the financial situation of the single buyer model in the power sector and ensures that feed-in tariffs are based on the law on Renewable energy. It includes a new term—"Encouraging tariff"–to denote the gap between feed-in tariffs and consumers' tariffs.

The purpose of this law is to regulate relations concerning generation of power using renewable energy sources and its delivery.

(The last amendment to the Renewable Energy Law was approved by the Parliament on 06 June of 2019). The following main amendments were included:

- A bid/competitive procurement mechanism was introduced, with competitive procurement for construction of renewable energy plants to be connected to the central energy grid, by taking into consideration relevant technical conditions and capabilities, and with electricity tariff offers made by potential project developers. The Ministry of Energy will be responsible for tendering and bidder selection.
- The tariff for electricity per kWh to supply the CRES grid with wind power was changed from the range of USD 0.08-0.095 to having an upper limit of USD 0.085.
- The tariff for electricity per kWh to supply the CRES grid for hydro power (capacity up to 5000 kW) was changed from a range of USD 0.045-0.08 to a range of USD 0.045-0.06.
- The tariff for electricity per kWh of supply to the CRES grid for solar power was changed from a range of (USD 0.15-0.18 to a fixed value of USD 0.12.
- Regulations and tariffs for Distributed Renewable Energy Resource/Net metering were introduced: Households and companies are allowed to install solar PV systems and wind generators at their facilities and sell excess electricity to the grid at higher tariffs. (see the tariffs in Table 4-6). The Energy Regulation Commission (ERC) is responsible for setting and monitoring tariffs and prices of energy generated and supplied by renewable energy power sources, including electricity supplied by households and companies.

Foreign Investment Law of Mongolia: Approved on 01 July 1993 (Several amendments were made on 2002, 2008, 2011 and 2012; source: www.legalinfo.mn).

The purpose of this law is to encourage foreign investment, to protect the rights and property of foreign investors in Mongolia, and to regulate matters relating to foreign investment.

Law of Mongolia on Concessions: Approved on 24 Feb 2010. The purpose of this law is to regulate matters related to the organization of tenders for granting investors concessions over state- and local government-owned property, as well as to the conclusion, revision and termination of concession agreements, and the settlement of disputes.

The Energy Conservation Law of Mongolia: Approved on 26 Nov 2015**.** The purpose of this Law is to provide regulations related to energy conservation and the efficient use of energy.

5.2.2 State Policy on Energy 2015-2030

The "State Policy on Energy" was approved in 2015 by the Parliament of Mongolia. The main objectives of the policy are to build the energy security of the country, assure sustainability of energy sector development, and create the basis for faster deployment of renewable energy in the future. There are three fundamental principles and priority areas in the Policy document, as well as six strategic goals and 27 objectives. Priority areas and strategic goals under the policy are shown in Table 5-3.

Table 5-3: Priority areas and strategic goals in the "State Policy on Energy" 2015-2030

Priority areas	**Strategic Goals**
1. Reliable supply and Energy security	• Ensure energy safety and reliable supply • Develop mutually beneficial cooperation with regional countries • Develop human resources
2. Energy efficiency	• Transform the state-dominated energy sector into private-based competitive markets • Support innovation and advanced technology in the energy sector, and implement conservation policies
3. Environmental sustainability and green development	• Increase the production share of renewables and reduce negative environmental impacts from traditional power generation. including reducing greenhouse gas emissions

The "State Policy on Energy" 2015-2030 establishes interim and final goals in two stages:

- **The 1st stage covers the 2015-2023** period with a focus to develop energy safety and backup power capacity, establish the foundations for the development of renewable energy, and improve the legal environment for the renewables sector.

- **The 2nd stage corresponds to the 2024-2030** period with goals to export secondary energy and to further develop the sustainable renewable energy sector.

The expected results from these implementation stages are shown in Table 5-4.

Table 5-4: Summary of Energy Policy Expected Results –Criteria

Indicators of criteria	2014 /Base year/	1st stage /by 2023/	2nd stage /by 2030/
Reserve Capacity for Electricity Generation	-10%	10%≤	20%
Reserve Capacity for Heat Generation in Cities	3%	10%≤	15%
Profit Share on Tariff Structure in Central Region	16.22%	0%	5%
Own Use of CHP's	14.4%	11.2%	9.14%
Transmission & Distribution Loss /Excluding Oyutolgoi/	13.7%	10.8%	7.8%
Share of Renewables on total installed Capacity for Domestic Supply	7.62%	20%	30%
Greenhouse Gas Emission per 1 Gcal Power Generation	0.52 ton CO_2 equivalent	0.49 ton CO_2 equivalent	0.47 ton CO_2 equivalent
Reduction of Building Heat Loss	0%	20%	40%
Technological Achievements that have to be utilized in Energy Sector	CFB	Sub Critical Coal Bed Methane, Battery Energy Storage	Super Critical, Ultra S/Critical, Hydrogen, Concentrated Solar Plant

Source: Annex to Resolution No 63 of Government (2015), "State Policy on Energy" 2015-2030, https://www.legalinfo.mn/annex/details/6812?lawid=11130

5.2.3 Government Action Plan 2016-2020

The "Government Action Plan 2016-2020" was approved in September 2016, and its main objectives for the power sector are to extend the installed capacity of existing CHPPs, to build new power plants in the central region, and to increase the share of renewable generation, as described in Table 5-5.

Table 5-5: Power Sector Main Objectives in Government Action Plan 2016-2020

Objectives	**Action**
Extend installed capacity of existing CHPPs	-Extend Capacity of CHP Plant #3 in UB by 250 MW -Extend Capacity of Choibalsan CHP Plant by 50 MW -Extend Capacity of Erdenet CHP Plant by 35 MW
Build new Power Plants in central region	-TavanTolgoi 450 MW PP -New Power Plant in Central region Project
Increase share of Renewable generation	-Egiin 315 MW Hydro Power Plant -Khovd 60 MW Hydro Power Plant -Solar Plant Projects, 30 MW -Wind Farm Projects, 100MW -Solar Heating in district heating in rural towns
Extend power transmission network	- Baganuur-Choir 220 kV 178 km OHTL and extension of the substations - Baganuur-Undurkhaan 220 kV 202 km OHTL and substations - Choir-Sainshand 220 kV 216 km OHTL and substations
Renew heat supply systems in provincial centres	- Build new Heat Plant with centralized heating system in 10 provincial centres - Rehabilitate district heating system in Darkhan city
Enhance efficiency and introduce advanced technology	- Improve efficiency of CHP #4 Plant of Ulaanbaatar - Expand SCADA system in Central Transmission System - Introduce new voltage levels in electricity distribution networks - Build Semi-coke oven based on the CHP #2 Plant in UB - Install a 3 MW Heat Pump system based on cooling tower heat source of CHP #3 Plant in UB

5.2.4 Medium-term Energy program 2018-2023

The medium-term program for the implementation of the energy policy documents was approved on 14th October 2018. Within this program the following main projects will be implemented:

Main scope	Action to be implemented
Primary energy and fuel security	-To ensure that Baganuur coal mine exploitation reaches a capacity of 8-10 million tons per year, to increase the reliable operation of the Shivee-Ovoo coal mine, and to provide support in financing technical and technological renovation in these mines -To identify exploitable reserves of coal-bed methane by conducting detailed studies of coal deposits -To conduct a research study of hydrocarbon-bearing shales for use in energy production.
To ensure domestic electricity and heat demand (extend existing installed capacity and construct new thermal plants)	-To expand the Darkhan CHPP capacity by 35 MW -To renovate turbine generators №1-4 of CHPP-4 of UB city -To expand the Erdenet CHPP capacity by 35 MW -To expand the Choibalsan CHPP capacity by 50 MW -To expand the capacity of high-pressure section of CHPP-3 of UB city by 75 MW -To expand the Amgalan thermal power plant of UB city, making it a 50 MW combined heating and electricity producing station; -Expansion and renovation adding 250 MW to CHPP-3 of UB city -To commence expansion work (with 1 block having gas generator operating in regulating mode.) to augment the capacity of CHPP-2 in UB by 300 MW -To construct TTPP (300 MW) -domestically supply the energy demand of the Oyu Tolgoi copper mining and processing plant by relying upon the Tavan Tolgoi coal deposit -To develop and implement technical and technological solutions for thermal power plants projects such as the 700 MW Baganuur plant and the 300 MW capacity Booroljuut plant; -To commence construction of generation sources with capacity not lower than 100 MW for the Altai-Uliastai energy system -To commence construction of thermal power plants relying on coal deposits to supply 5 aimags in the Western region
Construction of renewable energy sources	-To commence construction of the 315 MW capacity Egiin Gol hydro power plant -Erdenburen Hydro PP -Storage system with large capacity (100 MW)

	-Upscaling renewable energy program (30 MW) -New Solar PP -60 MW -New Wind PP-100 MW
Creating an integrated energy system by connecting regional energy systems with high-capacity power conducting lines	-Construction of the UB-Mandal-Gobi 330 kV, 2-circuit, a 260 km long overhead power line and a 220 kV sub-station -Full expansion and renovation of the Choir 220 kV sub-station -Commence construction of the Choir-Sainshand-Zamyn Ude 220 kV long overhead power line and sub-station -Commence construction and expansion work on the 220 kV, 2-circuit 118 km long overhead power line and associated sub-stations that will interconnect the Baganuur sub-station with the Ulaanbaatar sub-station -Commence construction and expansion work on a 220 kV, 2-circuit 518 km long overhead power line and a 220 kV sub-station to serve the Baganuur-Undurkhaan-Choibalsan area -Conduct a study on construction of a 220 kV, 2-circuit 380 km long overhead power line and sub-station to Uliastai-Durgun-Myangad and commence associated work -Conduct a study on construction of a super-voltage long overhead power line and sub-stations for Ulaanbaatar-Uliastai

Expanding energy collaboration through establishment of long-term mutually beneficial energy import and export agreement with neighboring countries:	-Establish collaborations in planning and negotiations on energy sector resource cooperation between the governments of the Russian Federation and Mongolia; -Establish a collaborative agreement on energy sector activities between the governments of the People's Republic of China and Mongolia; -Collaborate with neighboring countries towards the development of electricity transmission and gas pipeline transit infrastructure within the scope of an initiative to establish an Economic Corridor between Mongolia, the Russian Federation, and the People's Republic of China; and -Initiate mine expansion and construction of a power plant of 2528 MW capacity with a DC power conducting line of 660 kV to export power to the PRC, relying upon the Shivee-Ovoo lignite coal deposit, and establish an associated energy export agreement ensuring project commencement. - For energy collaborations involving international organizations and regional countries, pursue proactive involvement in international initiatives and regional collaborations such as Central Asian Regional Economic Cooperation, The Tumen Initiative, the Energy Charter treaty, One Road One Region, and establishment of the Northeastern Asian integrated energy grid;
Collaboration with regional countries to export electricity to North eastern Asian countries	-To implement the Gobitech-Asian integrated energy grid initiative that will export electricity to North-eastern Asian countries from high-capacity renewable energy complexes based on the abundant reserves of Mongolian Gobi regional solar and wind resources; -Conduct baseline studies of Gobitech-Asian integrated energy grid initiatives in collaboration with international banks and other financing organizations and with regional countries; and - Collaborate with regional countries and international organizations to develop a framework for collaboration and negotiation mechanisms related to the Asian Super Grid-Ulaanbaatar international initiative

6 Mongolia's Involvement in Discussions on Regional Energy Sharing

6.1 Electricity

Electricity grid interconnections have been discussed for two decades in the Northeast Asia (NEA) region with a key goal being to build an economically efficient, renewable power system.

Research studies have been conducted by international organizations and by scientists and power engineers to quantify the economic and environmental benefits from connecting the region's multiple power grids. The results of these studies indicated only modest benefits in lowering total costs because of the large initial investments required to develop remote renewable energy sources and the transmission lines to connect them to load centers in the region. Grid interconnections, however, are projected to become more economically attractive under higher fuel price and/or lower initial cost situations.

According to the Melentiev Energy Systems Institute, the Russian interconnected energy power systems were developed as a part of the Soviet Union's unified electric power system to link with the systems of both the European and Asian former Soviet republics. To date, however, there are only a few short 110–220 kV transmission lines connecting Russia to neighboring Mongolia, China and other Northeast Asian countries. The largest electricity flows within the NEA are exports from Russia to China and from China to Mongolia. Mongolia is the only regional state where international power trade plays a significant role in the domestic electricity balance, and it has the lowest electricity tariffs in the NEA (see Figure 6-1).

Figure 6-1: Map of Existing Electricity Interconnections in Northeast Asia

Source: Asia International Grid Connection Study Group, Interim Report (2017), Renewable Energy Institute, Tokyo, https://www.renewable-ei.org/en/activities/reports/20170419.html

In the framework of the "Strategy for Northeast Asia Power System Interconnection" (NAPSI) project, to date, a total of 5 Workshops have been organized at regional level.

- The first Asian Super Grid (ASG) conference was held on August 28–29, 2017, in Irkutsk, Russia, followed on October 30, 2017 by a conference in Seoul, South Korea, on March 22–24, 2018, in Kitakyushu, Japan, and on 31 October 2018, in Ulaanbaatar, with a final marketing module workshop assessment held on 28 Feb 2019, in Ulaanbaatar. The

NAPSI project partners have been introducing their findings in a series of conferences throughout Asia under the general theme of the "Asian Super Grid".

- The Mongolian government secured $1.75 million in technical assistance funding from the ADB for a two-year study (running through May 2019) to explore how the country might more effectively utilize its abundant renewable wind and solar resources in the Gobi Desert, together with Mongolian and Russian hydropower sources, to reduce the carbon footprint of Northeast Asia.
- Although Mongolia boasts rich and cheap fossil fuel mineral reserves, the government is committed to exploiting its renewable resources. It has set a target of 30 percent of its electricity generation to come from renewable energy by 2030, to build export-oriented power plants and to become an energy exporting country in the future by utilizing its rich renewable energy resources.
- The latest NAPSI study was undertaken by the Mongolian Ministry of Energy, Électricité de France, China Electric Power Reach Institute (EPRI), and Nova Terra LLC. The final report was prepared by Électricité de France (EDF) and released in October 2019.[21]

As indicated in the ADB Technical Assistance Consultant's Report on "Strategy for NAPSI" (completed in October of 2019) by EDF under Project Number: 48030-001, the main summary conclusions of the NAPSI study were as follows:

- The study has confirmed the huge potential for both wind and solar power for future exportation. Most of the best sites for wind and solar are situated in the same locations convenient for exports from Mongolia in the direction of China (the Gobi Desert is part of this region).
- Wind and solar developments in Mongolia are likely to be the most competitive in terms of costs and output compared with developments in the other NEA countries. Assuming that the development of wind and solar will be in a 50/50 ratio. three scenarios were explored under NAPSI, with findings that
    - *Scenario 1: +5 GW in 2026 mainly for exportation to neighboring countries between 2026 and 2036*;
    - *Scenario 2: +10 GW in 2036* (generating around 30 TWh) *for export to neighboring countries as well;* and even
    - *Scenario 3: +100 GW* in the long term (generating around 300 TWh) is feasible for exporting power from Mongolia.
- Under Scenario 1, by about 2026, a total investment of USD 5.55 billion would be expected to go into the renewable energy sector in Mongolia, which is the equivalent to roughly one-quarter of the country's projected GDP at that time.

