Greater Tumen Initiative

Regional Cooperation in Industrial Energy Efficiency

June 2019

Contents

List of Tables

List of Charts

Executive Summary

The Greater Tumen Initiative/GTI Energy Working Group brings together policy and business communities for intensive discussions with the goal of providing a road forward on various energy and energy efficiency issues, including the industrial energy efficiency and the ways to international cooperation in this field. Over the past years, industry and governments of GTI work together to map the transition to a regional framework where the private sector and the marketplace have motivations to drive improvements in technology and business practices. The energy dialogue has provided a platform to discuss national energy efficiency policy questions with the goal of ensuring that economic growth and regional cooperation is flourishing.

This report is the result of a joint participation of experts from the GTI countries, which examines issues related to industrial energy efficiency in GTI, the way it is developed by the countries, their progress and major challenges. It focuses on opportunities for cooperation in key areas such as funding, development of regional markets, industrial integration and skills development. Efforts to increase industrial energy efficiency could play a key role in the region's socio-economic development and be a driver of regional integration. It seems logical that industrial energy efficiency policies implemented in the countries should reflect individual strategies made by neighbouring countries but proximity of their markets should create complementarities and the opportunities for economies of scale. Challenges (increasing demand for energy and its reliable supply, sustainable development, low competitiveness, reducing environmental impacts) and opportunities (value added, job creation, transfer of knowledge and technology acquisition) that GTI countries are experiencing today call for collective action across the whole region, oriented towards tangible results. For example, the need for significant investments required to modernise regional industrial sectors and organise associated technology transfers, offer many opportunities to build truly innovative international public private partnerships.

The region could strengthen its position forming the GTI cooperation in industrial energy efficiency and start collaborate with other regions in Asia based on a long-term vision and common strategic areas through strengthening of the dialogue, information and knowledge exchange, harmonisation of policies and regulatory frameworks and implementation of joint projects.

During the GTI Energy Board conference in Moscow, November 2017, speakers agreed on the necessity to harmonise national circumstances and priorities with the regional goals for economic prosperity and encourage business to invest and innovate. A prominent part of the discussion was the improvement of industrial energy efficiency and the development and deployment of innovative technologies to benefit the society. Discussions also focused on a review of experiences, possibilities and unknowns associated with the pursuit of an energy efficient economy, efforts to better understand one another's perspectives on how economic and environmental policy approaches can be promoted

effectively in Northeast Asia/NEA, and, in particular, the role that national market-places and regulatory frameworks could play in taking regional marketplaces towards higher industrial energy efficiency. It was also stressed that successfully bringing new energy technologies into the marketplace will require far greater investment in innovation by the private sector. Therefore, a primary objective of international cooperation in the region should be to catalyse private investment flows.

Prior to that, in April 2016, the GTI Energy Board approved the project titled "Research on Regional Cooperation in Industrial Energy Efficiency". The project was designed to promote energy efficiency cooperation in the NEA region and overcome obstacles to the cooperation. Its aim was to define policy for implementing cooperation in energy conservation technologies and best practices, increase awareness, deepen common interests facilitating collaboration in regional industrial energy efficiency. It was agreed to

- analyse government agencies in charge of industrial energy efficiency and relevant policies and regulations
- describe national development targets and ways to implement industrial energy efficiency
- discuss opportunities and challenges faced by member states of GTI in industrial energy efficiency cooperation.

As an ideal outcome, the project aimed to summarise aspects in which countries could make contributions to the cooperation among GTI member states in industrial energy efficiency and make recommendations leading to further openness of scientific and technological innovations.

The report is divided into several parts, including description of main industrial energy consumers, energy conservation and emission reduction technologies, introduction of national government agencies in charge of industrial energy efficiency and relevant policies and regulations, analysis of the present situation, development targets and implementation ways in each country and finally, the conclusion with proposals facilitating regional cooperation.

Energy efficiency improvements in GTI region

As can be observed from the national reports, in the GTI region, energy is consumed in the industrial sector by a diverse group of industries including manufacturing, agriculture, mining, transport and construction and for a wide range of activities, such as processing and assembly, space conditioning, and lighting. In recent years, countries have achieved considerable progress in energy efficiency level and improvement of their industries to significantly reduce energy consumption.

Highly impressive is China's achievement in the field of energy efficiency. The 2017 reports of International Energy Agency dedicate a lot of research to China and its industrial sectors energy efficiency and it is difficult not to notice exceptional achievements of the country, important for the

international cooperation in NEA region. According to IEA Energy Efficiency 2017 Report[1], global investment in energy efficiency increased by 9% to USD 231 billion in 2016, maintaining the upward trend of recent years and the strongest rate of growth was in China at 24%. The global energy service company (ESCO) market expanded by 12% to USD 26.8 billion in 2016, where China has by far the largest market, making up over 60% of global revenues, thanks to strong government incentives. The energy intensity of industry, fell by nearly 20% between 2000 and 2016[2]. Improvements in China, with the world's largest industry sector, accelerated after 2006, primarily as a result of energy efficiency policies. Globally, industry continued to produce more gross value added (GVA) per unit of energy consumed. China, with an Efficiency Policy Progress Index / EPPI of 10.9 in 2016, has been the global leader in implementing mandatory efficiency policies in recent years, accounting for more than half of the increase between 2000 and 2016, mainly due to policies in the industrial sector. Worldwide, the EPPI would have been just 2.9 without China. The fall in global energy intensity means that the world is able to produce more GDP for each unit of energy consumed – an energy productivity bonus. This bonus was USD 2.2 trillion in 2016 and China accounted for half of this bonus thanks to its big fall in intensity and the size of its economy. The size of the efficiency effect varies across countries. The difference in improvement rates before and after 2008 also highlights the impact of policy developments, particularly in China, where the influence of the 11th and 12th Five-Year Plans is seen via a 16% improvement in the efficiency effect since 2008[3].

Another member of GTI, Republic of Korea (ROK), also has a prominent role in the IEA 2017 report as one of the world champions in the field of industrial energy efficiency. There are areas where GTI members should take an experience of ROK as an example to follow, such as for example, energy efficiency standards, mandatory to apply. For example, Korea has a special dedicated to Transport sector Programme, called Green and Smart Transport Partnership, where experience sharing with GTI members will be beneficial. Korea's energy efficiency objective, which was established in its Basic National Energy Plan 2008-2030, was to reduce energy intensity by 46 percent between 2007 and 2030. The overall energy savings goal for 2030 is nearly 38 Mtoe, 44 percent of which should be achieved in industry (17 Mtoe), 32 percent in the residential and commercial sector (12 Mtoe), 19 percent in the transport sector (7 Mtoe), and 5 percent in the public sector (1.9 Mtoe).[4] In 2000-2008, Korea had impressive overall 10% improvement in the efficiency effect and much is expected in the nearest years,

[1] http://www.iea.org/publications/freepublications/publication/Energy_Efficiency_2017.pdf, page 13
[2] IEA Energy Efficiency Report, page 66
[3] IEA Energy Efficiency 2017, Energy Efficiency Trends and Indicators, page 22
https://www.iea.org/publications/freepublications/publication/Energy_Efficiency_2017.pdf
[4] South Korea Energy efficiency report ABB Group,
https://library.e.abb.com/public/557d50223ed20a76c1257beb0044f3bc/South%20Korea.pdf, page 2

for example, in vehicle fuel efficiency standards, a major driver of efficiency gains[5]. According to IEA, policy makers started to pay attention to fuel efficiency standards for trucks, which represent 43% of total oil consumption for road transport, quite recently. In 2016, only 16% of the energy use of trucks worldwide was covered by mandatory efficiency policies. IEA reports that fuel economy standards are in place in only country of GTI region – China, whereas Korea is going to introduce standards in the coming years[6]. However, in Russia, a specific technical regulation of the Customs Union adopted in 2011 is in place[7], in accordance with which Russia moved up environmental classes of gasoline and diesel fuels in January 2016.

Energy intensity of Mongolia's GDP on 2005 constant price keeps a general tendency of reduction from 1990 to 2015[8]. However, according to the 2018 Energy Trilemma Index Report, Mongolia dropped by 5 places to rank Nr. 111 out of 125 countries with relatively weak in all three Trilemma dimensions of the World Energy Council's /WEC Energy Trilemma Index ranks: Energy Security, Energy Equity, and Environmental Sustainability, based on global and national data. The transition period of restructuring and transforming its previously centrally planned economy into market-based and private sector driven until 1995 was characterized by significant decrease of energy supply and consumption in the country, followed by a period of modest increase of the supply and demand levels till 2005. After the economic transition period, until the 2000, Mongolian economy is recovering and growing fast with 4 to 10 % annual growth rate of GDP until 2010 and reached at 17.3% in 2011, 17.3% in 2012. The rise of economy has followed a continuous increase in final energy demand of the country.

Energy intensive sub-sectors of Mongolia are mostly in the industrial sector which account for more than 30% of the country's GDP. The potential for energy efficiency improvement is huge and both, government and industries realise that on the path to energy sustainability, efficiency comes first. Investment needs for the improvement of industrial energy efficiency are just too large to be met through the Government's own resources. Accordingly, the key financing strategy is to mobilise as much finance through the Public Private Partnership arrangements as possible. The Government is also

[5] IEA Energy Efficiency 2017, Energy Efficiency Trends and Indicators, page 22
https://www.iea.org/publications/freepublications/publication/Energy_Efficiency_2017.pdf

[6] IEA Energy Efficiency 2017, Energy Efficiency Trends and Indicators, page 12
https://www.iea.org/publications/freepublications/publication/Energy_Efficiency_2017.pdf

[7] ЭНЕРГЕТИЧЕСКИЙ БЮЛЛЕТЕНЬ Выпуск №29, октябрь2015, Технический регламент Таможенного союза «О требованиях к автомобильному и авиационному бензину, дизельному и судовому топливу, топливу для реактивных двигателей и мазуту» ТР ТС 013/2011, page 10

[8] Research on the cooperation between Mongolia and GTI member countries in industrial energy efficiency 2019 report, Executive Summary, p. 3; Energy Import, p.p. 7-8

