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GHG EMISSIONS AND ITS MITIGATION MEASURES AND TECHNOLOGIES IN ENERGY SECTOR OF MONGOLIA

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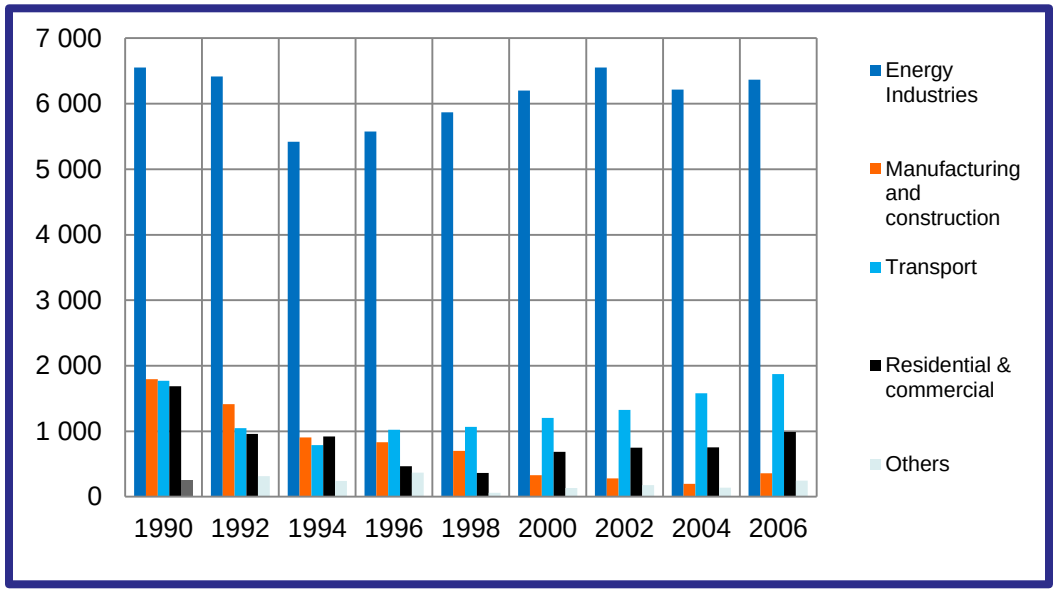
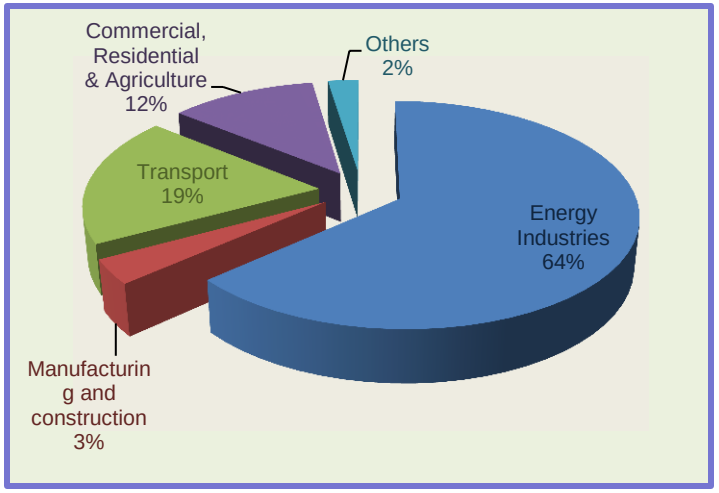
Greenhouse Gas emissions from Mongolian energy sector



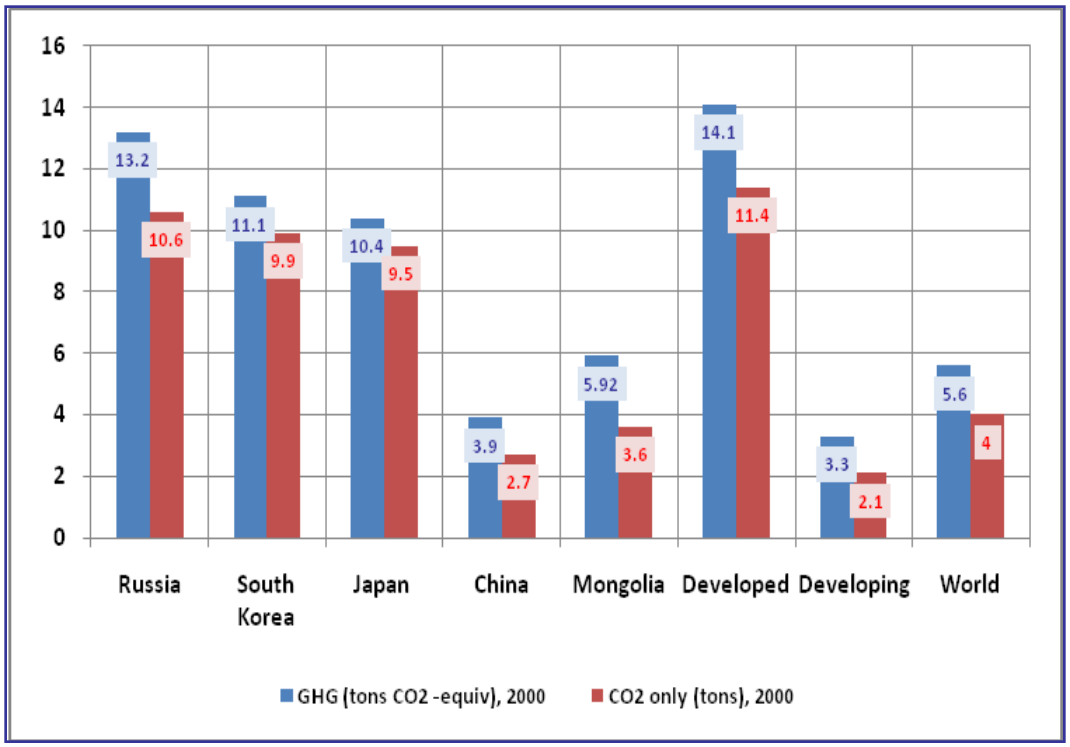


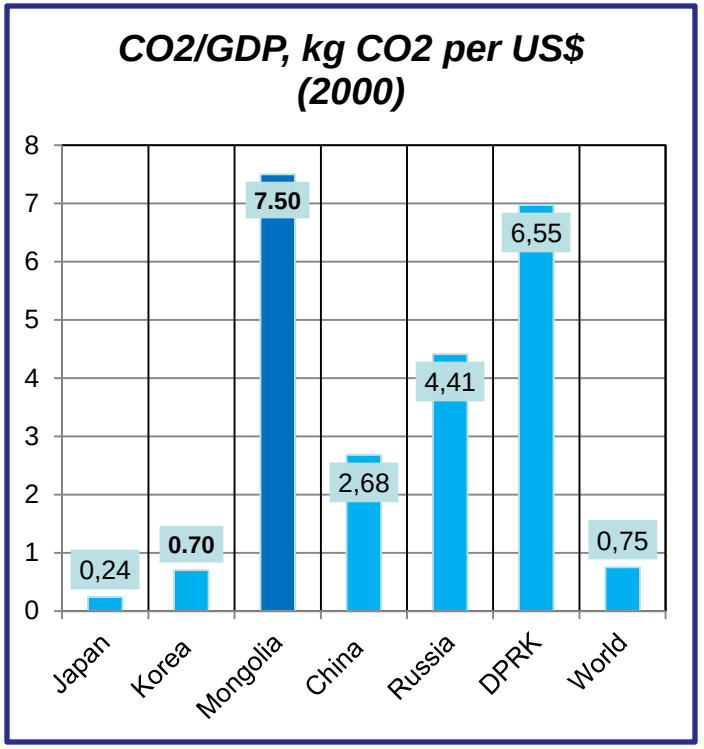
	Unit	1990	1995	2000	2004	2005	2006
Total emissions (gross)	$GgCO_2$-eq	23,645	17,205	16,896	16,910	17,582	18,868
Energy sector	$GgCO_2$-eq	12,529	8,710	8,865	9,247	9,635	10,220
Energy industries subsector	$GgCO_2$-eq	6,585	5,600	6,231	6,247	6,421	6,399
	% in total emissions	*27.9*	*32.5*	*36.9*	*37.0*	*36.5*	*33.9*
	% in energy sector emissions	*52.6*	*64.3*	*70.2*	*67.6*	*66.6*	*64.0*

