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

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I. INTRODUCTION

In this Special Report, Oyunchimeg, Tuya, Zorigt, Sukhbaatar and Bayarkhuu describe the current status and recent trends and challenges in Mongolia's energy sector, and describe projections by other groups of Mongolia's energy future with respect to both meeting its growing domestic needs and becoming a major exporter of energy. Mongolia's energy policies and discussions with nations in the region regarding infrastructure for energy sharing are also summarized.

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Banner image: South Gobi Tsetsii Wind Farm, photo by Oyunchimeg Ch.

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

In Mongolia, total primary energy supplies continue to be dominated by coal, and electricity generation is largely from 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 3.2 million (Table 1-1) and an average population density of 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 between 2012 and 2017

Population	2012	2013	2014	2015	2016	2017
Total	2,867,744	2,930,277	2,995,949	3,057,778	3,119,935	3,177,899
Male	1,393,453	1,425,843	1,466,455	1,503,612	1,533,983	1,562,370
Female	1,474,291	1,504,434	1,529,494	1,554,166	1,585,952	1,615,529

Source: Mongolian Statistical Yearbook 2017, NSO (National Statistical Office) of Mongolia

Table 1-2: Population and Population Growth in Mongolia by Region, 2010 and 2015

	Population (thous)		%	Percentage	
Region	2010	2015	2015 / 2010	2010	2015
TOTAL	**2647.5**	**2990.2**	**12.9**	**100**	**100**
Western	352.3	387	9.8	13.3	12.9
Khangai	514.7	573.1	11.3	19.4	19.2
Central	440.7	477.2	8.3	16.6	16
Eastern	185.3	207.5	12	7	6.9
Ulaanbaatar	1154.3	1345.5	16.6	43.6	45

Source: 2015 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 disaster), 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 and at the beginning of 2018 relative to previous years, with the GDP growth rate increasing from 1.2 percent in 2016 to 5.1 percent in 2017 and 6.4 percent in 2018 (see Table 1-3).

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

Table 1-3: Mongolia Economic Data, 2013-2017

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

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

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 2018, 93% of total electricity was produced by thermal power plants, and 98% of district heat was provided by coal.

Mongolia has estimated total coal resources of approximately 173 billion tons, and based on the ADB Sector assessment report on Energy sector (2017), 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 2018, coal production in Mongolia reached 54.5 million tons, of which 45.5 million tons were sold and 36.7 million tons were exported, with the remainder placed in storage. Based on the coal balance of 2018, a total of 0.4 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 5,948.7 million kWh in 2017, with a peak load of 1016 MW, and its annual average growth rate has been about 4–5% in recent years. Electricity consumption per capita is increased rapidly, from 1,314 kWh to 1,929 kWh, over the period between from 2012–2017.

1.3 Key Energy Policy Issues for Mongolia

Based on the "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
- Environmental sustainability and green development

As stated in the energy policy, 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 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, 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 1280 MW (as of 2018). 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 5,948.7 million kWh in 2017, with a peak load of 1016 MW. Mongolia imports electricity from Russia and China, which accounted about 20% (1,574.3 million kWh) in 2017 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 year, and Figure 2-1 shows the trend in peak demand growth in Mongolia since 2001.

Table 2-1: Mongolia Electricity Balance, 2012–2017; (Unit: million kWh)

Indicators	2012	2013	2014	2015	2016	2017
Gross electricity generation	4,815.6	5,019.5	5,375.8	5,513.2	5,667.1	6,027.3
Imports	366.0	1,195.5	1,349.2	1,416.8	1,446.3	1,574.3
Distribution -Total	5,181.6	6,215.0	6,756.8	6,895.0	7,047.5	7,601.7
Consumption	3,772.6	4,732.1	5,158.4	5,283.5	5,445.7	5,948.7
Industry and construction	2,338.9	2,930.7	3,171.6	3,261.4	3,356.3	3,692.0
Transport and communication	156.8	196.9	211.4	3,261.4	222.9	247.5
Agriculture, forestry and fishing;	39.8	49.9	63.7	3,261.4	56.6	62.8
Household and communal housing	906.7	1,139.2	1,251.4	3,261.4	1,321.3	1,426.6
Other	330.4	415.4	460.4	3,261.4	488.6	519.8
Losses in transmission and distribution	675.4	739.5	792.6	3,261.4	817.1	810.9
Station internal use	712.4	725.3	772.4	3,261.4	748.7	816.4
Export	21.2	18.2	33.4	3,261.4	36.0	25.7
Electricity produced per capita, kW.h	1,762.3	1,797.9	1,866.2	3,261.4	1,872.2	1,945.8

Source: Mongolian Statistical Yearbook 2017, Mongolian Statistics Office of Mongolia (NSO)

Figure 2-1: Peak Demand Growth in CES, 2001–2017, MW (Excluding Oyu Tolgoi Mining)

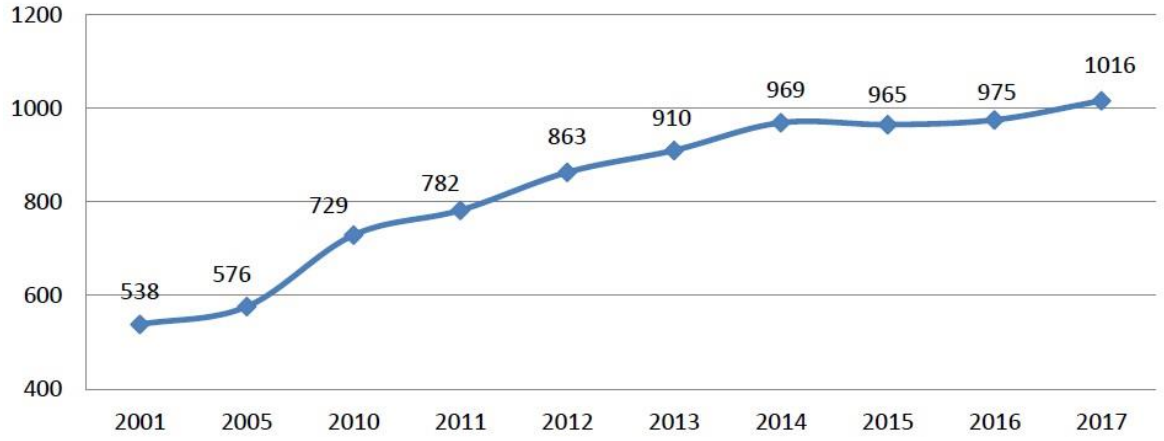
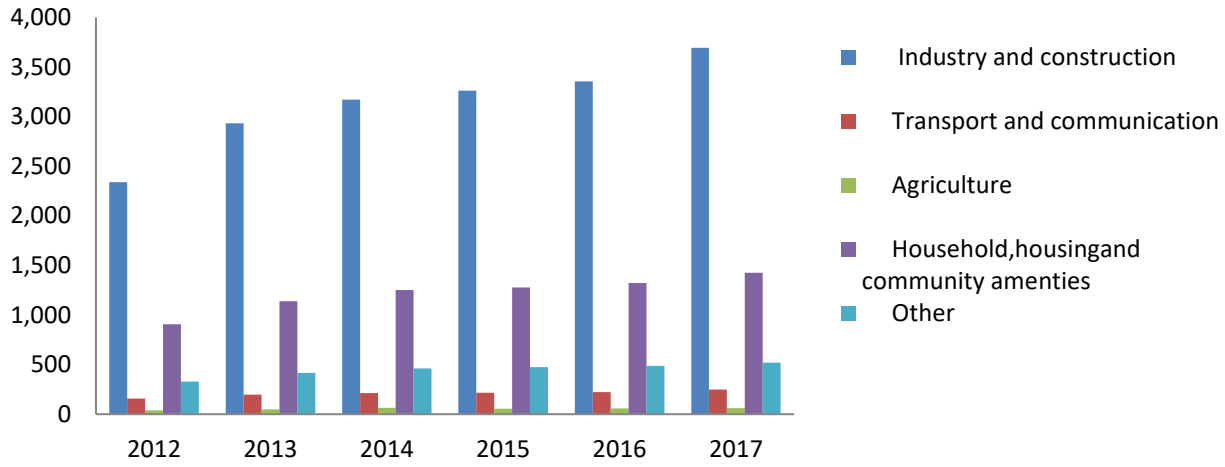
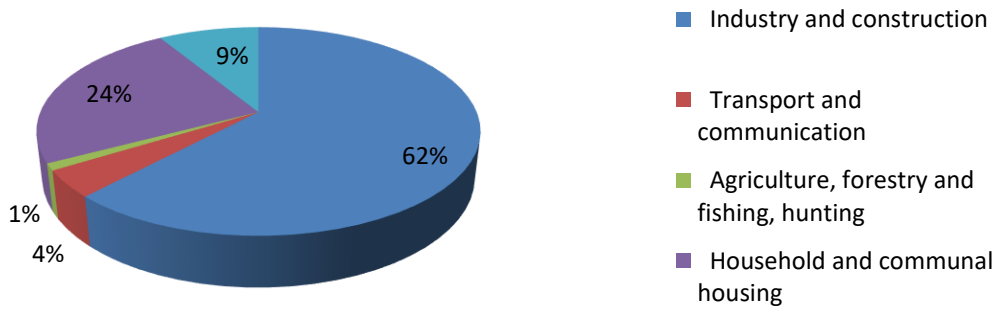


Figure 2-2: Electricity Consumption by Sectors, GWh, 2012–2017



The highest-volume electricity consuming sector in Mongolia is the industrial sector, as shown in Figure 2-2, which accounts for 62% of electricity use and consumed 3,692 million kWh in 2017, while the Household and communal housing sector accounted for 24 % of demand with consumption of 1,426 million kWh in 2017.

Figure 2-3: Electricity Consumption Share for 2017 by Sectors, by percentage



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 three widely used studies: (*ADB Updating Energy Sector Development Plan 2013* (the "ADB study"), the Global Green Growth Institute *(GGGI)* study *Strategies for Development of Green Energy Systems in Mongolia*, completed in 2015, (the "GGGI study"), and the ADB *Energy sector Assessment 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 (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 shows for the whole of Mongolia which includes and excludes 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 concerned is projected to reached at 4,073 MW in 2030. (Table 2-2, Low scenario)

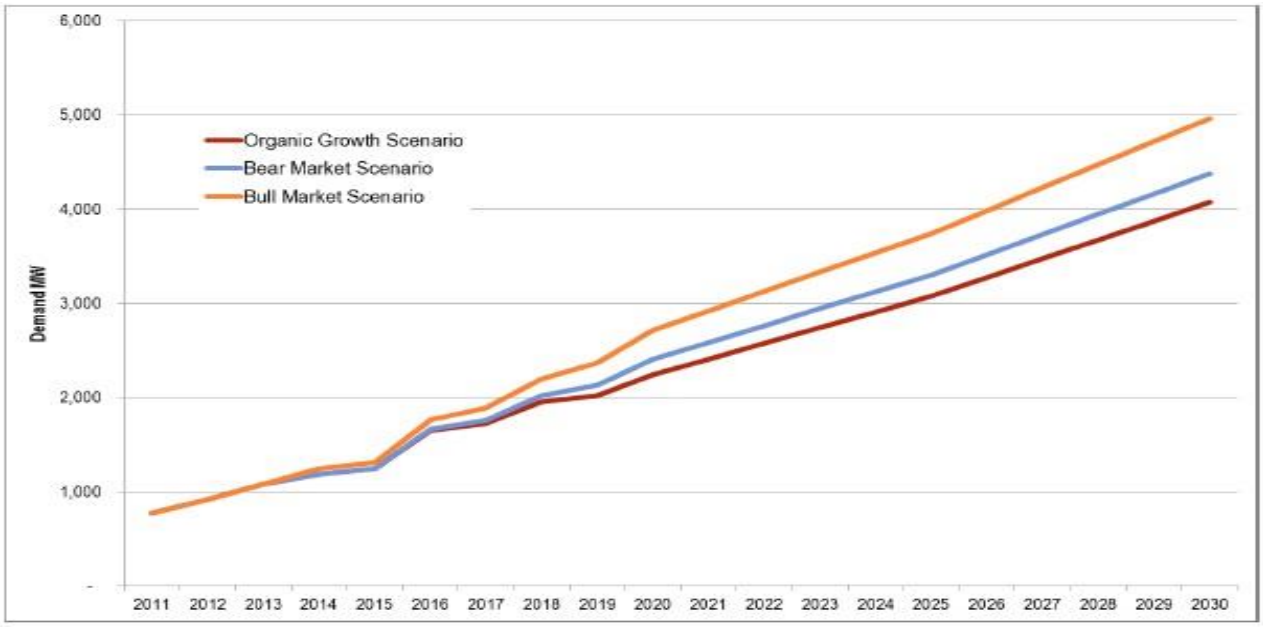
Table 2-2: Whole of Mongolia Electricity Demand Forecast (including and excluding OT and TT)

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. According to the study, excluding OT and TT, the estimated growth rate (7.1%) is consistent with the average growth rates in Mongolia over the past decade (see Figure 2-4).