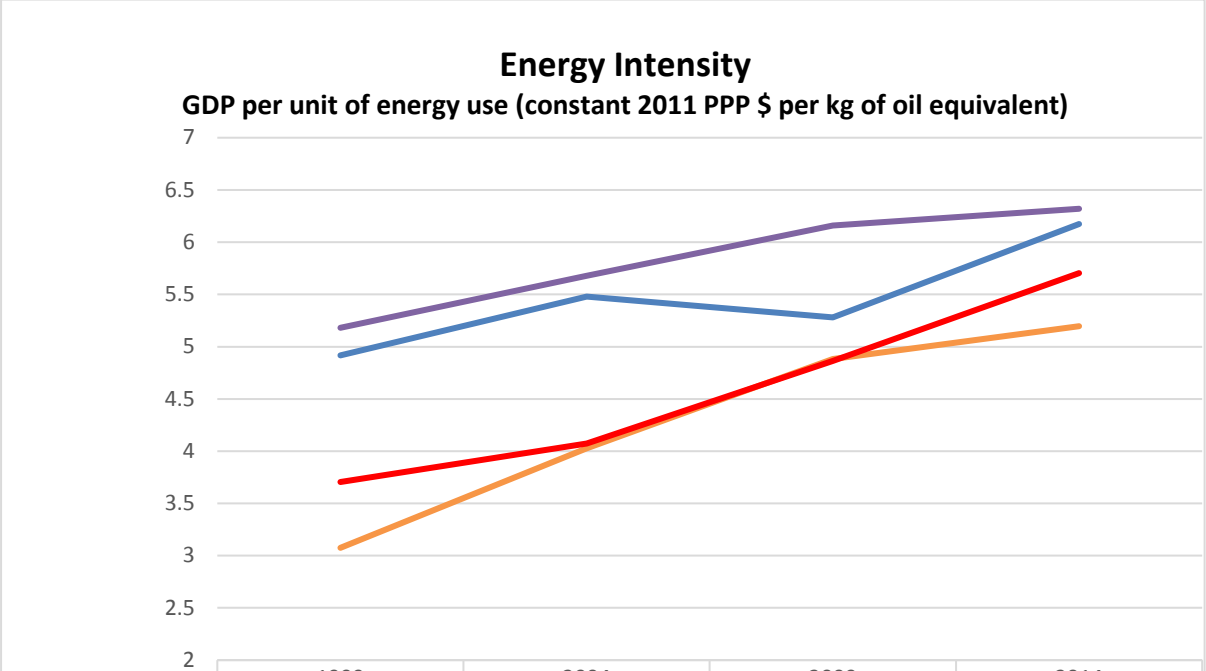
attracting direct foreign investment and engaging with domestic enterprises for investment in the energy sector. The policy framework for private participation is already in place. Further efforts will be made to strengthen this policy in order to ensure adequate flow of private investment in energy sector.

The energy efficiency regulation in Russia was updated in April 2018, when the government approved the Order No. 703-p.[9] It requires modernisation of processes and upgrade of technologies to improve energy efficiency of regulated companies in the infrastructure sector, industrial enterprises, public sector organisations, and apartment buildings. It is expected that it will lead to the annual GDP energy intensity reduction at about 1.5% per year. Government policy measures aimed at increasing energy efficiency require mandatory energy audits, establishment of the process to perform continuous energy efficiency level monitoring in industries and appropriate government support instruments.

GTI members have different ways of assessing their internal energy efficiency. For a simple comparison one can use the World Bank's data - Energy Intensity measured in 2011 PPP$ per kg of oil - to illustrate the efficiency differences between states. From the chart below we can observe the trends described in each country-specific research paper. On paper, ROK is leading the way in overall energy efficiency, while the others are also on a stable course for improvement. A caveat should be added, that having energy-intensive industries reduces your efficiency indicator somewhat disproportionately. We can see this in the case of China, where based on the data its economy is less efficient than that of Mongolia but deeper analysis shows that this is due to the abundance of heavy industries in the China and lack thereof in Mongolia. The data below is an approximation and should be used as an indicator, bearing in mind that in there may even be dips in efficiency as we go forward but these can be taken as a win if shown to be the Jevons Paradox in action. The takeaway from the graph below is that member states are becoming increasingly efficient and are converging. This bodes well for deeper mutual integration and cooperation in the energy sector.

Chart 1

[9] Об утверждении комплексного плана по повышению энергетической эффективности экономики России, 23.04.2018, http://government.ru/docs/32368/



	1999	2004	2009	2014
Mongolia	4.917	5.478	5.28	6.174
Russia	3.075	4.028	4.882	5.196
China	3.705	4.073	4.865	5.704
Soith Korea	5.181	5.679	6.16	6.32

ROK had a developed high-tech industrial capabilities from before 2000. Thus, much of its economy had already achieved low energy intensity. China on the other hand was still somewhat behind at the turn of the century but has improved spectacularly over each consecutive FYP period. At present the two countries have likely caught up in energy intensity. As new technology is increasingly easier to disseminate and implement, the movement towards lower energy intensity together is likely to continue. Apart from overall economic development, the strong disparity between the states around the year 2000 could be partially due to the differences in the nature of industrial output. Presumably China produced more heavy industrial output which is naturally more energy intensive, while Korea has continued to concentrate on high-tech industry. As the two countries' economies qualitatively converge, so will naturally their respective energy intensities. Russia's impressive energy intensity of GDP can be linked to the crash of the 90s and the resulting serious reduction in heavy industrial output. That is why, starting from 2010, the State Programme of energy efficiency in Russia requires the 40% energy intensity of GDP fall by 2020 compared to 2007, when the industries started to recover and grow. The similar approach applies to Mongolia.

GTI's Role: GTI's role could be to foster further experience sharing to enable the aforementioned processes. It can grow into a more constant dialogue platform for energy efficiency professionals and policy makers. Increasing cooperation around energy efficiency policy in terms of sharing experience and formulating new ideas of how to tackle common problems will obviously benefit said efforts in all member states. Considering the remarkable success of all GTI countries in the field of industrial energy efficiency, it is important that they all play an active role in deepening NEA region multinational cooperation.

Below extracts from the national reports in alphabetical order describe efforts to ensure higher levels of industrial energy efficiency in each of the GTI member countries. An analysis of how best to increase regional cooperation from the perspective of each country follows.

Industrial energy consumers

In all GTI region countries, industrial sector is responsible for the largest share of energy consumption, higher than 50%, and uses a variety of energy sources including natural gas, electricity, coal and coal coke. The following industries are considered to be energy-intensive: chemicals, petroleum refining, iron and steel, nonferrous metals (primarily aluminum), and nonmetallic minerals (primarily cement), ceramics, textiles, food and beverage production, building materials industry (especially cement and brick production, glass production).

China [10] main industrial energy consumers

In recent years, China has constantly optimized its industrial economic structure and significantly reduced the energy consumption per 10,000-yuan of industrial added value as the economic restructuring and upgrading gains momentum. Enterprises above the designated scale reduced their energy consumption per unit of added value by 28%, outperforming the industrial energy conservation target set by the 12th Five-Year Plan (2011-2015) period. They saved 690 million tce, contributing above 80% of the reduction of energy consumption per unit of GDP. The energy consumption per unit of product of key industries and major energy-using units kept going down. The energy consumption of industrial added value recorded an average decrease of 26.5% in iron & steel, nonferrous, petrochemical, chemical, building material, machinery, light industry, textile and electronic information industries. The five-year comprehensive energy consumption per unit of product descended by the average 17.1% in crude steel, crude cooper, caustic soda and cement industries. The energy

[10] Research on the Cooperation between China and Northeast Asian in Industrial Energy Efficiency, 28 February 2017

consumption reduction per unit of product of all major energy consumption industries met the targets set by the 12thFive-Year Plan.

The national energy consumption per 10,000-yuan of GDP fell by 5.6%. Industrial enterprises reduced their comprehensive energy consumption per ton of crude cooper by 0.79%; cut down their comprehensive energy consumption per ton of steel by 0.56%, decreased their standard coal equivalent consumption per kilowatt hour of thermal power generation by 0.95%, lowered their comprehensive energy consumption per unit of caustic soda by 1.41% and brought down their comprehensive energy consumption per ton of cement by 0.49%, demonstrating China's enormous progress in energy conservation and emission reduction.

Large energy consumption enterprises of the iron & steel industry of China

Large energy consumption enterprises of the iron & steel industry, among which, China Baowu Steel Group Corporation Limited (Baowu Group for short) is China's largest steel company.

Table 1. Nine Major Energy Consumption Enterprises of China's Iron and Steel Industry

Serial No.	Company Name	Address	Telephone
1	China Baowu Steel Group Corporation Limited	Baosteel Tower, No. 370, Pudian Road, Pudong New Area, Shanghai	86-21-20658888
2	HBIS Group Co., Ltd.	No. 385, SportsSouth Avenue, Shijiazhuang, Hebei, PRC	86-311-66778886
3	Jiangsu Shagang Group Co., Ltd.	Yongxin Road, Jinfeng Town, Zhangjiagang City, Jiangsu Province	
4	Bohai Steel Group Co., Ltd.	No. 1, Jinghui Road, Dongli Lake, Dongli District, Tianjin	
5	Xinxing Cathay International Group Limited	Floor 62, Fortune Financial Center,No.5, Dongsanhuan Zhonglu,Chaoyang District,Beijing	+86-10-65168690
6	Shougang Group	East Gate of Shougang Factory, Shijingshan District, Beijing	+86-10-88291114
7	Ansteel GroupCorporation	No. 1, Huangang Road, Tie Xi District, Anshan City, Liaoning	+86-412-6734881
8	JISCO Limited Company	No. 12, Xiongguan Donglu, Jiayuguan City, Gansu Province	+86-937-6714151
9	Shandong Iron&Steel Group Co., Ltd.	Building 4, Shuntai Plaza,No.2000, Shunhua Road, Jinan High-tech Development Zone	+86-531-67606760

Large energy consumption enterprises of the power industry

There are mainly five large energy consumption enterprises in the power industry, namely China Huaneng Group, China Huadian Corporation, China Guodian Corporation, China Datang Corporation and State Power Investment Corporation.

China Huaneng Group: The group's installed capacity broke through 160 million kilowatts in 2015, ranking top in the world. Of which, the installed capacity of hydropower, wind power and solar power reached 20.89 million, 15.08 million and 1.17 million kilowatts respectively.

China Huadian Corporation: A company with an installed capacity of 134.76 million kilowatts and a total asset of 769.4 billion yuan. Its 600,000kWcoal-fired installed capacity and above accounted for 48% of the coal-fired installed capacity.

China Guodian Corporation: In 2015, the corporation generated 483.7 billion kWh of electricity and supplied 178.95 million GJ of heat. It has an installed capacity of 135 million kilowatts and coal consumption of 310.4g/kWh for power supply.

China Datang Corporation: In 2015, the company had an installed capacity of 107.4015 million kilowatts, generated 380.787 billion kWh of electricity and sold 196 million GJ of heat throughout the whole year.

State Power Investment Corporation: The company's installed capacity totaled107.4 million kilowatts. Of which, 68.27 million kilowatts were thermal power, 20.94 million kilowatts were hydropower, 3.36 million kilowatts were nuclear power, 4.85 million kilowatts were solar power and 9.98 million kilowatts were wind power. The proportion of clean energy accounted for 40.06% of the total installed capacity.