Source: Mongolia Second National Communication, 2010

Greenhouse Gas emissions from Mongolian energy sector

Per Capita Emissions





If compare with the other developed and developing countries, the total GHG emissions is small, but per capita and per GDP emissions is high. Mongolia's per capita emissions were 6.0 tons /person, which is almost 2 times more than developing countries average. Per GDP CO_2 emissions are 10 times more than world average

Mongolian energy sector development scenarios

The projection of GHG emissions from Power and heat plants was calculated by using Long-range Energy Alternatives Planning system (LEAP) model. The LEAP is a scenario-based energy-environment modeling tool. Its scenarios are based on comprehensive accounting of how energy is consumed, converted and produced in a given region or economy under a range of alternative assumptions on population, economic development, technology and so on.

In order to develop different scenarios, following key assumptions were adopted

Key assumptions for energy sector development scenarios

	2010	***2015***	***2020***	***2025***	***2030***
Pop Growth Rate, %	1.6	1.6	1.6	1.6	1.6
Population, 1000 person	2761	2989.1	3236.0	3503.3	3792.6
Households , 1000 households	742.3	803.6	870.0	941.9	1019.6
Income, 1000 USD	2.1	2.7	4.1	6.8	11.7
Income Growth Rate, %	3.5	6.8	10.0	11.0	12.0
GDP, Billion USD	5.7	8.0	13.2	23.7	44.4

Source: GHG Mitigation Scenarios in Energy Sector, MEGD, 2013

Mongolia energy sector development: Reference scenario

Energy demand in the future is increased rapidly due to population growth and economic development. Especially, the energy consumption in industrial sector is rapidly increased due to development of mining and quarrying industry such as Oyu tolgoi, Tavan tolgoi and other mining projects

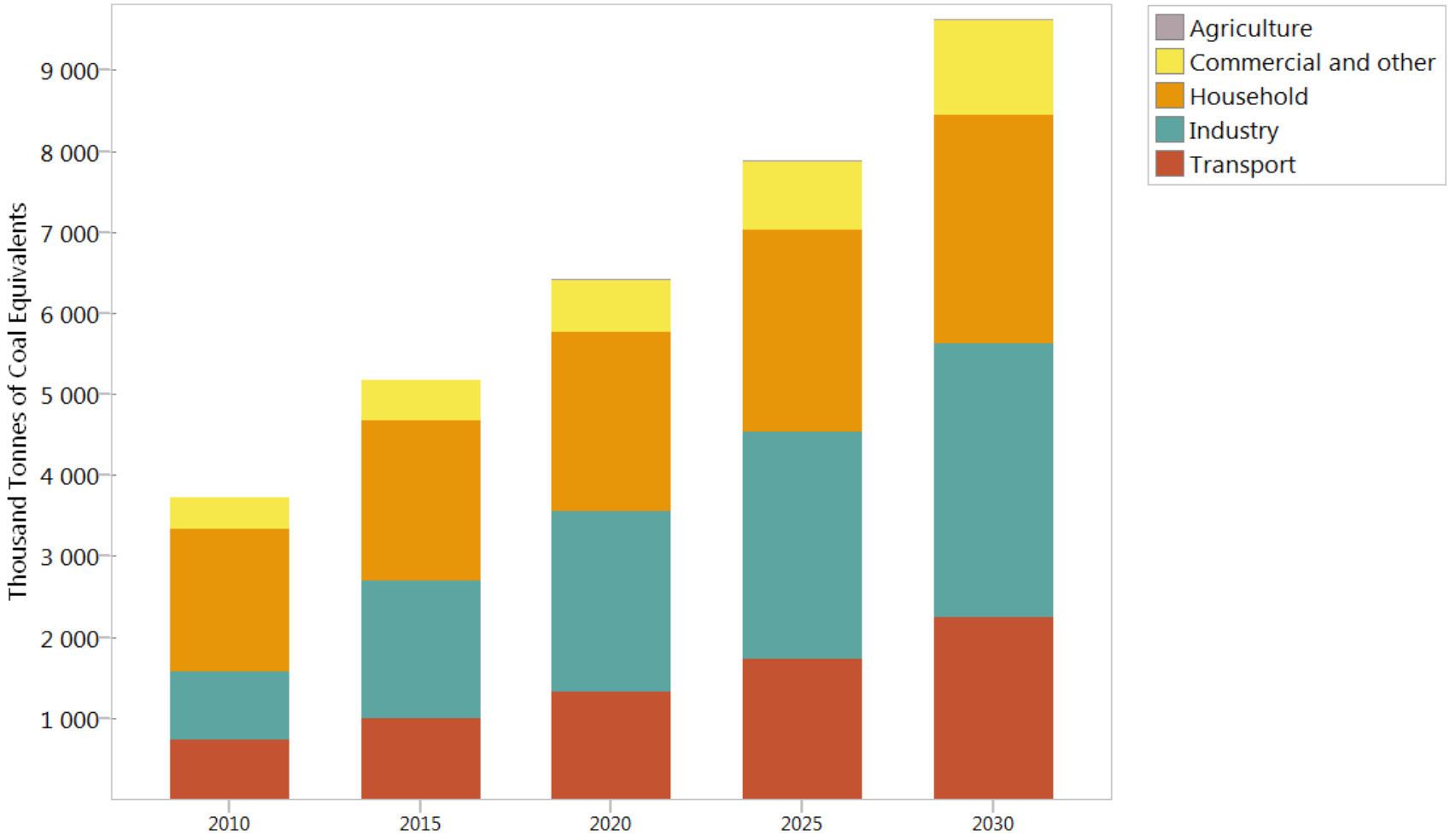
Million kWh

	2010	***2015***	***2020***	***2025***	***2030***
Household	808,7	986,9	1263	1715	2496
Industry	2090,2	4495,2	5927,9	7120,6	8325,8
Transport	0	0	0	0	0
Commercial and other	436	568,4	862,4	1427,2	2470,5
Agriculture	35,6	45,4	58	74	94,5
TOTAL DEMAND	3370,5	6095,9	8111,3	10336,8	13386,8