Figure 2-4: 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 growth rates are shown for the CRES (see Table 2-3) are considered reasonable by authorities in Mongolia. Population growth in the CRES is expected to continue at a high rate, increasing 17% by 2020 relative to 2017, mostly as a result of 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 forecast by GGGI study on Strategies for Development of Green Energy Systems in Mongolia:

This study was carried out as part of an ongoing collaboration between GGGI and the Government of Mongolia focused on the strategic objectives of green development. As a part of this study, energy demand was projected using the LEAP model under four broad scenarios of how energy supply and demand could evolve in Mongolia through the year 2035. (The Long-range Energy Alternative Planning system (LEAP) is software tool for energy policy analysis and climate change mitigation assessment developed by the Stockholm Environment Institute). A brief explanation of the scenarios included in the GGGI study is as follows:

- *The Reference scenario:* Continuation of largely coal-based energy supply for a rapidly expanding economy driven by mining exports, particularly coal and copper. Gradual improvements in energy intensity of demand
- *The Recent Plans scenario:* Same economic and demographic forecast, but with accelerated introduction of key technologies reflecting recent developments and priorities;
- *The Expanded Green Energy scenario:* describes a future where Mongolia makes an even stronger transition to renewable energy and implements extensive energy efficiency potentials conducted in the country;
- *The Shift in Energy Export scenario*: same as the *Expanded Green Energy scenario* with an additional shift in the types of fuel and energy exported from coal to renewable (wind and solar);

Table 2-4 presents overall scenario results from the GGGI study for the first three scenarios described above in term of overall energy demand of Mongolia through 2035.

Table 2-4: Overall Energy Demand of Mongolia, (TJ) in Three Scenarios

Scenario	2010	2015	2020	2025	2030	2035
Reference	133	189	248	298	356	419
Recent plans	133	188	243	288	339	393
Expanded green energy	133	186	223	244	265	285

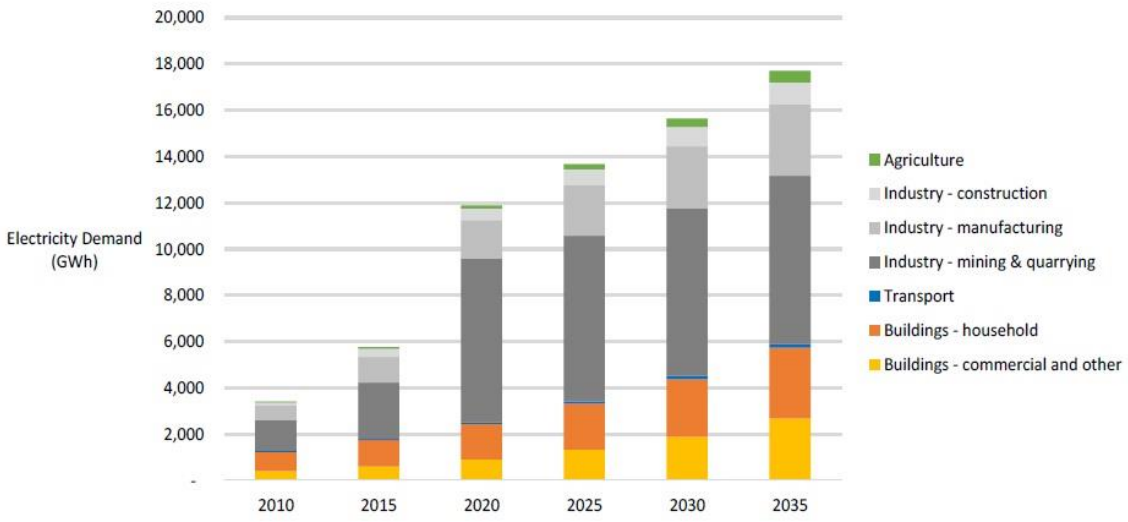
Source: GGGI, Report on Strategies for Development of Green Energy Systems in Mongolia (2013–2035)

Based on the *GGGI study*, overall energy demand by 2035 for Mongolia is projected to reach to 419 TJ in the *reference scenario* (see Figure 2-5), 393 TJ in the *recent plans scenario*, and 285 TJ in the *expanded green energy scenario*, respectively. The GGGI report describes the recent plans case as reducing energy use in 2035 relative to the *reference* case by 6%, while the *expanded green energy* case reduces overall energy demand by 32% relative to the reference case.

As noted in the report, the combination of measures in the recent plans case reduce 2035 electricity demand by 3.5% relative to the *reference* case, while the more extensive suite of

options in the *expanded green energy* case reduce overall 2035 electricity demand by 27%, despite the addition of some electricity demand, relative to the *reference* case, in the buildings (for ground-source heat pumps) and transportation sectors.

Figure 2-5: Electricity Demand by Sector, Reference Scenario, GGGI Report



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 a 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, pushes electricity and heat load demand growth further. Heat load demand in Ulaanbaatar grew by 35% between 2006–2016, and it is projected to grow to 8,096 Teracalories (thousand billion, or 10^{12} calories) in 2030 from 5,059 Teracalories in 2017 (see Table 2-5. 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 at 20% reserve margin for electricity and 15% for heat by 2030.

Table 2-5: 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 2-6) the largest share of output belongs to the Mining and quarrying (extraction) industries (56.1% as of 2017) while manufacturing industries make up 34.8% of total industrial output.

Table 2-6: Gross Industrial Output, by Sub-sectors

Sub-sector/Divisions	2012	2013	2014	2015	2016	2017
	Unit: percentage					
Mining and quarrying	58.9	58.4	64.4	55.1	55.6	56.1
Manufacturing	30.7	30.8	28.1	35.9	33.3	34.8
Power&Heat producing industry (Electricity, gas,steam and air conditioning supply)	8.4	8.7	5.9	7.1	9.1	7.4
Water supply; sewerage, waste management and remediation activities	2	2.2	1.7	1.9	2	1.7

Source: Mongolian Statistical Yearbook 2017, NSO

For the years between 2005 and 2016, the extraction of copper ores increased by 180%, coal by 330% and crude oil by 400%. As Mongolia is a country with natural resource based, Mongolia exports mostly raw products, such as coal and copper concentrate and gold, and imports finished products (see Table 2-7 and Table 2-8).

Table 2-7: Coal Production and Exports, tonnes, 2014–2018

	Striping /ths.m3/	Coal production /th.tons/	Coal sale /th.tons/	Coal export /th.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

Source: Mineral Resources and Petroleum Statistics 2018, Mineral Resources and Petroleum Authority of Mongolia,

Table 2-8: Gold Exports, 2012–2017

Indicator	2012	2013	2014	2015	2016	2017
	Unit: tonne					
Gold production	6.0	8.9	11.5	14.5	18.4	19.8
Gold Export	2.8	7.6	10.0	11.3	19.2	14.6

Energy use in the industrial sector

In the Energy balance, the electricity consumption share for the industry and construction sector in the CRES accounted for 62% of total industry use on the system (Figure 2-1), while Household and communal housing accounted for 24% of the total. For the period 2012–2017, electricity consumption increased from 2,338.9 million kWh to 3,692.0 million kWh for 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 460.5 GWh for Darkhan Steel Industry and 1045.5 GWh for Erdenet Copper Industry.

In the format of the "*New estimation developed by the ADB and NSO on Energy account"*, sectors are separated by their energy use, and for the first time Mongolia had official figures for the total energy supply and energy use by each sub-division in accordance with international reporting standards (see Table 2-9). This energy use estimate was done in 2018 based on data from 2015 and 2016.

Table 2-9: Total Energy Use (TJ), by sector, 2015–2016

	2015	2016	2015 by %	2016 by %
ENERGY USE	**832 262.7**	**1 102 973.5**	**100**	**100**
Net energy use	**829 219.8**	**1 098 242.6**	**99.6**	**99.6**
Energy use by industries	**232 262.9**	**236 233.7**	**27.9**	**21.4**
Agriculture, forestry and fishing	785.6	745.8	0.1	0.1
Mining and quarrying	20 484.5	25 827.2	2.5	2.3
Manufacturing	15 104.7	14 549.3	1.8	1.3
Power&Heat producing industry (Electricity, gas, steam and air conditioning supply)	150 380.3	151 809.5	18.1	13.8
Water supply; sewerage, waste management and remediation activities	976.6	919.4	0.1	0.1
Construction	6 822.1	7 209.7	0.8	0.7
Wholesale and retail trade; repair of motor vehicles and motorcycles	7 715.2	5 890.3	0.9	0.5
Transportation and storage	7 771.7	8 356.5	0.9	0.8
All other services	22 222.4	20 925.9	2.7	1.9
Energy use, by households	**105 900.7**	**111 835.9**	**12.7**	**10.1**
Changes in inventories and produced assets	**64 558.1**	**4 935.4**	**7.8**	**0.4**
Export	**426 498.2**	**745 237.6**	**51.2**	**67.6**
Energy losses	**3 042.9**	**4 730.9**	**0.4**	**0.4**

Source: Statistical Database, www.1212.mn; National Statistic Office of Mongolia

Diesel fuel accounts for nearly half of the energy used by the mining industry whereas, the manufacturing industries' energy use is dominated by the electric power and heat industry.

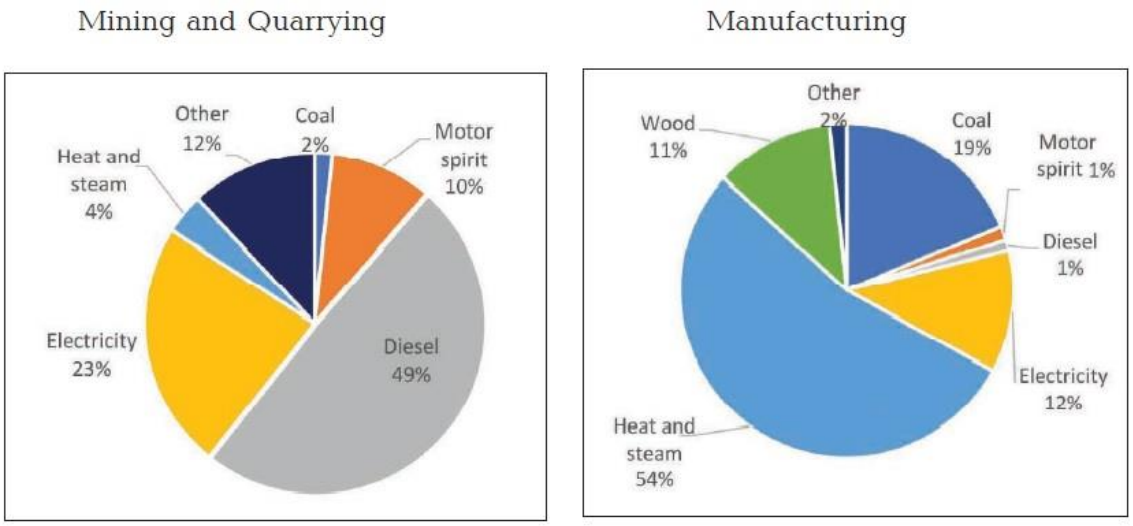
The Oyu Tolgoi copper and gold mine is a large electricity user and is located in the South Gobi region. Power demand in the South Gobi region was projected by both the ADB and GGGI studies (see Table 2-10) to grow rapidly as a result of both existing and new mining development. Oyu-Tolgoi and Tavan Tolgoi plan to build power plants to service their own needs. (Currently, the Oyu Tolgoi Mining is using electricity imported from China and its electricity consumption is thus not included in the CRES Energy balances.)

Table 2-10: 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

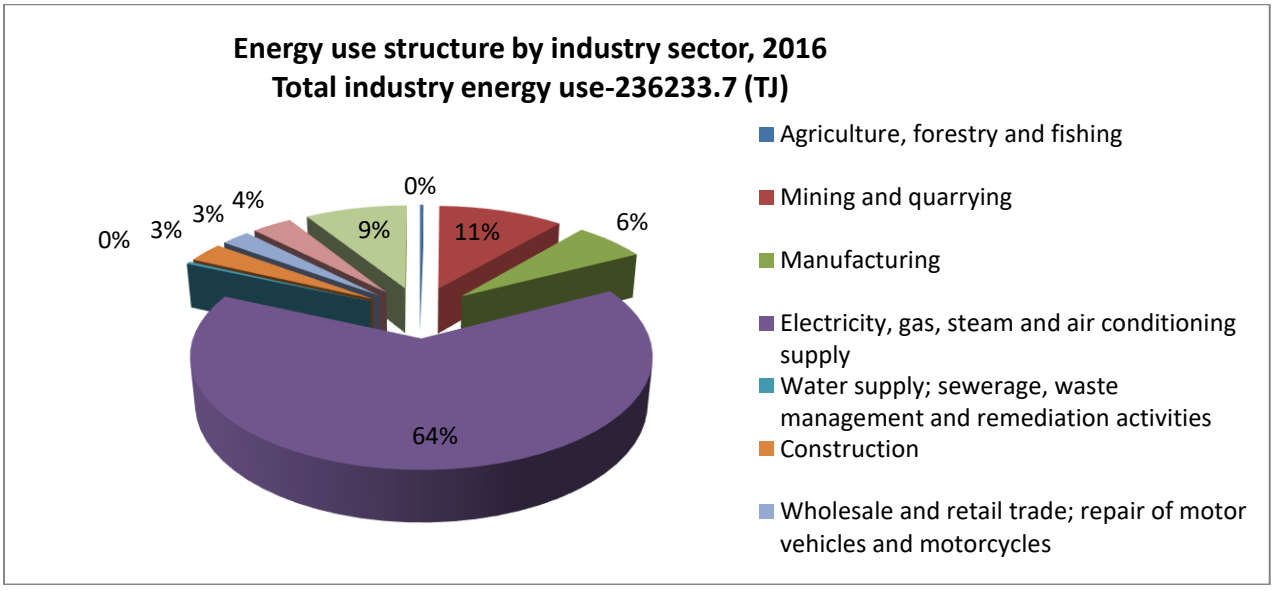
Source: ADB, Updating Energy Sector Development Plan (TA No.7619-MON)

Figure 2-6: Energy Use by Energy Product, 2016



Industries have different energy use profiles with regards to the energy products they use. In Mining and Quarrying there is high use of diesel fuel, which is used in the heavy mining equipment and machinery used to extract minerals from the earth. The use of electricity is high. In the manufacturing industries 19% of energy use is from coal, 54 percent from centrally supplied district heat and steam, 12 percent from electricity and 11% from wood comprise most of the remaining energy use. In the Power and heat supply sector (the electricity, gas, steam and air conditioning supply industries) 96% of the energy use came from coal in 2016 (see Figure 2-6).