Table 2. Five Major Large Energy Consumption Enterprises of China's Power Industry

Company Name	Address	Telephone
China Huaneng Group	No. 6, FuXingMenNei St., Xicheng District, Beijing	+86-10-63228800
China Huadian Corporation	No. 2, Xuanwumennei Street, Xicheng District, Beijing	+86-10-83566666
China Guodian Corporation	6-8 Fuchengmen Bei Street, Xicheng District, Beijing	+86-10-58682000
China Datang Corporation	No. 1, Guangningbo Street, Xicheng District, Beijing	+86-10-88008800
State Power Investment Corporation	Building 3, No. 28, Financial Street, Xicheng District, Beijing	+86-10-66298000

Large energy consumption enterprises of other industries

Building materials

China has five major cement enterprises, namely South Cement Company Limited, China United Cement Corporation, Tangshan Jidong Cement Co., Ltd., China Resources Cement Holdings Limited and Anhui Conch Cement Company Limited.

Table 3. Key Enterprises of China's Cement Industry

Name	Address	Telephone
South Cement Company Limited	Floor 20, LJZ Plaza, No. 1600, Century Avenue, Pudong, Shanghai	+86-21-50816620
China United Cement Corporation	Floor 18, Building 2, Guohai Plaza, No. 17, Fuxing Road, Haidian District, Beijing	+86-10-68138588
Tangshan Jidong Cement Co., Ltd.	Linyin Road, Fengrun District, Tangshan City, Hebei Province	
China Resources Cement Holdings Limited	Floor 17, China Resources Building, No. 5001, East Shennan Road, Luohu District, Shenzhen	+86-755-82691700
Anhui Conch Cement Company Limited	No. 39, Wenhua Road, Wuhu City, Anhui Province	+86-553-3118688

Nonferrous metals

China's large nonferrous metals enterprises include: Aluminum Corporation of China Limited, China Minmetals Corporation, China Nonferrous Metal Mining (Group) Co., Ltd., China National Gold Group Corporation, Metallurgical Corporation of China Limited, Jiangxi Copper Corporation, Jinchuan Group Co., Ltd., Tongling Nonferrous Metals Group Holdings Co., Ltd., Western Mining Co., Ltd. and Shandong Nanshan Aluminum Co., Ltd., etc.

Table 4. Key Enterprises of China's Nonferrous Industry

Name	Address	Telephone
Aluminum Corporation of China Limited	No. 62, Xizhimen North Street, Haidian District, Beijing	

China Minmetals Corporation	China Minmetals Corporation,TowerA, Minmetals Plaza, No.3 Chaoyangmen North Street, Dongcheng District, Beijing	86-10-60169000
China Nonferrous Metal Mining (Group) Co., Ltd.	CNMC Building,No.10,Anding Road, ChaoyangDistrict,Beijing	86-10-84426666
China National Gold Group Corporation	No. 9, Andingmenwai Street, Dongcheng District, Beijing	86-10-56353688
Metallurgical Corporation of China Limited	No. 28, Shuguang Xili, Chaoyang District, Beijing	010-59869999
Jiangxi Copper Corporation	No. 7666, Changdong Avenue, Gaoxin District, Nanchang City, Jiangxi, China	86-791-82710388
Jinchuan Group Co., Ltd.	No. 98, Jinchuan Road, Jinchuan District, Jinchang City, Gansu Province	86-935-8811528
Tongling Nonferrous Metals Group Holdings Co., Ltd.	West Changjiang Road, Tongling City, Anhui Province	86-562-5860016
Western Mining Co., Ltd.	No. 52, Wusi Street, Xining City, Qinghai Province	+86-971-6123-888
Shandong Nanshan Aluminum Co., Ltd.	Nanshan Village, Dongjiang Town, Longkou City, Shandong Province	0535-8666352

Republic of Korea[11]

Industrial energy consumers

The primary energy supply for 2014 in Korea amounted to 281.9 million toe, which represented a 0.5% increase over the previous year. In the same year, Korea's dependency on fuel imports was 95.2% requiring the spending of $102.7 billion on imported fuels.

Final energy consumption amounted to 213.9 million toe, breaking down into oil (37.2%), coal (30.1%), and natural gas (17.0%). The industrial sector accounted for the largest share energy consumption at 136.5 million toe equivalent, amounting to 63.8% of the final energy consumption, followed by the transport sector (18.9%), household sector (29.3%), and the public and other sectors (3.7%). The data have shown that industrial energy consumption continues to grow.

[11] Industrial Energy Efficiency Policy Report, National Report, Republic of Korea, 16 April 2017

Chart 2. Trend in final energy consumption by sector, 1990-2014 (Unit: Million toe)

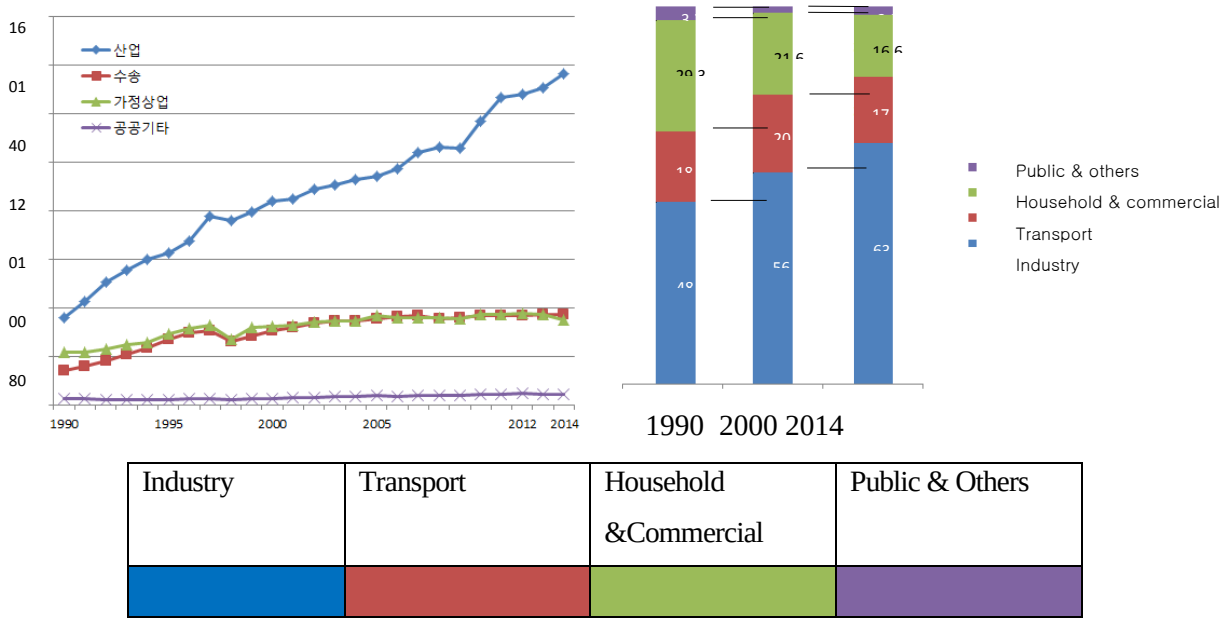


Table 5. Trend in final energy consumption by sector, 1990-2014 (Unit: Million toe, %)

Year	Industry		Household & commercial		Transport		Public & others		Total
	Amount	Share	Amount	Share	Amount	Share	Amount	Share	
1990	36.2	48.1%	21.97	29.3%	14.17	18.9%	2.81	3.7%	75.1
2000	83.9	56.0%	32.37	21.6%	30.95	20.7%	2.63	1.8%	149.85
2012	128.32	61.7%	37.88	18.2%	37.14	17.8%	4.77	2.3%	208.12
2013	130.91	62.3%	37.34	17.8%	37.33	17.8%	4.67	2.2%	210.25
2014	136.54	63.8%	35.41	16.6%	37.29	17.4%	4.67	2.2%	213.90
Variation rate against the previous year	4.3		∆0.1		∆5.2		-		1.7
(2000~2014)	3.5%		0.6%		1.3%		4.2%		2.6%

Source: Energy Statistics Monthly (March, 2015)

According to the 2014 statistics, of the total number of 3,777 business sites consuming more than 2,000 toe annually, 2,695 sites, 71.4% of the total, belong to the industrial sector. The energy consumption of these 2,695 business sites accounted for 87,354,000 toe/CO2, which is equivalent to

64.2% of the total energy consumption of 136,086,000 toe of all 3,777 business sites. This reveals that the industrial sector consumes a substantial proportion of Korea's total energy consumption.

Table 6. Trend in change of annual number of energy intensive business sites

Category / Year	Industry fields							Subtotal	Buildings	Power generation	Total
	Food	Textiles	Paper & Timber	Chemicals	Ceramics	Metals	Other industries				
2010	224	200	113	434	156	785	214	2,126	894	34	3,054
2011	223	206	112	458	167	864	227	2,257	887	34	3,178
2012	229	202	112	469	168	876	237	2,293	925	34	3,252
2013	261	200	111	515	178	1,009	288	2,562	997	35	3,594
2014	264	200	112	560	178	1,070	311	2,695	1,044	38	3,777
Share (%)	(7.0)	(5.3)	(3.0)	(14.8)	(4.7)	(28.3)	(8.2)	(71.4)	(27.6)	(1.0)	(100.0)
Variation rate against the previous year	1.2	0.0	0.9	8.7	0.0	6.1	8.0	5.2	4.7	8.6	5.1

Table 7. Annual and sectoral energy consumption of the reporting business sites, final energy, 1,000 toe, GWh

Category		Industry			Buildings			Transport (C)	Total		
		Total industries (A)	Reporting industries	Share (%)	Total buildings (B)	Reporting buildings	Share (%)		Domestic total (A+B+C)	Reporting business sites	Share (%)
2010	Fuel	97,717	55,415	56.7%	23,782	936	3.9%	36,750	158,249	56,351	35.6%
	Electric power	223,174	153,239	68.7%	208,802	14,482	6.9%	2,186	434,162	167,721	38.6%
	Total	116,910	68,594	58.7%	41,739	2,181	5.2%	36,938	195,587	70,775	36.2%
2011	Fuel	106,056	63,821	60.2%	23,989	895	3.7%	36,682	166,727	64,716	38.8%
	Electric power	242,209	169,447	70.0%	210,616	14,676	7.0%	2,244	455,069	184,123	40.5%
	Total	126,886	78,393	61.8%	42,102	2,157	5.1%	36,875	205,863	80,550	39.1%

Category		Industry			Buildings			Transport (C)	Total		
		Total industries (A)	Reporting industries	Share (%)	Total buildings (B)	Reporting buildings	Share (%)		Domestic total (A+B+C)	Reporting business sites	Share (%)
2012	Fuel	106,898	64,537	60.4%	24,146	909	3.8%	36,949	167,993	65,446	39.0%
	Electric power	249,140	174,696	70.1%	215,209	15,412	7.2%	2,256	466,605	190,108	40.7%
	Total	127,213	79,561	62.5%	42,654	2,234	5.2%	37,143	207,010	81,795	39.5%
2013	Fuel	108,581	64,752	59.6%	23,898	880	3.7%	37,230	169,709	65,632	38.7%
	Electric power	256,837	183,868	71.6%	215,837	16,587	7.7%	2,163	474,837	200,455	42.2%
	Total	130,669	80,565	61.7%	42,460	2,307	5.4%	37,416	210,545	82,871	39.4%
2014	Fuel	113,329	70,798	62.5%	22,011	827	3.8%	37,456	172,894	71,625	41.4%
	Electric power	264,618	192,521	72.8%	210,971	17,399	8.2%	2,003	477,592	209,920	44.0%
	Total	136,086	87,354	64.2%	40,155	2,324	5.8%	37,628	213,870	89,678	41.9%

Note: The values of total buildings include the amount of energy consumed by households, commercial users and public entities.