[21] A summary of the NAPSI project is available as Ministry of Energy and ADB (2019), "Strategy for Northeast Asia Power System Interconnection–Way Forward", North-East Asia Regional Power Interconnection and Cooperation Forum 2019 |SEOUL, OCTOBER 24, 2019, available as https://www.unescap.org/sites/default/files/Session%202.%20NAPSI.pdf.
"Strategy for NAPSI" Technical Assistance for Mongolia, Final Report (October of 2019), Prepared by EDF for the Government of Mongolia and ADB, TA 9001-MON: EDF References:CIST-DCO-Phl-19-188, available as https://www.adb.org/sites/default/files/project-documents/48030/48030-001-tacr-en.pdf

Under Scenario 2, total additional new investments of USD 4.2 billion (beyond those in Scenario 1) would be expected by 2036, which would equal 10% of the country's projected GDP in 2036. Under Scenario 3 a total investment of USD 57.33 billion is expected by 2051, equivalent to 68% of the projected GDP at that time (see Figure 6-2).

Figure 6-2: Comparison of Mongolian GDP and Proposed Renewable Energy Investments

Source: p49 of Asian Development Bank (2020), Mongolia: Strategy for Northeast Asia Power System Interconnection [NAPSI], prepared by Electricite de France, Project Number: 48030-001, dated February 2020 and available as https://www.adb.org/sites/default/files/project-documents/48030/48030-001-tacr-en.pdf

- For Scenario 2 it was assessed that investments in renewable generation will represent an opportunity for Mongolia to reach an investment level similar to those of the largest mining projects that have been developed in the country. Table 6-2 shows total investments by types and by phase (step) of the NAPSI project.

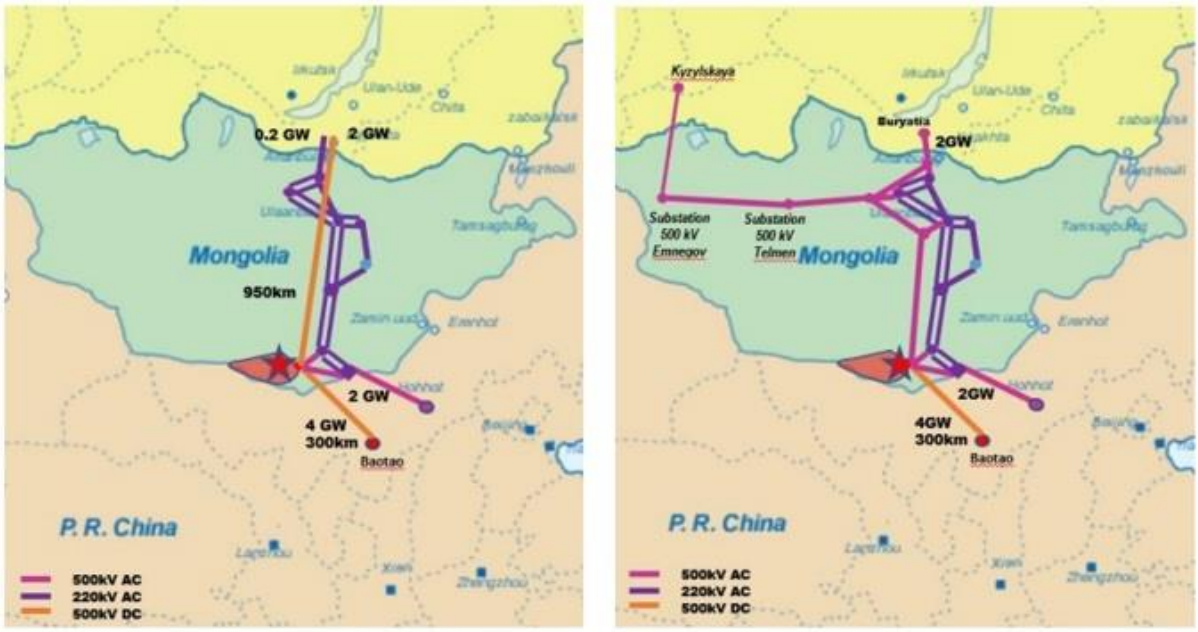
Table 6-1: Solar and Wind Investments in Mongolia and in NEA Grid Interconnections Evaluated in ADB NAPSI Project

Step	Year	Description	Solar &Wind Generation MON Export 5GW b$	Solar and Wind Generation MON Export 10GW b$	Solar and Wind Generation MON Export 100GW b$	Grid b$	Total
1	2026	Interco Russia-MON-PRC-ROK-Japan with MON Export 5GW	5.5			7.4	12.9
2	2036	Interco Russia-MON-PRC-ROK-Japan with MON Export 10GW		4		1.7	5.7
3	2036+	Interco Russia-MON-PRC-ROK-Japan with MON Export 100GW			75	54	129
Total			9.5		75	63	148

Source: ADB NAPSI Report (2020), ibid. Note that the elements of phase 2 and 3 are additive to the elements of the earlier phases. The difference in the totals shown in phase 3 here and in Figure 6-2 presumably are related to some project expenditures coming after 2051.

- The NAPSI interconnection schemes have been developed taking into consideration economic and energy exchange between the different countries, technology development and geographical/ geological conditions. A dedicated set of assumptions for supply and demand for each of the 5 NEA nations has been developed taking into account the existing grid and power projects in the short and medium terms in each country.
- Regarding electricity transmission technologies, high voltage direct current (HVDC) technologies are recommended for the interconnections, for example, between Mongolia and other nations, because HVDC technologies are advancing rapidly in both capacity and operating voltage levels (see Figure 6-3).

Figure 6-3: Mongolia's Possible Grid Upgrades Under NAPSI



Source: ADB Technical Assistance Consultant's Report, 2019

- The main findings and key messages from this study are the followings:
  - Interconnections between North East Asia countries are beneficial already under the current situation and with the existing generation fleets in each country.
  - Existing and future interconnecting transmission and lines are and will be used in both directions of power flow, allowing countries to export or import as warranted based on the hours when power is needed and the grid situations in the connected countries.
  - Development of renewable generation in Mongolia will bring additional benefits in the mid-term (2036), due to the expected significant cost reductions for generation based on renewables in Mongolia in the coming decades.
  - Generating electricity from renewable energy in Mongolia will bring higher profit than producing the same amount of renewable energy in Korea or Japan due to the lower costs and better wind and solar resources in Mongolia.
  - Beyond financial profits, the proposed future changes to the regional electricity system will bring other valuable benefits (including reduction of CO_2 emissions, contribution to the achievement of the clean energy objectives for the interconnected countries, job creation, and opportunities for adaptation of national networks).

During the fifth meeting of the Ulaanbaatar Dialogue on Northeast Asian Security, which was held on 28 February, 2019 in Ulaanbaatar, the results of a number of studies on Northeast Asia electricity interconnections, including the NAPSI project described above and additional analyses described below (as well as others), were presented in open workshops organized in the NEA countries and validated in meetings of the Steering Committee of the Project where most of

the main stakeholders including the national utilities of the 5 countries were represented. The participants in the Ulaanbaatar Dialogue meeting, however, expressed concerns that the size of the needed investment as well as the volatile political climate in the NEA remain major challenges to the realization of substantial electricity interconnections between nations. In another study of regional interconnections, The Energy Charter (based in Belgium), has advanced the "Gobitec" concept to produce clean energy from renewable energy sources in the Gobi Desert and to deliver the energy produced to high-demand power areas via the planned Asian Super Grid (ASG), which is designed to connect Russia, Mongolia, China, South Korea and Japan.[22]

According to the forecast announced by international agencies for 2030-2050, by 2030 it is projected that 30-50% of the electricity generated in each country of Northeast Asia will be supplied from renewable energy.

As indicated in the ASG Interim Report developed by the Renewable Energy Institute (REI) of Japan in April 2017,[23] in considering the potential for power supply by renewable energy in Northeast Asia, Mongolia is considered a particularly important country. The potential for wind power and solar PV mainly in the area around the Gobi Desert in the south has been highly valued. Mongolia has a large area suitable for wind power generation from the southern to the central region of the country, and that area is estimated to have the potential to generate 10,673 TWh per year. As for the potential for solar PV, the International Renewable Energy Agency (IRENA) evaluated Mongolia's potential annual PV power generation as 4,777 TWh in its 2016 report. By simply adding these figures, 10,673 TWh (wind power) and 4,777 TWh (solar PV), the total estimate potential power generation for these areas of Mongolia could be 15,000 TWh or more, which is much more than the total electricity demand in China (5,693 TWh) and Japan (949 TWh) combined as of 2015. It is expected that Mongolia will supply power to neighboring countries in the future by utilizing its rich renewable energy resources.

As of 2019 bilateral interconnections in Northeast Asia had been achieved between Russia and China, Mongolia and Russia, and Mongolia and China, and trading in electricity is currently underway between these countries.

At present, Mongolia is making up for its lack of domestic power sources by utilizing imports from Russia and China. Mongolia shares its northern border with Siberia in Russia, and imports electricity from Russia through an interconnection (Figure 6-1) in order to compensate for the shortfall of electricity supply in the northern central area during the winter peak period. Across the south interconnection, electricity is imported from China to meet the electricity demand of the Oyu Tolgoi copper mine. In 2019, the amount of electricity imported from China was 1,315.0 million kWh for the Oyu Tolgoi mining area.

To summarize, there are 3 future projects that Mongolia has been involved in discussions of regarding NEA power (electricity) sharing and related interconnection schemes:

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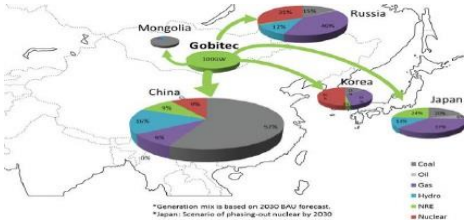
[22] See, Shuta Mano, Bavuudorj Ovgor, Zafar Samadov, Martin Pudlik, Verena Julich, Dmitry Sokolov, and Jae Young Yoon (2014), Fraunhofer ISE and other partners, *Gobitec and Asian Super Grid for Renewable Energy in Northeast Asia*, Energy Charter Secretariat Organization Internationale Ent (E), dated January 2014, and available as https://energycharter.org/fileadmin/DocumentsMedia/Thematic/Gobitec_and_the_Asian_Supergrid_2014_en.pdf.

[23] Renewable Energy Institute, Tokyo, Asia International Grid Connection Study Group, *Asian Super Grid Interim Report*, dated April 2017, and available as https://www.renewable-ei.org/en/activities/reports/img/20170419/ASGInterimReport_170419_Web_en.pdf

1. Gobitec and the Asian Super Grid
2. Supergrid, Smart Energy Belt
3. Mongolia-China joint initiative on electricity export based on the output of the Shivee-Ovoo coal mine

These are described in Table 6-2, below.

Table 6-2: Summary of Mongolia's Potential Involvement in Proposed Regional Electricity Interconnection Schemes

Proposed Regional Schemes	**Project name and Mongolia's Involvement**
 	***1. Gobitec and Asian Super Grid*** The Asian Super Grid initiative was proposed first in 2011 by the Japanese Soft Bank and subsequently by other international organizations. The Gobitec concept represents the idea of producing clean energy from renewable energy sources in the Gobi Desert and delivery of the produced energy to regions with a high demand for electric energy. The delivery of the energy produced is planned to use new and existing power corridors making up the planned Asian Super Grid (ASG), connecting Russia, Mongolia, China, South Korea and Japan. (Using the Asian Super grid, the goal is to utilize renewable energy across Asia by connecting China, South Korea, Russia, and Japan via an international power grid using solar and wind power generated in Mongolia as the main power supply.)
	***2. Supergrid, Smart Energy Belt*** In 2014, Korea Electric Power Corporation announced the Northeast Asia Super Grid plan in cooperation with the Russian research institution Skoltech and other organizations. The company set out the concept of a Smart Energy belt that connects Japan, China, South Korea, Russia, and Mongolia with a highly efficient electricity supply-demand system combining **power storage technologies** and smart grid elements. The concept

	was proposed at an International Conference held in Tokyo, in 2016.
	3.***Mongolia-China joint initiative on electricity export based on Shivee-Ovoo coal mine*** In 2015, a MOU was signed between the Chinese and Mongolian Governments on a feasibility study for the Shivee-Ovoo-based Energy export project. The scope of project is to build large-scale power generation and DC power transmission between Mongolia and China as the start of the Asian Super Grid Initiative in Northeast Asia. It is a complex project that includes: • -Development of a power plant with installed capacity of 5280 MW for export plus 70 MW for domestic use; • Construction of a transmission line with the capability to transmit 4,600 MW at ± 660 kV UHV DC; and • Development of a power plant based on renewable energy with an installed capacity equal to 15% of the project total capacity. The project location lies 200 km to the southeast of Ulaanbaatar, and 400 km from the Mongolian and Chinese border. (The project location is near the Shivee ovoo coal deposit in Gobisumber aimag.)

6.2 Natural Gas

On many occasions Mongolia's successive leaders have indicated their interest in participating in the development of oil and gas pipelines from Russia to China through Mongolia. During the last trilateral meeting between the presidents of Mongolia, Russia and China in Qingdao, China, it was reported by public news outlets that both Russia and China supported the possibility of such pipelines at the highest levels of government and recommended detailed study of the technical and economic aspects of oil and gas pipelines interconnecting the countries.

Following these discussions, several active high-level discussions and actions have been carried out:

- As reported by the Office of the President of Mongolia published on 04 Nov of 2019,[24]

  "In connection to Mongolia's hosting of the Executive Committee Meeting of the Northeast Asian Gas & Pipeline Forum, President of Mongolia Khaltmaagiin Battulga received delegates led by its President Nobuo Tanaka on 04 Nov 2019.

  "At the meeting, the sides emphasized the increasing relevance of energy and natural gas supply in the Northeast Asian region owing to the growth of regional population and economy and agreed on the importance of Mongolia's engagement in supplying these rising demands. For instance, the shortest route for building gas pipeline between the Russian Federation and the People's Republic of China is a 1,100 km long course via Mongolia, and it is considered possible to supply energy to consumer countries such as Japan and the Republic of Korea, consequentially reducing energy prices. This matter was discussed in depth with scientists and experts from the People's Republic of China, the Republic of Korea, the Russian Federation, and Japan expressing their respective views.

  "The Northeast Asian Gas & Pipeline Forum studies the strategic aspects of building a natural gas pipeline network within the region and the profits to be gained from natural gas consumption and generates an important database on the gas markets of countries in the Asia & Pacific region. Therefore, President Battulga asked the participants of the meeting to pay close attention to and work closely regarding the matter of building the gas pipeline through Mongolia."

- As reported by Reuters on published 09 September 2019, "Russian President Vladimir Putin told the head of state-controlled Gazprom GAZP.MM to consider making Russian gas exports to China via Mongolia, the Kremlin said on Monday."[25]

  "Gazprom is due to start exporting gas to China in December via the eastern Power of Siberia pipeline.

  "'Please, look into the resources of Yamal (Peninsula) as well, in order to gather the necessary resources for the supplies via the western route to China via Mongolia,' Putin told Gazprom head Alexei Miller at a meeting, adding that the partners in China also 'lean toward' this route."

- A news article from Montsame reported on the Prime Minister of Mongolia U. Khurelsukh, paying a courtesy call on President of the Russian Federation Vladimir Putin in Sochi, Russia.[26]

[24] See "MEETING WITH EXECUTIVE COMMITTEE MEMBERS OF THE NORTHEAST ASIAN GAS & PIPELINE FORUM", dated November 4,2019, available as https://president.mn/en/2019/11/04/meeting-with-executive-committee-members-of-the-northeast-asian-gas-pipeline-forum/.

[25] Reuters (2019), "Putin pushes idea of Russian gas supplies to China via Mongolia ", dated September 9, 2019, and available as https://www.reuters.com/article/us-russia-china-mongolia-gas/putin-pushes-idea-of-russian-gas-supplies-to-china-via-mongolia-idUSKCN1VU19G.