Figure 2-7: Total Energy Use, by Industrial Sector, TJ



The power and heat-producing industries (Electricity, gas, steam and air conditioning suppliers) dominate energy use more than other sector in Mongolia, accounting for over 38.7% (151,810 TJ) of final energy demand in 2016 (Figure 2-7).

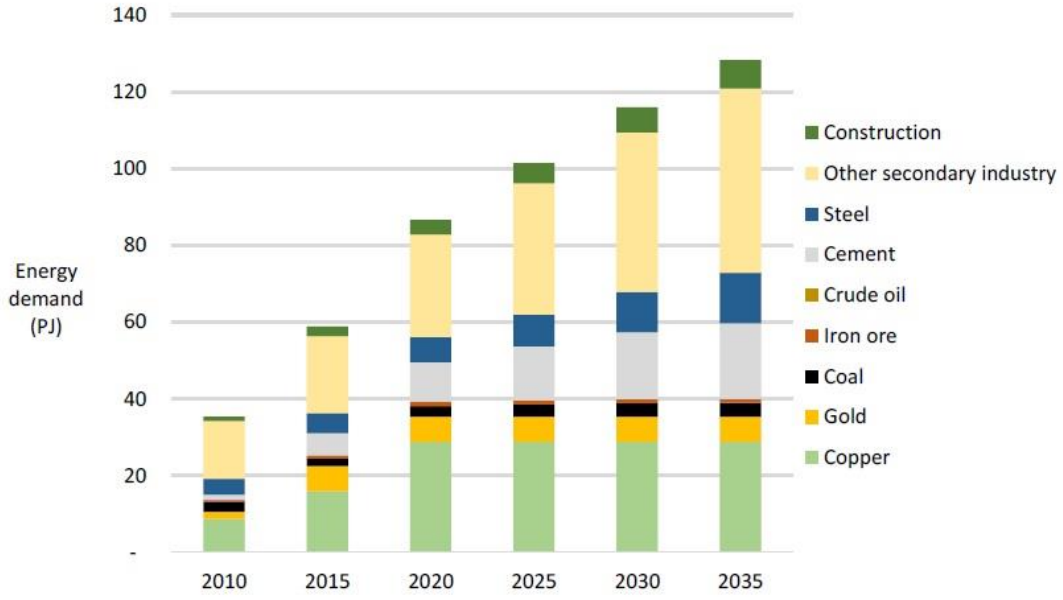
Energy Demand Forecasts for the Industrial Sector

As forecasted in the *ADB study*, in accordance with the *CRES Electricity "Low" forecast scenario*, electricity consumption for the Industrial Large sector of CRES (Darkhan Steel and Erdenet Copper are considered as "Heavy Industry-Large Consumer") 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 by 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 2-4: Mongolia-wide Electricity Demand Forecast (including OT and TT)".

In with the projections prepared as a part of the *GGGI study*, demand in the industrial sector grows more than in any other sector in the *reference scenario*, overtaking buildings (the residential and commercial sectors) as largest overall energy user in the next several years. Figure 2-8 shows the growth in energy consumption by subsector for the industrial sector. Electricity use in the sector jumps with the increase in copper output from 2014 on, with electricity initially imported from China, and later produced by the Tavan Tolgoi mine-mouth power plant.

Figure 2-8: Energy Demand by Subsector in the Industrial Sector, Reference Scenario, GGGI Study



2.3.2 Buildings

The buildings sector in Mongolia is divided into 2 the household subsector and the "commercial & other" subsector. Buildings, including both housing and businesses 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 2015 Population and Housing By-census for Mongolia, 45.4 % of households live in traditional Mongolian dwellings (gers), 54.2 % percent live in buildings and the remaining 0.4 % live in other types of housing (see Table 2-11). Since the last full census (in 2010), the percentage of households living in gers has increased by 0.2%, with the percentage of households living in buildings increasing by 0.6%.

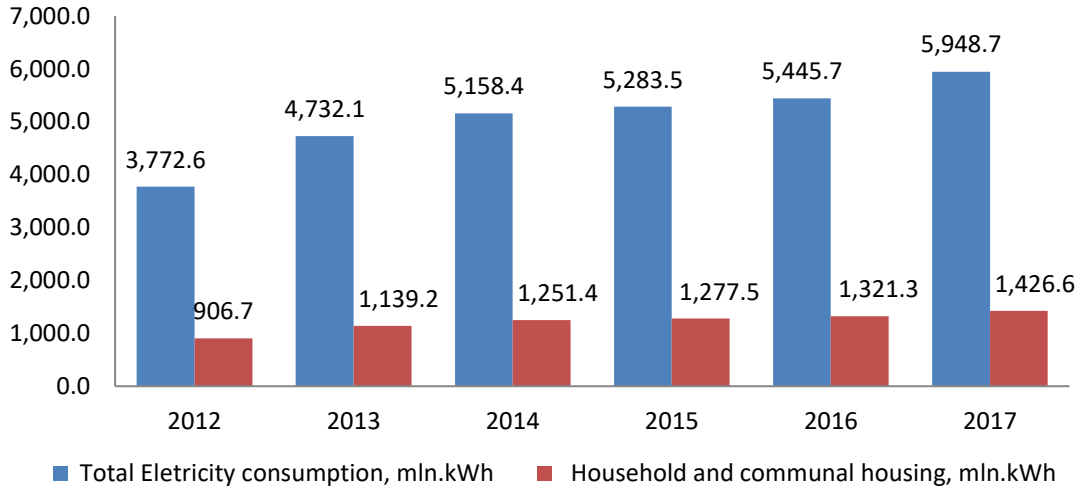
Table 2-11: Households (HH) by Housing Type, 2010, 2015

Housing Type	2010		2015	
	thous. HH	%	thous. HH	%
TOTAL	713.8	100	859.1	100
Ger	322.8	45.2	389.9	45.4
Building (apartment, single family home, public dwellings)	382.8	53.6	465.3	54.2
Other housing	8.2	1.1	3.9	0.5

Energy use by households

Electricity consumption by the buildings sector for the period between 2012–2017 increased from 906.7 million kWh to 1,426.6 million kWh (see Figure 2-9).

Figure 2-9: Electricity Consumption for Households, Housing and Community Amenities Sector, 2012–2017, million kWh

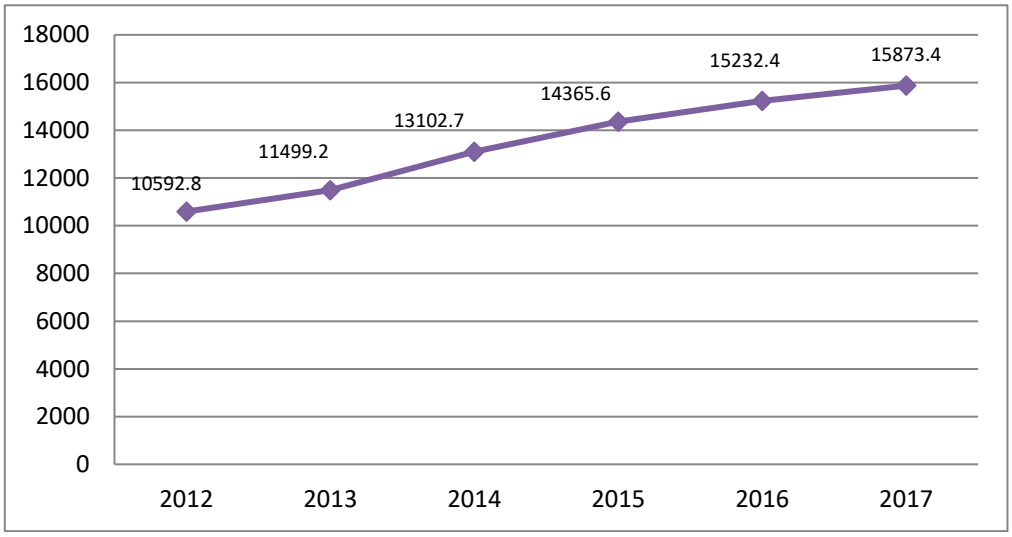


Electricity consumption for households in the Historical Energy balances (Table 2-1), is calculated together with Commercial and Community amenities considered as one category.

As energy use in households is driven by population growth, and Mongolia's population is expected to grow from 3.1 million in 2017 to 4.9 million in 2045, an increased demand for housing will be created, as well as an increase in household energy use. Figure 2-10 shows the increase in housing stock over the five years from 2012 through 2017.

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. Figure 2-10 shows the growth in housing stock from 2012 through 2017 in Mongolia.

Figure 2-10: Housing Stock Floor Space, Thousand square meters, 2012–2017



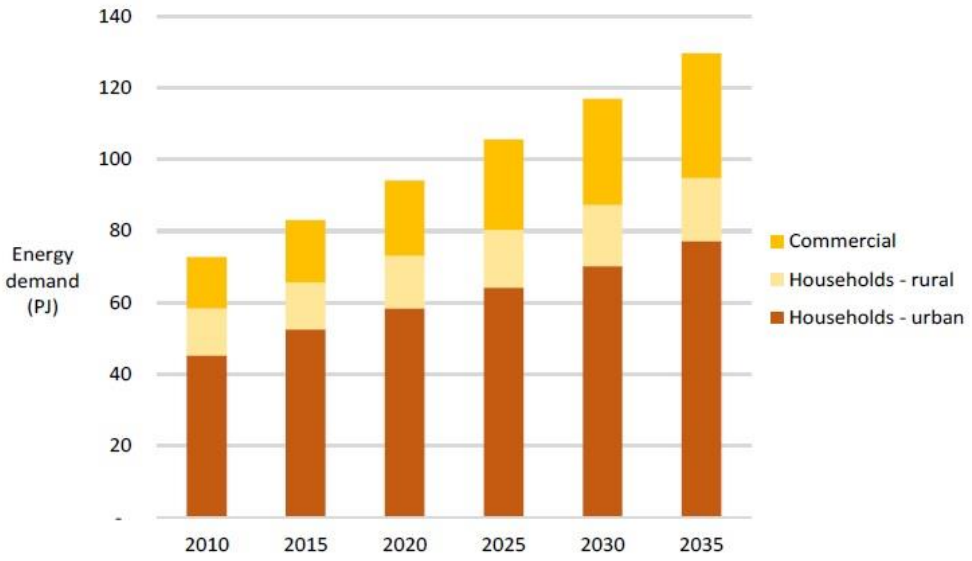
Energy demand forecasts in the buildings sector

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.

In the *GGGI study*, energy demand for the buildings sector was forecast in *4 scenarios*. In the *recent plans scenario*, relative to the *reference case*, year 2035 energy demand was reduced by 20%. In the *expanded green energy scenario*, relative to the *reference case*, year 2035 demand was reduced by over 35%.

Figure 2-1shows overall energy demand in the buildings sector in the *reference scenario*, based on results of the *GGGI Study*. In the Reference scenario, energy savings from better insulation in residential buildings is offset by increases in thermal comfort, which generate opposing trends in heating energy intensity. In the commercial sector, new buildings tend to have more glass area, which contributes to greater heating needs in the winter due to poor insulation values, and increased cooling needs in the summer due to higher solar gain. Urban household energy use dominates energy demand in the buildings sector, with demand projected to nearby double between 2010 and 2035, despite the combination of energy efficiency improvements and ongoing shift away from less-efficient biomass heating fuels.

Figure 2-11: Energy Demand in the Buildings Sector in the Reference Scenario (GGGI Study)



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. In particular, there has been a strong trend towards increases in the number of private passenger vehicles (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. As a result of this import pattern, most of the vehicles currently used in Mongolia are over 10 years old (see Figure 2-12). A substantial fraction of vehicles imported in recent year 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 2-13).