The breakdown of industrial energy consumption by type of business reveals that three types of business account for 75% of the total energy consumption. These are metals (43.1%), chemicals (25.7%), and ceramics (6.2%). These energy intensive industries are therefore capable of having a significant impact on efforts to improve national energy efficiency.

Table 8. Industrial energy consumption by business type, final Energy, 1,000 toe

Category	Food	Textiles	Paper & timber	Chemicals	Ceramics	Metals	Other industries	Total
2000	1,135	1,887	2,057	15,889	5,141	18,405	5,223	49,737
Share	(2.28)	(3.79)	(4.14)	(31.95)	(10.34)	(37.01)	(10.50)	(100.00)
2011	1,100	991	1,757	20,394	5,312	34,629	14,210	78,393
2012	1,118	1,000	1,723	21,111	5,262	34,303	15,044	79,561
2013	1,135	961	1,507	22,056	5,347	33,903	15,656	80,565
2014	1,137	909	1,377	22,416	5,435	37,667	18,412	87,354
Share	(1.3)	(1.0)	(1.6)	(25.7)	(6.2)	(43.1)	(21.1)	(100.0)
Variation rate against the previous year	0.2%	∆5.4%	∆8.6%	1.6%	1.7%	11.1%	17.6%	8.4%

Note: The values for industrial energy consumption were generated excluding steam, water heating, coal and other energy sources.

The analysis of the energy consumption data from reporting industrial sector business sites demonstrates that metals, chemicals and ceramics are among the most energy intensive industries.

Table 1 Number of reporting companies in the industrial sector, number of companies

Category toe	Industry							Subtotal	Share
	Food	Textiles	Paper & Timber	Chemicals	Ceramics	Metals	Other industries		
2,000-5,000	141	131	35	241	64	512	110	1,234	45.8%
5,000-10,000	77	40	15	106	51	264	69	622	23.1%
10,000-20,000	28	13	16	74	26	137	42	336	12.5%
20,000-50,000	15	8	27	60	18	82	39	249	9.2%
50,000-100,000	3	3	11	37	6	27	20	107	4.0%
Over 100,000	-	5	8	42	13	48	31	147	5.5%
Total	264	200	112	560	178	1,070	311	2,695	100.0%

The following table shows an energy intensity index measuring the amount of energy consumed to produce $1,000 worth of goods in Korea. Energy intensity to produce $1,000 worth of goods was 0.26 in 1990s but was measured at 0.22 in 2013, an improvement of 18.2%.

Table 2. Trend in improvement of energy intensity

Year	1973	1980	1990	2000	2010	2013
Energy intensity (toe/1,000$)	0.27	0.29	0.26	0.26	0.23	0.22
Energy intensity (ppp, toe/1,000$)	0.21	0.22	0.20	0.20	0.18	0.17

Source: Energy Balances of OECD Countries (IEA, 2015)

Mongolia

Mongolian main industrial energy consumers

Energy Regulatory Commission (ERC) has identified total 134 large entities in 2017 that are consuming above the set threshold for energy consumption and their total consumption for electricity compared with the State total consumption, was 56% and for heating was 12.5%. The priority sub-sectors in Mongolia based on their electricity and heat energy consumptions are: mining; metal

processing; cement; food & beverage; building and construction; and utility. These energy intensive sub-sectors are mostly in the industrial sector which account for more than 30% of the country's GDP. Coal is the major source of energy in these sub-sectors in Mongolia.

If all designated companies take actions which require low investment, they will have at least 15% conservation and the following shows the calculation:

- *Energy Generators:* If they decrease the internal consumption by 1 unit, the electricity conservation will be 53.2 million kWh;
- *Transmission, distribution network:* If they decrease their loss by 1 unit, the electricity conservation will be 50.7 million kWh;
- *Consumers with high consumption:* If they decrease their electricity usage by 15%, the electricity conservation will be 395.9 million kWh, If they decrease their heating usage by 15%, the heating conservation will be 70.75 million kWh.

Residential energy consumers have a potential to save 73 billion tugriks on their energy bill.

Power, mining & construction sectors are main energy consumers in Mongolia. Key energy sources for mining companies in Mongolia are electricity and coal (for heat generation), and these companies are located outside heat energy grid. For those consumers with heat energy grid connection, heat energy is supplied by the utilities. As for consumers outside the main heat energy grid, heat energy is supplied by HOB or steam boilers.

Large energy consumption enterprises in power sector

More that 80% of electrical and heat district energy generation is based primarily on coal. The single biggest coal consumers are the Combined Heat and Power Plants (CHPs) and Heat-Only-Boilers (HOBs). In Mongolia's power sector, there are over 40 energy generating and distributing companies. Five of these power companies are designated consumers mandated to improve energy efficiency in the facilities. Below companies are four high volume energy consuming entities from the power sector.

Nalaikh thermal power plant

Nalaikh Thermal Power Plant was established in 1976 to provide district heating to Nalaikh city. It consists of two boilers setups, one is KBTC -20/150 used to supply hot water during the winter season and KBTC -10/150 is used to supply hot water during the summer season. There are three winter boilers with the capacity 20 Tons and two summer boilers with the capacity of 10 Tons installed in the plant. The major energy consuming equipment in the plant is its boilers and auxiliaries.

Ulaanbaatar District Heating Company

Ulaanbaatar district heating company (UBDHC) was established in 1959 in order to provide t he heat energy to the city. The UBDHC has been supplying heat energy to residents, industries and c ommercial buildings connected to the district heat system. Most of the heat distributed to district heat ing system in heating application during winter season for the process of heating in industries. Follow ing figure illustrates the percentage of heat consumption in the three types of consumers.

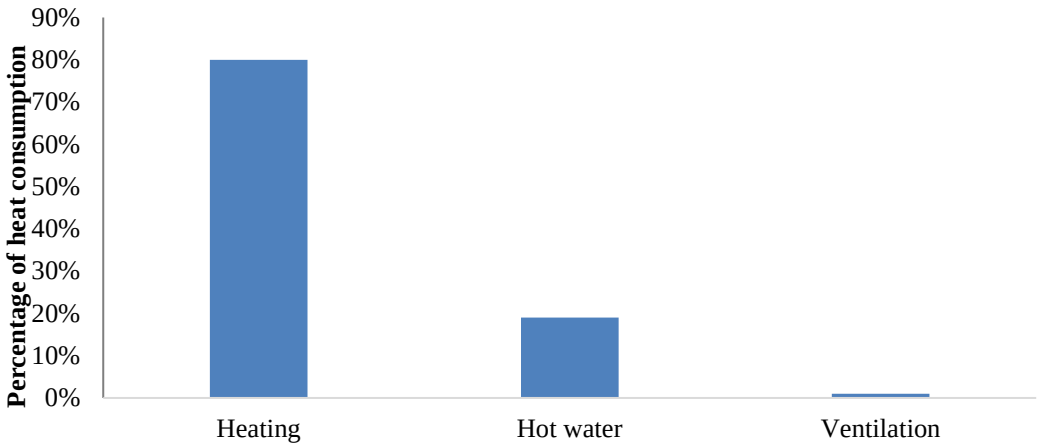


Chart 3. The percentage of heat consumption in distribution network

Around 80% of the distributed heat is used for the heating applications, 19% for hot water usage ap plication and only 1% for ventilation purpose.

Ulaanbaatar Thermal power plant #3.

Ulaanbaatar Thermal power plant #3 was established in 1968 with the capacity of 148 MW and 485 Gcal. Further its installed capacity expanded between the year 2013 and 2014 by installing 50 MW and it's brought up the plant capacity to 198 MW and 585 Gcal. The status of electricity generation, export and internal consumption for the last year is as below:

- The medium pressure power plant is having an average internal consumption of 22.3% that is found inefficient and considered as very high.
- The high pressure power plant is having an average internal consumption of 15.7% that is considered to be high consumption.

Major areas of energy consumption: The major energy consuming equipment in the medium pressure power plant is boiler auxiliaries, followed by feed water pumps, coal mills, cooling water pumps, district heating hot water pumps, ash-handling plant and turbine auxiliaries.

Ulaanbaatar Electricity Distribution Network.

Ulaanbaatar Electricity Distribution Network (UBEDN) is one of the leading companies in domestic energy market distributing household, businesses and industries with electricity across the capital city of Ulaanbaatar and 16 soums of Tuv province. It has the overall installed capacity of 1601.4 MVA, handling the power load of 541 MW in Ulaanbaatar city with the total customers of 340,495. Its energy facilities include:

- 54 substations of 35 kV
- 2,026 distribution substations of 6, 10kV
- 62 power transmission substation 6-10 kV
- 920.6 kilometers of 35 kV power lines;
- 17.4 kilometers of high-voltage cable lines;
- 1,544.9 kilometers of 6, 10 kV overhead power lines
- 1,142.3 kilometers of 6, 10 kV underground power cables
- 2,025.9 kilometers of 0.4 kV overhead power lines
- 649.2 kilometers of 0.4 kV power lines

Mongolia has high loss of Transmission and Distribution networks, and this is primarily due to overload in the distribution networks in the cities, while long power lines were constructed to serve population in remote areas. The existing distribution and transmission loses in Mongolia were 13.4% in 2017, much higher than the international best practice of about 5%. There is an urgent need in rehabilitation and upgrade T&D systems in order to improve the energy efficiency.

Large energy consumption enterprises in mining sector

In Mongolia, exploration of coal and copper has rapidly proceeded, for which production is now poised to grow four-fold by the end of this decade. Copper extraction is expected to be a major driver of economic growth in Mongolia. In addition to these primary resources, other resource industries will also grow in Mongolia: iron and steel production, cement production, and a host of other secondary industries.

Baganuur Joint Stock Company

Baganuur JSC is the biggest coal mining company, which meets 60% of Mongolian energy demand and 70% of central region energy demand. It was formally established in 1978 under the name “Baganuur temporarily mine” with the capacity of extracting 200 thousands of tons of coal. The company supplies coal to thermal power plants of the central power system. Facility has various types

of diesel consuming vehicles to transport coal from one place to other place. These 47 diesel vehicles consume diesel fuel depending on the mining operations and seasons.

Achit-ikht LLC Copper Plant

Achit-ikht LLC was established in the year 2014, having copper production capacity of 10,000 tons per annum. This is the Mongolia's first modern hydrometallurgical plant built by private investment.