[26] Anudari M. (2019), "Gas pipeline between Russia and China to run through Mongolia", Montsame, dated December 6, 2019, and available as https://montsame.mn/en/read/209183.

"At their second meeting in the last three months, the sides agreed to start a project to have the natural gas pipeline between Russia and China run through the territory of Mongolia.

'The gas pipeline project to be implemented under the economic corridor program will make significant contributions to the social and economic development of Mongolia, Russia, and China,' the Prime Minister underlined. Russian President Vladimir Putin said there is no political obstacle to the implementation of the project.

"The sides thus finalized the matter of having the pipeline pass through Mongolia that has been under discussion for many years, with the signing of a Memorandum. Research working groups of the two counties will now commence their economic impact analysis and feasibility studies on the project that will open up an opportunity for Mongolia to take part in the regional energy integration."

- Projects for pipeline gas supplies from Russia to China via the Power of Siberia 2 gas pipeline across Mongolia, via the western route, and from Russia's Far East, were discussed by Russia's Gazprom and the Chinese National Petroleum Corporation. An article on the discussions included the following:[27]

"Stable and flexible gas supplies are essential to achieving China's environmental goals that call for reduced use of coal by industrial and residential consumers.

"Gazprom's main partner in China is CNPC, a state-owned oil and gas company. Power of Siberia is the largest gas transmission system in Russia's East. The trunkline supplies gas to consumers in Russia's Far East and China. It has an export capacity of 38 billion cubic metres of gas per year. In 2020, Gazprom started to assess the possibility of gas supplies across Mongolia in the amount of up to 50 billion cubic meters of gas per year."

- Another article announced the formation of a special purpose company established to prepare a feasibility study of the gas pipeline project:[28]

"A Memorandum of Understanding (MoU) on the establishment of a joint Mongolian-Russian special purpose company to develop a feasibility study of the project on building pipelines between Russia and China going through the territory of Mongolia was signed today (25 Aug 2020). The MoU was signed by Deputy Prime Minister of Mongolia Ya.Sodbaatar and Deputy Chairman of the Board of Directors and the Chairman of the Management Committee A.Miller on behalf of their respective Governments.

"The participants of the meeting noted that the realization of the project to build Power of Siberia-2 gas pipeline connecting Russia and China though the territory of Mongolia, which will transport 50 billion cubic meters of natural gas a year to China, has taken a step forward.

[27] New Europe (2020), "Gazprom may boost gas supplies to China via Power of Siberia" published on November 27, 2020, and available as https://www.neweurope.eu/article/gazprom-may-boost-gas-supplies-to-china-via-power-of-siberia/.

[28] Erdenejargal.E (2020), Special purpose company established for feasibility study of gas pipeline project", *Montsame*, dated August 25, 2020, and available as https://montsame.mn/jp/read/234547.

"The meeting reviewed the implementation of the bilateral joint plan and agreed on further measures and activities to be taken by the sides. Next week, a "Confidentiality Agreement" will be established between Gazprom PJSC and Erdenes Mongol LLC.

"At the request of the Russian side, Prime Minister of Mongolia U. Khurelsukh took part in the virtual signing ceremony and delivered an address.

"In his address at the signing ceremony, PM U. Khurelsukh highlighted that the signing of a Memorandum of Understanding on jointly exploring the possibilities of implementing the project was one of the most important results of his official visit to Russia in December 2019.

"Emphasizing that the successful implementation of the project is significant to not only enrich the comprehensive strategic partnership between Mongolia and the Russian Federation but also advance bilateral cooperation to a new level, the PM pledged to put special attention to the progress of the project and provide relevant support and assistance.

"Gazprom PJSC, China National Petroleum Corporation (CNPC) and Erdenes Mongol LLC are working on the implementation of the project, reports the Media and Public Relations Department of the Government."

- A 2020 report by Independent Commodity Intelligence Services (ICIS) reads as follows:[29]

"The new route for Russia's Power of Siberia 2 gas pipeline to China via Mongolia [see Figure 6-4] may give exporter Gazprom a strong competitive edge in the long run.

"Instead of entering China from the far west, over 3,200 km away from Beijing and where central Asian pipeline gas enters China, Russian gas would arrive just 560 km away from the capital, in the most populous region where demand is the highest and expected to grow.

[29] Diane Pallardy (2020), "GIF Inside Story: Power of Siberia 2's new route makes Russian gas supplies to China more feasible", ICIS, dated April 30, 2020, and available as https://www.icis.com/explore/resources/news/2020/04/30/10503185/gif-inside-story-power-of-siberia-2-s-new-route-makes-russian-gas-supplies-to-china-more-feasible

Figure 6-4: The New route for Russia's Power of Siberia 2 Gas Pipeline to China via Mongolia [As included in the ICIS article]

Source: https://www.icis.com/explore/resources/news/2020/04/30/10503185/gif-inside-story-power-of-siberia-2-s-new-route-makes-russian-gas-supplies-to-china-more-feasible

"Russia's largest reserves are located in west Siberia in the Yamal peninsula and already feed the European Union.

"Compared to the route crossing the Russian-Chinese western border, the one via Mongolia would be shorter and lead to China's most populated area.

"This reduces construction and transportation costs and so price negotiations can start lower.

"'The choice of route makes an agreement with CNPC easier to achieve, due to reduced delivery distance inside China. With reduced transportation costs, CNPC might be willing to agree on a slightly higher price,' according to Jack Sharples, researcher at the Oxford Institute for Energy Studies (OIES).

"This new route also allows Russian gas to be more competitive against China's other pipeline supplies.

"China's largest pipeline imports currently come from Central Asia. Central Asian pipeline gas sourced in Kazakhstan, Uzbekistan and Turkmenistan cost an average $6.28/MMBtu in 2019, Chinese customs data showed.

"Gazprom has been bullish regarding its ambition to increase sales in Asia. CEO Alexei Miller told Putin in a recorded conversation published on Gazprom's website that supplies to China via Power of Siberia 2 may total up to 50 billion cubic meters (bcm) per year, almost double the volumes preliminary agreed. Gazprom and China's CNPC agreed in principle on a 30bcm/year contract for this route. A source from CNPC told ICIS in early April that "CNPC will not absorb more gas that is higher than the agreed 30bcm, given the current low market price levels".

"Chinese demand is expected to grow in the long term, as its commitment to environmental policies, including coal-to-gas switch holds firm despite the economic disruption caused by the coronavirus.

"Russia may also be counting on creating gas demand in Mongolia, which relies on coal for 90% of its electricity production and where air pollution, particularly in capital Ulaanbaatar, is a significant public health problem."

6.3 Oil, Oil processing and Oil storage

As mentioned in section 3.2 of this Report, although there is some extraction of crude oil from conventional deposits, Mongolia, up to the present, has no refining capacity. As a result, the country exports all of its raw crude oil, mostly to China, and imports its petroleum products from Russia.

This situation will change when the new refinery, which is currently under construction, begin operations (planned for 2022).[30] Mongol Refinery, the state-owned company responsible for the project, said in a press release that the plant, which is located in the Southeastern region of Mongolia (in Altanshiree soum in southern Dornogovi province), will be able to process 1.5 million metric tons of crude oil annually—about 30,000 barrels per day (bpd) , and will produce 560,000 tons of gasoline, an additional 670,000 tons of diesel, and 107,000 tons of liquefied petroleum gas (LPG). The refinery will meet all the nation's demands for petrol, diesel, aviation fuel and LPG, and will reduce Mongolia's import dependence while ensuring energy security for the country.

"The refinery is to be built at an approximate cost of USD 1.25 billion. It is being developed under a line of credit of USD 1.236 billion extended by India during Prime Minister Narendra Modi's visit to Mongolia in 2015 and subsequently enhanced during the state visit of the President of Mongolia Kh. Battulga to India in September 2019."

Engineers India Ltd (EIL) will begin construction of the long-awaited oil refinery. EIL, a "public sector undertaking" under the Indian Ministry of Petroleum and Natural Gas, is the project management consultant for the development of the oil refinery.

As of late 2020, construction of the oil refinery infrastructure was fully completed. Construction works on the 27 km branch line to be used for transporting equipment and devices and goods from the Sainshand railway station to the oil refinery, on a 17 km long auto road with heavy load

[30] Sources: "Mongolia completing infrastructure work for oil refinery", *News.MN*, published on 2019-03-13, and available as https://news.mn/en/786844/; "Indian Company begins construction of Mongolia's first oil refinery", *News.MN*, published on 2019-10-08, and available as https://news.mn/en/789294/, and refinery company website: http://mongolrefinery.mn/467.html (in Mongolian). "Infrastructure development works of oil refinery completed", Montsame.MN, published on 2020-10-09, and available as https://montsame.mn/en/read/203257 (in English).

carrying capacity, and on a 110 kV power transmission line have been completed on schedule and were handed over to the State Commission on October 8. The first construction phase, which has been the responsibility of the Mongolian government, was planned to be completed by the end of 2020. The latest news published on the "Mongol Refinery" website as of February 2021 reads "The contract between JMC Projects India and 'Mongol Refinery' State Owned LLC, which was selected as the General Contractor for the 'Engineering-Procurement-Construction (EPC-1) of Non-Technological Utilities' project for the construction of an oil refinery, was signed electronically on 05 October 2020. Ambassador M.P. Singh said that the project to build an oil refinery, funded by a $1.2 billion soft loan from the Government of India, is proceeding according to plan. With the signing of this agreement, it can be considered that the construction of the plant has officially started". Following the completion of the refinery, an Indian company also will construct (EPC-2) Technological Utilities -the refinery itself. A road connecting the refinery and Sainshand, the administration center of Dornogovi province, has been constructed by a group of over 200 soldiers from the 7780th military unit with more than 80 bulldozers, graders and other vehicles.

Mongolia is close to achieving an economic development goal that will be a first in the country's history. It has been estimated that Mongolia's overall GDP will increase by no less than 10% due to contributions of the refinery in reducing import costs and offering the opportunity for higher-value-added exports.

6.4 Coal

Based on Mongolian Customs statistic data, in 2019 Mongolia exported an all-time high of over 36.8 million tonnes of coal to China. This is an impressive number, since exports of coal from Mongolia started only in the early 2000s. Since the supply of export coal in Mongolia (domestic production for export) is highly dependent on demand in China, volumes fluctuate widely, for instance falling by almost 40% in August 2018 compared to the previous month. Fluctuations depend on a variety of economic, political and geopolitical factors such as the general demand for steel in China, annual import quotas by the Chinese government (for Mongolia and other exporters), international sanctions on the DPRK (also a coal supplier to China), relations between Australia and China, the intricacies of bilateral relations between Mongolia and China, road transport bottlenecks (since all exported coal is shipped on trucks across the border), and commercial disputes between various producers, shippers, and buyers, as well as other factors. In the short run the Ministry of Mining of Mongolia has announced its objective of increasing exports to 40 million tonnes, but the reality of that objective might be determined by the unpredictable interplay of all these factors. which can combine to produce sharp increases and drops on an annual or even monthly basis. Once the railway links announced recently by the Mongolian government have been built to connect major producing centers and border points, allowing both larger volumes to be shipped and stimulating demand competition for the Mongolian coal across the border, the volumes produced and exported are likely to increase even more significantly.

7 Report on Development of Mongolia LEAP Model

Overall Structure

We have developed a model of Mongolia's energy system using the Low-Emissions Analysis Platform software tool (LEAP) that includes four broad scenarios of how energy supply and demand could evolve in Mongolia through the year 2050. (LEAP, formerly the Long-range Energy Alternative Planning system, is a software tool for energy policy analysis and climate change mitigation assessment developed by the Stockholm Environment Institute—United States)

The overall structure of the LEAP model for the Mongolia includes energy demand and transformation (supply) components. Within the demand structure, the following sectors are included: Households, Industry, Agriculture and Forestry, Transport and Communications, and Commercial Services and Institutional.

The Household sector is divided into urban and rural subsectors. Based on the available data on energy consumption by fuel, housing types in each subsector were categorized into traditional gers, buildings, and other housing. The Buildings category is further divided into 3 groups based on housing types.

The Industry sector is divided into 2 subsector branches: Manufacturing and Mining. Within the manufacturing industries, the following branches are included: Food Industry, Wool and Cashmere, Cement and Construction industry, and Other Manufacturing, In the Mining subsector, branch categories include Copper, Gold, Molybdenum, Iron Ore and Other Minerals production.

The Transport sector includes Automobile Transport, Railway, Air Transport and Others. Energy use in the automobile/road transportation subsector is modeled based on the fuels used by autos in Mongolia: diesel, gasoline, liquefied petroleum gas (LPG), with a separate category for hybrids (vehicles with both gasoline and electric motors).

The energy transformation components of the LEAP model describe the conversion of primary energy to secondary energy forms. Key modules within the Mongolia LEAP model describe electricity generation (by power plants and combined heat and power plants, CHPPs) and district heat production by CHPPs and heat-only plants. Data within modules, under processes (types of power or heating plants or individual plants) include the names of each process (power plant name or type), the feedstock fuel used, auxiliary fuels used, capacities, efficiencies, plant lifetimes, historical output, and all planned or proposed capacities for all power plants and heating plants. Exports and imports are also described in the electricity generation module. CHPPs generate electricity and heat, which is modeled as a coproduct of electricity generation by CHPPs, as well as in a separate "Heat only DHP's" module under Transformation in the LEAP model for Mongolia. In addition to electricity generation, the transformation modules used in the mode include transmission and distribution, coal mining and oil production, with refining and gas imports also covered in the model for use in future years.

Coal, wind, solar, hydro, crude oil, and biomass are included as primary energy resources in the LEAP model.

7.1 Key Sources of Data

The data and information used to develop the LEAP model were collected from various available sources including the following:

- Energy Balances 2015-2019, issued by Mongolian National Statistic Office of Mongolia (NSO)
- Statistics from the Mongolian Statistical Yearbooks 2016, 2017, 2019 (NSO)
- Statistics on Energy performance 2015, 2016, 2017, 2019 Energy Regulatory Commission of Mongolia
- Energy performance statistics, Ministry of Energy of Mongolia
- Mongolia National Statistics Database: www.1212.mn
- Sector Reports issued by NSO and by relevant sector Authorities
- Reports and Papers located in Mongolian National Library;
- Reports and Papers developed by Local and International research institutions
- Reports and Feasibility studies done within ADB and WB financed projects
- Various studies from the internet
- Presentations made by Government Agencies in last 5 years at international conferences and workshops
- 2015 Population and 2019 Pre- Population and Housing by-census of Mongolia
- Others

7.2 Energy Pathways (LEAP Scenarios)

LEAP scenarios for Mongolia have been based on the recent trends in the Mongolian energy sector and economy and on projection in State Energy Policy documents, as well as concepts developed by the Mongolia Working Group and in collaboration with other Regional Energy Security project Working Groups.

The four major scenarios developed and evaluated for the evolution of the energy sector in Mongolia are as follows:

- *The Reference scenario:* This scenario represents "business as usual" for Mongolia, in terms of both growth in driving activities such as population, GDP growth, and output pf industrial products, and in terms of trends in energy intensities such as the amount of energy used to heat homes and to produce a ton of cement and per unit of other key commodities. The Reference case continues to use mainly coal-fired systems to supply power and heat for the energy users of Mongolia. It is based on recent trends and reference-case government plans
- *The Recent Plans with DSM scenario* assumes the same driving activities as the Reference case, but includes the introduction of higher levels of building energy efficiency and energy efficient equipment and appliances, especially in the home. (In the

future, this case will be updated to include industrial sector energy efficiency through accelerated introduction of key efficient technologies reflecting recent developments and priorities in Mongolia and in other countries.)