Table 2-12: Number of Vehicles in Mongolia

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

Source: Road transport sector 2017 statistic, Ministry of Road and Transport development of Mongolia, http://mrtd.gov.mn/single/88/item/1485

Figure 2-12: Vehicles Usage, by Age, 2012–2017

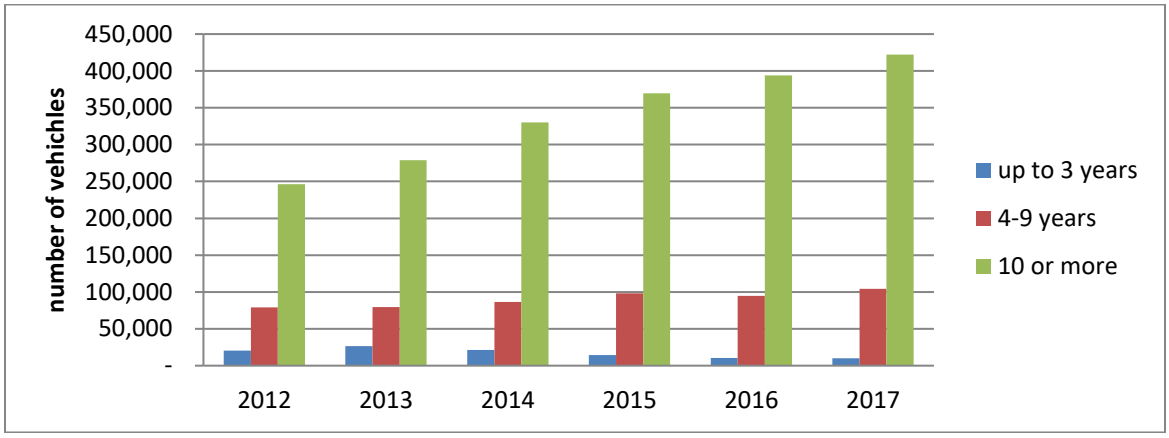
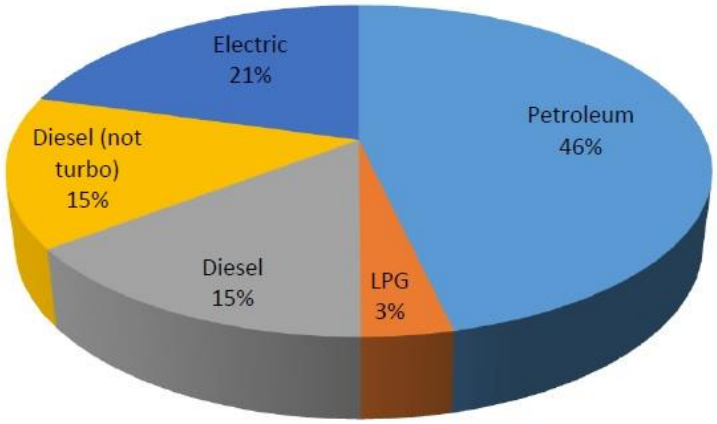


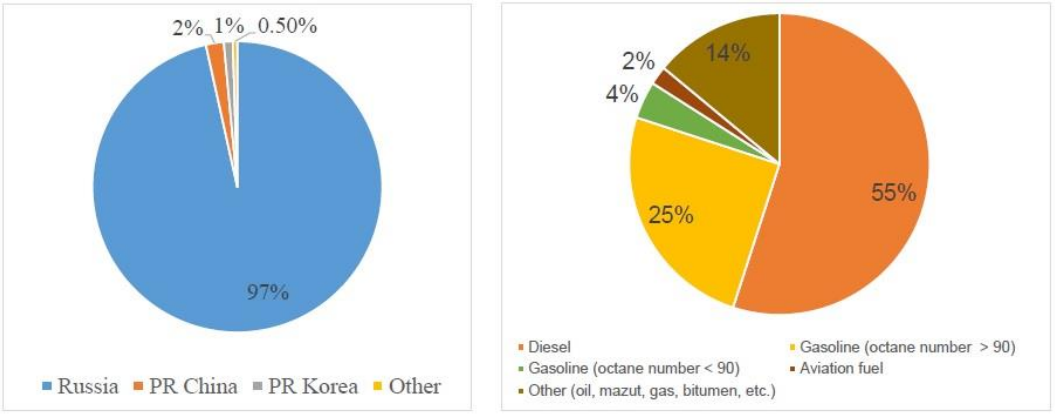
Figure 2-13: Vehicles, by Engine and Fuel Type, 2017



Energy use in the transport sector

In the transportation and storage industries, transport diesel and aviation fuels accounted for 73 percent of the industry's total energy use in 2016. Mongolia imports all of the petroleum products it uses. In 2017, Mongolia imported a total of 410.8 kilotonnes gasoline and 805.3 kilotonnes of diesel fuel. The sources and types of Mongolia's fuel imports in 2017 are shown in Figure 2-14.

Figure 2-14: Shares of Petroleum Products Imports and Use in Mongolia, 2017



In accordance with NSO's new estimates, the total energy use for the Transportation and Storage sector was 7771.7 (TJ) in 2015 and 8356.5 (TJ) in 2016.

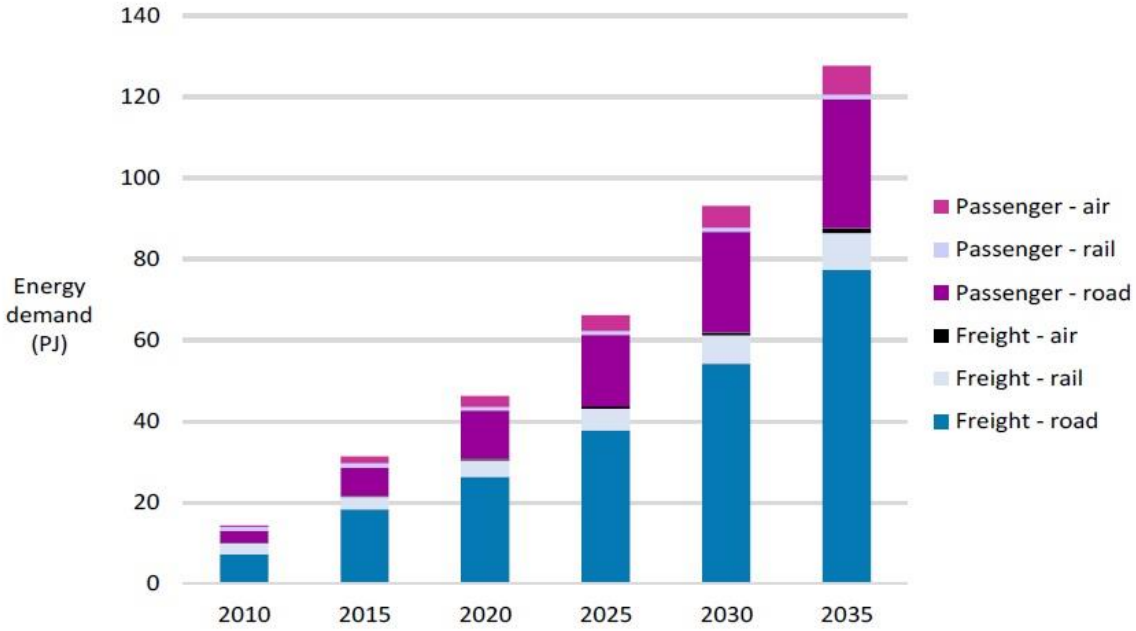
Energy Demand Trends in the Transportation Sector

Based on the *reference* scenario of the *GGGI study*, , a continued increase in personal travel is expected, as the total passenger-km traveled increases with both population growth and with a roughly five-fold increase in travel per person by 2035 relative to 2010. In addition, a greater fraction of passenger transport is by private cars (40% of passenger-kms in 2020 and 49% in 2035, up from 25% in 2010) and air (at 27% by 2020, maintained through 2035, up from 21% in 2011).

A gradual decline in the energy intensity of vehicles, following forecasts international vehicle efficiency trends, occurs for both passenger (declining at about 1% per year for cars, 0.5% per year for buses) and freight vehicles (declining 0.4% per year).

Figure 2-15 shows the *GGGI study reference* case trends in energy demand in the transport sector, by subsector. Freight road transport dominates (using diesel fuel), with much of the demand related to coal and minerals production.

Figure 2-15: Energy Demand in the Transport Sector in the GGGI Reference Scenario



2.3.4 Agriculture Sector

In Mongolia, Agriculture is still vital to the country's economy and animal breeding is part of the lives of Mongolians. In 2017 a total 66.2 million head of livestock were counted in the annual livestock census. Animal husbandry accounts for over 80% of the country's agricultural production.

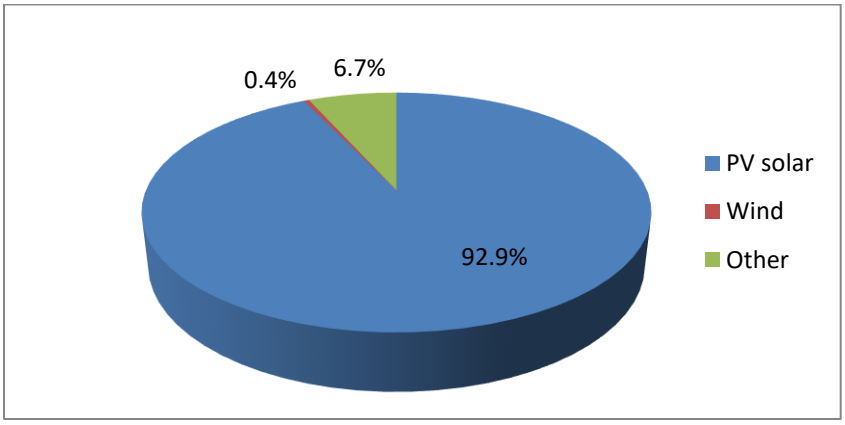
Mongolia has enormous potential to boost its meat production, dairy food processing, and other value-added activities. Cashmere wool and animal skin products are a particular potential growth area. Accessing export markets is critical for Mongolia's economic growth and to lift rural populations out of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

The number of herding households reached 169.7 thousand in 2017, showing a 2.3 percent increase relative to the previous year.

Energy use in the Agriculture Sector

Traditionally, livestock production uses limited amounts of commercial energy (oil products, coal and electricity), although in recent years most of 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 138.5 thousand herders households in 2017, 94% of herding family used solar PV systems while 0.4% used wind and 6.8% other sources, as shown in Figure 2-16.

Figure 2-17: Herder's Households with Electricity Systems, by Source Types



By NSO's new estimates, the Agriculture and Forestry sector's total energy use amounted to 785.6 TJ in 2015 and 745.8 TJ in 2016, which represented only 0.1 percent of Mongolia's total use of energy (see Table 2-9).

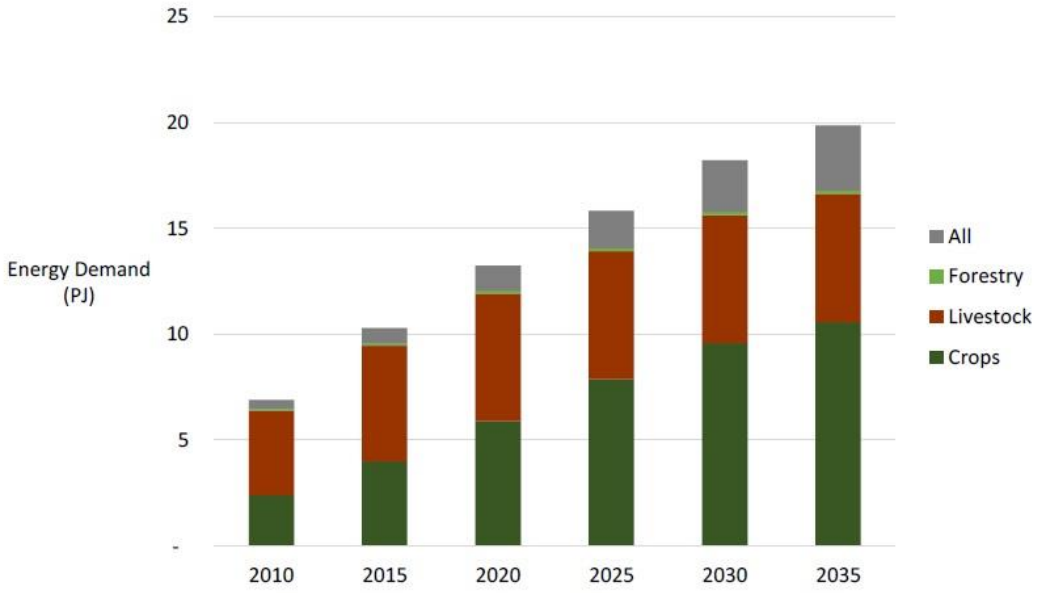
Energy Demand Trends in the Agriculture Sector

For herders' households, small-scale independent renewable energy sources (wind turbines and PV systems) will continue to be used by herders.

As indicated in the *GGGI report*, in the *reference* scenario, it is assumed that there is a trend in Mongolia to expand production of fodder to stabilize food for livestock from year to year to reduce livestock deaths in years when natural pasture productivity is inadequate, and also in consideration of the trend toward increased intensification of livestock production for milk and meat. This will result in more use of electricity, for example, for dairy, pig and poultry farms, and diesel will continue to be used for general farm machinery, for tractors, and for generators to provide power for on-farm and field use. The *Reference scenario* also considered improvements in device efficiency (see Figure 2-18).

In the forestry subsector, the future growth rate of the commercial wood harvest is assumed in the *GGGI study* to be 3% per year through 2020, declining to 2% per year by 2030.

Figure 2-18: Energy Demand by Subsector in the Agriculture Sector, Reference Scenario



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

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 86.4% of primary energy (Table 3-1), and it is the sole available resource that is easy to transport and use in CHPPs to meet the electricity and district heating needs in the country. In 2018, 93% 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), 2015–2016

	2015	2016	2015 %	2016 %
TOTAL PRIMARY ENERGY SUPPLY, by product, (TJ)	**745 047.6**	**1 009 128.9**	**100**	**100**
Hard coal (domestic production)	475 931.1	735 669.6	63.9	72.9
Brown coal (domestic production)	126 934.5	136 512.6	17	13.5
Coke and semi-coke of coal (domestic)	5.6	0.8	0	0
Crude oil (domestic)	51 914.3	48 838.8	7	4.8
Motor spirit	19 567.7	17 911.6	2.6	1.8
Kerosene	195.8	2 602.7	0	0.3
Transport diesel	28 199.9	23 595.7	3.8	2.3
Jet fuel for aircrafts	2 412.9	2 403.6	0.3	0.2
Fuel Oils	128.5	104.6	0	0
Lubricants	467.4	501.5	0.1	0
Other petroleum and oil products	106.3	140	0	0
LPG	1 120.3	1 388.5	0.2	0.1
Petroleum Jelly, paraffin waxes and Bitumen and asphalt, natural products	1 908.8	2 070.5	0.3	0.2
Wood, wood waste & other solid biomass, charcoal (domestic production)	30 423.8	31 514.5	4.1	3.1
Electrical energy - produced from wind and hydro only	5 730.8	5 873.8	0.8	0.6

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 for the next 20 years.

