



MINISTRY OF ENVIRONMENT
AND TOURISM



МОНГОЛ УЛСЫН ШИНЖЛЭХ УХААН
ТЕХНОЛОГИЙН ИХ СУРГУУЛЬ
MONGOLIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY



DATA FOR THE IPCC EMISSION FACTOR DATABASE

CO₂ emission and conversion factors for Energy sector (Results from the scientific and technological project “Studies on country specific GHG emission and removal factors for Mongolia” Namkhainyam B. et al., 2014)

Tegshjargal Bumtsend
Environment and Climate Fund under the
Ministry of Environment and Tourism of Mongolia

15th Expert Meeting on Data for the IPCC Emission factor Database (EFDB)
13-14 December 2017, Paris, France

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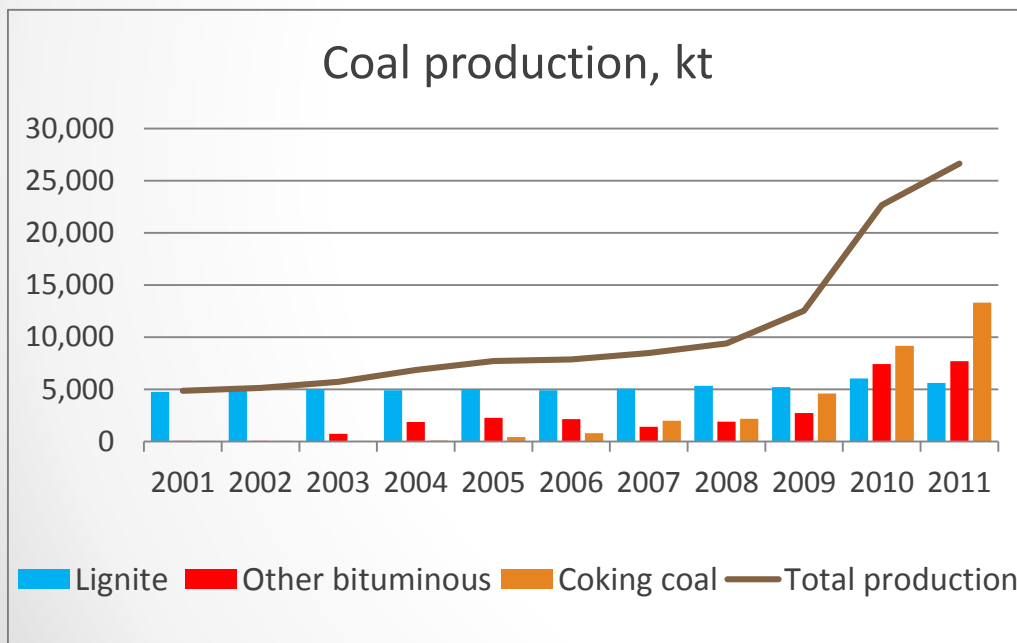
BACKGROUND INFORMATION

Project information

Project title	Studies on country specific greenhouse gas emission and removal factors for Mongolia
Project number	Agreement No. 05/12 (30.04.2012)
Duration	April 2012 – December 2013 (2 years)
Executing entity	Mongolian University of Science and Technology (MUST)
Funding entity	Ministry of Education, Culture and Science (MECS), Mongolian Foundation for Science and Technology (MFST)
Budget	76,563 thousand tugrik (MNT)
Team leader	Namkhainyam Busjav, Leading professor of MUST (Chapter 1)
Team members	Researchers: - Ph.D, Natsagdorj L. (Chapter 4) - Ph.D, Dorjpurev J. (Chapter 5) - Ph.D, Tseyen-Oidov J. (Chapter 2) - Ph.D, Tserendolgor D, (Chapter 3) - Ph.D, Byambatsogt P. (Chapter 6) - MSc, Tsolmon B. (Chapter 7)

Coal production in Mongolia

- ✓ Coal is a strategic fossil and the main source of energy & heat production for Mongolia - more than 90% from coal.
- ✓ Research on coal production of each mine for the period 2001-2012 (data from mines differ to data from national statistics).
- ✓ Bituminous and coking coal export from 2003 – almost a half of production will be exported.



Source: National Statistics Office (NSO), Statistics of Energy Regulatory Commission (ERC)