Source: GHG Mitigation Scenarios in Energy Sector, MEGD, 2013

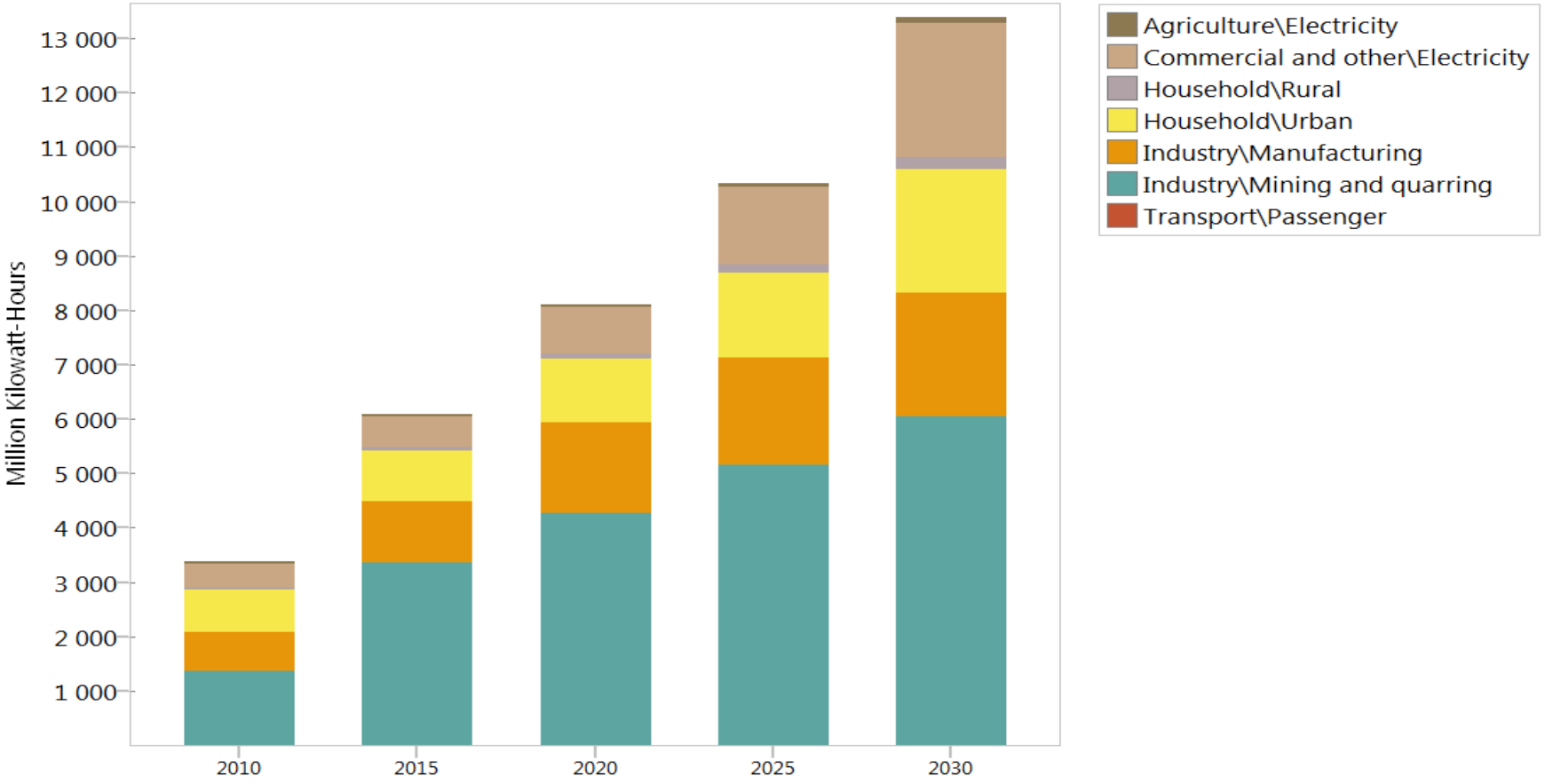
Demand: Energy Demand Final Units

Scenario: Reference, Fuel: All Fuels



Demand: Energy Demand Final Units

Scenario: Reference, Fuel: Electricity



Mongolia energy sector development: Reference scenario

In order to meet the growing energy demand, the following new energy sources are expected to be constructed, according to the government's infrastructure development program for the next few years:

- Combined Heat and Power Plant (CHP-5) in Ulaanbaatar with capacity 820MW (First stage 3x150MW, second stage 2x150MW + 1x170MW);
- The Mogoin gol thermal power plant with a capacity of 100 MW (2x50MW);
- The Tavan tolgoi coal fired thermal power plant with a capacity 300 MW;
- The Hushuut coal fired thermal power plant of 36 MW.

It is also assumed that existing power plants will be rehabilitated and their capacity increased. For reference scenario it is assumed that in the future up to 2030 will be constructed coal fired thermal power plants for meeting grown electricity demand

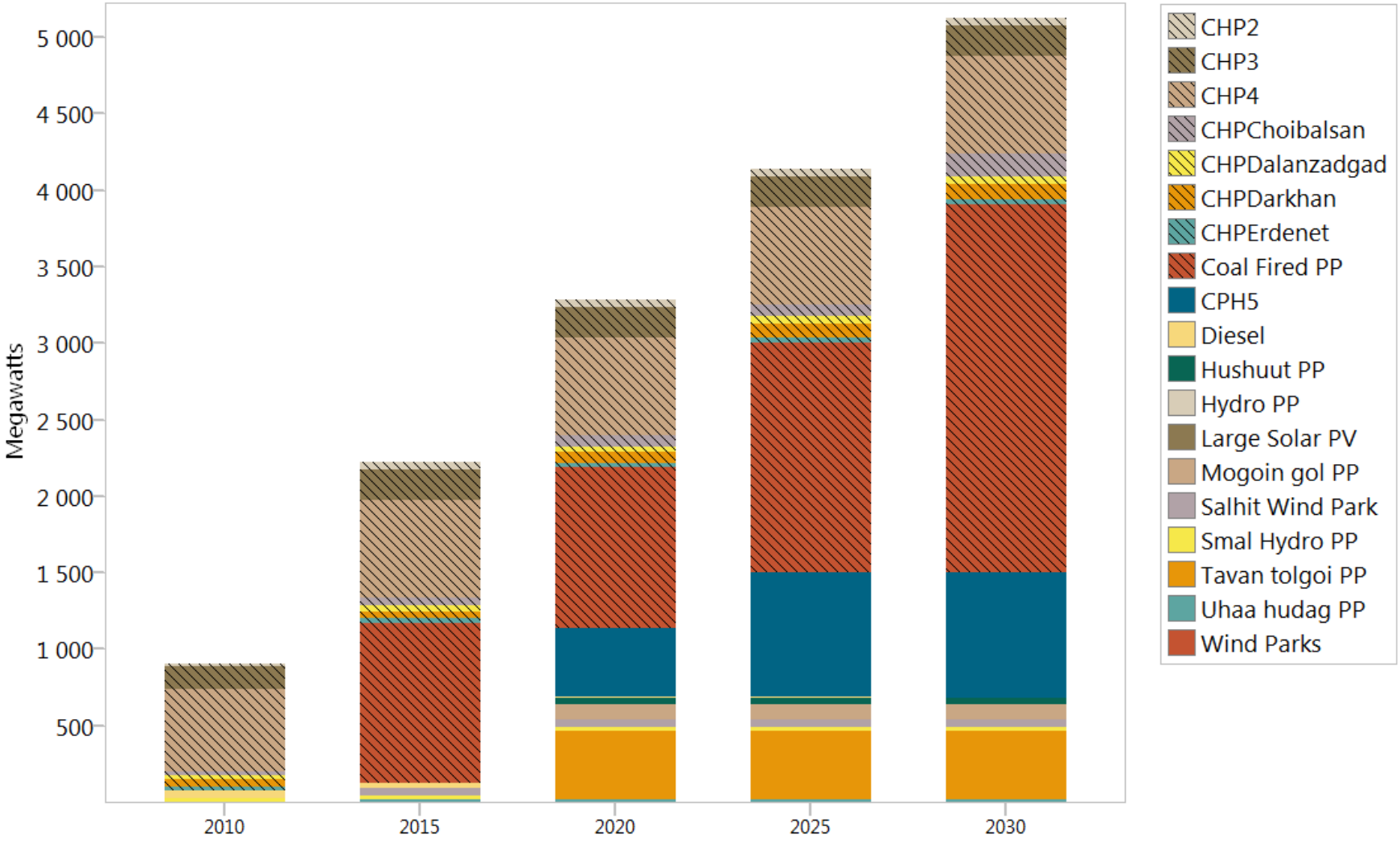
Mongolia energy sector development: Reference scenario