About one-third of the coal resources are in Gobi region in the south, one third in the eastern region and the balance in the rest of the country, of which the central region accounts for about half. Bituminous coal is found in South Gobi and in the western basins. Most of the resources in the central, north and western regions 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 2018, coal production in Mongolia reached 54,5 million tons, of which 45,4 million tons were sold and 36,6 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 the coal mined in Mongolia.

Table 3-2: Mongolia's Coal Exports in 2012–2017, by Importing Country

	2012	2013	2014	2015	2016	2017
China	20,520,066.07	18,193,264.59	19,461,343.22	13,965,736.78	25,317,322.77	32,291,706.23
Russia	2,736.61	584	19,937.33	76,761.13		3.74
Korea			36.24	1,092.94		
England				161,501.80	316,604.45	489,821.49
Singapore				221,220.10		91,631.75
India	23,302.73					
Kong hong	1,299.05				79,959.00	117,764.85
Other	7.16		1			
Total	**20,547,411.62**	**18,193,848.59**	**19,481,317.79**	**14,426,312.75**	**25,713,886.22**	**32,990,928.06**

Source: Customs Statistics 2017, Customs' Authority of Mongolia

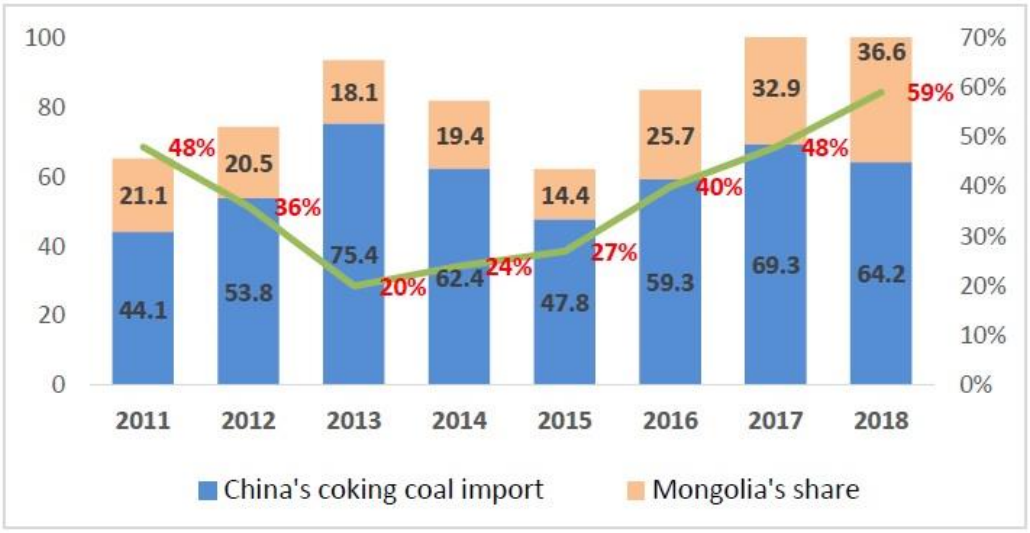
Table 3-3: Coal Sales and Exports, by Coal Type, Thousand Tons, 2018

	TOTAL	Export	Local
TOTAL	**45,741.0**	**36,671.4**	**9,069.6**
Washed coking coal	**5,479.5**	5,479.5	-
Raw coking coal	**14,404.2**	14,404.2	-
Weak coking coal	**11,680.5**	11,680.5	-
Thermal coal	**5,107.2**	5,107.2	-
Brown coal	**9,069.6**	-	9,069.6

Source: Coal Research Division, MRPAM

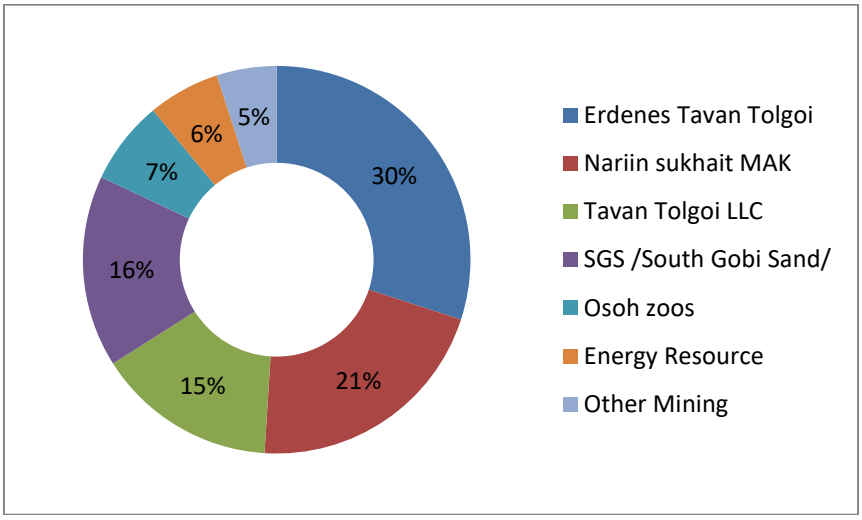
Mongolia is the largest export coal supplier to China. In 2018, China's coking coal imports were 64.2 Mt of which 59% or 36.6 Mt was supplied by Mongolia. Figure 3-1 shows recent trends in Chinese coal imports from Mongolia, and Figure 3-2 shows the export shares of Mongolia's major coal mining companies.

Figure 3-1: Mongolia's Share in 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-2018-down-8-from-2017

Figure 3-2: Major Coal Mining Companies in Mongolia, Export Shares 2017, 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 2012 through 2017.

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

Name of Plant	2012	2013	2014	2015	2016	2017
	Thousand tonne					
CHPP-2	192.6	189.3	204.6	225.4	236.7	241.5
CHPP-3	1,128.1	1,111.2	1,238.8	1,277.6	1,267.4	1,275.4
CHPP-4	3,104.1	3,302.6	3,381.0	3,305.4	3,286.6	3,451.2
Darkhan CHPP	394.9	367.1	405.2	342.1	371.2	400.8
Erdenet CHPP	247.5	287.2	306.8	285.6	269.4	326.2
Dornod CHPP	322.9	381.5	413.4	425.3	482.7	500.6
DzCHPP	35.9	30.9	21.4	20.1	24.8	25.8
Baganuur TP	65.6	60.9	59.4	57.3	61.9	57.8
TPS in Nalaikh district	55.1	53.3	51.9	53.6	57.5	48.9
Amgalan TP				39.9	109.7	159.0
LH- in rural areas				242.8	333.4	330.5
Total consumption	**5,546.7**	**5,784.0**	**6,082.5**	**6,275.1**	**6,501.3**	**6,817.7**

Source: Energy Statistic 2017, 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

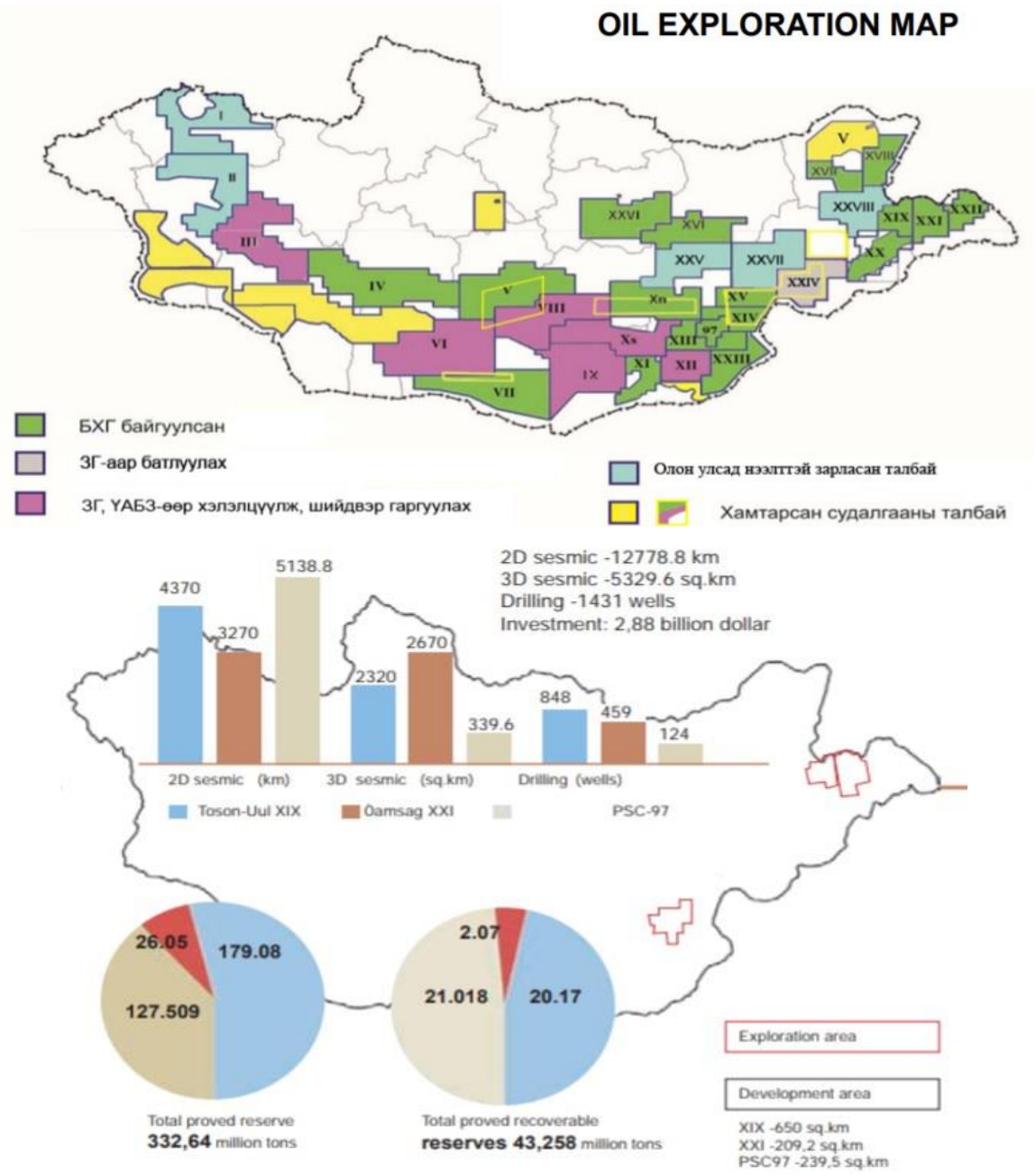
There are 31 exploration blocks for crude oil defined in Mongolia, and the country's current proven oil reserves are about 332.64 million tons.

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" (between 1993 and 2016) drilled 1465 wells for exploration, 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 estimation 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) led to Mineral Resources and Energy Minister Decree 41 (May 16, 2012) approving the block's proved reserves at 127.509 million tonnes, with proved recoverable reserves by use of natural well pressure as 14.01 million tonnes and proved recoverable reserves using wells pressurized by pumping water at 21.018 million tonnes, followed by registration 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 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

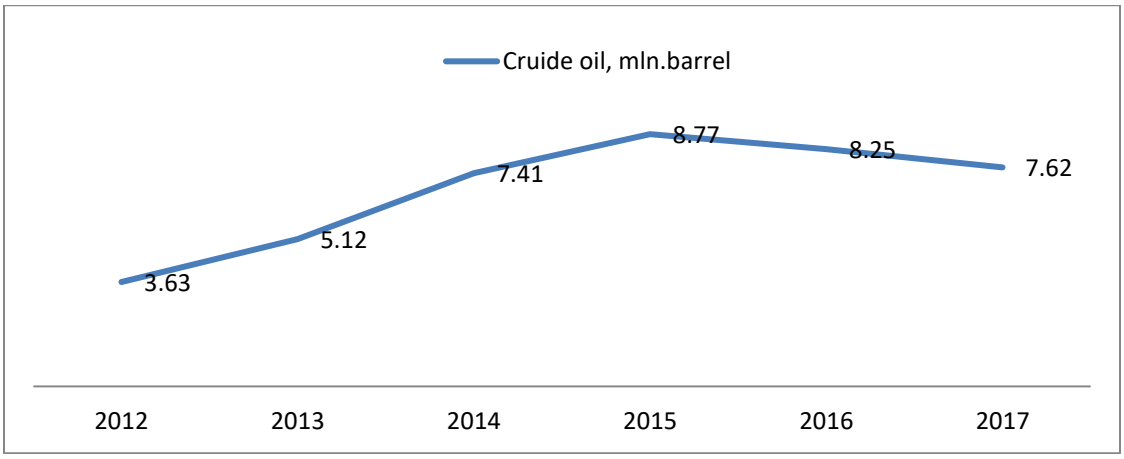


Oil production, imports and exports:

There is some extraction of crude oil from conventional deposits in Mongolia, but all of the crude oil produced is 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.