● Data for IPCC EFDB

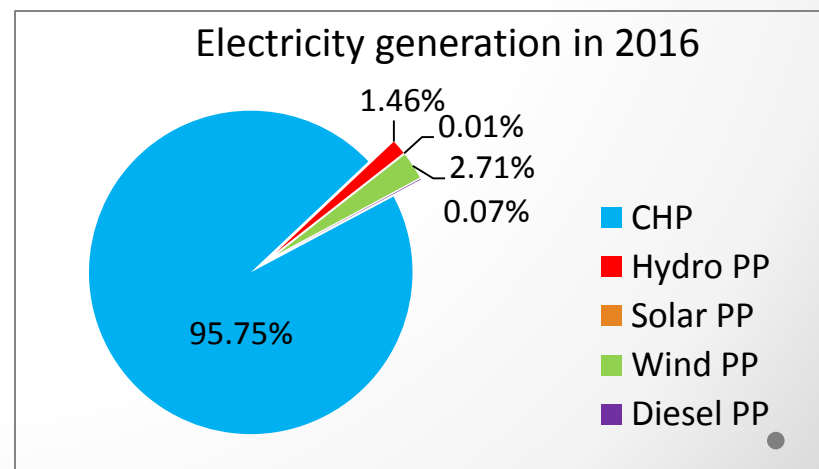
Coal types Mongolia	Coal types IPCC	Net Calorific Value, MJ/kg	Average NCVs
Коксжих нүүрс	Coking coal	21.30-22.20	21.75
Чулуун нүүрс	Other bituminous coal	14.20-34.80	23.62
Хүрэн нүүрс	Lignite	10.46-23.35	14.40
Нүүрсэн шахмал түлш	Coal briquettes	-	15,92
Модны үртсэн шахмал түлш	Sawdust briquettes	-	14.66

Electricity & heat production in Mongolia

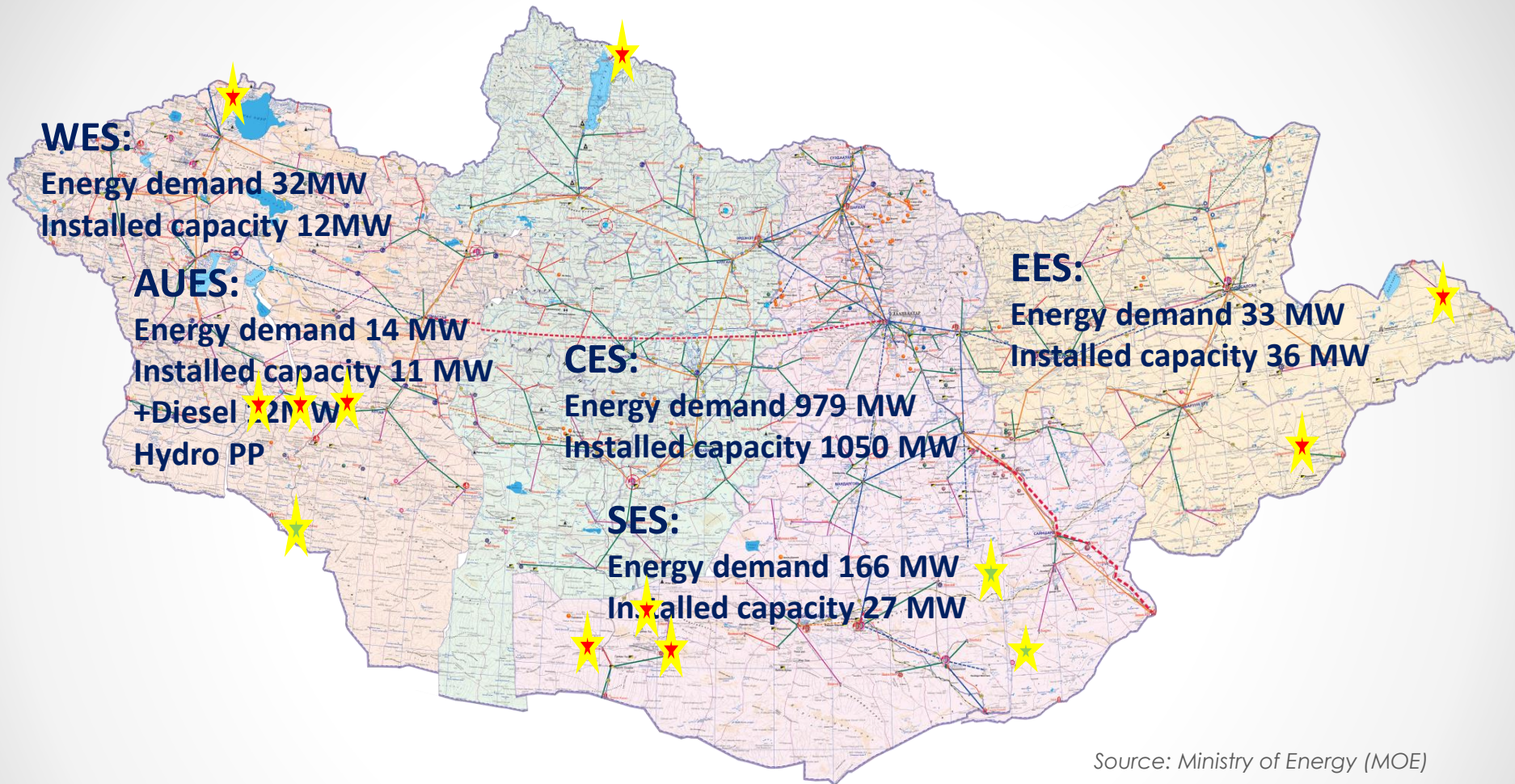
- ~98% of the total electricity generation and 100% of the heat produced by coal in Mongolia.
- Electricity import from Russia 1,419.1 million kWh in 2016.
- Heat production around 94% by water, 6% by vapor in 2016.