- *The Coal Large Shivee ovoo CHP-based scenario* describes a future where Mongolia becomes an even stronger power supplier based on its rich coal resources by building a large-scale coal-fired power plant complex and associated transmission capacity to export most of the power from that plant to China.

  Under this scenario, Thermal coal resources that can be utilized for on-site electricity production for the purpose of export. This includes construction of a power plant at Shivee ovoo with a capacity of 5,280 MW for export, plus another 70 MW for domestic use, plus a transmission line with the capability to transmit 4,600 MW at 660 kV UHV DC, and a coal mine with a capacity of over 20 million tons/per year. As part of the Shivee-Ovoo complex project, renewable energy power plants with installed capacity of 15 percent of that of the coal-fired power plants are included. To model this feature of the project, wind power plants with a total capacity of 700 MW are assumed to be constructed under this scenario. The main purpose of the Shivee Ovoo project is to build a large-scale power and DC power transmission power line between Mongolia and China as the start of the Asian Super Grid Initiative in Northeast Asia.

- *The Renewable energy-based scenario* charts a transition to renewable energy use based on a government policy shift in the types of fuel and energy exported from the current coal-based exports to exports based on renewable resources (wind and solar).

  This scenario emphasizes large-scale energy exports using renewable energy generation and storage technologies scenario, as suggested in international concepts such as the Asian Supergrid, the Smart Energy Belt, and others. Here Mongolia would focus on generation of wind and solar electricity in the Gobi region, with electricity storage or conversion to gaseous or liquid fuels to assist in being able to offer consistent power flows for both export and domestic applications. A sub-scenario related to either this renewable energy exports case or one or both of the other cases might include developing more renewable energy for domestic use, coupled with energy (electricity and/or heat) storage technologies to make better use of renewable electricity and to address national priority issues such as urban air pollution due to consumption of polluting home heating fuels

Based on the Reference scenario results, overall energy demand by 2050 for Mongolia is projected to reach 423 PJ (petajoules, or million gigajoules) in the *reference scenario* (see Figure 7-1), 412 PJ in the *recent plans with Demand Side Management (DSM) scenario,* and 423 PJ (same as the reference scenario) in both the *Coal Large Shivee ovoo CHP-based scenario*, and the *Large Renewable energy-based* scenario. The results shows that the recent plans with DSM case as reducing energy use in 2050 relative to the *reference* case by 2.6%, but it should be emphasized that this scenario only includes a small portion of the energy efficiency measures that could be implemented in Mongolia.

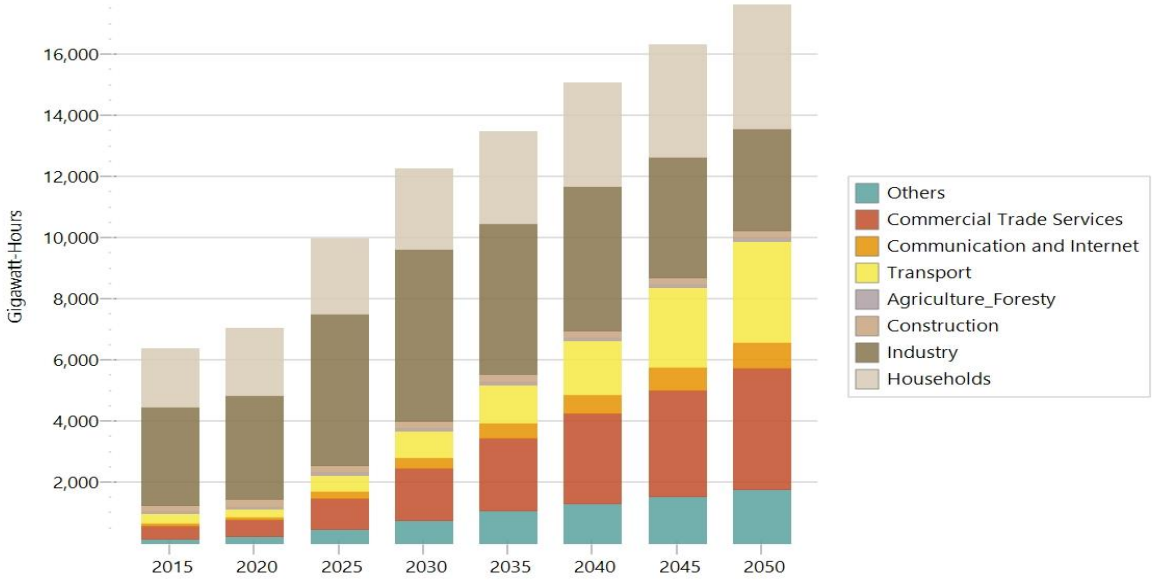
Table 7-1. presents overall scenario results for the four major scenarios in terms of electricity generation and overall energy demand.

Table 7-1: Electricity Generation and Energy Demand in Four Scenarios

Variable and Scenario	2015	2020	2025	2030	2035	2040	2045	2050
Electricity generation, GWh								
Reference	7,025	9,290	13,917	15,915	16,744	18,048	18,970	19,912
Recent plans with DSM	7,025	9,290	13,917	15,915	16,744	18,048	18,970	19,912
Large Coal Shivee ovoo CHP based	7,025	11,408	22,417	45,283	45,310	45,338	45,338	45,338
Large Renewable Energy based	7,025	9,295	26,655	30,816	46,847	148,375	281,965	281,965
Overall energy demand, TJ								
Reference	166	188	244	301	339	377	393	423
Recent plans with DSM	166	188	241	296	333	368	384	412
large Coal Shivee ovoo CHP based	166	188	244	301	339	377	393	423
Large Renewable Energy based	166	188	244	301	339	377	393	423

These results show that as of 2050, the level of electricity generation in the Reference and Recent plans with DSM cases are the same. The reason for this is that at present the "with DSM" scenario includes only measures to save non-electric energy, although the Working Group plans to explore opportunities for electricity savings in Mongolia as well in the future. Thus, at present, the electricity demand shown in Figure 7-1 is the same for the Reference and Recent plans with DSM cases. For the Coal large Shivee Ovoo CHP based scenario, electricity generation will reach 45,338 GW by 2050 (Table 7-1).

Figure 7-1: Electricity Demand by Sector, Reference Scenario



In these projections, electricity demand in the industrial sector grows more in absolute terms than in any other sector in the *reference scenario in the short-term*, overtaking buildings (the combination of the residential and commercial sectors) as the largest overall energy user in the next several years (through 2030). This change is driven by rapidly growing capacity, in the next few years, for copper production. as electricity use for copper production grows much more rapidly than electricity use in other subsectors, fed by electricity initially imported from China, and later produced by the Tavan Tolgoi mine-mouth power plant.

The forecasted electricity demand based on LEAP calculations for all demand sectors will reach 17,622 GWh by 2050, an increase of 2.5 times from 2019 levels (Figure 7-1). In connection with production increases in mining, electricity demand in the mining sector reaches 4,880 GWh in 2030 but declines thereafter as copper and coal production decrease.

In the LEAP Reference and Recent Plans with DSM cases, electricity generation projection reaches 19,912 GWh by 2050, largely following recent government energy policies, while electricity demand projections reach 17,622 GWh by 2050, with the difference between the two figures being station own use and transmission and distribution losses.

The projections for the Coal large Shivee Ovoo CHP based scenario show electricity generation reaching 45,338 GW by 2050, more than double projected domestic electricity demand of 17,622 GWh by 2050, with the surplus electricity are available for export to neighboring countries through HVDC transmission lines. On the other hand, results show that the electricity generated by existing and planned energy sources under Government plans to supply the domestic electricity demand up to 2050 suffice, without construction of the large coal-fired Shivee Ovoo CHP station (5280 MW capacity) but with continued inputs from China and Russia at about 10 percent of total national requirements.

8 The Coronavirus Pandemic and Its Impact on Key Mongolian Economic and Energy Indicators

DEF: pandemic /pan'dɛmɪk/ *- (of a disease) prevalent over a whole country or the world "without discriminating nations based on its economic welfare, geographical location, and number of population"*

8.1 COVID-19, Mongolia's Response to the Pandemic, and the Mongolian Energy Sector – a Brief Summary

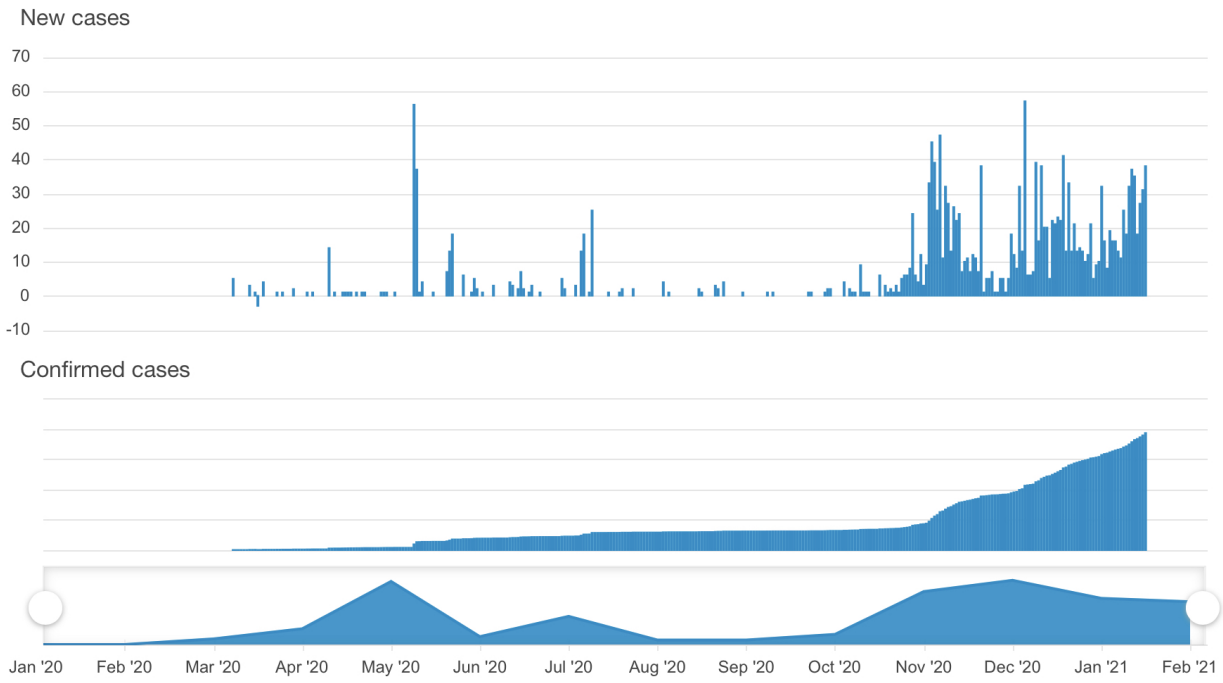
8.1.1 COVID-19: How did it start in Mongolia?

Below we describe the action plans that the Government of Mongolia has taken since the recording of the first case of COVID-19 in the country on 2nd March 2020.

As the neighbor of China, the people and government of Mongolia were aware of the presence of the coronavirus from the first days of the outbreak in Wuhan's in late 2019. As a consequence, the Mongolian government quickly placed restrictions on crossing of its international borders, starting with restrictions on flights originating in South East Asia. But the first case of COVID-19 in Mongolia did not come from China, rather from Europe, in March 2020, after which the state authorities and an emergency council took rapid action via a state emergency declaration that started with Level 1 (the least restrictive) measures under the guidance of the World Health

Organization (WHO). The first stages of the emergency declaration in Mongolia closed all public gatherings and schooling, requesting pupils to use schooling via remote means, but a stay-home order was not put in place until November 2020. Although Mongolia has had relatively few infections in comparison to many countries, this delay may have caused the local outbreak to spread more quickly than expected. As of February 2021, although total cases reached 2000 and 2 deaths recorded (please see Figure 8-1*)*, the recovery rate is around 70% thanks to the strict hospital quarantine action that the Government mandates for infected individuals.

Figure 8-1: Confirmed Daily Cases of COVID-19 in Mongolia



Reference: WHO dashboard

Concerned about the danger of infections rising throughout the year, due to the overcrowded status of the capital city Ulaanbaatar where well over 45% of the Mongolian population lives, the government increased measures associated with the state of emergency step-by-step and prepared the public and private sectors by providing them with information allowing a complete understanding of the risks of COVID-19.

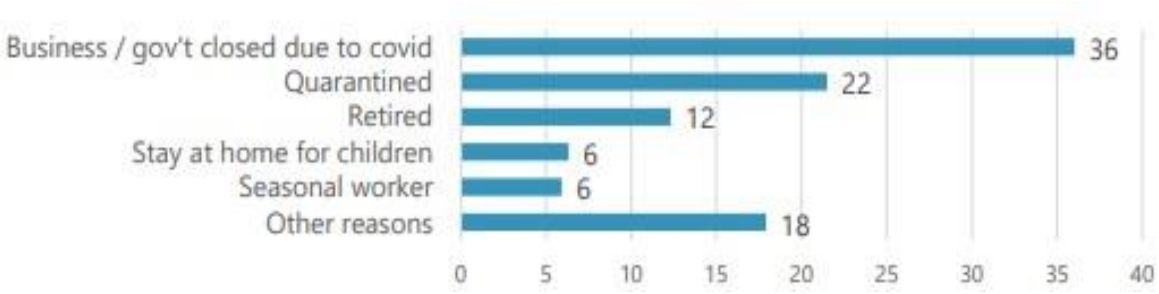
8.1.2 Local COVID-19 Clusters and Lockdown

The combination of strong awareness of the dangers of COVID-19 on the part of the public and strict quarantines were insufficient to stop the spread of COVID-19 in Mongolia. A domestic outbreak was recorded in November 2020, the date when the first-ever nationwide five-day lockdown was ordered.

On December 21st, 2020, the Mongolian Government ordered that a state of "all-out-preparedness" and associated lockdown measures would be reimposed in Ulaanbaatar for a 2-week period. This decision followed reports of several additional local clusters of infection recorded in various locations. The public is once again urged to stay home and leave only to purchase necessities.

During the lockdown, the Government has provided support for households and small enterprises in part by canceling all utility bills for electricity, heat, water, and waste pickup services from December 1st, 2020 through July 1st, 2021. This means that the government will be responsible for shouldering the cost of bills for electricity and heat consumption to levels not more than each consumer's consumption during the same period of the previous year, with each consumer paying any cost for extra consumption by themselves. To support Ger households in providing heat for their dwellings, the price of coal briquettes was reduced by 75% during the winter period. This support action was well-received by the public, as the lack of mobility surely affected households' income. The World Bank and the National Statistics Office of Mongolia (NSO) have implemented a joint COVID-19 Household Response Survey to evaluate the outcome of the lockdown by focusing on the economic transmission channels and welfare impacts of the COVID-19 pandemic. The results of this investigation showed COVID-19's strong negative impact on residents contacted during the phone survey. Figure 8-2 shows the ways in which respondents lost income between the first and third rounds of interviews carried out during the survey (units are number of respondents).