Electric capacity, MW

	2010	2015	2020	2025	2030
CHP3	148	198	198	198	198
CHP4	540	640	640	640	640
CHPChoibalsan	24	48	72	72	148
CHPDalanzadgad	24	36	36	48	48
CHPDarkhan	48	48	72	96	96
CHPErdenet	28,8	28,8	28,8	28,8	40
CHP2	21,5	50	50	50	50
Uhaa hudag PP	0	18	18	18	18
CPH5	0	0	450	820	820
Hushuut PP	0	0	36	36	36
Mogoin gol PP	0	0	100	100	100
Tavan tolgoi PP	0	0	450	450	450
Diesel	50	30	10	7,5	5
Salhit Wind Park	0	50	50	50	50
Smal Hydro PP	23	23	23	23	23
Hydro PP	0	0	0	0	0
Large Solar PV	0	0	0	0	0
Wind Parks	0	0	0	0	0
Coal Fired PP	**0**	**1050**	**1050**	**1500**	**2400**
	907,3	2219,8	3283,8	4137,3	5122

Transformation: Capacity

Scenario: Reference, Capacity Type: All Capacity Types



Energy Balance

Scenario: Reference, Year: 2010 (Thousand Tonnes of Coal Equivalent)

	Electricity	Gasoline	Jet Kerosene	Kerosene	Diesel	LPG	Coal Bituminous	Coal Lignite	Wood	Wind	Solar	Hydro	Heat	Total
Production	-	-	-	-	-	-	230	3786,1	629	0,2	0,7	9,8	-	4655,9
Imports	27,8	297,8	30,1	0	461,4	0,5	-	-	-	-	-	-	-	817,7
Exports	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Primary Supply	27,8	297,8	30,1	0	461,4	0,5	230	3786,1	629	0,2	0,7	9,8	-	5473,6
HOBs	-	-	-	-	-	-	-	-219,8	-	-	-	-	142,9	-76,9
Generation	546,1	-	-	-	-24,6	-	-	-3083,3	-	-	-	-9,8	1119,2	-1452,4
Transmission and Distribution	-77,5	-	-	-	-	-	-	-	-	-	-	-	-30,1	-107,6
Station own use	-82,4	-	-	-	-	-	-	-	-	-	-	-	-73,1	-155,5
Total Transformation	386,2	-	-	-	-24,6	-	-	-3303,1	-	-	-	-9,8	1158,9	-1792,4
Household	99,3	-	-	0	-	0,5	-	408	629	0,2	0,7	-	615,1	1752,9
Industry	256,7	-	-	-	28,8	-	230	-	-	-	-	-	325	840,6
Transport	-	297,8	30,1	-	408	-	-	-	-	-	-	-	-	736
Commercial and other	53,6	-	-	-	-	-	-	75	-	-	-	-	264,7	393,3
Agriculture	4,4	-	-	-	-	-	-	-	-	-	-	-	-	4,4
Total Demand	414	297,8	30,1	0	436,8	0,5	230	483	629	0,2	0,7	-	1204,8	3727,1

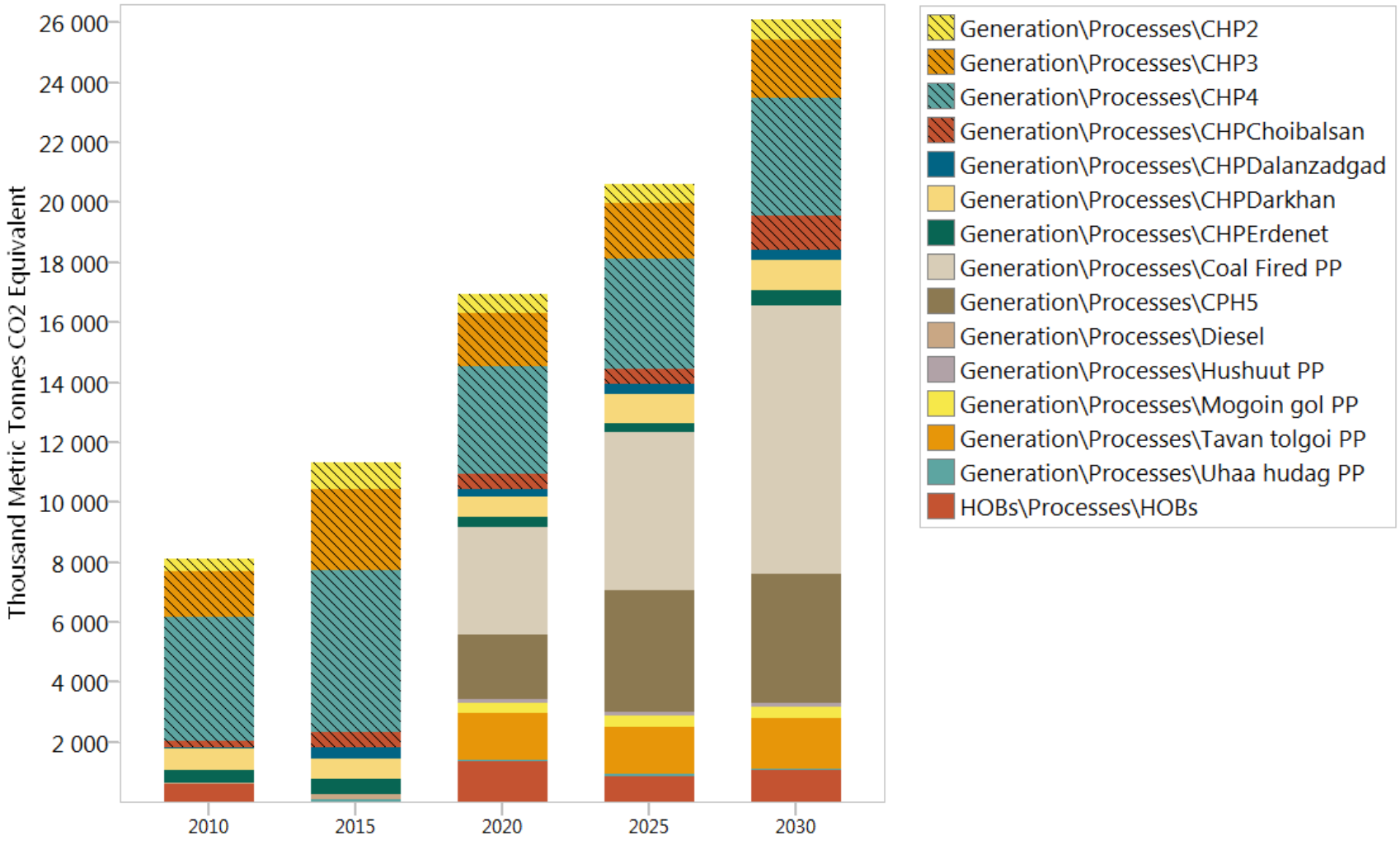
Energy Balance

Scenario: Reference, Year: 2020 (Thousand Tonnes of Coal Equivalent)