Source	2011	2012	2013	2014	2015	2016
CHPs	4,450.0	4,775.5	5,014.0	5,191.3	5,415.8	5,555.9
Diesel PP	20.2	28.7	5.4	8.2	6.0	3.8
Solar PP	-	-	-	0.6	0.5	0.3
Hydro PP	52.6	52.1	59.9	66.3	59.3	84.7
Wind PP	-	-	52.9	125.4	152.5	157.5
Total, million kWh	4,522.8	4,856.3	5,132.2	5,391.9	5,634.2	5,802.4

Source: Statistics of Energy Regulatory Commission (ERC)



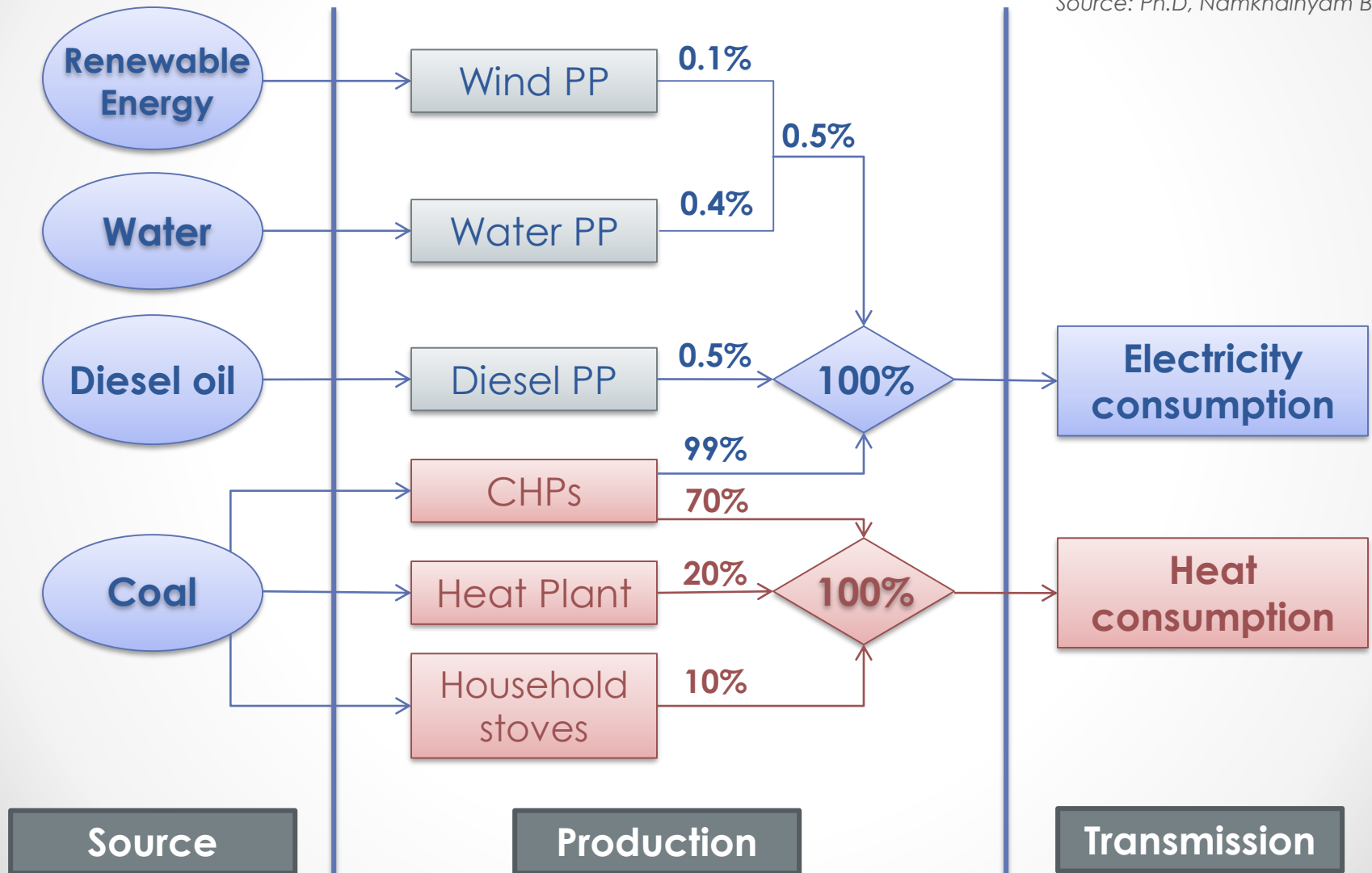
Mongolia's energy system 2015



Mongolian 329 out of 330 soum centers are connected to the grid. 1 soum which isn't connected to the grid provides its electricity from renewable sources.

Structure and ratio of the Mongolian energy production by 2013 (at the time of study work)

Source: Ph.D, Namkhainyam B.