Large energy consumption enterprises of light industry.

Erdenet Textile Corporation (Carpet/textile manufacturing)

Erdenet Textile Corporation (ETC) is a producer of pure wool carpets and rugs. In April 2014, Erdenet Carpet became a subsidiary of the newly established Natural Textile Group. The major energy consuming parts in the plant are spinning section (16.55%), wool shacking section (12.09%), preparation section (11.53%), mixing plant (7.36%) followed by other sections.

Suu Joint Stock Company (Dairy product processing)

Suu Joint Stock Company is a milk market leader by supplying 48% of dairy product and 80% of fresh milk to the consumers in Mongolia. The major energy consuming sections in the plant are Refrigeration system (60.6%), followed by process machineries (24.1%), packing section (7.4%), air compressors (5.9%), lighting (2.7%) and heating plant (2.1%).

Gobi Corporation (Wool processing)

Gobi Corporation is Mongolian biggest cashmere manufacturer holding 66% of domestic market share and one of the biggest vertically integrated cashmere factory in the world. The major energy consuming sections in the plant are washing & separation section (30.46%), special production (17.05%), spinning (10.01%), sorting section (7.45%) and sewing section (7.18%). 58.39% is spread across the remaining sections of the plant.

The Mongolian National Television (Building sector)

The Mongolian National Television's building built in 1967.The major energy consuming equ ipment in the building is air-conditioners (40%), process motors (26%), lighting (21%) and water pum ps (13%).

Russian Federation

Industrial Energy Efficiency Consumers in Russia

Russia occupies leading positions in the production of coal, oil, gas and electricity generation but works hard to minimise energy losses on the way from production to the consumer. Fuel and energy industries, public organisations, housing and communal services, transport enterprises and industrial enterprises are not efficient consumers of energy and heat. At present, with a total final energy consumption in the amount of 125-130 million tons.e. manufacturing industry is the largest energy end-user i accounting for about 30% of total final energy consumption, or 15-18% of primary energy consumption[12]. Up to 70% of the energy saving potential is concentrated in several of the most energy-intensive industries, which include:

1) industries with the highest absolute indicators of the consumption of fuel and energy resources: metallurgical industry (production of iron, steel and non-ferrous metals), chemical and petroleum refining industries

2) industries with a high share of fuel and energy costs in total production costs: building materials industry (especially cement and brick production, glass production), pulp and paper industry (pulp production, paper and cardboard production), light industry (weaving) and engineering.

Table 11. Power consumption by economic activities (billion kilowatt hours) [13]

	2010	2011	2012	2013
Mining	**114,0**	**119,9**	**125,4**	**128,4**
including:				
Extraction of fuel and energy minerals	90,6	94,8	99,7	102,2
including:				
Extraction of coal, lignite and peat	7,5	7,5	7,7	7,6
Production of crude oil and natural gas related service areas	82,1	86,3	91,1	93,6
Extraction of minerals, except for fuel and energy	23,4	25,0	25,6	26,2
Manufacturing	**287,8**	**295,3**	**296,5**	**290,0**
including:				
Food, drinks, tobacco	13,6	14,0	14,3	14,1
Textile and clothing	1,7	1,5	1,5	1,4
Leather, leather goods and show production	0,2	0,2	0,2	0,2
Woodworking, wood products manufacturing	3,4	3,5	3,7	3,6

[12] Энергосбережение в зеркале промышленной политики, Анатитический центр при правительстве Российской Федерации, Гашо Е.Г.; http://ac.gov.ru/files/publication/a/3017.pdf

[13] http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/economydevelopment/#

pulp and paper industry; publishing and printing	16,5	16,5	15,9	15,9
Production of coke and petroleum products	17,1	17,2	17,0	18,4
Chemical products manufacturing	34,7	35,2	34,8	35,2
Rubber and plastic goods	3,8	4,1	4,2	4,4
Other non metallic mineral products	16,0	17,3	17,8	18,4
metallurgical production and production of finished metal products	146,5	150,9	151,3	144,3
machinery and equipment production	7,2	7,3	7,2	7,0
manufacture of electrical and optical equipment	4,7	4,6	4,5	4,1
Production of vehicles and equipment	9,5	9,8	11,0	10,1
Production, distribution electricity, gas and water	**98,8**	**96,7**	**101,1**	**101,9**
including:				
Production, transmission and distribution of electricity	67,9	65,5	70,5	68,0
Production and distribution of gaseous fuel	0,3	0,3	0,3	0,2
production, transmission and distribution of hot water, steam (thermal power)	17,2	18,0	17,7	21,4
Collection, purification and distribution of water	13,4	12,8	12,6	12,3

[1)] without small businesses

Table 3 Consumption of certain types of fuel and energy resources by economic activities[14]

	2005	2010	2011	2012	2013
	Motor gasoline, 000 tonnes				
Mining	**269**	**314**	**145**	**149**	**150**
including:					
extraction of coal, lignite and peat	42,2	22,0	23,3	22,3	18,3
production of crude oil and natural gas related service areas	159	225	74,7	67,5	89,5
extraction of minerals, except for fuel and energy	33,1	20,5	21,6	32,0	21,0
Manufacturing	**1120**	**727**	**720**	**711**	**609**
including:					
Food, drinks, tobacco	437	292	262	234	211
Textile and clothing	21,8	16,0	9,6	9,3	8,0
Leather, leather goods and show production	4,6	1,9	1,7	1,4	1,2
Woodworking, wood products manufacturing	35,6	18,9	19,3	83,7	15,0
pulp and paper industry; publishing and printing	28,3	21,9	30,1	23,8	18,6
Production of coke and petroleum products	2,6	0,9	0,9	0,7	0,6

[14] http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/economydevelopment/#

Chemical products manufacturing	28,6	15,4	12,5	11,8	10,7
Rubber and plastic goods	56,1	30,7	32,7	28,6	35,3
Other non metallic mineral products	15,1	21,2	11,0	15,1	10,6
metallurgical production and production of finished metal products	87,4	56,2	56,4	60,0	63,0
machinery and equipment production	99,8	52,2	48,0	44,5	67,2
manufacture of electrical and optical equipment	80,8	53,6	48,6	50,4	43,5

Table 13. Specific electricity consumption

Production of certain types of products and work (kilowatt hours per ton)[15]

	2005	2010	2011	2012	2013
coal	22,9	19,4	19,2	18,3	18,4
Extracted oil, including gas condensate	104,3	126,2	129,8	134,1	137,6
Bread and bakery products	202	234	229	236	243
paper	1113	943	911	894	903
Oil due to processing (primary processing of oil)	46,6	45,7	45,7	46,4	44,0
Synthetic rubbers	2700	2576	2414	2600	2488
cement	135	104	106	103	98,0
electric steel	631,7	543,7	543,3	534,8	554,3
Sheet finished ferrous metals	139,0	126,4	124,6	127,1	132,4
electroferroalloys	5348	5204	4401	3815	4018

GTI cooperation:

Metal, chemical and cement industries are shared heavy heat consumers in the GTI region. The GTI governments should set out a long-term roadmap to minimise business energy costs and collectively develop rational trans-border supply side energy strategy by utilising each member country core competence. The possibility to jointly build an industrial strategy that addresses long-term challenges to the regional economy should serve an aim to improve living standards and ensure competitiveness and economic growth by increasing productivity and driving growth across the whole region.

Industrial sectors compete for new investment. The conditions that will allow GTI investment destinations to succeed include the availability of supportive research programmes, relevant skills in local labour markets and capable supply chains. And for continuing success, these foundations must be maintained and strengthened. This will help to close the gap between the regional most productive

[15] http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/economydevelopment/#

companies, industries, places and people and set out a new vision for the long-term roadmap. A vision for a modern GTI industrial strategy must not repeat the mistakes of the past by learning lessons of neighbours' successes. It should support, strengthen and develop different industries, identify regional competitive strengths, explore the ways in which governments can help the industry and put in place institutions and relationships to sustain higher levels of productivity over the long term, creating regional economy resilient to change and tailored for the future. Factors driving forward regional industrial strategy across the entire economy should be:

- science, research, innovation and skills
- infrastructure
- business growth and investment
- procurement
- trade and investment
- affordable energy
- cross sectoral policies and right institutions to bring together sectors and places

These pillars should frame common approach, and across each of them programme of cooperation should be set.

Government Agencies, Policies and Regulations related to Industrial Energy Efficiency

Reports of National consultants show that national energy efficiency action plans setting primary energy saving targets against business-as-usual projections are led by the Ministries responsible for the government's energy efficiency policies. Functions, tasks and obligations of the ministries are generally similar, however all GTI governments and ministries structure their work in different ways and have different systems to monitor the implementation of these tasks, time horizons and methods of strategic planning. On the one hand, this complicates the development of multilateral cooperation, and on the other, it opens up broad opportunities for joint discussion and borrowing best practices from each other.

For example, there are clear similarities in the responsibilities of ministries in China and Mongolia. In China, MIIT is developing five-year plans, being responsible for supervising and managing national industrial energy conservation and organising the formulation of industrial energy strategies and plans, total energy consumption control and conservation objectives, energy conservation policies and standards. The MIIT is also responsible for organising and coordinating the popularisation and application of new technologies, new products, new equipment and new materials for industrial energy conservation; it guides and organises industrial energy conservation inspections, among other

related works. The MIIT departments in charge of industry and information technology of local people's governments above the county level take charge of industrial energy conservation supervision and management within their respective administrative regions.

In Mongolia, The Energy Regulatory Commission (ERC) exercises powers of the Energy Conservation Council which has duties of regulating and implementing policies on energy conservation nationwide. ERC has a specialised unit responsible for implementing energy efficiency policies, licensing of enterprises in electricity; district heating markets in accordance with terms and conditions that meet the interests of general public and supplier. It sets and supervises prices and tariffs for electricity and heat and resolves disputes between consumers and licensees. The ERC also approves electricity market rules.

In Korea and Russia, the implementation of industrial energy efficiency policy has a more multi-level character and structure. In Korea, the Framework Act on Low Carbon, Green Growth is the supreme law governing the basic philosophy and objectives of Korea's energy policies. According to the Act, the Korean government establishes and implements a national strategy for low-carbon, green growth which contains policy objectives, implementation strategies, and programs to pursue low-carbon green growth. It also stipulates that a Presidential Committee on Green Growth shall be established under the prime minister's office to deliberate on major policies, plans and matters which are relevant to the national strategy of low-carbon, green growth. As the head of national energy policies, the Minister of Trade, Industry, Energy (MOTIE) oversees energy supply and demand management, energy efficiency, renewable energy, climate change responses, and research and development relevant to these policies. Under the 2nd Vice Minister and Director General for Energy Resource Policy, the Bureau of Energy and New Industry Policy oversees four divisions which are responsible for the establishment and implementation of demand side management and of sectoral energy efficiency improvement policies. Other responsibilities of the bureau include the establishment of energy and new industry regulation reforms, the establishment and implementation of a national GHG mitigation plan, and an Emission Trading Scheme.