Figure 8-2: Survey Respondents' Indications of Income Losses Related to COVID-19



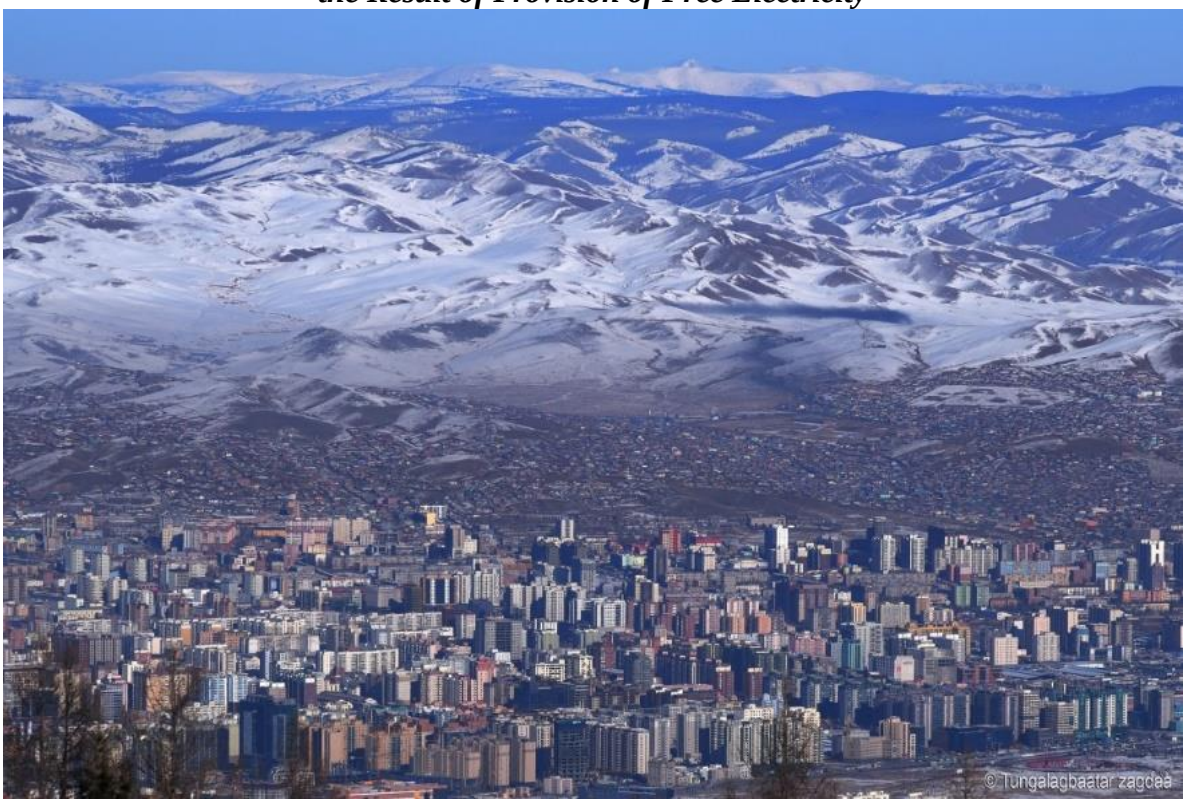
Reference: World Bank (2021), "Results of Mongolia Covid-19 Household Response Phone Survey (Round 3)", presentation dated January, 2021, and available as http://pubdocs.worldbank.org/en/674291610418865659/MNG-HF-phonesurveyR3-Final.pdf.

The key measures and support actions taken by the Government side to support households' well-being during the COVID-19 pandemic have included:

1. Supporting the stay-home order by households, especially those living in "ger" district, by providing those households with cheap coal briquettes and electric heaters to provide heat for their Gers and houses.

2. Mitigate lowered household incomes by covering the majority of monthly utility bills
3. Mitigating urban air pollution by replacing the coal-fired stoves and furnaces with electric heaters by providing incentives for households to purchase electric heaters, whose use increased due to the provision of free electricity. Figure 8-3 illustrates the visibility across the capital city on the coldest day of December 2020. Under typical winter conditions, in recent years, the airshed in Ulaanbaatar would be heavily polluted, with very limited visibility, due to a combination of power plant/heating plant emissions and, mostly, household use of raw coal and other high-polluting heating fuels.

Figure 8-3: Excellent Winter Visibility in the Capital City, Ulaanbaatar in December 2020 - the Result of Provision of Free Electricity



8.2 The Impact of COVID-19 on the Mongolian Economy

Since the global announcement of the spread of the Coronavirus (COVID-19) pandemic by World Health Organization (WHO), Mongolia experienced few local outbreaks or transmission of the virus and has experienced very few deaths or other tragic events to date linked to COVID-19. With the exception of Mongolian citizens brought back to Mongolia on state-organized chartered flights from Europe, the USA and South-East Asia, all commercial flights have been banned since March of 2020. The chartered flights carried Mongolian citizens who were in critical condition under specific pre-arranged conditions that included secure transport from the airport to the hospital, where arrivals were quarantined without interactions with anyone except

for the quarantine team and medical personnel. The current (February 16, 2021) number of confirmed COVID-19 cases in Mongolia is 2444, with just two deaths and 1,777 cases judged successfully recovered, among the national population of 3.2 million.[31]

Global news reports describe Mongolia as a special case, appraising its government actions during the pandemic lockdown as a role model to other nations – including the early initiation of wearing facial masks, high usage of hand-sanitation, closing public schools and event venues, and bringing a positive attitude to prevent the outbreak from spreading. The effectiveness of the lockdown, however, was significantly enhanced by the willingness of the inhabitants of the capital city of Ulaanbaatar, numbering 1.5 million, to follow strict stay-at-home rules, which allowed the government to obtain rapid control of the outbreak before COVID-19 could spread dramatically.

Although there have been a relatively low number of Coronavirus cases in Mongolia thus far, the pandemic and the measures taken to prevent its spread have had an effect on the nation's economy and energy system, and additional impacts are likely in the future. The remainder of this section considers details of key impacts on the economy and the energy sector by observing short and long-term indicators of changes due to the effects of the virus and the preventative actions taken since the beginning of 2020.[32] This research aims to provide a mostly qualitative review focusing on key sectors of the economy such as the residential, industry, commercial, transport and agriculture sectors. The analytical background focuses on data comparison techniques with previous years' available information considering business-as-usual assumptions.

8.2.1 Key Changes in the Mongolian Economy Due to COVID-19

With vast pastureland for agriculture and livestock, and its wealth of mineral resources, Mongolia's economic future is promising. To explain the current status of the nation's economy and energy sector, and national expectations of a rapid economic recovery following lifting of the COVID-19 lockdown, this section of the RES Mongolia Working Group Report continues by examining key indicators of the economy and their relation to the energy demand and consumption with regard to the potential integration of COVID-19 considerations as a scenario within the Long-Range Energy Planning (LEAP) energy futures modeling described above.

(1) INFLATION AND ECONOMIC GROWTH

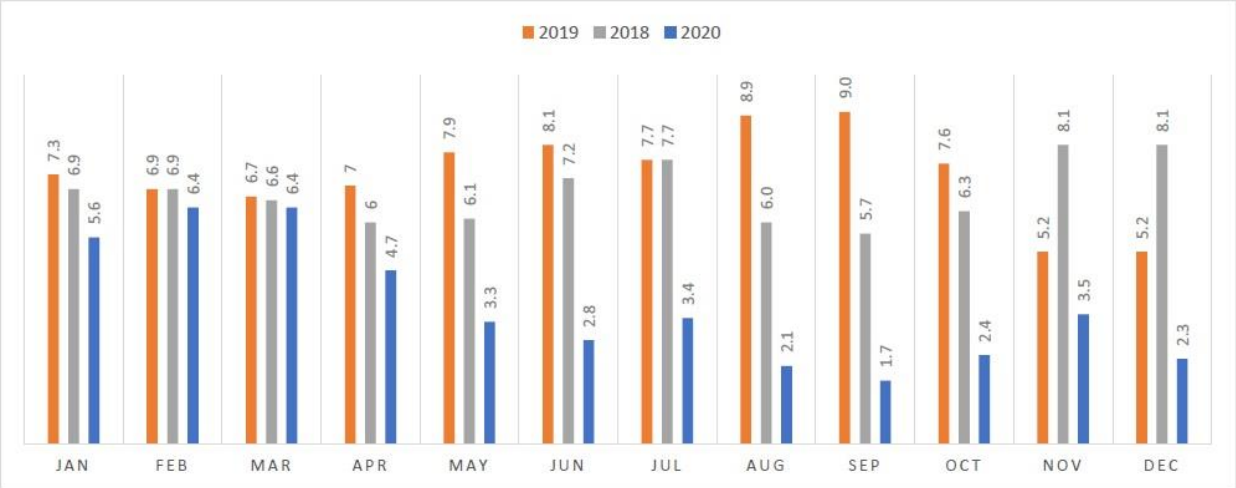
The majority of Mongolia's economy is dependent on foreign trade, as the local production portion to the economy is small in comparison to imports and exports. As such, the Mongolian economy could be expected to be significantly affected by changes in border restrictions. As

[31] Johns Hopkins Coronavirus Resource Center (2021), "COVID-19 Dashboard", as of February 17, 2021, accessed at https://coronavirus.jhu.edu/map.html.

[32] The Mongolian Government made an unprecedented decision to close all schools and kindergartens starting from January 25, 2020, right after the WHO announcement of the Wuhan-spread COVID-19 pandemic status. The closures were originally intended to last for a month, but it was scheduled to continue until 1st June 2020 with potential extensions if cases of infection increase. The new 2020-2021 academic year for all kindergartens and general educational schools across Mongolia was started on 01 Sep 2020 after months-long closures amid the COVID-19 pandemic. After two months, because of the domestic transmission revealed on the 11th of November, a national lockdown was initiated on November 12. The lockdown has since been which is extended several times, most recently, as of this writing, to 23 Feb 2020. The lockdown includes closure of the borders with Mongolia's two surrounding neighbors, -- Russia and China. The border closure does not allow any foreigners/locals to arrive/depart the country for any reason except for via special charter flights dedicated to bringing Mongolian nationals back from different locations.

shown in Figure 8-4, however, although COVID-19 and its lockdown did not have a significant impact on inflation in the first three months of 2020 , starting from April through December of 2020, inflation was significantly reduced relative to previous years.

Figure 8-4: Inflation in Mongolia, Last 3 Years, Year on Year Comparison of Percent Increase by Month

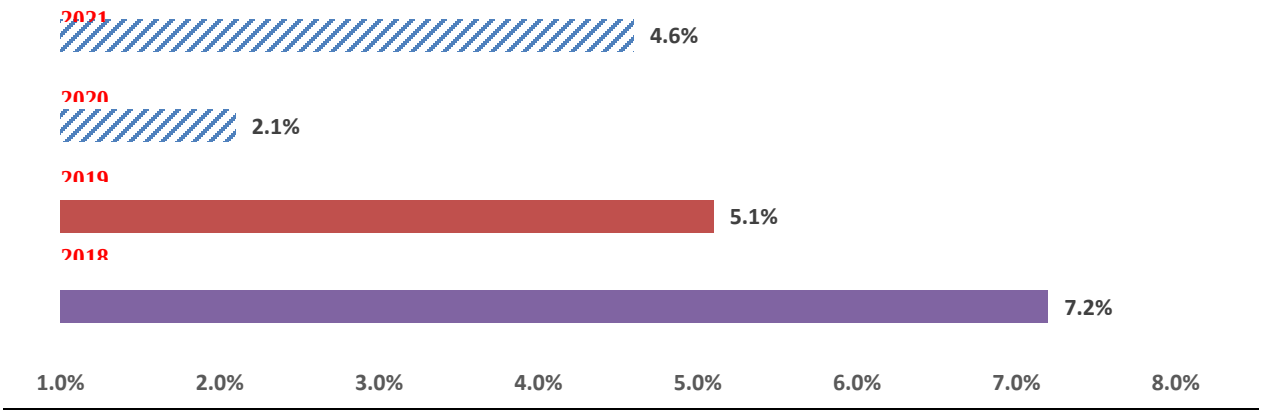


Source: Mongol Bank- Central Bank of Mongolia, https://www.mongolbank.mn/eng/dblistcpi_mng.aspx

The changes in inflation in April-December of 2020 shown in Figure 8-4 were caused, in large part, by the border closings and related measures, which resulted in a decrease in economic activity, including transportation sector restrictions and mining trading slowdowns, This result is consistent with projections by the Asian Development Bank (ADB).[33] ADB projections call for Mongolia's inflation rate to decrease, which may have a bi-directional correlation with economic growth. ADB expects Mongolia's economic growth to fall to 2.1% in 2020, significantly lower than its initial forecast of 5.1% growth, but still sees growth recovering smoothly in 2021 as shown in Figure 8-5. The major slowdown in the Mongolian economy is expected to be caused by commodity price declines *(such as in coal and metals)*, due to lower consumption in regional and global markets, plus trading restriction with China and further restrictions related to access by Mongolian transportation companies to the port of Tianjin, China which is Mongolia's most important access point to international trade.

[33] *Mongolia: Economy* bulletin by Asian Development Bank (2020), available as https://www.adb.org/countries/mongolia/economy.

Figure 8-5: Recent and Expected Economic Growth in Mongolia (GDP growth rate, %/yr)



Source: Mongolia, Monthly Bulletin, Asian Development Bank

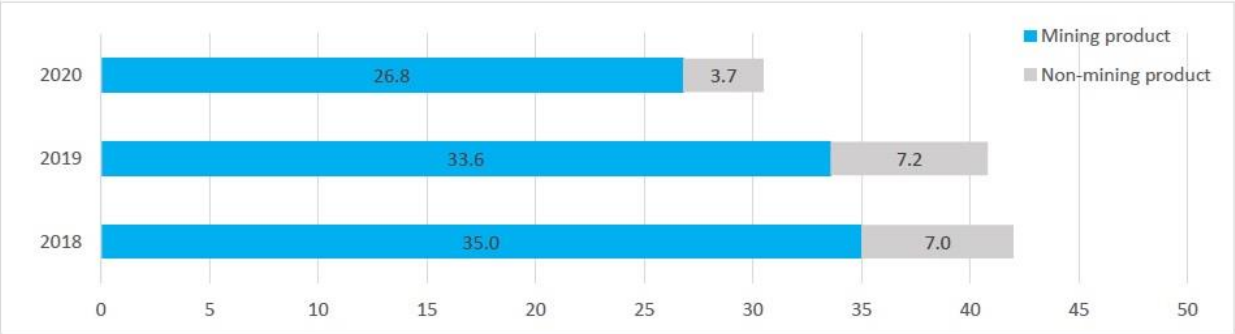
(2) TRANSPORTATION

Although the Mongolian Government has imposed travel restrictions on entering or departing from the country, the flow of major import- and export-related products has continued under strict border security and inspections.

The current net exports and imports of Mongolia with Northeast Asia region are highly dependent on transportation between China and Mongolia. For the mining sector, the typical transport method used is mostly road truck hauling between the mines to the nearest Chinese warehouse lot across the border. The length of the road from the major mining area to the border is only 80 km, but the National Security Council has set a strict border control regime –allowing only state-authorized trucks to cross the border within a limited time interval as a measure to prevent further outbreak of the virus.

NSO preliminary statistics, compared to the same period of the previous year, show that the total non-mining-product freight carried by road decreased by 48.6% in 2020. Overall road freight carried decreased by 10.4 million tonnes (25.4%) during the same period, as shown in Figure 8-6. These decreases were caused mostly by a decrease in the transportation volume of mining products of 6.8 million tons, or 20.2%.