	Electricity	Gasoline	Jet Kerosene	Kerosene	Diesel	LPG	Coal Bituminous	Coal Lignite	Wood	Wind	Solar	Hydro	Heat	Total
Production	-	-	-	-	-	-	965,4	7069,9	585,3	14	0,9	10,1	-	8645,6
Imports	-	544,5	35,3	0	905	29,8	-	-	-	-	-	-	-	1514,7
Exports	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Primary Supply	-	544,5	35,3	0	905	29,8	965,4	7069,9	585,3	14	0,9	10,1	-	10160,3
HOBs	-	-	-	-	-	-	-	-491,6	-	-	-	-	319,6	-172,1
Generation	1429,1	-	-	-	-17,5	-	-	-5797,6	-	-13,7	-	-10,1	1407	-3002,8
Transmission and Distribution	-227,9	-	-	-	-	-	-	-	-	-	-	-	-39,7	-267,6
Station own use	-204,8	-	-	-	-	-	-	-	-	-	-	-	-96,5	-301,3
Total Transformation	996,4	-	-	-	-17,5	-	-	-6289,2	-	-13,7	-	-10,1	1590,3	-3743,8
Household	155,1	-	-	0	-	29,8	-	618,8	585,3	0,3	0,9	-	824,3	2214,7
Industry	728,2	-	-	-	147,8	-	965,4	-	-	-	-	-	396,2	2237,5
Transport	-	544,5	35,3	-	739,6	-	-	-	-	-	-	-	-	1319,4
Commercial and other	105,9	-	-	-	-	-	-	161,9	-	-	-	-	369,8	637,7
Agriculture	7,1	-	-	-	-	-	-	-	-	-	-	-	-	7,1
Total Demand	996,4	544,5	35,3	0	887,5	29,8	965,4	780,8	585,3	0,3	0,9	-	1590,3	6416,4

Environment: Global Warming Potential

Scenario: Reference, Fuel: All Fuels, GHG: All GHGs



Mongolia energy sector development: Mitigation Scenario

GHG Mitigation scenarios

Renewable energy scenario

- Hydropower power plants
- Wind parks
- Large scale solar PV

Energy Efficiency (Demand site management) scenario

- Reduction of electricity transmission and distribution losses
- Reduction of station own uses
- Efficient electric lighting in households
- Building insulation improvement

Mongolia energy sector development: Mitigation Scenario

Renewable energy scenario:
Capacity of renewable energy sources for electricity generation for mitigation scenario, MW

		2013-2020	***2020-2025***	***2025-2030***
1	***Hydropower plants***			
	Shuren	300		
	Eg		220	
	Orkhon		100	
	New			200
2	***Wind Parks***			
	“Clean tech” Co., Ltd	250		
	“Shainshand wind park” Co., Ltd		52	
	“AB Solar wind”		100	
	“Aydiner global” Co., Ltd		50.4	
	New			150
3	***Large scale solar PV***			
	New	50	100	200

Source: GHG Mitigation Scenarios in Energy Sector, MEGD, 2013

Mongolia energy sector development: Mitigation Scenario

Energy Efficiency (Demand site management) scenario

Efficient lighting Scenario

Technology penetration: A program to install

efficient lighting systems could reduce electricity consumed in urban household using co mpact fluorescent (CFL), light emitting diodes (LED) and other technologies. Assume that t he program starts in 2011 and is capable of reaching 60% of all urban households by 2020 and 90% in 2030.

Technology performance: Efficient lighting can be assumed to consume only 30% of the electricity used by conventional lighting in urban households.

Building insulation and heating efficiency improvement Scenario

Technology penetration: Assume that building insulation and heating efficiency improve ment program starts in 2014 and is capable of reaching 50% in 2020 and 90% of apartmen ts in 2030

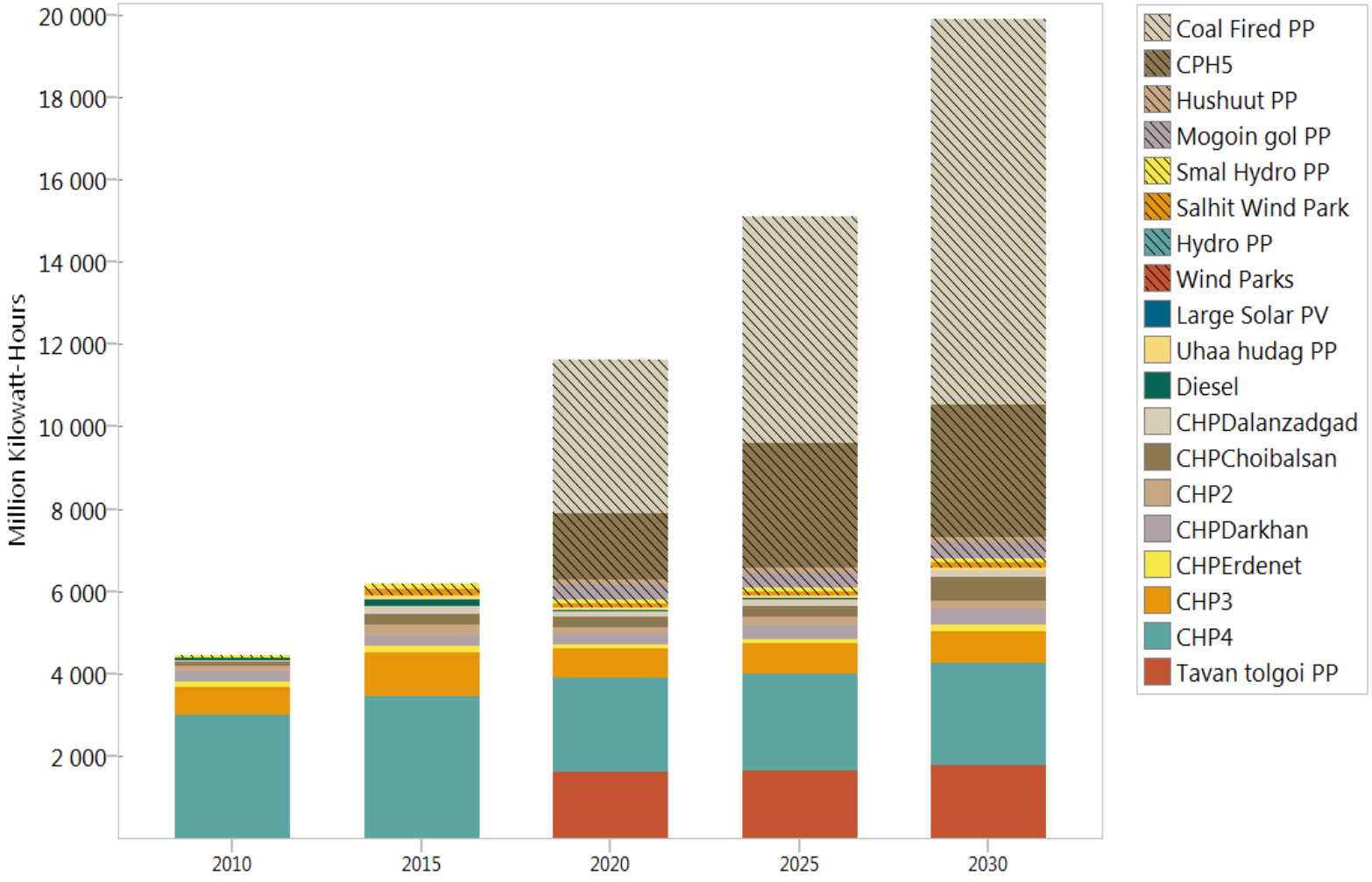
Technology performance: It is assumed that, building insulation and heating efficiency impr ovement program can reduce energy consumption of households by 50-60%.