In Russia, the Ministry of Economic Development is the coordinator of energy efficiency tasks for all ministries of the Russian government. It has the authority to prepare an annual state report on the state of energy conservation and energy efficiency in the Russian Federation, as well as support the state information system in the field of energy conservation and energy efficiency and the corresponding resource provision. Many goals of industrial energy efficiency are developed jointly by the Ministry of Energy, Ministry of Economic Development and Ministry of Industry and Trade.

Government stakeholders in the IEE domains

Table 4 GTI Member States' Systems of Energy Efficiency Governance

Country	China	Mongolia	ROK	Russian Federation
Main body responsible for IEE	Ministry of Industry and Information Technology of the People's Republic of China (MIIT)	The Energy Regulatory Commission (ERC)	Ministry of Trade, Industry, Energy (MOTIE),	Ministry of Economic Development from 2018. Ministry of Energy from 2009 to 2017.
Main Law	Comprehensive Work Plan for Energy Conservation and Emission Reduction during the Five-Year Plan Period and several Policy documents /Notices	The Energy Conservation (EC) Law of Mongolia, The Government resolution #294 on Designated consumer's energy consumption threshold	The Energy Master Plan, Framework Act on Low Carbon, Green Growth	Federal Law FZ №261 of 11.2009 On Energy efficiency and energy conservation; State Program "Economic development and innovative economy"; Annual Report on the state of energy efficiency and energy conservation.

In all GTI countries energy efficiency policies have a critical role in addressing economic objective. The institutional arrangements and types of programmes, described in reports, provide valuable insights for several proposals put forward to make more effective governments' actions for overcoming market barriers and improve energy efficiency in the national industries. To materialise substantial industrial energy efficiency potentials, voluntary and obligatory targets concerning energy efficiency gains are negotiated between the government and associations representing major industrial branches. Credit facilities and tax exemptions for energy-efficient equipment's stimulate the interest of the entrepreneurs and the setting-up of ambitious targets. As a rule, energy efficiency policies target several priority areas such as energy generation and distribution, metallurgy, chemical, construction and other industries, buildings, appliances, lighting, transport, energy utilities and cross-sectional issues and many of them are addressed and managed by specific for the country Energy authorities. Government policies can be categorised as administrative, economical, educational and R&D promotion - all of these areas are good basis for the international cooperation in NEA region. As a common concern and another ground for the cooperation can be an issue of growing the market for energy services through energy service companies (ESCOs). For energy-intensive industries voluntary agreements together with energy audits have played a major role. A good case for successful experience sharing could be taken from the Republic of Korea as the country with the longest experience in this field. Energy audit programmes

offering energy audits for SME industry and energy efficiency networks are also becoming common.

In one way or another, below listed approaches as the main instruments the GTI governments and other stakeholders have been used to promote energy efficiency gains in their industries, which could find common grounds for cooperation and future experience sharing workshops are:

- Effective education methodology of technical, economic and financial information about efficient equipment and practices for companies' staff
- Industries' courses on energy management and energy conservation measures
- Methodology of total or partial financing, through public funds or tariff rebates for energy audits of industrial premises
- Types of credit facilities for efficient industrial equipment
- Minimum energy performance standards for equipment in industry
- Energy Service Companies (ESCOs) and energy performance contracts in industrial energy efficiency programmes
- Diffusion of technical, economic and financial information about efficient industrial processes for some products / benchmarking
- R&D projects funding concerning efficient industrial equipments and processes
- Adoption of national energy management standards and codes in national industries, compatible with the quality code ISO and the opportunities for their harmonisation within GTI area
- Legislation and regulation regarding mandatory energy efficiency programmes in industry.

In all GTI countries, industries and their professional associations have to follow the main state law, regulations and standards on energy efficiency. They also play a more and more active role in strategy formulation and implementing energy saving plans.

In China, industry associations include professional organisations of: Power industry, China Electricity Council, Iron and Steel industry, Cement industry, Nonferrous industry. They are popularising energy conservation technologies and calculating energy consumption, play a positive role in energy conservation publicity, training and information consulting, and the benchmarking of and meeting energy efficiency standards.

China’s key industries have considerably improved their production process, equipment and technologies and made outstanding achievements in the popularisation and application of advanced and applicable energy conservation technologies. The iron and steel industry is a large energy consumer in the industrial circle and also one of the most potential industries in energy conservation and emission reduction. In this case, the iron and steel industry has become a key and tough industry for energy

conservation and emission reduction of the entire society. In the meantime, the energy conservation and emission reduction results of the iron and steel industry have also contributed a lot to the entire social advancement of energy conservation and emission reduction. It is interesting to notice that energy conservation and emission reduction technologies to be popularised in the iron and steel industry going forward are divided into stages of popularisation and include the following four aspects:

(1) Energy conservation and emission reduction technologies for comprehensive popularisation

(2) Energy conservation and emission reduction technologies for prioritised popularisation

(3) Energy conservation and emission reduction technologies for demonstrated popularisation

(4) Energy conservation and emission reduction technologies for frontier reserve

In Korea, designated energy intensive companies and buildings submit their data for government, which compiles and analyses the status of energy consumption by company, energy saving, and energy equipment, to be used as basic data for energy use rationalisation policies. The Energy Consumption Statistics are based upon energy data reported by the targeted companies and buildings. The Korea Energy Agency (KEA) plays a role in finalising the data from the targets of mandatory energy consumption reporting by reviewing the list of reporting business sites, the national energy database, and the results of inspections and audits for the past three years. The KEA provides a manual for energy consumption reporting to the targeted business sites.

In Mongolia, a chapter “ENERGY CONSERVATION SERVICES” from the Energy Conservation (EC) Law of Mongolia, includes the rights and obligations for Energy Auditing Agencies, Energy Auditors and Professional Organisations providing energy efficiency services and accredited Conservation Managers responsible for Energy Conservation. Professional Organisations which provide Energy Efficient Services must also qualify the requirements set by The Energy Conservation Council and obtain the accreditation to be able to implement all kinds of energy conservation activities to improve energy efficiency.

In Russia, there are specific rules approved by the government, setting energy efficiency and energy saving programmes for organisations engaged in regulated activities, which include most of energy companies. Companies focused on achieving the best energy efficiency indicators should establish their energy-saving control system and increase the energy efficiency by introducing an energy management system, serving as enterprise Technological regulation. This includes structuring and implementing corporate standards and technical regulations with specific requirements for energy efficiency and the Best Available Technologies. They also have to introduce company's internal and external energy efficiency promotion programmes.

Policy documents issued by the governments for improving industrial energy efficiency are revised every five years. In China, by the end of 2016, the Chinese government had released a series of important policy documents for improving industrial energy efficiency targeting key energy consumption industries, mainly involving power, iron and steel, glass and other industries. These include the Comprehensive Work Plan for Energy Conservation and Emission Reduction, the Energy Conservation and Environmental Protection Industry Development Planning, the National Action Plan on Energy Conservation, the Work Plan on Controlling Greenhouse Gas Emissions, Program for the Construction of an Energy Conservation Standard System, measures for Industrial Energy Conservation and Program of Industrial Energy Conservation Supervision in 2016, Rules for the Implementation of the Energy Efficiency "Pacemaker" System in High Energy Consumption Industries.

In Korea, supervised by MOTIE, the KEA provides supports for establishing and implementing the policies of the Bureau of New Energy Industry Policy. In this case, it should be noticed how responsibilities are logically spread across departments for easier monitoring of implementation. Programs within the responsibility of the Demand Side Management Division include:

- Supporting the government in establishing comprehensive measures for energy use rationalization
- Nurturing and providing supports related to new energy industry
- Operating energy efficiency resources markets
- Investing in demand management for energy suppliers
- Evaluating energy policies and measures, and overseeing the verification of measurements
- Overseeing energy supply emergency responses
- Overseeing projects for electricity efficiency improvements

Programs within the responsibility of the Industrial Energy Management Division include:

- Developing and providing support policies and measures for energy use rationalization in the industrial sector
- Providing technical assistance for energy use rationalization in the industrial sector
- Overseeing the operation of EnMs (Energy Management Systems)
- Overseeing corporate partnership programs for large companies and SMEs
- Establishing and reviewing plans for the supply of CHP (Combined Heat & Power)
- Supporting to activation the dissemination of Distributed Power Generation
- Offering consultations on energy use plans

Programs within the responsibility of the Energy Efficiency Promotion Division include:

- Energy Efficiency Labelling, Certification of High Efficiency Equipment, and e-Standby Power.
- The Energy Efficiency Finance Division is in charge of providing loans and tax incentives to energy use rationalization projects, and operating the ESCOs Program.
- Programs implemented by the Regional Cooperation Division include overseeing audits for heat generating equipment, evaluating and managing regional energy plans and enforcement plans for energy use rationalization, and regional energy saving projects.
- The Climate Change Policy Division is responsible for programs such as providing supports for the establishment and implementation of comprehensive policies and measures to mitigate GHG emissions, operating voluntary agreements for GHG mitigation, participating in climate change negotiations, and overseeing the verification and certification of GHG reduction.
- In response to climate change challenges, the Climate Change Policy Division is responsible for supporting the government in establishing comprehensive policies and measures and their implementation, operating a voluntary agreement program for GHG reduction, supporting climate change related international negotiations, and over viewing the verification and certification of carbon credits.

Finally, the Energy Consulting Division oversees an energy audit scheme, manages energy auditors, and provides energy consulting services. Among Korea's energy policies, a master plan has been established based upon the Framework Act on Low Carbon, Green Growth. Concrete plans have been prepared and are being implemented through ten sub-plans under the master plan. The energy master plan has been prepared to serve as a new national development paradigm called Low Carbon and Green Growth which minimises the use of energy, resources, and GHG emissions while realising sustainable development. This national strategy aims to take care of the energy needs of the next generation, energy security, energy efficiency and green energy policies. The energy master plan covers all sectors related to energy and as in China, is revised every five years for twenty years.

There is a certain similarity between the way policy documents for improving industrial energy efficiency issued in China, ROK and Mongolia. It is important to analyse these similarities and find the ways of policy harmonisation, since the needs of investments in the energy sector of Mongolia are very high, and government documents express the direction of possible closer cooperation between the countries of GTI.

The Energy Conservation (EC) Law of Mongolia has five chapters and 17 articles. The main concept of the EC Law to conserve energy by imposing a compulsory obligation is clearly expressed in the Chapter 3, "RIGHTS AND OBLIGATIONS OF ENERGY CONSUMERS" and includes the

relations of rights and obligations for designated consumers such as citizens, consumers, entities and companies whose energy consumption is exceeded the determined limits in accordance with The Government Approved Regulations. Those Government and Private sector's consumers whose annual energy usage is exceeded the Government Defined Limits, are registered as "Designated Consumers". These large energy consumers are mandated to undergo energy audit and report annually its energy consumption as well as its plans and activities to reduce their energy consumption. The designated consumers must have Energy Managers work for them and make contracts with Energy Auditing Agencies to receive auditing service, get their energy efficiency conditions evaluated, and receive the conservation services from Energy Professional Organisations by Law. By taking actions on Energy Conservation, the operational expenditure will decrease and they will be able to receive incentives.