Coal consumption in Mongolia

No	Consumer	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	CHPs	3.15	3.64	3.66	3.61	3.62	3.82	3.98	4.13	4.41	4.65	4.94	6.65
2	Medium heat plants (10-14MW)	0.90	1.04	1.05	1.03	1.04	1.09	1.14	1.18	1.26	1.33	1.41	1.90
3	Small heating boilers (0.1-1.4MW)	0.45	0.52	0.53	0.52	0.52	0.55	0.57	0.59	0.63	0.66	0.70	0.95
4	Total consumption, (million tons)	4.50	5.20	5.23	5.16	5.18	5.47	5.69	5.90	6.30	6.65	7.06	9.50
5	CHPs, %	70.0	70.0	69.8	70.0	69.9	69.8	69.9	70.0	70.0	69.9	70.0	70.0
6	Medium heat plants, %	20.0	20.0	20.1	20.0	20.1	19.9	20.0	20.0	20.0	20.2	20.1	20.0
7	Small heating boilers, %	10.0	10.0	10.1	10.0	10.0	10.1	10.1	10.0	10.0	9.9	9.9	10.0

Average coal consumption:

1) CHPs=70.0%; 2) Medium heat plants=20.0%; 3) Small heating boilers=10.0%

Source: Ph.D, Namkhainyam B., Ph.D, Tseyen-Oidov J.

№	Name of mines		Coal quality indicators					Coal types
			Moisture, %	Ash, %	Volatile substance, %	Sulfur content, %	Calories, kcal/kg	
1	Tavan Tolgoi	Baruun umnud	0.03-1.80	13.50-27.00	19.70-33.10	0.40-1.30	5,400.0	Coking coal
2		Tsanhi	0.01-3.40	9.90-39.70	17.50-35.90	0.20-1.20	5,250.0	
3		Ukhaa khudag	0.30-0.80	16.00-34.00	16.00-32.20	0.60-1.60	5,600.0	
4		Zuun	0.10-0.90	10.60-36.30	25.00-39.00	0.20-0.90	5,650.0	
5		Bor tolgoi	0.10-3.28	16.00-22.00	32.00-36.00	0.30-0.90	5,780.0	
6	Khushuut		0.40-4.30	10.60-29.30	15.30-23.40	0.30-0.60	6,084.0	Other bituminous
7	Nariin sukhait		1.03-2.80	8.30-30.20	28.30-40.40	0.10-0.80	6,850.0	
8	Nuurst khotgor		0.10-7.70	7.70-45.90	19.20-49.30	0.10-0.80	4,300.0	
9	Eldev		1.70-14.10	9.80-29.80	22.80-50.00	0.60-0.90	4,100.0	
10	Bayanteeg		0.70-12.50	6.50-36.20	39.10-84.60	0.27-3.50	4,380.0	
11	Saikhan-Ovoo		0.90-14.40	10.20-33.60	7.12-40.70	0.20-1.36	3,450.0	Lignite
12	Baganuur		3.80-26.70	4.60-39.80	33.90-53.60	0.03-3.80	3,430.0	
13	Shivee-Ovoo		6.38-9.20	7.20-26.10	44.00-53.60	0.64-0.92	2,790.0	
14	Aduunchuluun		15.80-18.20	16.60-19.70	38.40-63.10	0.13-2.70	2,930.0	
15	Ikh ulaan nuur		3.10-12.90	6.20-35.50	26.30-42.40	1.20-5.90	3,429.0	
16	Uvdug khudag		3.60-18.30	7.50-32.10	30.00-48.70	0.20-6.20	3,058.0	
17	Tevshiin govi		6.20-17.60	6.70-35.00	31.20-51.60	0.12-1.40	2,500.0	
18	Tsaidam nuur		9.58	11.20-15.00	31.90-61.30	0.58-1.00	3,700.0	
19	Tugrug nuur		5.90-14.90	7.70-39.30	31.90-61.30	0.15-1.39	3,262.0	

STUDY ON TYPE OF COAL STOVES & BOILERS AND THEIR COMBUSTION EFFICIENCY

Study on type of coal stoves & boilers and their combustion efficiency

- This study covered:
 1. 62 stoves of CHPs in the big cities (e.g. UB, Erdenet, Darkhan, Choibalsan);
 2. 65 HOBs of medium heat plants in the city, aimag and soum centers;
 3. 2,700 small heating boilers (0.1-1.4 MW) in the city, aimag and soum centers, which are not connected to centralized heating system.
- From above study, coal combusted in average 70% in CHPs, 20% in medium heat plants and 10% in small heating boilers.
- **Weighted average value of fuel combustion efficiency (2013):**

$$\eta = a_1 \times \eta_1 + a_2 \times \eta_2 + a_3 \times \eta_3 = 0.7 \times 0.96 + 0.2 \times 0.91 + 0.1 \times 0.88 = \mathbf{0.942}$$

Here:

a_1, a_2, a_3 – percentage of fuel consumption in CHPs, HOBs of medium heat plants and small heating boilers ($a_1=0.7, a_2=0.2, a_3=0.1$)

η_1, η_2, η_3 – combustion efficiency of these boilers and stoves

$\eta_1=0.96$ (CHPs), $\eta_2=0.91$ (HOBs of medium heat plants), $\eta_3=0.88$ (small heating boilers)

STUDY ON CONVERSION FACTORS OF SOME COAL TYPES IN MONGOLIA

Study on conversion factors of some coal types in Mongolia

✓ As of 2013 there are active 44 coal mines in Mongolia and from that:

- 21 lignite,
- 21 other bituminous coal and
- 2 coking coal mines.