Figure 8-6: Product Transport by Road, Million tons (mining products in colors vs other products shown in grey)



Source: Monthly Bulletin, National Statistics Office, Mongolia

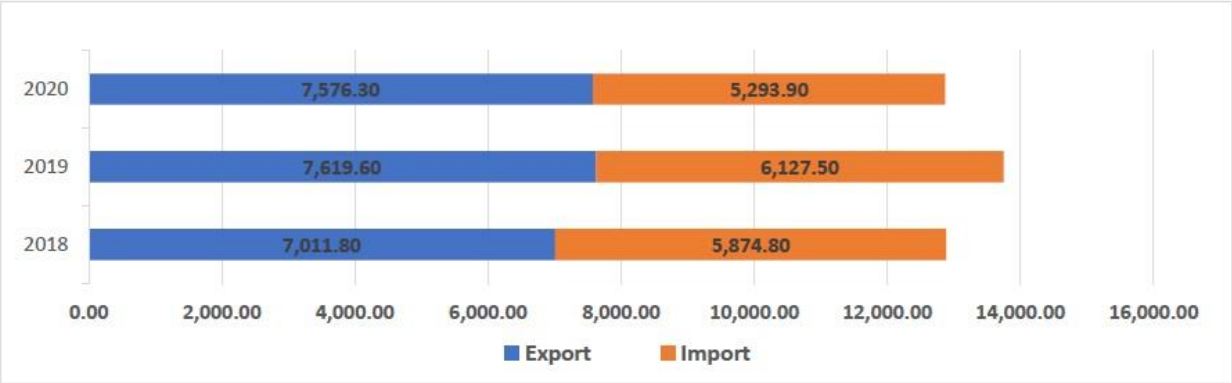
As defined by the National Statistics Office of Mongolia, "Carried Freight" or transported goods covers any type of goods exported to the country by air, road transport, and railway. As a direct effect on the economy, a decrease in transported goods may cause a slowdown in private sector growth as a reduction in imports may mostly affect the timelines of activities in the construction and commercial sectors. Imported commercial trade goods such as clothing, construction raw materials, and food imports, among other products, are as part of the lockdown faced with border closing that require cargoes to either (a) go through quarantine of 14 to 21 days depending on the product specification, or, (b) not be allowed to cross the border at all due to the Chinese COVID-19 situation. Under Mongolia's implementation of strict border restrictions, a significant decrease on transported goods resulted for the 2020 compared with the previous year's performance, as shown in Figure 8-6 for road transport, which constitutes the major mode of goods imports into Mongolia.

(3) FOREIGN TRADE

Here we focus on Mongolia's key export products such as coal, copper concentrate, and gold, and key imports, which are mainly finished products. Figure 8-7, below, summarizes the value of exported and imported goods and services for 2020 compared with the previous two years' performance. These figures show that imports decreased by 833.6 million USD (13.6%), while exports decreased by 43.3 million USD (0.6%) from the previous year. Although imports decreased by 13.6%, overall imports show still a stable trend, as Mongolia does not have a domestic oil refinery, oil and gas related products represent the largest category of imported goods. Therefore, the changes due to COVID-19 remained largely unnoticeable for goods exported and imported from/to Mongolia, compared with typical trade patterns.

The summary provided in Figure 8-7does not illustrate the changes in imports and exports by products as it is expressed in dollars, but Figure 8-8 shows the change in exports from Mongolia by product in five major resource categories for 2020, compared with previous two years. .

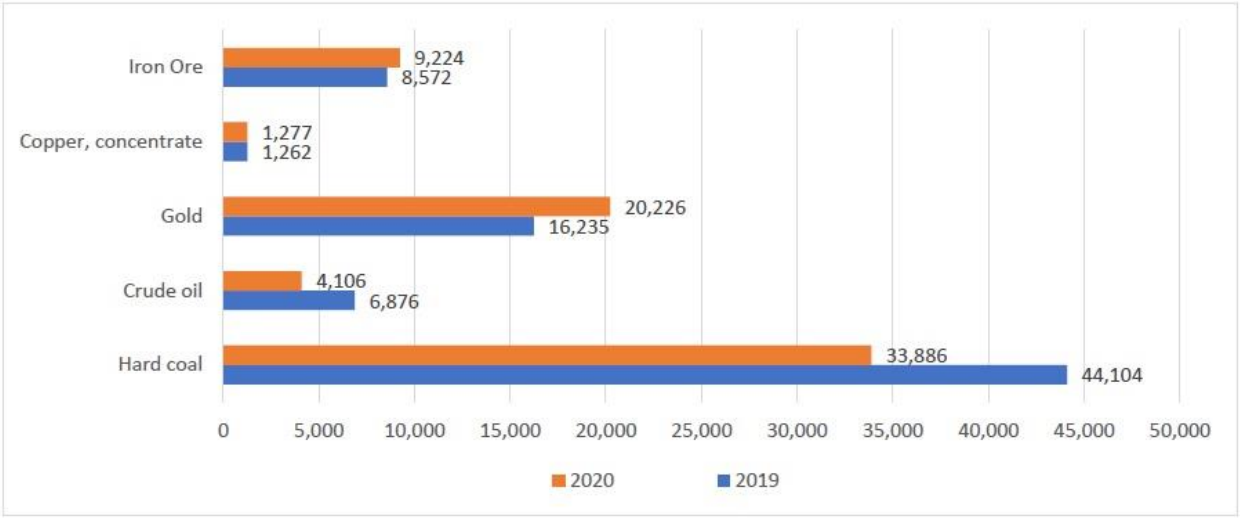
Figure 8-7: Foreign Trade (US$ million)



Source: Monthly Bulletin, National Statistics Office, Mongolia

The Mongolian mining industry provides the largest contribution to the state budget among the sectors of the economy, around 24% as of 2020. As seen from the value expressed in USD in Figure 8-7, the decrease in the value of exports was relatively minor (0.6%) compared with 2019. Figure 8-8 shows that the 2019 to 2020 change in volume of products from mining and oil extraction varied significantly by product, with iron ore and copper concentrate volumes rising modestly in 2020, gold output increasing significantly, and crude oil and coal outputs decreasing significantly.

Figure 8-8: Mining Product Summary Sheet (thousand-tons/barrels)



Source: Exported Goods Statistics, Customs Authority of Mongolia, Monthly Bulletin, National Statistics Office, Mongolia

(4) INDUSTRY, COMMERCIAL, AND MANUFACTURING SECTOR

According to the National Statistics Office, during 2020 the extraction of gold (as recorded in Mining and Quarrying sector data) increased by 24.5 percent compared to the previous year. The volume of gold sold to Mongol Bank increased in 2020 compared with the previous year. One positive impact of the COVID-19 pandemic for Mongolia is therefore this increase in gold reserves at Mongolia's own Central Bank, which allows the country to maintain a stable exchange rate and reduce volatility during times when the activities of the financial market are restricted due to the pandemic response.

In the manufacturing sector (based on preliminary results from 2020), production of bottled water, soft drinks, juice, wheat flour and milk increased by 0.8-11.5 percent compared to the previous year. The production increases in the food industry were caused by the closing of offices in Mongolia during the 2020, which in exchange increased peoples' activities at home. From the perspective of air quality, improved coal briquette production increased by 56% compared to the same period in 2019 – the result of a new restriction on raw coal usage for fire starting and heating purposes in the "ger" district around Ulaanbaatar, an area not connected to central heating and sewage pipelines. On the other hand, the production of alcoholic beverages, lime, copper cathodes, combed cashmere, meat, concentrated coal, cashmere products, metal steed and cigarettes decreased by 0.8-49.1 percent compared to the 2019.
In the commercial sector, business activities slowed down due to the stay-at-home requirements of the lockdown. As noted on the Government News, in accordance with current available statistics, during Q1 of 2020 revenue from restaurants and other public gathering places dropped by 60 percent. According to the National Statistics Office, over 11,000 people work in the food serving business in Mongolia and are thus significantly at risk of suffering from unemployment. The reduction in commercial sector activity is also having indirect effects on real estate owners who offer rental services to small-and-medium enterprises, including restaurants and other shops food and beverage service facilities. These landlords are facing difficulties in receiving rental income. According to the NSO's latest available statistics on activity in the commercial subsectors, in the first 11 months of 2020, the total trade turnover reached MNT 18.9 trillion, a decrease by MNT 1.9 trillion (8.9%) compared to the same period of the previous year.

Tourism is one of main sectors that has in recent years created significant business opportunities in Mongolia, but tourism has started showing signs of crisis in the last few months. There are no foreign travelers due to border lockdown, resulting in the cancellation of numerous pre-booked activities for the year.

A recent report from the Mongolia News Agency includes the following quote from the President of the Mongolian Restaurant Association, M. Yesunmunkh, regarding the impact of the COVID lockdown on tourism: "The tourism industry brought income of MNT 1.6 trillion or USD 607 million to Mongolia in 2019. It makes up 7.2 percent of gross domestic product. The figure stands at 30-35 percent in countries where tourism has developed. Mongolia welcomed 577 thousand tourists in 2019. While the industry's income went down by 65.8 percent in 2020. A total of 2,300 entities are operating in tourism sector and 88,700 people or 6.7 percent of Mongolia's total work force are employed in the sector." Quoting another tourism official, the article noted that in total "...570 tour operator companies ran their operations in 2019, earning USD 240 million of income. Unfortunately, 98 percent of the sector's operation halted in 2020

due to the pandemic, leading 49 percent of total workers to be unemployed. Workplace for the rest is at risk as well."[34]

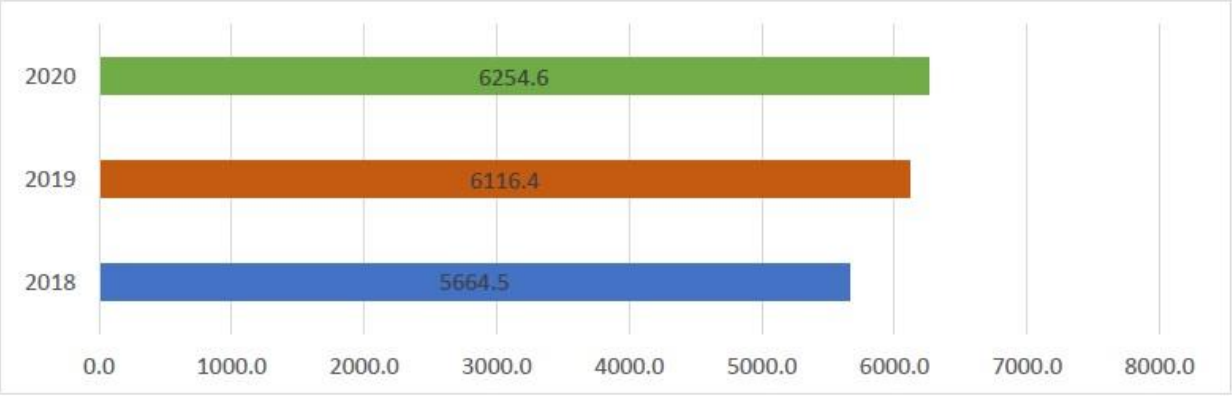
In public, under the lockdown, gatherings for entertainment, including concerts, theater, and the cinema are not allowed with these venues being shut down since the beginning of the year. As a result, the commercial sector has been affected heavily and its recovery is expected to take time. No quantitative data are available at present to characterize the change in private sector activities, including in the commercial sector, as of now.

The lockdown has had a positive impact on air quality, as the average measured concentrations of PM 10 *(particulate matter measuring less than 10 microns)* and PM 2.5 *(less than 2.5 microns)* in the air in Ulaanbaatar have dropped by 0.078mg/m^3 (49%) and 0.027mg/m^3 (56.5%), respectively, compared to the same period of previous year, although the reduction was partially due to the restriction put in place on the use of raw coal for heating.

(5) ELECTRICITY PRODUCTION

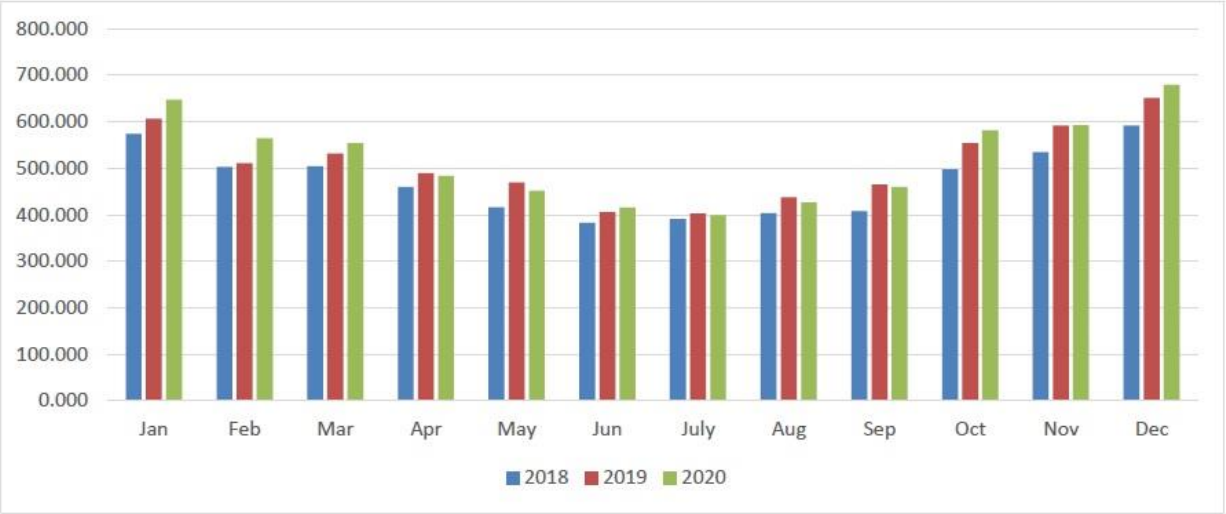
To address the impact of COVID-19 on the local economy, the text that follows focuses on domestic energy production, comparing output in 2020 with production in the previous two years on a year-on-year basis. As shown in Figure 8-9, there has been only a small change in production from the supply side of the sector during the 12 months in Mongolia, and the increase shown between years is likely mostly a function of economic growth. Trends in energy consumption during the same period are shown in Figure 8-10.

Figure 8-9: *Electricity Production (Million kWh)*



[34] Batchimeg B. (2021), "PM holds meeting with representatives of tourism industry", *Mongolian News Agency (Montsame)*, dated February 25, 2021, and available as https://www.montsame.mn/en/read/254873.

Figure 8-10: Electricity Consumption (Million kWh)



Source: Ministry of Energy, Mongolia

Preliminary analysis shows that there were no major changes in either electricity production or consumption in 2020, for Mongolia as a whole, relative to previous years. In accordance with the latest NDC Report, as published in the Mongolian *Energy & Engineering Journal* (January 2021) for the full year 2020, the total electricity supplies (including domestic generation and imports) across all of Mongolia reached 9055.8 million kWh, and the total electricity provided to consumers after accounting for distribution losses was 8181.7 million kWh. The consumption of electricity in the CRES area reached 6109.0 million kWh, and increased by 95.0 million kWh, or 1.6 %, relative to previous year.[35] Focusing on electricity imports and exports (electricity imports from Russia were reduced by 63.9 million kWh, relative to the previous year), there have also been no major changes, as the Mongolian Central grid is connected with Russia, and there is a mining company with a power purchase agreement (PPA) to supply electricity from Chinese Grid Company. Oyu Tolgoi (majority owned by Rio Tinto) is located in South Gobi and imports electricity from China. This imported electricity is used in Oyu Tolgoi's mining activities (see Table 8-1).

[35] Data as published in January 2021 in the Mongolian journal *Эрчим хүч & Engineering* [Energy and Engineering], January 2021-1(203), page 8.