In 2016, the government of Mongolia approved resolution and regulations, including:

- The Government resolution #294 on Designated consumer's energy consumption threshold;
- Energy Auditing Regulation;
- Requirements set for Energy auditing Agencies, Energy Professional Organizations and their Accreditation Regulations;
- Organizing the trainings to prepare Energy auditors, Energy Conservation Managers, issuing and provoking their certificates Regulation;
- Defining the designated consumers, designated consumer's energy conservation program, plan and procedures to develop them, and reporting the implementation Regulation;

According to the Government Resolution # 294, the Energy Regulatory Commission has identified 138 designated consumers and produced "Energy Auditing Guide Book", "Forms to receive information from Designated Consumers", and "Training instruction manual to prepare Energy auditors, Energy Conservation Managers".

State policy on Energy of Mongolia 2015-2020 identified three major policy principles. The scope of this policy covers the electricity and heat production, transmission, distribution and consumption. The target outcome of the policy is expected in two stages. For the period 2015-2023, the aim is to develop sources for energy security and back up capacity; establish foundation for the development of renewable energy; start the operation of the large scale power plant and implement Direct Current (DC) transmission line projects that will allow transfer of power between grid systems of neighbouring countries. It aims to double the installed power capacity, with hydropower contributing

to at least 10% of total installed power generation capacity, increase back up capacity by 10% and create an environment conducive to the development of the renewable sector.

For the period 2024-2030, the expected outcome is to be able to export energy and sustain the development of the renewable energy sector; have an integrated smart energy systems connecting regions with high voltage transmission lines, State owned Power companies will become a public company; distribution and supply service will be privatised. The energy sector will operate in a competitive market with regulations.

The Green Development Policy (GDP) of Mongolia consists of two high level documents: the Green Development Concept, and the Mid-term Program on Green Development. The concept paper sets the goals and purposes for green development until 2030, while the Mid-term Program designs policy and strategies to ensure that the goals and purposes are implemented.

The purpose of Renewable Energy Law of Mongolia is to regulate generation and delivery of power from renewable energy resources. Its objective is to encourage the development of privately financed power projects by setting up the legal framework that will allow electricity from RE to be bought. The law provides schemes for feed-in tariffs for renewable energy power projects, which allow recovery of capital and investment costs thus making RE investment attractive to developers and financiers.

In Russia, the Ministry of Economic Development is authorised to prepare an Annual State Report on the situation of energy conservation and energy efficiency, as well as support the State Information System monitoring energy conservation and energy efficiency and the corresponding resource provision. Within the ministry, Department of State Tariff Regulation, Infrastructure Reforms and Energy Efficiency are responsible for improvement of energy efficiency, tariff and pricing policies in the natural monopolies industries and restructuring of natural monopoly sectors

Energy efficiency legislation includes a Federal Law № 261-FZ (2009) "On energy saving and increasing Energy Efficiency" and Decrees on Amending Certain legislative acts of the Russian Federation" the purpose of which was to create a legal, economic and institutional framework stimulating energy saving and energy efficiency, which laid the foundation of energy efficiency in Russia. Public institutions were tasked to ensure the reduction of energy consumption by no less than 15% from the energy amount actually consumed in 2009, with an obligatory annual reduction of this amount by no less than 3%. To achieve this goal, a state programme "Energy saving and energy efficiency for the period until 2020" has been approved, as a sub programme called "Energy saving and energy efficiency" of the state programme "Energy Efficiency and Energy Development". State policy in energy efficiency and energy saving is implemented in four ways:

- Introduction of the state level energy management system to improve energy efficiency by 5%. The most important elements here are industrial sectors responsibility and tracking key

indicators of energy efficiency. State and regulated companies must implement Special Programs for energy saving and energy efficiency improvement in accordance with the federal law. The largest state companies should consider including their energy efficiency achievements in public reports.

- introduction of technological and environmental regulation in energy saving. This area includes the introduction of the best available technologies, energy efficient standards in the construction industry and equipment requirements.
- improvement of economic tax incentives for projects in the field of energy efficiency and ensuring their financing.
- popularisation of energy saving. Since the state policy is cross-sectoral, it includes indicators of energy efficiency and energy intensity of the economy in the state program "Economic Development and Innovative Economy". One of the major tasks should be an introduction of modern technologies and the modernisation of equipment in the production, transmission and use of energy resources, reduce energy consumption in the state budgetary sphere, state-owned companies, housing and communal services, including through the use of a benchmarking mechanism.

With regards to the industrial energy efficiency, the 2010 Russian Federation Government Resolution approved specific requirements for the energy efficiency and energy saving programmes of organisations engaged in regulated activities, including most of the energy companies. These includes introduction of the energy management system, corporate standards, technical regulations considering specific requirements for energy efficiency and the best available technologies, introduction of the company's internal and external energy efficiency promotion programme.

Areas for cooperation

Popularisation of technologies

As in Mongolia, all countries of GTI region include goals of efficient use of energy, and promoting the applications of advanced energy efficient techniques and technologies into their state programmes. There are similarities and differences between the way how these issues are addressed.

In China, a system of several stages how emission reduction technologies are popularised in certain industries, from detailed popularisation and mass adoption to the ones, which are classified as frontier reserve. This serves as clear indicators of the expected industrial progress.

In Korea, industries are expected to increase the level of energy technologies, from 60% compared to the levels of developed countries, to the top level of the world by 2030.

Mongolia identified all industries requiring modernisation and set the goals to raise an investment and a systematic step-by-step plan of technological upgrade in the energy sector.

In Russia, application of best available technologies (BAT) in industries is a requirement of the state regulation.

Thus, regular workshops helping to establish a shared system of constant update and progress in industrial energy efficiency are required to the benefit of the regional economic growth.

Addressing local energy poverty

State programmes of Korea include important measures on addressing energy poverty and renewable energy integration. Quality of life and welfare of the energy poor will be improved with the introduction of an energy voucher scheme in 2015. Complications caused by the establishment of new electrical grids and creation of renewable energy complexes shall be managed in a more appropriate manner. These issues are also a good field for the GTI members energy cooperation.

Public Private Partnership

The Second Master Plan of Korea reflected social agreements achieved by operating five public and private working groups. This was necessary because in the process of policy making private driven participation has become more important as energy policies are getting increasingly complicated and conflicts among stakeholders growing. The Master Plan was finalised through a consultation process conducted by the Energy Committee which consists of representatives from NGOs, public organisations, and the Presidential Committee on Green Growth. It laid out major activities as follows:

- focus on demand side management and application of ICT, adjustment of tax rates relating to energy, improvement of electricity fee systems
- strengthening of distributed power generation systems
- application of state-of-art technologies for GHG mitigation at new power plants to improve the sustainability of energy production policies
- improvement of safety of nuclear power generation
- addressing danger of cutting off from the electricity grids of neighbouring countries, including strengthening the capacity for overseas resource development
- diversification of energy supply channels to ensure the supply of conventional fuels including oil and gas.

This experience of Korea is a good basis for the GTI members workshops and conferences for best practice knowledge sharing about optimal balance of interests in the PPP projects, distributed power generation, safety of nuclear power, etc

IEE technology providers & their major solutions

Energy conservation and emission reduction technologies of the iron and steel industry

In China, the iron and steel industry is a large energy consumer in the industrial circle and has big potential for energy efficiency. Energy conservation and emission reduction effect of these industries contribute to the entire social advancement of energy conservation and emission reduction objective. During the 12thFive-Year Plan period, 90.89 million tons of backward iron smelting capacity and 94.86 million tons of backward steelmaking capacity were eliminated. Chinese industries extensively applied the energy conservation and emission reduction technologies represented by dry quenching, dry dedusting, sintering desulfurization and energy control center. Key large and medium-sized enterprises cut their comprehensive energy consumption per ton of steel, downsized their smoke and dust emission per ton of steel and lowered their new water consumption. Large-scale production process and equipment have been levelled up substantially. Conventional energy conservation measures, such as dry quenching, power generation by differential pressure at blast furnace top, and sintering waste heat power generation technologies have been basically popularised. At present, the energy conservation and emission reduction technologies to be popularized in the iron and steel industry going forward include the following four aspects:

(1) Energy conservation and emission reduction technologies for comprehensive popularisation

Efficient dust removal of sintering system, comprehensive treatment of unorganized smoke and gas of casting house, dry (semi-dry) dedusting or new type wet dust removing for converter gas, secondary and tertiary dedusting of converter (electric furnace), waste heat recovery of sinter, energy control center, efficient treatment and deep and comprehensive utilization of steel slag, and comprehensive sewage regeneration and recycling, etc.

(2) Energy conservation and emission reduction technologies for prioritised popularisation

Turning stock yard into shed and storehouse, sintering flue gas cyclic utilization, synergistic treatment of sintering flue gas and various pollutants, high temperature and high pressure dry quenching, ultrahigh pressure gas boiler power generation, medium and low temperature waste heat recovery and utilization, energy optimization and control technologies, urban recycled water regeneration and reuse and comprehensive utilization of dust mud containing steel and zinc, etc.

(3) Energy conservation and emission reduction technologies for demonstrated popularisation

Coke oven flue gas desulfurization and denitrification, sintering and electric furnace dioxin prevention and control technologies, coking (cold rolling) wastewater treatment for reuse and “zero discharge”, technologies of recycling and reusing sinter sensible heat in shaft furnace, concentrated salt

water reduction treatment and absorption, efficient utilization of waste heat of coke oven gas primary cooling systemand renewable and clean energy utilization, etc.

(4) Energy conservation and emission reduction technologies for frontier reserve

Slag waste heat recovery and utilization as resources, new composite ferrous coking, synergized optimization of steel plants' material flow, energy flow and information flow (big data), and CO_2 capture, utilization and storage, etc.

Energy conservation and emission reduction technologies of the nonferrous industry

Government organisation of China developed Detailed Rules for the Implementation of the Energy Efficiency "Pacemaker" System in High Energy Consumption Industries and carried out the activity of selecting energy efficiency "pacemakers". Through local and industry associations' recommendation, data integrity examination, review by industry associations and expert review, a list of entry enterprises and energy efficiency "pacemakers" has been shortlisted and determined from ethylene, synthesis ammonia, cement, plate glass and electrolytic aluminium industries for the year of 2016. Three electrolytic aluminium manufacturing enterprises have been shortlisted from the nonferrous industry and announced as 2016 National Energy Efficiency "Pacemakers". These three enterprises are Shandong Hongqiao New Material Co., Ltd.,Qinghai Qiaotou Aluminium & Power Co., Ltd. and Shandong Weiqiao Aluminum Electricity Co., Ltd. Other companies in this industry include:

(1) Northeast Light Alloy Co., Ltd.: In 2015, the company implemented more than 60 energy conservation measures through equipment upgrading and maintenance, including the No. 7 20-ton/hour boiler renovation project of its power plant, three-phase circulating water pump frequency renovation project for energy conservation and the project of air compressor renovation of the second air compressor station for energy conservation, etc.