✓ Average net calorific values for some type of coal:

- Lignite = 14.40 MJ/kg
- Other bituminous coal = 23.62 MJ/kg
- Coking coal = 21.75 MJ/kg

Study on conversion factors of some coal types in Mongolia

No	Name of mines	Coal type	Net calorific value, MJ/kg	No	Name of mines	Coal type	Net calorific value, MJ/kg
LIGNITE				OTHER BITUMINOUS COAL			
1	Baganuur	B2	14.40	1	Maanit	chuluun	25.05
2	Nalaikh	B3-D	14.65	2	Khuren gol	chuluun	31.85
3	Shivee-Ovoo	B2	11.70	3	Tsahiurt	J, G	18.28
4	Tevshiin govi	B2	10.46	4	Chuluun zeegt	D	17.50
5	Uvdug khudag	B2	11.70	5	Khar tarvagatai	D	18.90
6	Shariin gol	B3-D	17.20	6	Nuurst khotgor	GJ	18.00
7	Tugrug nuur	B2	13.00	7	Khuden	D	30.10
8	Khangai	B	12.90	8	Ikh myangan	D	16.50
9	Bayantsogt	B2	17.80	9	Bayantsagaan	chuluun	30.10
10	Ulziit	B3	20.40	10	Bayanduurakh	B-D	29.00
11	Talbulag	B2, B3	11.40	11	Bayan teeg	D	18.10
12	Aduunchuluun	B1	12.30	12	Saikhan-Ovoo	SS	14.40
13	Bulangiin khooloi	B	12.80	13	Jilchig bulag	D	30.60
14	Khuut	B	12.90	14	Nuurstein am	chuluun	27.20
15	Khulst nuur	B2, B3	18.60	15	Uvur chuluut	-	13.70
16	Chandgan tal	B3	17.90	16	Shine jinst	J, G	34.80
	Average		14.38	17	Alag togoo	GD	20.90
COKING COAL				18	Khuut	B3-D	27.60
1	Tavan tolgoi	OS, K	21.30	19	Gurvan tes	GEK	27.60
2	Mogoin gol	J	22.20	20	Nariin sukhait	GHKO	27.95
	Average		21.75	21	Ulaan-Ovoo	D	17.90
OTHER FUELS					Average		23.62
1	Coal briquettes	-	15.92				
2	Semi coking briquettes	-	18.85				
3	Semi coking fuel	-	23.00				
4	Sawdust briquettes	-	14.66				

Source: Ph.D, Namkhainyam B.

Study on conversion factors of some coal types in Mongolia



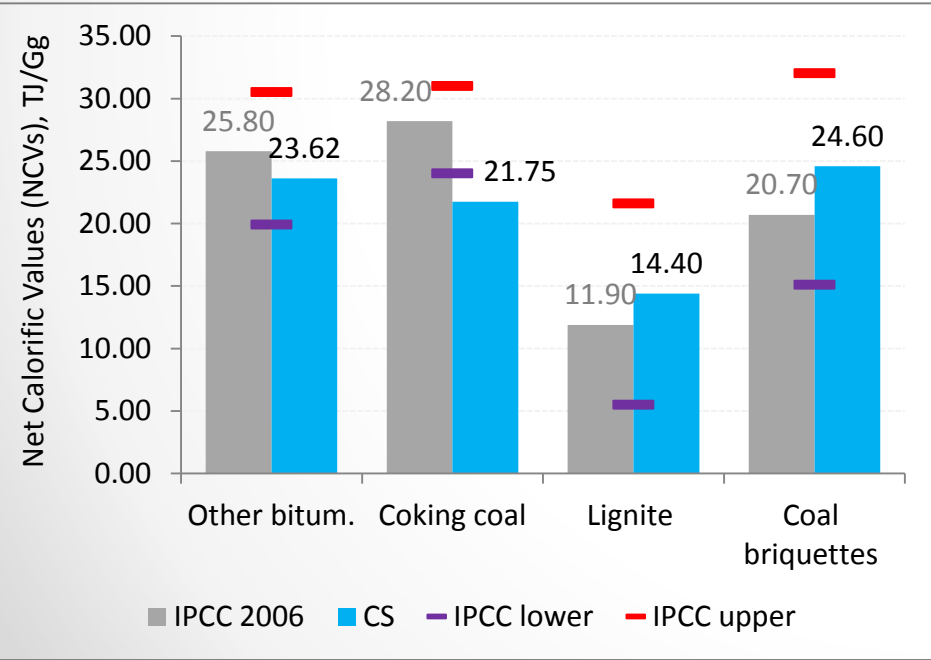
No	Fuel types	Net calorific value, MJ/kg	Conversion factor, TJ/t
1	Coking coal	21.75	0.02175
2	Other bituminous coal	23.62	0.02362
3	Lignite	14.40	0.01440
4	Coal briquettes	15.92	0.01592
5	Semi coking briquettes	18.85	0.01885
6	Semi coking fuel	23.00	0.02300
7	Sawdust briquettes	14.66	0.01466
8	Wood, at 15% moisture content	15.20	0.01520
9	Dung, at 15% moisture content	14.30	0.01430

Source: Ph.D, Namkhainyam B.