Transmission and distribution losses and station own use reduction Scenario

	2010	***2020***	***2030***
Electricity transmission and distribution losses	13.5	10.8	8.0
Station own use	15.6	13	10.0

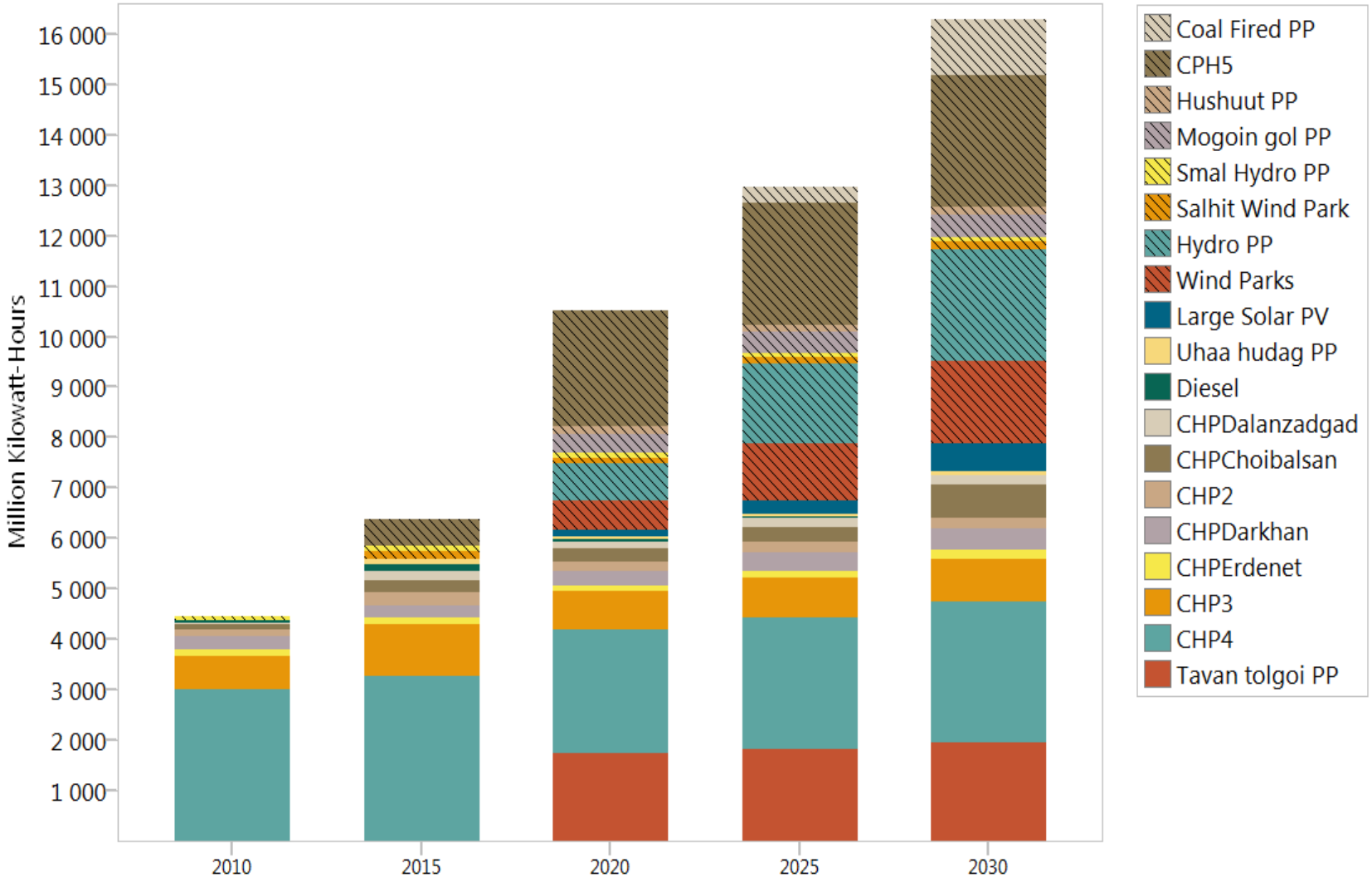
Transformation: Outputs

Scenario: Reference, Electricity



Transformation: Outputs

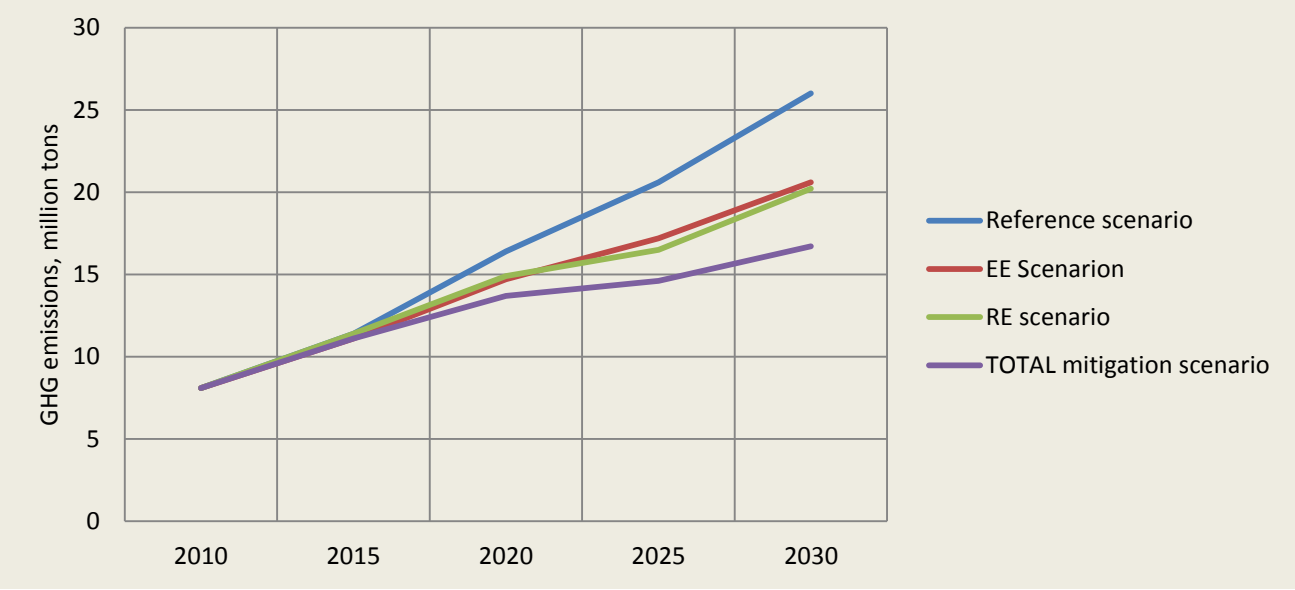
Scenario: TOTAL, Fuel: Electricity



Mongolia energy sector development: Mitigation Scenario

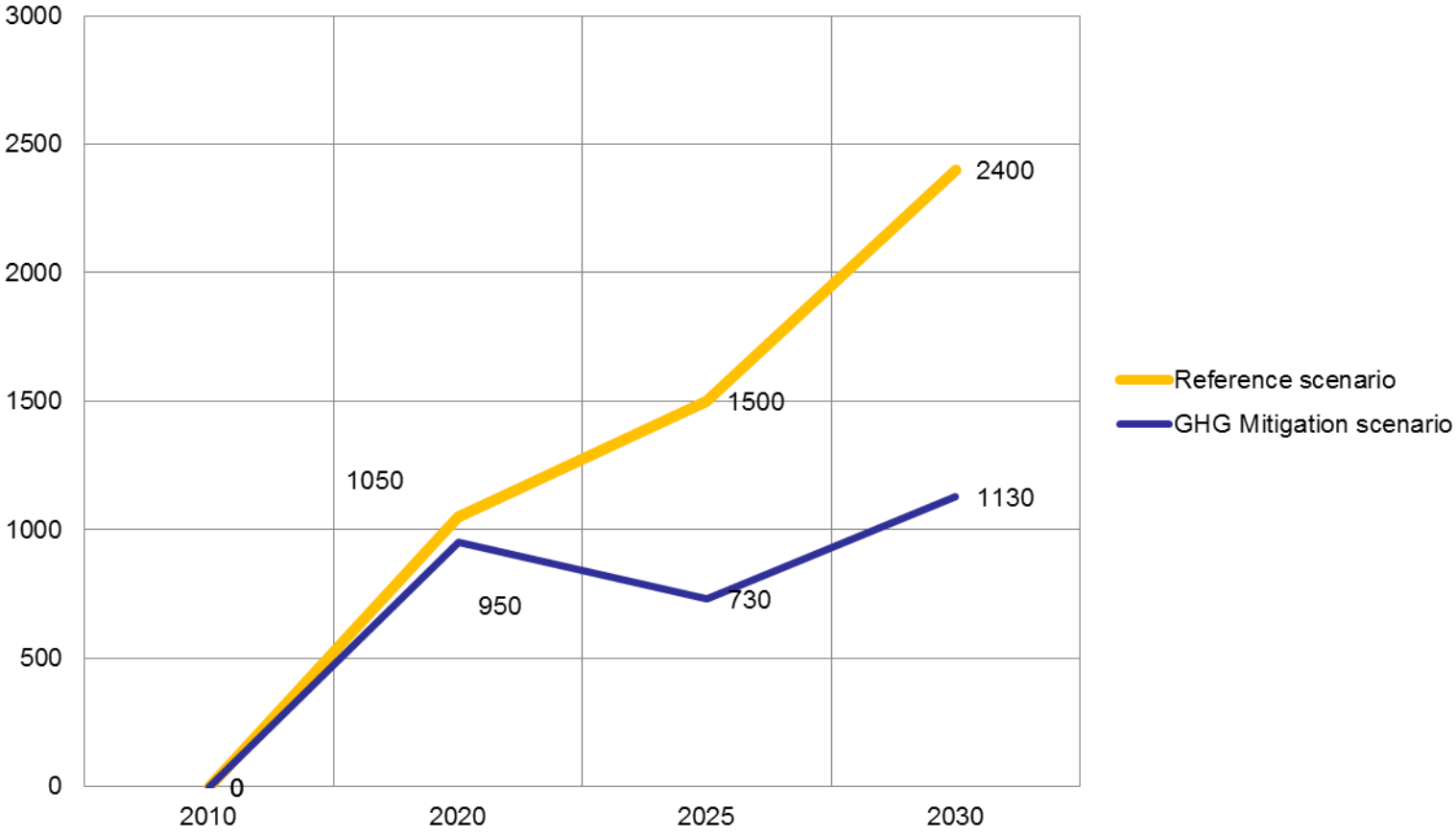
GHG emissions from EE and RE mitigation scenarios, million tons

Scenarios		***2010***	***2015***	***2020***	***2025***	***2030***
Reference scenario		***8.1***	***11.0***	***16.5***	***20.5***	***26***
EE Scenario	Emissions	8.1	10.8	14.6	17.5	21.3
	emission reduction	0.0%	1.8%	11.5%	14.6%	18.1%
RE scenario	Emissions	8.1	11.0	14.7	17.1	20.5
	Emission reduction	0.0%	0.0%	10.9%	16.6%	21.2%
TOTAL mitigation scenario	Emissions	***8.1***	***11.0***	***13.4***	***14.6***	***17.1***
	Emission reduction	0.0%	0.0%	18.8%	28.8%	34.2%



Source: GHG Mitigation Scenarios in Energy Sector, MEGD, 2013

Capacity of coal fired power plants



Mongolia energy sector development: Mitigation Scenario

Electricity generation from RE sources, million kWh

	2010	***2015***	***2020***	***2025***	***2030***
Total electricity generation	4445.9	6015.5	11634.1	15086.5	19822.6
Electricity generation from RE sources	**80**	**287.3**	**1969.8**	**3824.1**	**5764.5**
Salhit Wind Park	0	165.5	133.7	140.9	152.4
Smal Hydro PP	80	121.8	98.4	103.7	112.2
Hydro PP	0	0	802	1747.5	2499.5
Wind Parks	0	0	668.4	1268.3	1828.9
Large Solar PV	0	0	267.3	563.7	914.4
Share of electricity generation from RE sources	**1.8%**	**4.8%**	**17. 0%**	**25.3%**	**29.1%**