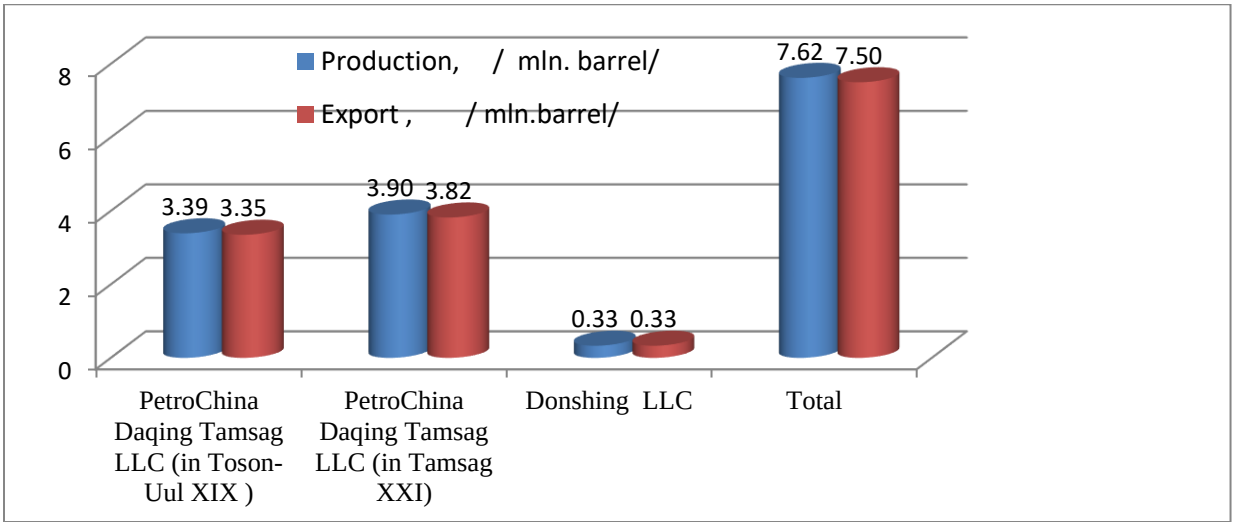
Approximately 59.7 million barrels (8.4 million tonnes) of oil were produced In Mongolia between 1996 and 2017. In 2017, 7.62 million barrels (1.07 million tonnes) of oil were produced and 7.51 million barrels of oil were exported. Figure 3-4 shows crude oil production in Mongolia over 2012 through 2017.

Figure 3-4: Crude Oil Production for 2012–2017, million barrels



Exports of crude oil in 2017 were estimated at 7.51 million barrels, with a value of 374.1 million USD. Compared to results from the previous year, exports in 2017 had decreased by 0.51 million barrels and the total value increased by 36.9 million USD. The average price per barrel crude oil received by Mongolia increased from 42.1 USD to 49.8 USD. 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 2012 through 2017.

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, 2012–2017

Main commodities	2012	2013	2014	2015	2016	2017
Petrol (thous.t)	389.1	380.1	416	433.5	385.3	410.86
Diesel /thous.t/	715.5	772.9	685.9	655	548.1	805.34
Jet fuel /thous.t/	36.2	38.8	26.2	27.3	24.8	30.66
Mazut /thous.t/	3.9	2.6	3.1	3.2	2.6	2.2

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 mineralisation 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.

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 cooperation with REC 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

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 in a total area of 23461 km², Mongolia can 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, in 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):

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.

Recently, there have been several pre-feasibility studies for geothermal energy projects conducted by government and private companies. The National Renewable Energy Centre of Mongolia has completed a number of surveys. 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 emission.

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".

Biomass:

In Mongolia, there are four major types of biomass resources: (1) Forest, (2) Crop wastes, (3) Animal husbandry residues, and (4) Industrial and domestic wastes. Table 3-8 summarizes forest land area by type and by region in Mongolia.

Table 3-8: Land with Forest Resources, 2017, (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 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' (CCPIU, 2017).

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 definitely help saving the plants in the Gobi Desert.

Resources of agricultural waste and livestock (dung): As of 2017 Mongolia had 66.0 million head of livestock, which means that Mongolia has a considerable amount of biomass resource originating from livestock. The forms of such 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 the 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. The minimum amount of thermal energy capacity: from cow dung is 10800–13300 kJ/kg, from sheep pellets is 8800–16700 kJ/kg, and from "khurzun" is 12500–14600 kJ/kg (based on studies from Aprovecho, 2009)

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 was 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.

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 2016, Thousand Tons

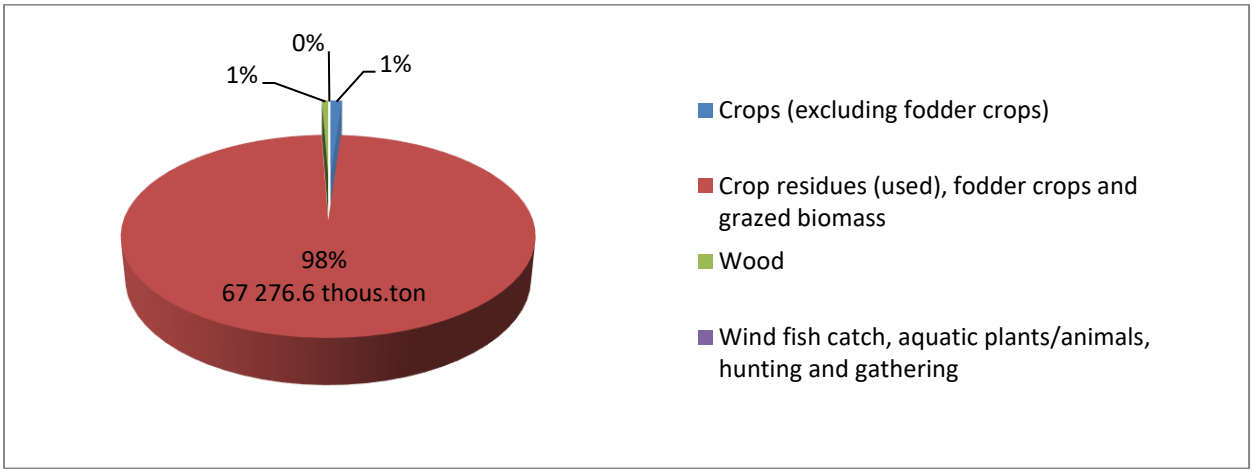
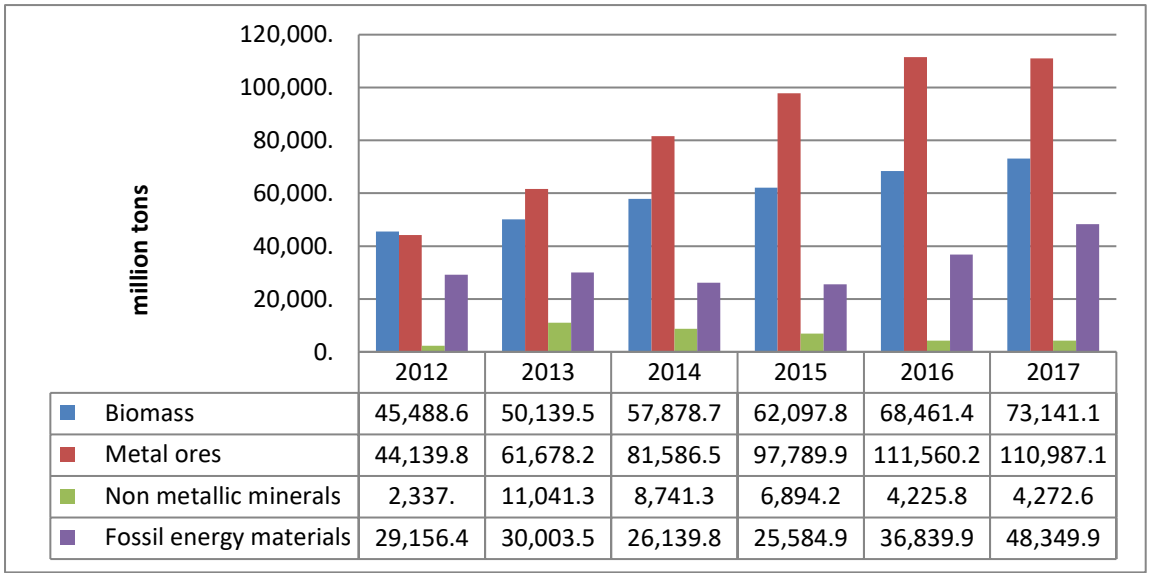


Figure 3-7: Biomass Domestically Used, 2012–2017, Million Tons



	2012	2013	2014	2015	2016	2017
Biomass	45,488.6	50,139.5	57,878.7	62,097.8	68,461.4	73,141.1
Metal ores	44,139.8	61,678.2	81,586.5	97,789.9	111,560.2	110,987.1
Non metallic minerals	2,337.	11,041.3	8,741.3	6,894.2	4,225.8	4,272.6
Fossil energy materials	29,156.4	30,003.5	26,139.8	25,584.9	36,839.9	48,349.9

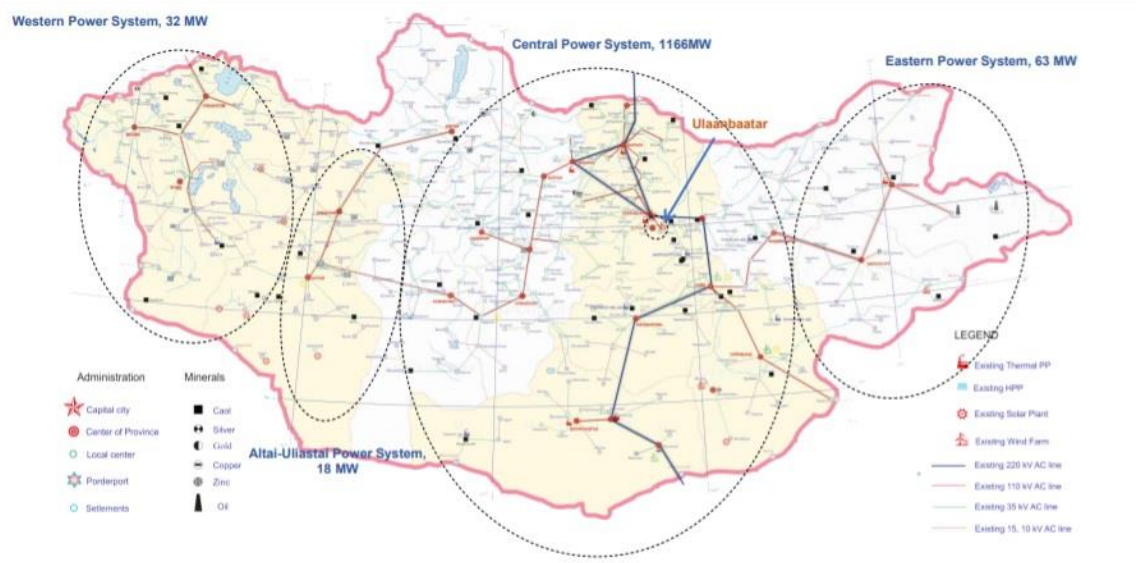
Source: Mongolian Statistical Database, http://www.1212.mn/tables.aspx?TBL_ID=DT_NSO_3600_001V1

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 system include around 1500 km of 220 kV, 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: Capacity and Number of Electricity Consumers, by Grid (as of 2018)

	Grid	Total capacity, MW	Electricity consumers
1	Central Region Energy System (CRES) incl	1166	83.3%
2	Southern Region Energy System (SRIES)		1.9%
3	Western Region Energy System (WRES)	32	6.6%
4	Eastern Region Energy System (ERES)	63	4.2%
5	Altai –Uliastain Energy System (AUES)	18	3.6%

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

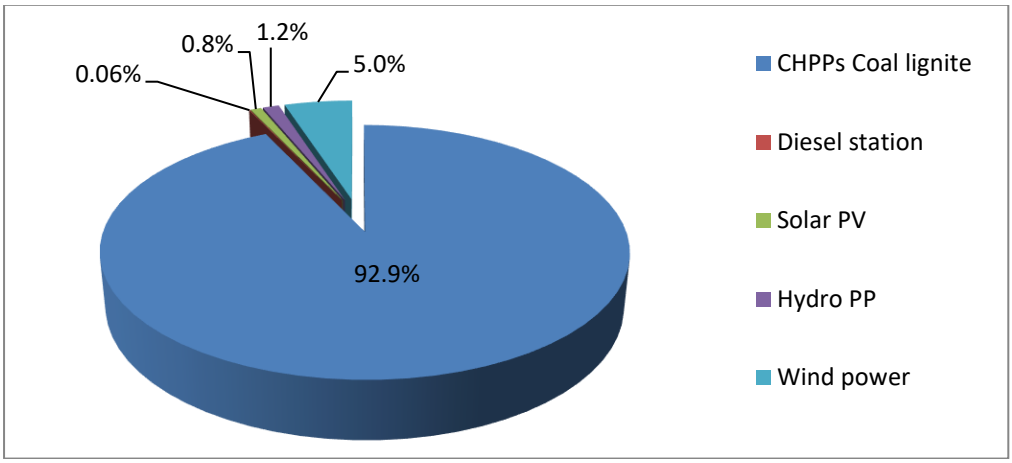
As of 2018, generators with a combined installed capacity 1280 MW, including renewable electricity systems, are operating and supplying 80 percent of national electricity demand. (The remaining 20% of electricity, totaling 1,683.6 million kWh, is imported from Russia and China.) Table 4-2 shows historical electricity generation from 2012 to 2018 by each of the domestic sources. A majority of the total electricity supply is provided by plants burning lignite coal, accounting for 92.9% of output in 2018. Electricity generation from renewable and distributed energy sources accounted as 7.1% of the total in 2018, of which 5% came from wind, 1.2% from hydro, 0.06% from diesel, and 0.8% from solar, as shown in Figure 4-2.