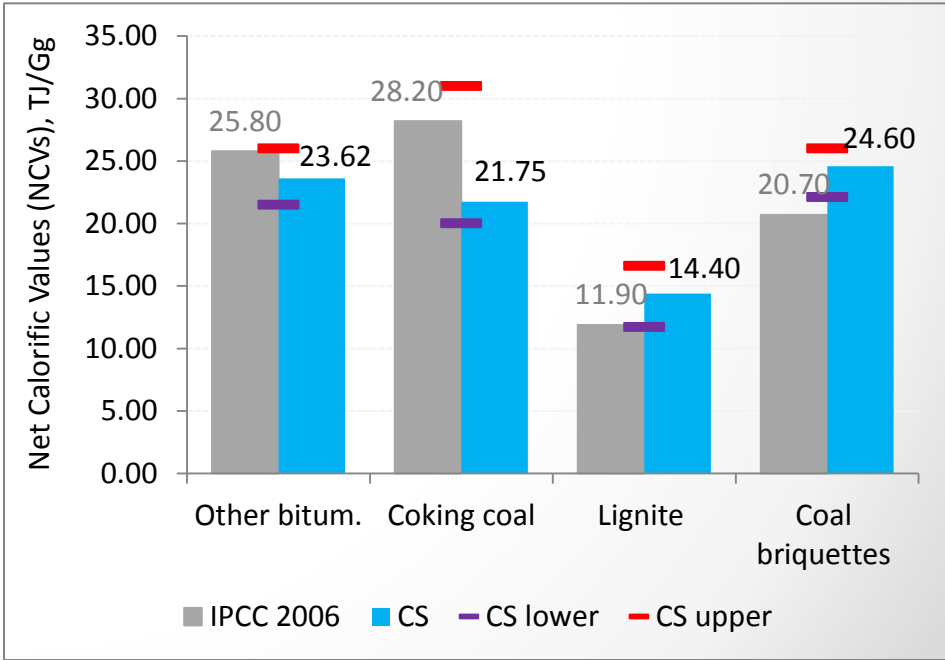
Study on conversion factors of some coal types in Mongolia

No	Fuel type	Net Calorific Value, TJ/Gg		Lower limit		Upper limit	
		IPCC 2006	CS	IPCC 2006	CS	IPCC 2006	CS
1	Other bituminous coal	25.80	23.62	19.90	21.50	30.50	26.00
2	Coking coal	28.20	21.75	24.00	20.00	31.00	31.00
3	Lignite	11.90	14.40	5.50	11.70	21.60	16.60
4	Coal briquettes	20.70	24.60	15.10	22.10	32.00	26.00

Comparison of conversion factors/NCVs with IPCC lower & upper limit



Comparison of conversion factors/NCVs with CS lower & upper limit



STUDY ON CO₂ EMISSION FACTORS OF COAL COMBUSTION IN MONGOLIA

Study on CO₂ EFs of coal combustion in Mongolia

No	Name of mines	Coal type	Carbon content, C ^{daf} , %	Carbon content, C ^r , %	No	Name of mines	Coal type	Carbon content, C ^{daf} , %	Carbon content, C ^r , %
LIGNITE					OTHER BITUMINOUS COAL				
1	Baganuur	B2	72.30	32.54	1	Nuurst khotgor	GJ	76.90	54.83
2	Nalaikh	B3-D	64.66	34.90	2	Khar tarvagatai	D	71.90	42.67
3	Uvdug khudag	B2	44.60	17.52	3	Khushuut	SS	79.80	63.34
4	Shivee-Ovoo	B2	67.60	34.34	4	Tsahiurt	J, G	64.31	44.56
5	Tevshiin govi	B2	69.44	33.74	5	Bayan teeg	D	55.00	33.44
6	Shariin gol	B3-D	71.93	44.60	6	Saikhan-Ovoo	SS	62.10	37.26
7	Aduunchuluun	B1	72.48	32.60	7	Alag togoo	GD	80.40	54.49
8	Ulziit	B3	58.95	40.02	8	Tsagaan-Ovoo	D	69.20	46.40
9	Talbulag	B2, B3	71.30	35.65	9	Eldev	GD	73.75	54.60
10	Chandgan tal	B3	73.80	60.10		Average		70.37	47.95
	Average		66.71	36.60	COKING COAL				
OTHER FUELS					1	Tavan tolgoi	OS, K	82.70	58.10
1	Semi coking fuel	-	-	50.39	2	Mogoin gol	J	63.90	41.85
2	Sawdust fuel	-	-	18.79		Average		73.30	49.98
3	Coal briquettes	-	-	39.16					

Source: Ph.D, Namkhainyam B.