Table 8-1: Electricity Imports and Exports for 2018, 2019, and 2020 (Million kWh)

	2018	2019	2020*
Import from Russia to CES	304.1	250.8	186.9
Export to Russia	26.9	26.5	39.8
Import from China	1,361.60	1,344.4	1,391.8
Oyu Tolgoi Mining	1,345.80	1,324.3	1,340.1

Source: National Dispatching Center Energy Report, 2018, 2019; Statistics, Customs Authority of Mongolia

The key reasons that the COVID-19 response in Mongolia has had relatively little impact on domestic electricity generation thus far in 2020 is the impact of seasonal cold weather in Mongolia, with December, January and February being the heat-targeted months for residential and commercial buildings, meaning that the large Combined Heat Plants (CHPs) on the Central Grid are key sources of space heat for buildings and thus tend to operate a full capacity for both heat and electricity regardless of electricity demand.

Furthermore, the COVID-19 epidemic poses an immediate threat to sensitive strategic infrastructure. Operation and maintenance of equipment in the power sector of Mongolia relies on imports – as local industries are incapable of producing the major equipment used in the power sector, thus operations and maintenance when commercial traffic across borders is flowing slowly require the efficient and agile use of a limited pool of parts and reserve equipment. In business-as-usual cases, scheduled maintenance takes place so as to ensure continuity of operations and availability, but the sudden decision to close the border crossings and extended procedures for processing and quarantining commercial shipments at the border may cause delays in the maintenance of power plants – which could result in possible production interruption.

Moreover, a reduction in daytime demand due to closures of commercial sector firms could have taken place during the several months since the national lockdown in response to the pandemic cause, although we see no dramatic change in electricity generation relative to previous years in Figure 8-9. This lack of an obvious reduction in demand could show the result of an energy offset in which peoples' activities (and electricity consumption) in residential areas increased during the lockdown, while commercial sector use has declined.[36]

Although the National Security Council has set border restrictions \for goods and services imported from Russia and China, the infrastructure for electricity trading remains open without restrictions beyond the capacity of the transmission lines, as no virus transmission is associated with remote electricity trades via transmission lines.

[36] *This conclusion only represents the author's opinion, as detailed electricity demand data for early 2020 is not available yet.*

8.2.2 Beyond COVID-19: Opinion and Summary

(1) MACROECONOMIC INDICATORS

Key indicators such as economic growth rates and foreign trade are expected to fall due to the pandemic impact in the short run. These impacts are expected to have a time-delay/lag, as the immediate result of the COVID-19 response measures in Mongolia have not yet appeared in available statistics.

(2) ENERGY PRODUCTION

As with data on production of other goods and services, electricity production indicators are examined and analyzed based above based on monthly data results, as shown in Figure 8-9 and Figure 8-10. Preliminary opinions as to the impact of the COVID-19 response on the electricity sector can also be linked with the actions that the government has announced or is likely to take, such as canceling all electricity bills for households and small business entities (with regard to this policy, please see section 8.1.2, above) and tightening the state budget. The potential slowdown of local production of goods and services due to the strict measures taken in the public sector can, for example, cause (a) a decrease in energy demand in the commercial and industrial sectors offset by a sharp increase in consumption by consumers who can take advantage of the availability of free electricity (b) an increase in interest to purchase cheaper sources of energy, for example, supporting energy production from older CHP units rather than investing in newer, cleaner plants (c) expected high curtailment on production of renewable sources of energy as the response to COVID-19 has a major impact on the single-buyer trading scheme of the central grid. The pandemic impact will very likely cause delays in implementation of any privately funded power projects as the global market will not be favorable to support any new projects linked with the revenue stream that in turn may be negatively affected due to the economic slowdown in Mongolia. For example, any revenue collection from sales of electricity will likely be reduced due to the effect of production and sales of local goods and services being reduced or placed temporarily in "closed down" status, in addition to the impacts of the policy of allowing consumers to receive free electricity during the pandemic.

(3) ENERGY AND ITS AVAILABILITY

To maintain a secure source of electricity (and heat) for Mongolia during any pandemic or lockdown status, all power sources need to be operated reliably and a secondary grid-forming unit will need to be implemented to act as a backup source of electricity in the event of a technical failure at the power plant that serves as the main grid-former for the Mongolian Central Grid, namely "CHP-4", the largest power plant in the country. For this reason, a mega-scale storage project supported by ADB will likely move forward in order to strengthen grid availability, whilst benefitting from the currently curtailed supplies of electricity available from renewable sources. Since renewable sources cannot act as grid forming units, and have only grid-feeding status, an advanced technology used for storing currently excess renewable electricity output is required. The new storage project, with capacity of 125MW/160MWh, currently scheduled to be completed in 2022. In the future, this type of electricity storage will be taken into account in the development of LEAP scenarios for Mongolia (a) by allowing increased integration of renewable sources in the long-run, and (b) by declaring "partial" independence in

terms of grid-forming and voltage and frequency regulation on the Central grid, which is currently done with the assistance of the Russian Grid.

(4) ENERGY AND MINING

As indicated by figures on electricity consumption and import by large-volume consumers--particularly international mining companies--have so far had relatively little slowdown in production, even though they have been faced with a border lockdown, and production of both copper and gold in Mongolia rose in 2020 versus of 2019 as shown in Figure 8-8. In this circumstance, if electricity were supplied from the local market for these companies, it could benefit the state budget and sectoral revenue as an added value. For this reason, actions to promote local grid stability can be taken by adding more sources (for example, Tavan-Tolgoi CHP is planned to be built to supply electricity to Oyu Tolgoi Mining. This CHP plant is scheduled to be commissioned in 2024) of energy in different alternative formats that meets the technical requirements of large-volume electricity purchasers (such as mining companies). If so, these changes could favor (a) advanced-format hybrid renewable sources, or (b) cheap sources of electricity that could benefit from interconnections with the international market that allow decentralized electricity trading between countries.

(5) ENERGY AND DOMESTIC PRODUCTION

The experiences of lockdown and border restrictions have allowed the government and local producers to acquire an understanding of product needs under pandemic conditions. As a result, it is likely that a greater appreciation of and support for domestic production will result from Mongolia's experience during the pandemic, ultimately resulting in an increase in local energy demand. Mongolia is a vast of land that is capable of (a) growing any type of vegetables (b) performing any farming action, and (c) producing raw materials to support mining and construction sector.

Therefore, as a result of the COVID-19 experience, it is expected that business owners, entrepreneurs, and decision makers will gain an enhanced understanding of the value of local and domestic production of goods, and that local production should be supported. The impact of this appreciation for local and domestic production on the energy sector in general, and the electricity sector in particular, will likely be significant, as electricity is increasingly a required input for almost all goods and services.

(6) ENERGY AND STATE POLICY UPDATE

Based on the authors' opinion, the following paragraphs review published state policies and explore possible government action plans that might be implemented to mitigate the economic and other impacts of COVID-19 on the energy sector. This exploration focuses on whether the existing timeline of state policy for the energy sector is capable of coping with potential changes in the sector itself. The Midterm Energy Policy approved by the government in 2015 focuses on an action plan and policy regime though 2030. The Midterm Energy Policy is summarized in Table 8-2, below:

Table 8-2: Summary of "State Policy on Energy" 2015-2030 Midterm Action Plan

Priority areas	Strategic Goals
4. Reliable supply and Energy security	• Ensure energy safety and reliable supply • Develop mutually beneficial cooperation with regional countries • Develop human resources
5. Energy efficiency	• Transfer the state dominated energy sector into private based competitive market • Support innovation and advanced technology in the energy sector, and implement conservation policy
6. Environmental sustainability and green development	• Increase the production share of renewable generation and reduce negative environmental impacts from traditional power generation, as well as greenhouse gas emissions

Source: State Policy on Energy 2015-2030, Mongolia

The timeline itself was established in two stages to reach final goals:

- **2015-2023** – The 1st stage of the policy focuses on development of energy safety and backup power capacity, establishing foundations for the development of renewable energy, and improving the legal environment for the renewable sector. Its expected result is to allows the state to develop reserve capacity for electricity generation while lowering transmission and distribution losses through potential upgrades to the grid. The key target of supporting renewable energy relies on increasing the fraction of renewable generation on the grid to 20% using domestic supplies.
- **2024-2030** – The 2nd stage of the policy focuses on exporting secondary energy to neighboring countries and on further developing the sustainable renewable energy network. Moreover, the second stage has the key aim to increase the renewable penetration to the grid as described above to reach 30% of domestic output, while in parallel developing further advanced technologies such as hydrogen energy storage and use, with concentrating solar-thermal power plants also helping to provide both heat and electricity for use by households and businesses, potentially allowing some coal-fired CHP units to be retired.

As described above, state energy sector policies are not likely to be significantly affected over the longer-term by the COVID-19 lockdown, and in fact the recent lesson-learned from the lockdown may help to advance the actions needed to implement the midterm policies. Mongolians during the lockdown gained an increased appreciation that energy sector is the key at any time to be able to run businesses, operate hospitals, to allow people to work from home offices, and even to deliver key alert messages using the internet and other communication tools. For this reason, the Mongolian Government, with financial support from the Asian Development

Bank, is speeding up actions to improve its grid capacity by implementing the storage project mentioned above, under a financial loan agreement signed on the 12th of May 2020. This electricity storage enables the country to improve the degree to which it can supply its own electricity needs as they fluctuate during the day and week, in parallel with supporting potential development of and grid integration of solar, wind, and other renewable energy in the future. In addition, the storage unit will make supply more reliable and improve energy security, which was a key goal underlying the Midterm State Policy of Mongolia.

Mongolian authorities' main wish for the energy sector is to improve its autonomy – which is in turn is seen as a key door, the opening of which will allow Mongolia to explore further opportunities to have synchronized energy trading with both neighboring countries. Sales of electricity derived from the vast land area and rich resources of wind and solar energy in Mongolia will help to strengthen the state budget at all times of the year if the electricity trading via interconnections starts with neighboring countries, mostly targeting China and the ASEAN region – where economic production has been booming but which substantially lack additional cheap sources of energy. This part of the trading scheme is consistent with and can be implemented under the "2nd stage of State Policy on Energy" as the implementation of trading schemes and the extra revenue provided by the use of alternative sources of energy is a key focus for state budget expansion and for stabilizing economic growth.

As there is no finding that COVID-19 virus itself can be spread via electricity transmission lines, trading energy "by wire" remains the safest mean of trading energy for countries in any state of lockdown. Continuing this line of thought, COVID-19 is just one among a series of developments that may bring about a new era for Asia's energy landscape. According to the International Monetary Fund (IMF), the current crisis is counted as "the worst" economic disaster since the Great Depression".[37] The magnitude of the changes of indicators that the market has witnessed, such the collapse in oil prices, rising international tensions between nations, growing stress on international institutions, and a partial global financial recession, has been unprecedented, and all derived from the slowdown in economic production caused by the response to COVID-19 around the world. Yet, one noticeable finding from these global trends is that small economies such as Mongolia have been partially affected throughout the course of the global pandemic because (i) its partial ability to produce necessities that it normally sources via imports using its domestic capabilities, and (ii) its close-to-full potential to supply its own energy domestically except for the mining area. Although international financial markets have been moving up and down in response to COVID concerns, these tensions had less impact on Mongolia's key economic indicators. This allows Mongolia to take as its steps in the energy sector to act as a support unit for its neighboring countries, most especially China, during the global post-COVID recession phase by providing cheap sources of energy, if available. This is a prevalent concern for beyond-China countries as well, where both dense urban population and isolated rural locations with poor health care that are the rule rather than the exception in places such as Southeast Asia, and where responses to COVID-19 such as social distancing and home-working could be difficult to practice due to a lack of electricity distribution or reliable electricity supplies.

[37] IMFBlog (2020), "The Great Lockdown: Worst Economic Downturn Since the Great Depression", dated April 14, 2020, and available as https://blogs.imf.org/2020/04/14/the-great-lockdown-worst-economic-downturn-since-the-great-depression/.

Once an electricity interconnection happens, one key research question we would like to address in the current round of Regional Energy Security Project research, and one that extends the research on energy interconnections in Asia that have taken place over the last two decades, is to what extent, in the event of future pandemics or similar emergencies, Mongolia's energy exports can enable other nations hit much harder by the COVID crisis than Mongolia to more rapidly recover from the crisis, .

Looking at the longer-term impacts of the COVID epidemic on Mongolia energy policy, the starting point is the Long-term State Policy of Mongolia (Final draft of Vision 2050 of Mongolia), which was recently discussed and approved in May 2020 by Parliament. Under this long-term policy, energy sector development is projected to be as shown in *Table 8-3*, below.

Table 8-3: Summary of "Long term State Policy of Mongolia" 2020-2050 Midterm Action Plan

1st decade (2020-2030)	2nd decade (2030-2040)	3rd decade (2040-2050)
• -Extend and upgrade existing CHPs • Build big capacity power storage system • Build new CHPs (450 MW Tavan Tolgoi, 400 MW Baganuur, 300 MW Buuruljuut including export-oriented CHP with biggest capacity of 5280 MW planned to be constructed near the Shivee Ovoo Coal Mine) • Improve renewable energy shares (Develop feasibility study for Hydro PP with small and medium sized capacities in central region and construct Hydro Power Plants: 315 MW Egiin gol Hydro PP, 64-100 MW Erdeneburen HPP, and 100 MW Telmen HPP) • Connect the Integrated Power System throughout Mongolia	• In this stage, capacity for power generation is increased and domestic power generation will meet all demands. • Infrastructure (power generation and transmission) for large amounts of electricity exports to NEA countries is put in place. • Build Waste Treatment Eco Park and build power plant that produces electricity using wastes	• Increase the capacity of green energy (Renewable energy) and supply renewable electricity to all regions of country, as well as exporting electricity to North East Asian countries.

Our opinion is that Mongolia's experience in dealing with the coronavirus will not substantially change the long-term trajectory of its energy system and energy policy. At present, more aggressive development of renewable energy is delayed because of the need to provide generation (and storage) to help regulate Mongolia's grid. This means renewable energy

generation using intermittent wind and solar power for domestic use can be promoted only after development of the hydro power plant that can provide for better domestic grid regulation. As a result, in the next ten or so years, development of hydro power will be promoted over wind energy, and only about between 50-100 MW of wind farms are planned in the next few years. Energy imports will continue until Mongolia had sufficient capacity to supply domestic demand in Mongolia. The construction of the 450 MW Tavan Tolgoi CHP plant to supply electricity to Oyu Tolgoi in South Gobi is expected to move forward.

We also feel that the coronavirus experience will not affect the regional energy opportunities for Mongolia in East Asia in the medium term and beyond. As a consequence, as noted above, it is still possible and likely that energy sector development in Mongolia will follow the State Policy on Energy 2015-2030 Midterm Action Plan, and that the COVID experience will not decrease the probability that Mongolia will ultimately be a major electricity exporter in NE Asia using its rich renewable energy resources, particularly wind and solar resources identified in South Gobi region.

9 Conclusions

9.1 Key Energy Issues for Mongolia

The key issues in the energy sector in Mongolia involve economic, social, environmental, financing, governance/regulatory and regional dimensions.[38]

Economic issues

The priority in the energy sector remains expanding the existing electricity generation capacity and building new heat and power generators to meet the growing demand in industry, primarily in the mining subsector, as well as ensuring reliable and cost-effective access to energy in the commercial, residential and transportation sectors, notably in rural areas and urban outskirts.

In the medium-term, the energy sector, along with the transportation sector, should contribute to improved connectivity between different regions of Mongolia. Improving transport and energy services will help to develop the productive sectors of the economy, diversify the sources of economic growth, and build the basis for stronger regional linkages for Mongolia so that the country is able to harness the benefits of broader regional interconnectivity.