Table 4-2: Electricity Generation by Sources, 2018

Sources	2012	2013	2014	2015	2016	2017	2018
	GWh						
CHPPs Coal lignite	4,775.50	5,014.00	5,191.30	5,415.80	5,555.90	5,826.90	6,152.40
Diesel station	28.7	5.4	8.2	6	3.8	3.7	3.7
Solar PV			0.6	0.5	0.3	19.7	51.1
Hydro PP	52.1	59.9	66.3	59.3	84.7	84.5	78.7
Wind power		52.9	125.4	152.5	157.5	154.4	339
Total generation	**4,856.30**	**5,132.20**	**5,391.80**	**5,634.10**	**5,802.20**	**6,089.20**	**6,624.80**

Source: Energy Statistics, Energy Regulation Commission

Figure 4-2: Electricity Generation Share by Sources, 2018



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 1085.8 MW as of 2017 (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 supplies electricity to both urban and rural areas.

Table 4-3: Installed Capacity of CHPPs, 2017

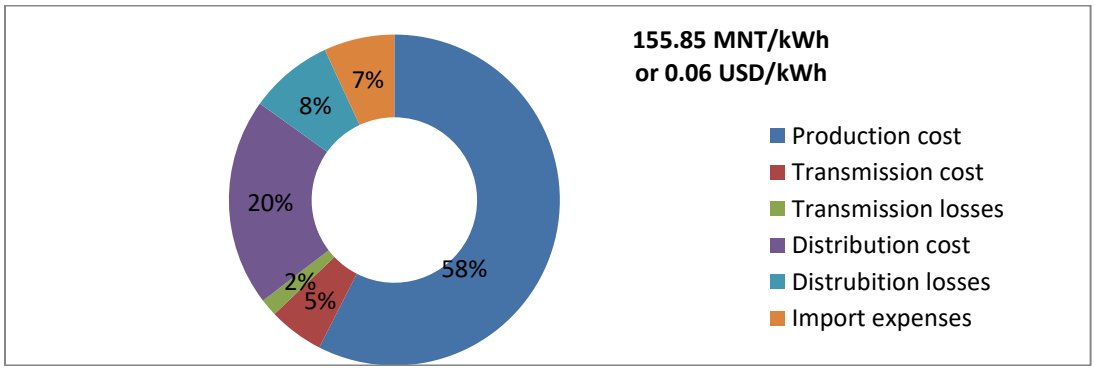
Plant	Installed capacity	Available Capacity	Auxiliary Electricity Usage	Thermal capacity	Commissioning
(Name)	MW	MW	%	Gcal/hour	Date
CHP#2	24	22	13.8	55	1961
CHP#3	186	153	16.9	585	1968
CHP#4	683	580	12.47	1373	1983
Darkhan CHP	48	44	17.6	181	1965
Erdenet CHP	28.8	27	19.6	120	1986
Erdenet factory CHP	53	35			(1976)2017
Choibalsan CHP	36	36	14		1967
Dalanzadgad CHP	9	4	39.7		2000
Ukhaa hudag CHP	18	16	10		2011
Total by CHPPs	1085.8				

The capital, Ulaanbaatar City, has three Combined heat power plants located inside the city area with a total installed capacity of 893 MW. Of the three, the largest is Combined Heat and Power Plant 4 (CHPP4) with a capacity of 683 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 and 1166 MW in 2018.

Electricity cost

The unit cost for electric energy generated by the CHPPs is 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 145.84 MNT, or approximately 0.06 USD in 2017, and 155.85 MNT (also equal to about 0.06 USD) in 2018.

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 2017 included a renewable energy levy (11.88

MNT per kWh, which equals 0.005 USD/kWh) and an entities capacity charge (9,000 MNT/kWh/month, which equals about 3.86 USD/kWh based on USD/MNT conversions as of 2017). Electricity tariffs in Mongolia in 2017 and 2018 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, 2017–2018

CONSUMER CATEGORY	Tariff for 2017		Tariff for 2018	
	MNT/kWh	USD/kWh	MNT/kWh	USD/kWh
Industrial				
Mining, processing industry	167.78	0.072	155.9	0.062
Other industries, entities	140.38	0.059	128.5	0.051
Residential				
Monthly consumption below 150 kWh	110.28	0.047	98.4	0.039
Monthly consumption above 150 kWh	130.08	0.055	118.2	0.047

Source: Energy Statistics 2017,2018, Energy Regulation Commission

4.3 Renewable Energy Sources

As of 2018, as shown in Table 4-5, below, a total of 16 renewable energy (RE) electricity sources were operating in Mongolia, of which three were wind, seven were hydro, and eight were solar, with capacities ranging between 0.1–10 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 by Renewable Electricity Sources in Mongolia, 2018

	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	Urgamal Solar PP	0.15
3	Sainshand WP	55	Guulin HPP	0.2	Buyantooroi Solar PP	0.1
4			Hungiin HPP	0.11	Altai Solar PP	0.3
5			Gauutain HPP	0.15	Mandakh Solar PP	0.2
6			Bogd River HPP	2	New Airport Solar PP	0.44
7			Durgun HPP	12	Darkhan Solar PP	10
8					Monnaran Solar PP	10
9					Gegeen Solar PP (since Nov 2018)	15
	Wind Total	**155**	**Hydro Total**	**25.835**	**Solar Total**	**36.33**

Costs of Renewable Energy

Feed-in-Tariffs (FiT) were initiated based on Article 11 ("Renewable energy tariffs and Prices") of the Renewable Energy Law, 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 sets the tariffs and prices of energy generated and supplied by renewable energy power sources connected to the transmission network (grid-connected), while the regulatory boards of aimags and the capital city can set tariffs of energy generated by stand-alone power sources (off-grid). Table 4-6 shows the ranges for FiTs for renewable energy sources.

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

	Hydropower			Wind	Solar
	Up to 500 kW	500-2000 kW	2000-5000 kW		
Grid-connected	0.045-0.06	0.045-0.07	0.045-0.08	0.08-0.095	0.15-0.18
Off-grid,	0.08-0.10	0.05-0.06	0.045-0.08	0.10-0.15	0.20-0.30

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. The maximum imports from Russia are limited—depending on contacted amount in Mongolia's Power Purchase Agreements (PPA) with Russian sellers in each year, although power imports to meet night peaks in Mongolia during winter can be exceed contracted totals by a limited amount of electricity.

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

Indicators	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Imported electricity, GWh	307.8	325.3	288	176.3	201.4	270.6
Exported electricity, GWh	21	23.3	30.3	54.3	33.9	34.1
Average price of imports, US$	0.069	0.077	0.084	0.072	0.082	0.08
Payment, thous.US$	21,271.80	24,932.80	24,149.70	12,628.70	16,441.60	21,52.2

Table 4-8: Total Electricity Import Overview, 2012–2017 (Million kWh)

	2012	2013	2014	2015	2016	2017
Import from Russia to CES, mln kWh	307.8	325.3	288	176.3	201.4	270.6
Import Western, others border points, mln kWh					103	0.9
Import from China to OT, mln kWh		760.52	987.7	1,090.05	1,095.50	1,130.70

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 Energy Resources 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 300 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 2018, the total heat energy production in Mongolia reached a volume of 9,425.1 thousand Gcal, an increase of 5%, or 448.5 thousand Gcal, compared to 2017. 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 in the 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
- Strong subsides of electricity and heat tariffs

Existing coal power plants are aging (see Figure 4-4), and have relatively low utilization rates and major electricity losses are occurring along the transmission and generation network.

Mongolia experienced losses of approximately 15 percent in transmission and distribution, far from the international best practice of 5 percent (Figure 4-5).

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

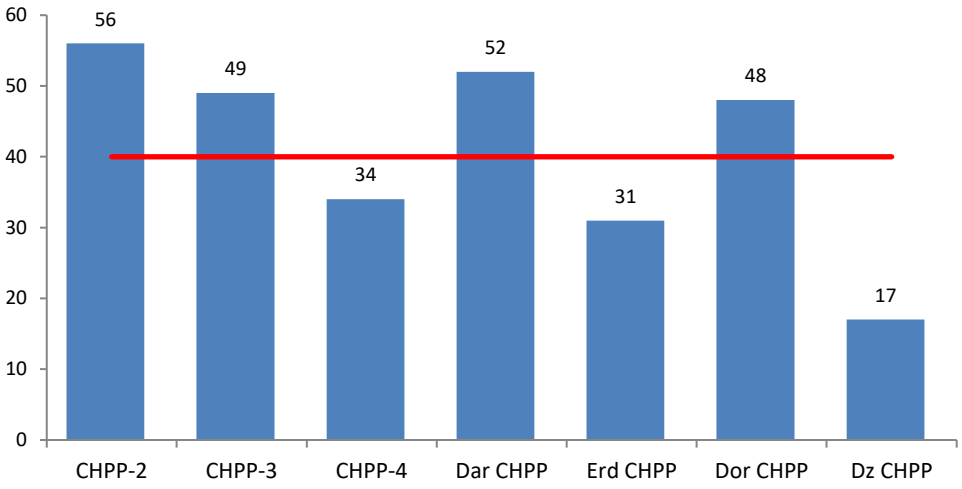
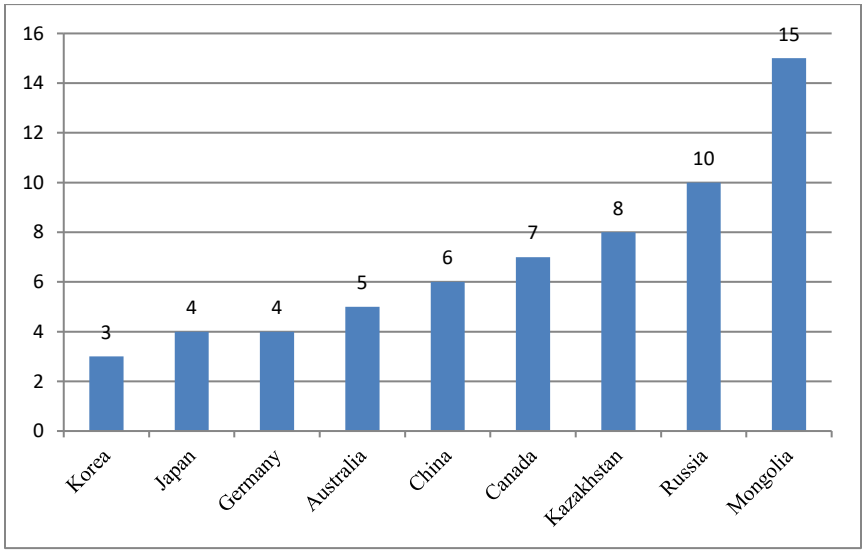


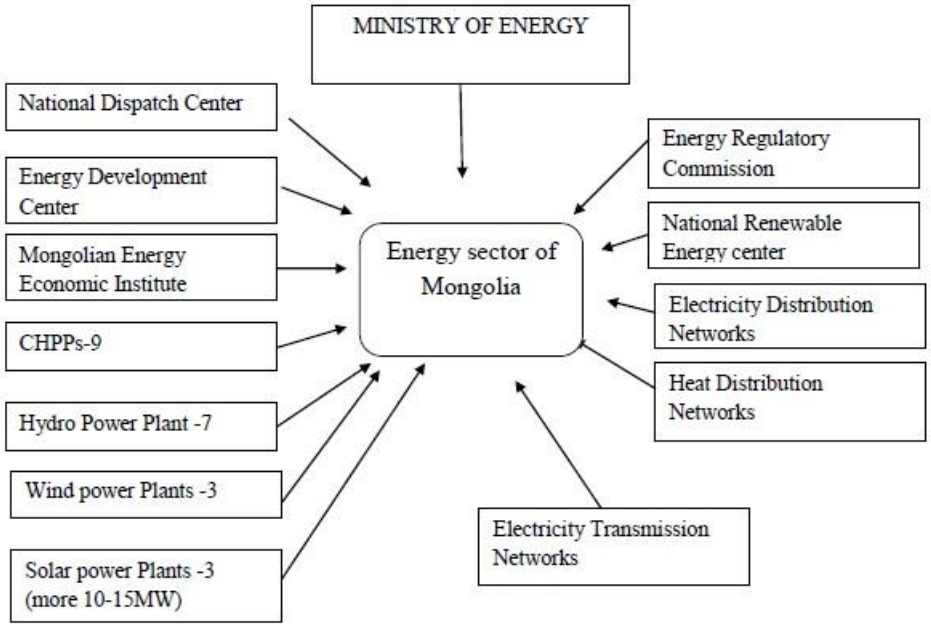
Figure 4-5: Transmission and Distribution Losses by Country (percent)



4.6 Structure of Energy Sector and Market Principles

As of 2018, the electricity sector of Mongolia is comprised of 9 thermal power plants, 3 wind farms, 7 hydro power plants, 3 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.

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' objective is 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 ecologically 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 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 Company, also state owned, is responsible for reliable and uninterrupted electricity distribution to consumers.

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 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.

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" LLC developed and approved an "Auction organization rule for the electricity competitive market".

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.*

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 5-1and Table 5-2).