Study on CO₂ EFs of coal combustion in Mongolia

IPCC CO₂ emission factor estimation for coal combustion

№	Fuel type	Carbon content, kg/GJ	Oxidation factor	CO ₂ emission factor, kg/TJ		
				Recommended	95% confidence limit	
		A	B	C= (A*B*44/12)*1000	Lower limit	Upper limit
1	Coking coal	25.80	1.00	94,600.00	87,300.00	101,000.00
2	Other bituminous coal	26.20	1.00	94,600.00	89,500.00	99,700.00
3	Lignite	27.60	1.00	101,000.00	90,900.00	115,000.00
4	Coal briquettes	26.60	1.00	97,500.00	87,300.00	109,000.00
5	Wood/Wood waste	30.50	1.00	112,000.00	95,000.00	132,000.00

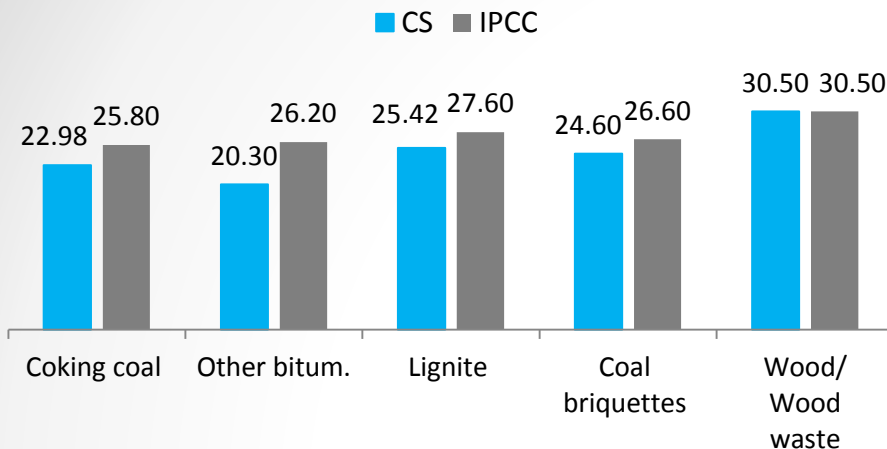
Country specific CO₂ emission factor estimation for coal combustion

№	Fuel type	Carbon content, kg/GJ	Oxidation factor	CO ₂ emission factor, kg/TJ		
				Recommended	95% confidence limit	
		A	B	C= (A*B*44/12)*1000	Lower limit	Upper limit
1	Coking coal	22.98	0.98	82,600.00	78,470.00	86,730.00
2	Other bituminous coal	20.30	0.94	70,000.00	66,500.00	73,500.00
3	Lignite	25.42	0.94	87,700.00	83,300.00	92,100.00
4	Coal briquettes	24.60	0.98	88,500.00	84,100.00	92,900.00
5	Wood/Wood waste	30.50	1.00	112,000.00	95,000.00	132,000.00

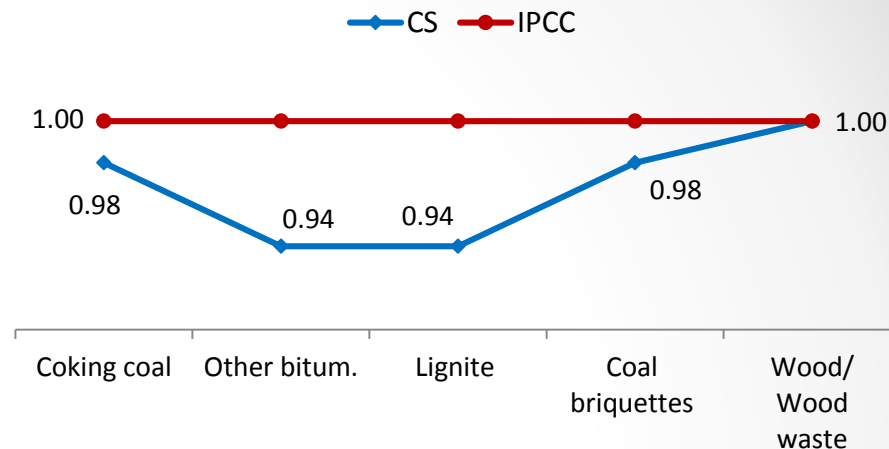
Source: Ph.D, Namkhainyam B.