Source: GHG Mitigation Scenarios in Energy Sector, MEGD, 2013

Mongolia energy sector development: Mitigation Scenario

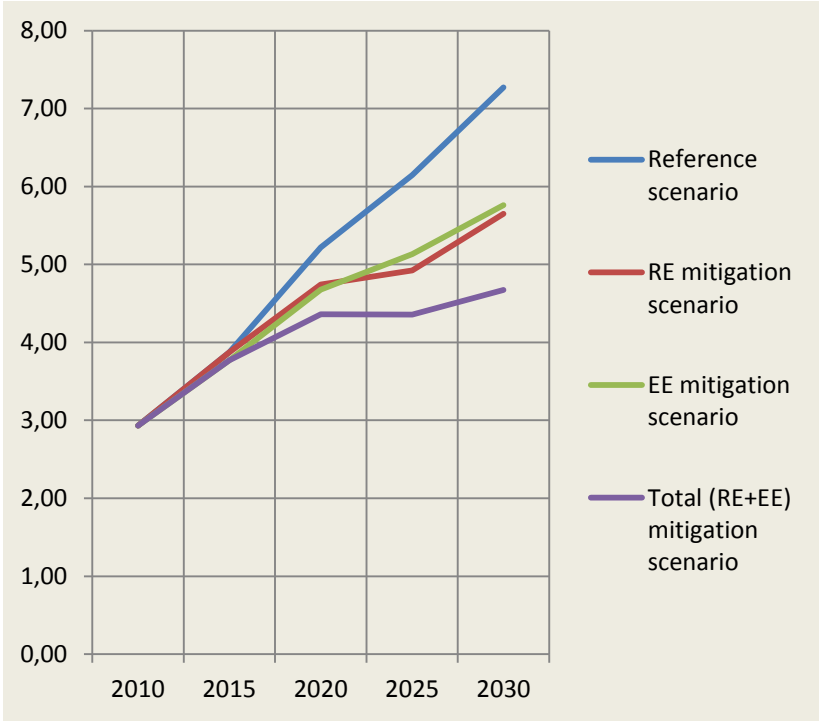
Per capita and per GDP emissions from energy industry

	2010	***2015***	***2020***	***2025***	***2030***
Population, 1000 person	2761	2989	3236	3503	3793
GDP, Billion USD	5.7	8.0	13.2	23.7	44.4
GHG Emissions, million tons					
Reference scenario	8.1	11.0	16.5	20.5	26.0
Mitigation scenario	8.1	11.0	13.4	14.6	17.1
Per capita GHG Emissions, tons/capita					
Reference scenario	2.93	3.68	5.10	5.85	6.86
Mitigation scenario	2.93	3.68	4.14	4.17	4.51
Per GDP GHG Emissions, kg/USD					
Reference scenario	1.42	1.38	1.25	0.86	0.59
Mitigation scenario	1.42	1.38	1.02	0.62	0.39

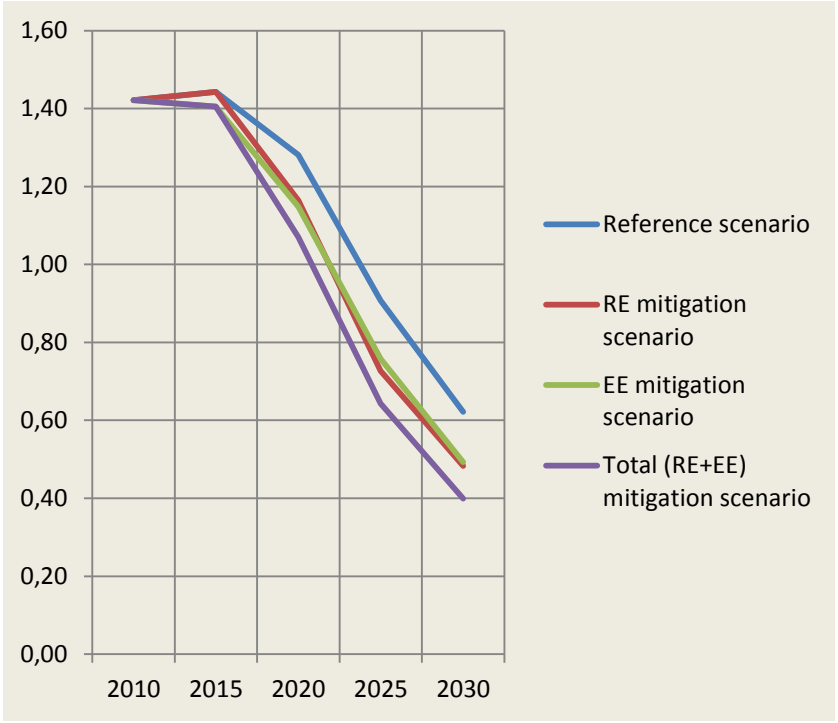
Source: GHG Mitigation Scenarios in Energy Sector, MEGD, 2013

Mongolia energy sector development: Mitigation Scenario

Per capita and per GDP emissions from energy industry



Per capita GHG Emissions, tons/capita



Per GDP GHG Emissions, kg/USD

Effects from improvement of coal fired thermal power plant efficiency in level of 2030

ДЦС-ын уурын анхны параметр		Циклийн АҮК	ЦЭХ үйлдвэрлэлийн жишмэл түлшний хувийн зарцуулалт гр ж.т/кВт	ДЦС-ын АҮК
$P_{0,}$ МПа	$T_{0,}$ ^{0}C			
3.5	435	0.34	460	0.29
9.0	565	0.42	395	0.33
13.0	565	0.436	350	0.36
24.0	570	0.48	320	0.41
30.0	600	0.5	290	0.43

Эх сурвалж: Б.Намхайням: Байгаль орчин, Эрчим хүч, технологи, Улаанбаатар -2014

	ДЦС АҮК =0.33	ДЦС АҮК =0.41
Түлшний зарцуулалт, сая тонн	22,1	20,8
Түлшний хэмнэлт, сая тонн		1,3
Хүлэмжийн хийн ялгаралт, сая тонн	25,6	23,7
Хүлэмжийн хийн бууралт, сая тонн		1,9

Эх сурвалж: LEAP загварын тооцоонд үндэслэн гаргав

Barriers for implementation of mitigation technologies in energy industry sector

The common economic and financial barriers are:

- inappropriate financial incentives,
- high cost of capital, high transaction cost;
- lack or inadequate access to financial resources, and
- uncertain macro-economic environment.

Common barriers regarding the policy, legal and regulatory aspects are:

- lack of long-term political commitment and uncertain government policies (political risks for inve stors),
- lack of government control for implementation of laws and regulations, and
- government or utility monopoly of energy sector.

Regarding the large scale HPP technology, policy-related barriers have first priorities. The plans on building large scale hydro power plants are reflected in every policy documents of the energy sector. The decision on the required investment had been made and projects had been discussed few times during the Parliament and Cabinet meetings. Even so, it still hasn't moved forward due to political reasons. For HPPs, politics is the main barrier.

Regarding the wind park, barriers of the highest priority are system constraints (capacity limits of the grid system). Wind parks adversely affect the energy system stability as their operations and electricity supply depends on irregular wind availability. Especially for a country like Mongolia whose energy system consists of coal fired combined heat and power plants, connecting many high capacity wind power plants will destabilize the system.

Source: "*Technology Needs Assessment: Volume 2 – Climate Change Mitigation in Mongolia",* MEGD, UNEP, GEF, 2013

Conclusions

- In comparison with 2010, the energy consumption for all sectors especially in industry sector will be increased 3-4 times in 2030. This dramatic increase is subject to natural resource exploration plants in Oyutolgoi and Tavantolgoi and the Sainshand Industrial Park, which all are going to be constructed.
- As a result of implementing the reference scenario, apart from the above sources, coal fired new sources, which have capacity of 1200MW in 2015, 1500-2550 MW between 2020 and 2030, are needed. As for the reference scenario, GHG emission from electricity and heat generation will be increased 2 times in 2020 and 3 times in 2030 more than 2010 indicators.
- As a result of implementing renewable energy scenario, the percentage of the renewable energy in total electricity production will be 17 per cent in 2020 and 29 per cent in 2030.
- It is important to analyze the barriers for implementation of GHG mitigation technologies and prepare technology action plan for enabling the implementation measures.

Thank you for attention