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

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

	LOW			Medium			High		
Year	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		

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)

	LOW			Medium			High		
Year	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		

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

Projections of electricity demand in Mongolia, in the CES and by main economic sectors have been reported in the 2nd section (Energy Demand in Mongolia) of this report.

In the GGGI study (*Strategies for Development of Green Energy Systems in Mongolia 2013*), electricity demand and generation were estimated and forecast for four scenarios. Results, including GHG emissions, are shown for three of these scenarios in Table 5-3 .

Table 5-3: Electricity Generation, Energy Demand, and GHG Emissions for Three Scenarios of Mongolia's Energy Development (from GGGI Study)

Variable and Scenario	2010	2015	2020	2025	2030	2035
Electricity generation, GWh						
Reference	4,591	6,865	14,006	15,953	18,084	20,283
Recent plans	4,591	6,857	13,961	15,757	17,745	19,571
Expanded green energy	4,591	6,747	13,027	13,431	13,927	14,508
Overall energy demand, TJ						
Reference	133	189	248	298	356	419
Recent plans	133	188	243	288	339	393
Expanded green energy	133	186	223	244	265	285
Greenhouse gas emissions, M t CO_2e						
Reference	16	20	37	43	49	56
Recent plans	16	20	35	38	43	49
Expanded green energy	16	20	27	28	27	28

Table 5-4: Electricity Output in the Reference, Recent Plans, and Expanded Green Energy Scenarios (GGGI Study)

Variable and Scenario	2010	2015	2020	2025	2030	2035
Electricity generation, GWh						
Reference	4,591	6,865	14,006	15,953	18,084	20,283
Recent plans	4,591	6,857	13,961	15,757	17,745	19,571
Expanded green energy	4,591	6,747	13,027	13,431	13,927	14,508
% as renewables						
Reference	1%	4%	2%	2%	1%	1%
Recent plans	1%	4%	4%	14%	12%	11%
Expanded green energy	1%	4%	31%	35%	42%	46%

Source: GGGI Strategies for Development of Green Energy Systems in Mongolia (2013–2035)

Table 5-4 shows electricity output for the three scenarios from the GGGI study, By 2035, generation in the *recent plans* case is 3.5% lower than in the *reference* case, while the suite of energy efficiency measures, plus some supply-side efficiency measures, in the *expanded green energy* scenario reduces overall generation requirements by over 28%. The *reference* case output from renewable energy systems is just over 1% by 2035, while the *recent plans* case includes nearly 11% renewables generation by 2035, and the *expanded green energy* case includes over 46% renewable power by 2035.

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, and 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 (Last amendments is made on June 2015), this law enhances the financial situation of the single buyer model in the power sector and ensures feed-in tariffs 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.

Foreign Investment Law of Mongolia: Approved on 01 July 1993 (Several amendments were made on 03 January 2002; 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 5-5.

Table 5-5: 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	• Transfer the state dominated energy sector into private based competitive market • Support innovation and advanced technology in energy sector, and implement conservation policy
3. Environmental sustainability and green development	• Increase the production share of renewable and reduce negative environmental impact from traditional power generation and greenhouse gas

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 5-6.

Table 5-6: Summary of Energy Policy Expected Results—Criteria

Indicators of criteria	2014 он /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, Pumped Storage	Super Critical, Ultra S/Critical, Hydrogen, Concentrated Solar Plant

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 5-7.

Table 5-7: 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 if 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 midterm 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 collaboration involving international organizations and regional countries, pursue proactive involvement in international initiatives and regional collaborations such as Central Asian rRegional Economic Cooperation, The Tumen Initiative, the Energy Charter treaty, One Road One Region, and establishment of the North eastern 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 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 Siberia Energy Systems Institute, the Russian interconnected energy power systems was 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 Interconnection in Northeast Asia

The following summary was prepared by Alicia J. Campi for the Jamestown Foundation (2018):

"During the fifth meeting of the Ulaanbaatar Dialogue on Northeast Asian Security, held on June 14–15, 2018 in Ulaanbaatar, regional energy and environmental cooperation projects were major highlights. Progress was particularly apparent on the "Strategy for Northeast Asia Power System Interconnection" (NAPSI):

- The Mongolian government has secured $1.75 million in technical assistance funding from the ADB for a two-year study (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.

- 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.

- Energy Charter (Belgium), has advanced the Gobitec concept to produce clean energy from renewable energy sources in the Gobi Desert and to deliver the produced energy to high-demand power corridors via the planned Asian Super Grid (ASG), which will connect Russia, Mongolia, China, South Korea and Japan.

- The NAPSI project partners have been introduced their findings in a series of conferences throughout Asia under the general theme of the Asia Super Grid. The first ASG conference was on August 28–29, 2017, in Irkutsk, Russia, followed, on October 30, 2017, in Seoul, South Korea, and then, on March 22–24, 2018, in Kitakyushu, Japan, in 31 October, in Ulaanbaatar; and a final marketing module workshop assessment will be held in June 2019, in Ulaanbaatar.

- Although Mongolia boasts rich and cheap fossil fuel mineral reserves, the government is committed to exploiting its renewable resources. It has set a targets 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 NAPSI project is currently looking at different cost-benefit scenarios, which will require $5.55 billion of investment by 2026, with another $4.2 billion by 2036, and a total of $57.33 billion in investment by 2051—projected to represent 60 percent of Mongolia's GDP. While the EBRD supports such large-scale renewable power investment schemes, the Ulaanbaatar Dialogue meeting expressed concerns that the size of the needed investment as well as the volatile political climate in the NEA remain major challenges to its realization.(The Jamestown Foundation, Global Research and Analysis, June 28, 2018)."

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

As indicated in the ASG Interim Report developed by the REI in April 2017, in considering the potential for power supply by renewable energy in Northeast Asia, is Mongolia 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 the area has a 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 potential power generation will be 15,000

TWh or more, which is much more than the total electricity demand in China (5,693 TWh) and Japan (949 TWh) in 2015. It is expected that Mongolia will supply power to neighboring countries in the future by utilizing its rich renewable energy resources.

As of 2017 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.

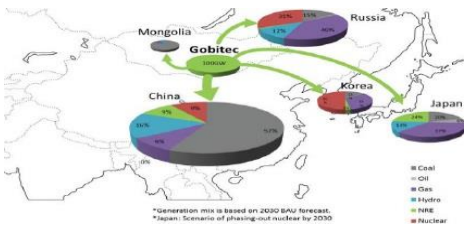
At present, Mongolia is covering its lack of power sources utilizing imports from Russia and China. As Mongolia shares its northern border with Siberia in Russia, and imports electricity from Russia through an interconnection (Figure 6-1) in order to compensate for the shortfall of electricity supply in the northern central area during the winter peak. Across the south interconnection, electricity is imported from China to meet the electricity demand of the Oyu Tolgoi copper mine. In 2017, the amount of imported electricity from China was 1,130.7 million kWh for Oyu Tolgoi mining.

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

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

These are described in Table 6-1.

Table 6-1: Summary for Mongolia's Involvement in Proposed Regional 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 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 of electric energy. The delivery of the energy produced is planned to be using power corridors: the planned Asian Super Grid (ASG), connecting Russia, Mongolia, China, South Korea and Japan. (By 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. In addition, it was proposed at 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 China and Mongolian Governments on a Feasibility study for the Shivee-Ovoo-based Energy export project. Scope of project: to build a large-scale power 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: - Power plant with Installed capacity 5280 MW for export plus 70 MW for domestic use; - Transmission line with the capability to transmit 4,600 MW at ± 660 kV UHV DC; - renewable power plant with 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. This issue, however, has not gained much traction until very recently. 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 such pipelines. While these studies may take time and may come to different conclusions, it is noteworthy that Mongolia's two large neighbors have suggested that the pipeline issue is at least worthy of study, and is the first time that they have done so. So far, no details or further developments have been reported publicly on this issue.

6.3 Oil, Oil Processing, and Oil Storage

The Government of Mongolia has announced that it is commencing the planning and construction of initial infrastructure for an oil refinery to be built in the Southeastern region of Mongolia. No details of the refinery have so far been made public, except to note that the refinery, which is to be financed using a soft loan from the Indian government, would be designed to process the oil from wells in Eastern Mongolia, a few hundred kilometers away from the refinery site, and the refinery will have the capacity to produce 1 million tonnes of final product annually.

No reports of other ongoing efforts to share, lease or otherwise develop Mongolia's refining capacity have been publicly available in recent years, and other developments of oil refining in Mongolia seem unlikely at this point.

6.4 Coal

In 2018 Mongolia exported an all-time high of over 38 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 coal in Mongolia (domestic production for export) is highly dependent on demand in China, volumes fluctuate widely, for instance falling by almost 40% in December 2018 compared to the previous month. Fluctuations depend on a variety of economic, political and geopolitical factors such as general demand for steel in China, annual import quotas by the Chinese government, international sanctions on the North Korea, 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 export to 40 million tonnes, however, the reality might be determined by a unfathomable inter-play of all these factors producing 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, it will allow both larger volumes to be shipped and stimulate 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

7.1 Draft Overall Structure

The draft overall structure of the LEAP Model for the Mongolia includes energy demand and transformation (supply) components. Within the demand structure, the following sectors were created: 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 divided into 3 groups based on housing types.

The Industry sector 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 sector is modeled based on the fuels used by autos in Mongolia: diesel, gasoline, liquefied petroleum gas (LPG) and hybrids (vehicles with both gasoline and electric motors).

The energy transformation component of the LEAP model describes the conversion of primary energy to secondary energy. 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: names of each process (power plant name or type), feedstock fuel used, auxiliary fuels used, capacities, efficiencies, plant lifetimes, historical output, exports, imports and all planned or proposed capacities for all power plants and heating plants. Although CHPPs generate electricity and heat, electricity and heat generation by CHPPs have been separated in the LEAP model for Mongolia. Except the electricity generation, the transformation modules for the transmission and distribution, coal mining and oil production are included and also refining and gas production in the future is being planned to be considered in model.

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

7.2 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 2017, issued by Mongolian National Statistic Office of Mongolia (NSO)
- Statistics from the Mongolian Statistical Yearbooks 2016, 2017, (NSO)
- Statistics on Energy performance 2015, 2016, 2017 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 Housing by-census of Mongolia
- Others

7.3 Proposed Energy Pathways (LEAP Scenarios)

Future LEAP scenarios for Mongolia will be based on the Recent trends and State Energy Policy documents, as well as concepts developed by the Mongolia Working Group and in collaboration with other RES project Working Groups.

The proposed Energy Pathways are:

1. Business as usual (BAU)
2. Coal Resource based Power trade scenario (electricity exports based on output of Shivee-Ovoo coal mine and other coal resources)

   The scope for the Coal Resource-based Power trade scenario, as described in recent Mongolian Government documents, will include:
   - Thermal coal resources that can be utilized for on-site electricity production for the purpose of export. This will involve construction of a Shivee ovoo power plant with a capacity of 5,280 MW for export, plus 70 MW for domestic use, plus as transmission line with the capability to transmit 4,600 MW at 660kV UHV DC, and a coal mine with a capacity of over 20 million tons/per year.

3. Energy exports using renewable energy power 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.

8 Conclusions

8.1 Key Energy Issues for Mongolia

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

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, and 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 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)
- 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. Improving electricity and heat supply to these districts and ensuring equitable access to energy services remains an 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 promote economic activity, create jobs, and reduce poverty. Increased use of renewable energy for these purposes should lessen dependence on the external power supply and 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. Currently, coal accounts for almost 70% of the greenhouse gas emissions. Achieving the government target of increasing the share of renewables in the energy mix to 30 per cent by 2030 should alleviate this problem.

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 the 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 IFI will remain an important source 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 look at the further sustainability of continued subsidizing of residential electricity and heat consumers via higher tariffs applied to industrial and commercial consumers.

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, identify and prioritize key technical, technological and investment needs, assess the benefits and risks of specific projects, and develop frameworks for risk reduction and practical implementation. World Bank representatives have 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 a power transmission line and a gas pipeline 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 local economy but also as a demonstration of Mongolia's willingness to contribute complementarily to, and participate in, regional economic integration.

8.2 Mongolia's Approach to Regional Energy Sharing

In the prospective regional energy sharing arrangements, Mongolia sees itself primarily as exporter of electricity generated by 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.

8.3 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 denuclearization on the Korean peninsula, the growing major power rivalry in the region, including competition for markets for energy exports, make energy-sharing a remote possibility. However, this should not 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.

8.4 Next Steps in Mongolia Energy Analysis

Next steps in Mongolia Energy Analysis for LEAP will include further data collection and detailed quantitative development of a future BAU pathway, followed by detailed quantitative development of other future pathways focused on Mongolia (such as coal-based exports, or conversion to electric heating based on renewables and storage), and future pathways based on energy cooperation (large-scale exports of power from renewable energy sources).

8.5 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 Government of Mongolia on the 24th of October,2018, the following main measures are planned to be taken towards expanding energy cooperation with neighboring and regional countries:

- Establish long-term agreement on energy trade with neighboring countries

- Cooperate with neighbors to develop energy transit infrastructure within the Initiative 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 following next steps shall be considered from the Mongolian side for Regional Energy Sharing.

- To coordinate with other country working groups for sharing of information and knowledge among 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;
- To have a clear policy for governmentally and politically for foreign investors;
- To develop infrastructure in border areas—including railways, roads, and the capacity of customs checkpoints; and
- Strengthening cooperation mechanisms for power interconnection in North-East Asia.

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III. NAUTILUS INVITES YOUR RESPONSE

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