Study on CO₂ EFs of coal combustion in Mongolia

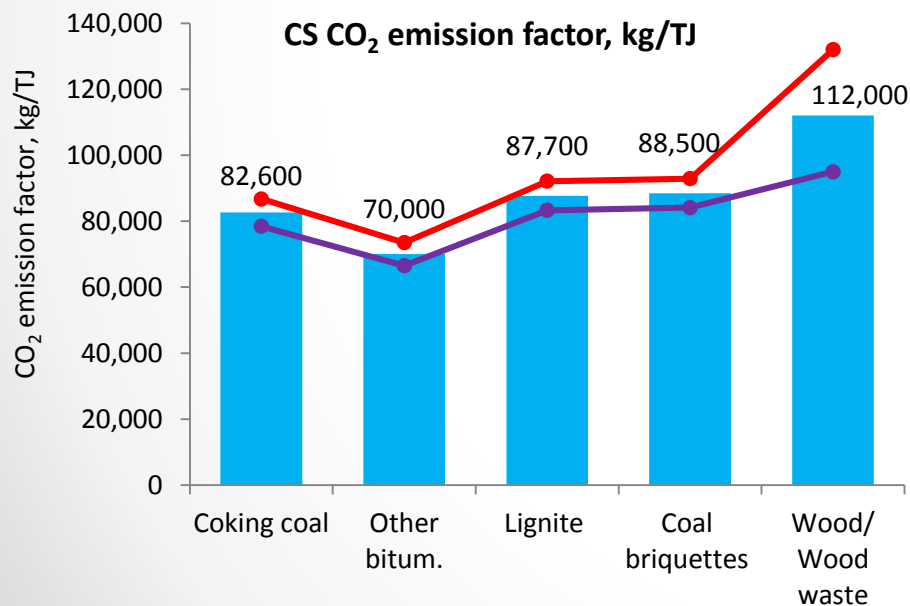
Carbon content, kg/GJ



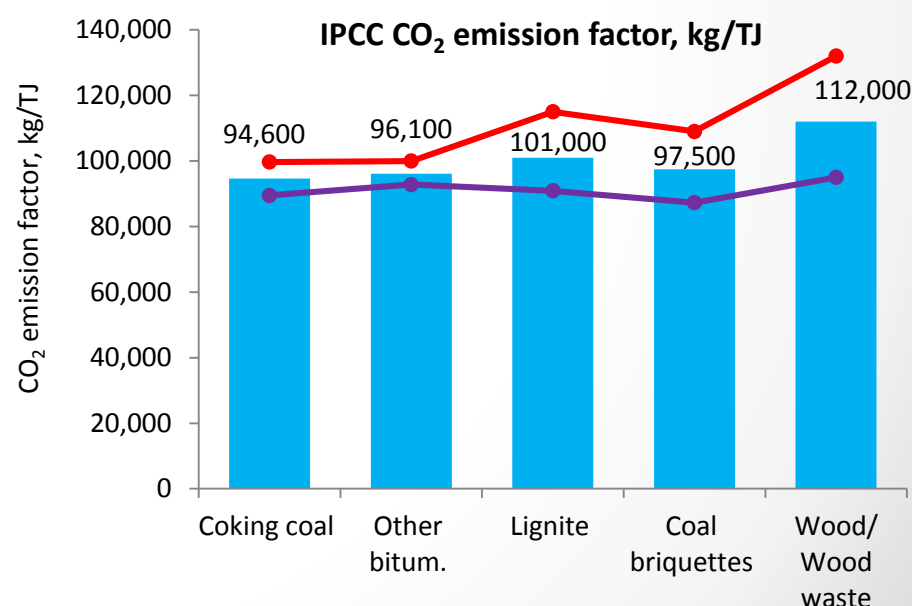
Oxidation factor



CS CO₂ emission factor, kg/TJ



IPCC CO₂ emission factor, kg/TJ



STUDY ON IDENTIFICATION OF METHANE CONCENTRATION FROM COAL MINING IN MONGOLIA

Study on identification of methane concentration from coal in Mongolia

- ✓ A detailed investigation of coal methane content in Mongolia has not been conducted.
- ✓ In the 70s the Soviet experts conducted a review study on the Nalaikh mine.
- ✓ In 2011-2013, the US research team (U.S. Environmental Protection Agency Contract 68-W-00-092 by Raven Ridge Resources) implemented “Coal mine methane resources assessment and emission inventory development in Mongolia” project in Mongolia and identified methane concentrations in some coal mines using measurements and mathematical models.

Mine classification	Methane emission factors,	
	Value used in Mongolia	IPCC default value
Underground mines:		
- Mining	17.5	10.0 - 25.0 (17.67)
- Post-mining	2.5	0.9 - 4.0 (2.47)
Surface mines:		
- Mining	1.2	0.3 - 2.0 (1.16)
- Post-mining seam gas	0.1	0.0 - 0.2 (0.1)

Source: Ph.D, Namkhainyam B.

Conclusion

- ✓ The emission factors estimated & presented above are consistent with the technology of the power generation and the characteristics of the fuel used in Mongolia for the period 1980-2020.
- ✓ The value of CO₂ emissions from fuel combustion is dependent on the fuel type, net calorific value, combustion efficiency → it should be updated for a certain period of time.
- ✓ More than 90% of Mongolia's energy is produced by the burning of lignite, and this is largely dependent on the CO₂ emission and its characteristics.
- ✓ Currently the methane from coal mining is not used in Mongolia, but if it will be used in near future, it'll be needed to estimate the CH₄ EFs.
- ✓ There are ongoing feasibility studies on methane utilization in Mongolia.

Thank you for your attention!

www.mne.mn, www.ncf.mn

tegshjargal@ncf.mn, tegshjargal77@gmail.com

Tel: +976-7000 0743, Fax: +976-310743