Expansion and access efforts in the energy subsectors should include:

- Expanding existing capacity and conducting renovation work at existing power and thermal plants, as well as major coal mines
- Building new power generating plants particularly in Southern Mongolia
- Diversification of energy sources (increasing solar, wind and hydro)

[38] Some of the text presented here is based on concepts in GGGI (2015), *Strategies for Development of Green Energy systems in Mongolia (2013-2035), Extended Executive Summary*, dated February 2015, and available as http://gggi.org/site/assets/uploads/2017/11/2015-02-Strategies-for-Development-of-Green-Energy-Systems-in-Mongolia-2013-2035.pdf.

- Using energy-efficient and modern technologies in energy system such as system stabilizers and energy storage
- Expansion and renovation of power sub-stations and overhead transmission lines to increase capacity and reduce transmission losses
- Building an integrated power grid by connecting (and strengthening connections between) the existing regional energy systems
- Oil exploration
- Encouraging energy efficiency and energy conservation, including through regulatory mechanisms
- Building energy and other infrastructure aimed at unlocking the development potential of productive sectors of the economy to diversify away from mining

Social issues

The use of coal-fired cooking and heating stoves in the Ulaanbaatar districts inhabited by low-income migrant dwellers constitutes a major cause of air pollution in the city (and, increasingly, in aimag centers) and thus presents a major health hazard.

In the winter of 2019-2020, air pollution was reduced by 50 percent in Ulaanbaatar, which is considered one of the cities with the most polluted air in the world. The main driver of this reduction was implementation of Resolution No.62 dated February 28, 2018, by which the Government decided to ban raw coal consumption in Ulaanbaatar starting from May 15, 2019, introducing refined coal briquettes as a replacement fuel in order to reduce pollution.

Prior to 2018, 1.2 million tons of raw coal were consumed annually consumed by 220,000 ger district households, causing 80 percent of the air pollution in Ulaanbaatar. With the introduction of refined coal briquettes in the ger district of Ulaanbaatar, the air pollution has been reduced by half, as noted above. Moreover, a second refined coal briquette factory, located in the southern part of Ulaanbaatar, with the capacity to produce 600 000 tonnes of briquettes annually was commissioned and constructed, and an opening ceremony for the new factory was held on 08 December of 2020. The new factory provides the capacity to be able to fully provide the city with refined coal briquettes.

Improving electricity and heat supply to the ger districts and other areas, and ensuring equitable access to energy services, remain important social issue.

Equally, better electricity supply – including off-grid supply - to low-load localities scattered around the country to support the livelihoods of rural residents, reduce rural migration to urban centers, and support regional development and economic diversification, notably through developing local agribusiness and tourism, should help to promote increased economic activity, create jobs, and reduce poverty. Increased use of renewable energy for these purposes should lessen dependence on the external power supplies and thus increase energy security.

Environmental issues

Reducing air pollution and carbon dioxide emissions from fossil fuels combustion and mitigating their impacts remains a major issue to be addressed in Mongolia. Currently, coal accounts for

almost 70% of the greenhouse gas emissions in Mongolia. Achieving the government target of increasing the share of renewables in the energy mix to 30 per cent by 2030 should help to alleviate this problem.

In the future, if a natural gas pipeline route passes though Mongolia, a fuel shift from coal-to-gas could be a positive influence for reduction of air pollution, as well as helping to address climate change and other environmental issues.

Financing

More private sector investment and public-private partnership financing schemes in the energy sector should be encouraged, especially in the electricity transmission and distribution sectors and in renewable electricity generation. Private business is likely to be more effective in providing better technology and efficiency in the provision of services than the public sector.

The international financial institutions will remain important sources of both resources and expertise for Mongolia in the face of the scarcity of public funds and the need for capacity development.

The government may also have to consider the further sustainability of continued subsidizing of residential electricity and heat consumers via higher tariffs applied to industrial and commercial consumers.

Additional tariff reform and other measures to ensure the financial sustainability of businesses in the energy sector will be required in the future.

As the energy sector of Mongolia will require considerable investment in the coming decades, there is a continuing urgent need to establish tariffs that support full cost recovery in order to promote increasing private sector participation in energy markets. Tariffs must allow energy sector companies to recoup their investment in infrastructure and operations, and to earn reasonable profits. As such, some recent tariff rates that have been set low enough that subsidies have been needed to compensate for losses by energy sector companies need to be adjusted based on the real cost situations in order to attract investors and private sector companies.)

Policy/Regulatory/Governance

The discussions initiated by the Ministry of Energy on developing an Energy Sector Master Plan for Mongolia should help identify the gaps in the energy sector infrastructure and in human capital that constrain the achievement of the country's sustainable development goals, identifying and prioritizing key technical, technological and investment needs, assessing the benefits and risks of specific projects, and developing frameworks for risk reduction and practical implementation should be included in the master planning process. World Bank representatives attended the first seminar on the proposed Plan held in November 2018.

Regional Cooperation

In the years ahead, maximizing Mongolia's renewable energy potential to make it a provider of electricity for a potential cross-border energy grid linking Northeast Asian countries (sometimes

referred to as the Asian Super Grid), and using the country's location between Russia and China to potentially serve as a transit route for power transmission lines and gas pipelines connecting these two countries are seen as important goals to pursue.

These are seen not only as economically attractive projects with spin-off effects on the local economy but also as demonstrations of Mongolia's willingness to contribute in complementary way to, and participate in, regional economic integration.

9.2 Mongolia's Approach to Regional Energy Sharing

In the discussion of prospective regional energy sharing arrangements, Mongolia sees itself primarily as an exporter of electricity generated using the solar and wind resources of the Gobi Desert and as the shortest transit route of gas pipelines and electricity transmission lines from Russia to China and onwards.

9.3 Key Issues and Constraints in Regional Energy Sharing from Mongolia's Perspective

There are at least three key constraints that make regional energy cooperation a challenging endeavor**:** the amount of the investment needed/the costs associated with implementing ambitious cross-country projects, the security situation in Northeast Asia, where nuclear issues and great power rivalry (including in the area of energy supply) darken the horizons, and the need to harmonize complex non-physical aspects of cooperation such as national rules and regulations in tariffs, prices, transit rules, border procedures etc.

Although said to be technically feasible, the concept of the Asian Super Grid remains a politically challenging project since the level of trust among its potential participants is such that few governments could be expected to fully commit to its implementation and to thus depend on neighbors for the crucial issue of provision of power.

The outstanding issue of addressing the nuclear weapons issue on the Korean peninsula, and the growing major power rivalry in the region, including competition for markets for energy exports, make energy-sharing a more difficult possibility. This should not, however, prevent the region's expert and professional community from continuing to explore and propose possible options and viable frameworks for regional energy cooperation, and working to shape the debate on the best ways to proceed.

9.4 Next steps in Mongolia Energy Analysis

The Mongolia LEAP model used to prepare the results above considered current Government plans for the energy sector, consistent with the Long-term plan Vision 2050 of Mongolia. The next steps in Mongolia Energy Analysis using LEAP will include further improvements in data collection in some sections, and more detailed quantitative development of a future BAU pathway, followed by more detailed quantitative development and analysis (of physical outputs, costs, environmental emissions, and other energy security considerations) of other future pathways focused on Mongolia (such as more work on coal-based exports, or on conversion from coal-fired heating of buildings to electric heating based on renewables and storage), and of

future pathways based on energy cooperation, including large-scale exports of power from renewable energy sources.

9.5 Next steps in Analysis of Regional Energy Sharing Possibilities from Mongolia's Point of View

In accordance with the "Midterm Action Program Implementing State Policy on Energy" approved by the Government of Mongolia on the 24th of October 2018, the following main measures were planned to expand energy cooperation with neighboring and regional countries:

- Establish long-term agreements on energy trade with neighboring countries
- Cooperate with neighbors to develop energy transit infrastructure within initiatives to create an economic corridor between Russia and China through Mongolia
- Support the Asian Super Grid international initiative and export-oriented energy projects

In addition, the Midterm Action Program includes the following next steps to be considered from the Mongolian side with regard to Regional Energy Sharing.

- To coordinate with other country working groups for the sharing of information and knowledge regarding all relevant initiatives for power interconnection in North-East Asia;
- To carry out joint scientific, research and planning work;
- To enhance the legal environment for investors, and keep the enhanced environment sustainable, for example, through changes in government;
- To have a clear policy governmentally and politically for foreign investments, so as to make rules clear for foreign investors;
- To develop infrastructure in border areas—including railways, roads, and the capacity of customs checkpoints; and
- To strengthen cooperation mechanisms for power interconnection in North-East Asia.

10 Selected References

Ministry of Energy, Energy Performance Report 2017, http://www. energy.gov.mn

Energy Regulatory Commission of Mongolia, Energy Law packages, Policies and regulations, http://erc.gov.mn/web/en/files?tag=15

Energy Regulatory Commission of Mongolia, Statistics on Energy Performance 2016, 2017

Mongolia Legal Information Data base, https://www.legalinfo.mn/

Mongolian Statistical Yearbook 2017, National Statistics Office of Mongolia,

Mongolian Statistical Database, National Statistics Office of Mongolia, www.1212.mn

ADB and National Statistics Office of Mongolia, Publication 2018, Selected Environmental-Economic Accounts of Mongolia,

Customs Authority of Mongolia, The Statistics on Exports and Imports, Annual Report 2017, www.ecustoms.mn

Energy Development Center, 2017, Publication on Energy Mongolia 2017, Special Edition

IRENA, March 2016, Mongolia Renewables Readiness Assessment, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_RRA_Mongolia_2016.pdf

Ana-Maria Seman, 2017. Mongolia's Energy Sector 2017, CEE Bankwatch Network, https://bankwatch.org/wp-content/uploads/2017/06/Mongolia-energy-sector-web.pdf

e.gen and Mon Energy Consult, 2013 Sep, ADB Updating Energy Sector Development Plan (TA No.7619-MON): Final Report. Prepared for ADB and The Mongolian Ministry of Energy

GGGI, 2015 Feb, Strategies for Development of Green Energy systems in Mongolia (2013-2035), Extended Executive Summary, http://gggi.org/site/assets/uploads/2017/11/2015-02-Strategies-for-Development-of-Green-Energy-Systems-in-Mongolia-2013-2035.pdf.

ADB, 2017 Sector Assessment: Energy sector; Ulaanbaatar Air Quality Improvement Programme (RRP MON51199). https://www.adb.org/sites/default/files/linked-documents/51199-001-sd-01.pdf.

EBRD, 2017 June, Strategy for Mongolia, Public Document of the European Bank for Reconstruction and Development, file:///C:/Users/user/Downloads/country-strategy-mongolia%20(2).pdf

Ana-Maris Seman, CEE bankwatch network, Apr 2017, Mongolia's Energy Sector, https://bankwatch.org/wp-content/uploads/2017/06/Mongolia-energy-sector-web.pdf

https://nautilus.org/projects/by-region/northeast-asia/

https://eneken.ieej.or.jp/en/publication/index.html

Renewable Energy Institute, Tokyo, Asia International Grid Connection Study Group, Asian Super Grid Interim Report, Apr 2017, https://www.renewable-ei.org/en/activities/reports/img/20170419/ASGInterimReport_170419_Web_en.pdf

Mongolia, XacBank LLC., Funding Proposals, Renewable Energy Program#1-Solar, Nov 2017, https://www.greenclimate.fund/documents/20182/574760/Funding_Proposal_-_FP046.

Fraunhofer ISE, Jan 2014, Shuta Mano, Bavuudorj Ovgor, Zafar Samadov., Gobitec and Asian Super Grid for Renewable Energy in Northeast Asia, Energy Charter Secretariat Organization Internationale Ent (E) https://energycharter.org/fileadmin/DocumentsMedia/Thematic/Gobitec_and_the_Asian_Supergrid_2014_en.pdf

ADB, 2018, Upscaling Renewable Energy Sector in Mongolia, https://www.adb.org/sites/default/files/project-documents/50088/50088-002-rrp-en.pdf

Government of Mongolia, 2015, Scaling -up Renewable Energy Programme (SREP) Investment Plan for Mongolia,

https://www.climateinvestmentfunds.org/sites/cif_enc/files/srep_ip_mongolia_final_14_dec_2015-latest.pdf,

ADB, *Proposed Loan and Administration of Grants Mongolia, 2018, Upscaling Renewable Energy Sector Project* document, https://www.adb.org/sites/default/files/project-documents/50088/50088-002-rrp-en.pdf

Dr Andrew J Minchener, 2013, Energy issues for Mongolia, IEA Clean Coal center, https://www.usea.org/sites/default/files/012013_Energy%20issues%20for%20Mongolia_ccc215.pdf

Ministry of Mining and Heavy Industry, Mineral Resources and Petroleum Authority of Mongolia, Annual Report on Minerals 2017 and, Mineral Resources and Petroleum Statistics 2018, https://www.mrpam.gov.mn/public/pages/131/monthly.report.2018.12.eng.pdf

National Statistic Office of Mongolia, Publication on 2015 Population and Housing By-Census of Mongolia,

Purevsuren Dorj, Geothermal Development in Mongolia: Country Update 2015, Proceedings World Geothermal Congress 2015 Melbourne, Australia, 19-25 April 2015,

The Report: Mongolia 2015, Energy, https://oxfordbusinessgroup.com/overview/much-undiscovered-potential-mongolias-energy-sector-government-laying-groundwork-future-development

The Jamestown Foundation, Global Research & Analysis, June 28, 2018, Mongolia's Place In Northeast Asia's Renewable Power Grid. By Alicia J. Campi, available as https://jamestown.org/program/mongolias-place-in-northeast-asias-renewable-power.

JCM Feasibility Study (FS) 2015 Summary of the Final Report "Distributed heat supply system using biomass and coal mixture combustion type boiler" http://gec.jp/jcm/en/wp-content/uploads/2017/05/2015FS201_sum_en.pdf

Enkhtaivan Gundsamba, Policy Planning Department, Ministry of Energy, Power Sector Policy of Mongolia, Mongolia-Korea Energy Sector Cooperation Forum 24 Nov 2016, UB

Ministry of Energy, the Potentials for Bioenergy development Mongolia 2016, http://www.uncsam.org/Activities%20Files/A0801/0302.pdf

Combustion of dung, https://energypedia.info/wiki/Cooking_with_Dung#Combustion_of_Dung

Master plan to define sustainable development of energy sector, Nov 2018, https://www.montsame.mn/en/read/170397,

China total coal import data, https://www.spglobal.com/platts/en/market-insights/latest-news/metals/012819-china-imports-6423-mil-mt-of-coking-coal-in-2018-down-8-from-2017

Uranium 2018 Resources, Production and Demand, Joint Report by the Nuclear Energy Agency and IAEA, https://www.oecd-nea.org/ndd/pubs/2018/7413-uranium-2018.pdf.

Report on Mongolia's Forest reference level submission to the UNFCCC, 2018) Ministry of Environment and Tourism, http://reddplus.mn/eng/wp-content/uploads/2018/01/2018-Mongolia-FREL_v1.5-1.pdf

Prof. Adyasuren Ts, Cleaner Fuel and Vehicles in Mongolia, 2018; http://cleanairasia.org/wp-content/uploads/2018/05/Adiyasuren-Tsokhio-Cleaner-Fuel-and-Vehicles-in-Mongolia.pdf

Leonardo Nascimento, Aki Kachi, Silke Mooldijk, Carsten Warnecke, 2019, Renewable heating virtual Article 6 pilot-Ground source heat pumps in Khovd, Mongolia, NewClimate Institute; https://newclimate.org/wp-content/uploads/2020/01/Mongolia-Art-6-Virtual-Pilot-13-January-2020.pdf

Asia International Grid Connection Study Group, Interim Report (2017), Renewable Energy Institute, Tokyo, https://www.renewable-ei.org/en/activities/reports/20170419.html

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