(2) Guangxi Huayin Aluminium Co., Ltd.: the project of "striving to make technological breakthroughs in applying the Bayer process to alumina production for energy conservation and emission reduction" was given the second prize of 2015 Baise Scientific and Technological Progress Award and also the honorary title of "2015Baise Scientific and Technological Progress Award".

(3) CHALCO Shandong Co., Ltd.: from the perspective of energy conservation and consumption reduction, the company has made full use of the waste heat from baking furnace to supply heat to communities in winter.

Energy conservation and emission reduction technologies of the building material industry

The proportion of cement clinker production by new type dry process went up from 2010 to 2014. The popularising rate of low temperature waste heat power generation technology grew almost twice during this period. Going forward, the energy conservation direction of the building material industry will be: developing the whole-process information-based fuzzy control strategy for cement manufacturing, new energy conservation flat glass furnace technology, digitalized intelligent control and management technology in the float glass production process, etc. The focus will also be put on the popularization of efficient clinker burning, generating power by using pure-low temperature waste heat of glass furnace, ceramic thinning and wet-to-dry process, among other technologies.

Energy conservation and emission reduction technologies of modern coal chemical industry

During the 11thFive-Year Plan period and 12thFive-Year Plan period, China's modern coal chemical industry systematically implemented demonstrated projects and constantly summarized the engineering experience. Systematic summaries have been made in some essential aspects, such as key technologies, system optimization and public engineering configuration and played an active role in enhancing the energy utilization efficiency in the production process. Various energy conservation measures shall be adopted starting from the design stage of modern coal chemical projects for energy conservation. Energy conservation in technological design shall follow the following principles. (1) employ energy conservation process and technologies, energy conservation equipment and advanced control system. (2) correctly match various process relations and key parameters and correctly select all kinds of equipment to prevent energy surplus. (3) optimize the technological process, implement cascade utilization of energy based on energy grade and realize multiple and full utilization of energy. (4) adopt effective measures to reduce energy losses. (5) set up heat supply centers in concentration based on cogeneration and plant integration to realize rational energy utilization.

1. Process and technology-based energy conservation

The technological design of modern coal chemical projects mainly takes into consideration the characteristics of feed coal and finished products and selects domestic and overseas advanced, mature, reliable and applicable technologies and process. The optimized portfolio of advanced and reliable process and technologies comes as the fundamental guarantee for realizing essential energy efficiency of modern coal chemical industry.

(1) Energy conservation through coal gasification

The choice of coal gasification technology should firstly meet the requirement of coal type and secondly be close to the product requirement for syngas composition. From the perspective of

improving energy efficiency, coal-to-natural gas projects should try to select the coal gasification technology generating more methane in the gasification process to reduce follow-up production load of system. Coal-to-oil, coal-to-olefin and coal-to-glycol and other such projects should try to apply the coal gasification technology featuring high gasification efficiency, less sewage discharge, and approximate hydrocarbon ratio required by gas composition and the subsequent synthetic unit. There is a need to try to increase the gasification pressure of coal gasification and correspondingly raise the subsequent operation pressure of the purification plant. This is to enhance the solvent absorption capacity of purification plant, decrease solution circulation volume and cut down power consumption on the one hand and link to the synthetic pressure of subsequent synthesizer and cut down power dissipation of compression of synthetic gas on the other hand.

(2) Energy conservation through transformation

Transformation technologies and process need to adapt to the high temperature water gas generated from front-end coal gasification and meet the requirement of back-end synthetic unit for gas composition. There is also a need to avoid the “cold and heat” problem in traditional process and enhance the heat recovery efficiency. There is a need to transform the by-product medium pressure steam and make full use of the low pressure steam so as to maximize heat utilization and minimize recycled water consumption.

(3) Energy conservation through purification

Currently, modern coal chemical projects generally employ the most advanced low temperature methanol washing purification process for acid gas removal. This low temperature methanol washing purification process represents an energy efficient purification technology featuring high degree of purification and low steam and power consumption.

(4) Energy conservation through synthesis

The synthetic technologies involved in modern coal chemical industry mainly include methane synthesis, Fischer-Tropsch synthesis and methanol synthesis, etc. Synthetic technologies should be mature, reliable, large-scale and advanced to try to improve by-product steam quality and make the best of by-product steam in the synthetic process.

(5) Energy conservation through air separation

Modern coal chemical projects require a huge amount of oxygen. Under the precondition of matching the main process series, it’s appropriate to choose large-scale air separation technologies and advanced process with supporting advanced control system and three major efficient, energy conservation, safe, stable and reliable units (air compressor, steam turbine and supercharger).

(6) Large-scale unit-driven energy conservation

Large compressors, such as air compressor, supercharger and synthesis gas compressor are directly driven by steam turbine to improve compression efficiency and avoid losses in energy transformation. Full-fledged projects may consider using electricity to drive the compressors through signing agreement with large power plants for directly power supply.

(7) Optimised utilization of process waste heat

It's to make full use of the waste heatand by-product steam of such process as coal gasification, transformation and synthesis and comprehensively utilize low-level heat.

2. Equipment-based energy conservation

(1) The plate tower uses new type and high-efficient tower tray to improve the gas-liquid contact state, avoid dead angle and blind area, improve the efficiency of tower tray, and thus save energy and lower consumption.

(2) According to different application situations, various kinds of new type, high-efficient and low pressure drop heat exchangers are used to improve the heat exchange efficiency and cut down energy consumption.

(3) High-efficient pumps and high-efficient and energy conservation electric machines are employed to improve equipment efficiency.

(4) According to different application situations, the intermediate storage tanks needs to be different in type; it's appropriate to use composite board structure for large equipment with thick walls to reduce energy consumption.

(5) Heat and cold insulation materials with good performance are used for equipment and piping insulation.

3. Automatic control-based energy conservation

(1) Rationally equip energy measuring instruments to ensure perfect energy consumption and product measuring instruments meeting the energy management requirements .

(2) Adopt advanced automatic production management system, i.e. advanced Integrated Control and Safety System (ICSS) and Manufacturing Execution System (MES) to form into production plan, production and operation management, production execution and production statistics and realize optimized operation, dispatching and enterprise resource and operation management.

(3) Optimize process control, i.e. employ the ICSS to optimize process control, make production and operation more accurate, safer, more stable and efficient and realize accurate equipment control.

4. Whole plant comprehensive heat utilization

(1) Heat-work cogeneration, i.e. use steam turbine to directly drive the turbine to reduce power loss in secondary electric energy conversion.

(2) Optimize the whole plant heat energy pipe network design, i.e. comprehensively analyze and study the heat energy conversion and availability during the production process and rationally arrange whole plant steam balance and steam pipe network level.

(3) Cascade recovery of waste heat of process unit, i.e. use process waste heat for by-product steam, heat boiler feed water, or preheat desalted water and make-up water based on the waste heat grade under the precondition of meeting the requirement of process unit so as to match energy supply and demand for one part and energy grade for another.

5. General plant layout-based energy conservation

(1) Optimize production equipment layout. i.e. divide the functional areas based on the characteristics of process production equipment, arrange equipment with close production relations close to each other so as to realize smooth technological process and short process pipeline, prevent process pipelines from circuitous routes and reduce energy consumption along pipelines.

(2) Rationally arrange the thermoelectric center of the whole plant, i.e. shorten the fuel import process and make it close to the main steam loading center under the precondition of meeting the requirement of the general layout and thus cut down energy losses.

(3) Rationally arrange power substation.

(4) Under the premise of meeting the requirement for fire protection, production, maintenance and construction, rationally define the width of passageways of the plant to reduce land use, pipeline length and energy consumption.

(5) Rationally select the location of ash loading area inside the plant and that of ash field outside the plant to shorten the transportation distance.

6. Other engineering-based energy conservation measures

(1) Electrical energy conservation.
(2) Heating-based energy conservation.
(3) Ventilation-based energy conservation.

(4) Air conditioning-based energy conservation.

(5) Lighting-based energy conservation.

(6) Piping layout-based energy conservation.

Republic of Korea

The Korean government has pursued an energy saving program since the 1980s. However, the government recognised the limitation of the government-led program and in 1991 introduced an Energy Service Company (ESCO) scheme which is led by the private sector. ESCOs make investments in retrofitting energy saving equipment at the request of energy consumers which lack technologies and financial resources. The government provides low-interest loans to ESCO providers.

ESCO providers can serve as business entities when they meet the requirements of the Framework Act on Energy Use Rationalisation, and they are registered with the Ministry of Trade, Industry and Energy (MOTIE). The business areas of ESCOs include: energy saving equipment such as waste heat recovery projects; process improvement projects; cooling and heating equipment installation projects; LED lighting installation projects; and renewable energy projects

The following table on loans provided by year and by equipment type shows the changing trends in energy efficiency technology needs.

Table 15 The top 10 ESCOs & amount of loans provided to them

No	ESCO providers	2012	2013	2014	2015(July)	Total	Ratio
Total loans by year		276,609	309,724	253,994	66,673	907,000	-
1	SAMCHULLY ES	2,017	38,913	46,993	10,370	98,293	10.8
2	Energy Management Technology	41,982	14,604	20,789	3,705	81,080	8.9
3	BENEFF KOREA	25,304	34,914	768	-	60,986	6.7
4	SAMSUNG EVERLAND	23,164	21,736	6,541	2,000	53,441	5.9
5	LIGENSULTING	21,771	25,492	-	1,214	48,477	5.3
6	Gyerimcon Edison	9,859	24,337	3,398	-	37,594	4.2
7	Jigu Enertech	1,000	18,562	8,395	315	28,272	3.1
8	Kolon Global	-	19,384	8,000	-	27,384	3.0
9	LSIS	6,710	6,221	4,862	-	17,793	2.0

No	ESCO providers	2012	2013	2014	2015(July)	Total	Ratio
10	GS Neotech	5,394	3,540	7,802	-	16,736	1.8

Unit: 1 million KRW, based on the amount recommended

KEA conducted a survey of companies which have their roles and participate in new energy industries including Nega-watt, Solar PV, Smart Factories, Smart Grids, Electric Vehicles, Zero Energy Buildings, Energy Storage Systems. KEA's publication the 'Green Pages Korea' contains details of the companies, and allows other companies to search for the energy technologies they need. The book provides information including the name of the company, the name of the CEO, the location, contact point, web address, sales volume, major products, major achievements, and final products and services.

Recently, there has been an increasing need for comprehensive information on reliable Korean companies and their technologies due to growing demand and for creating partnership opportunities between Korean and overseas companies. The KEA has come up with a new publication, 'Green Pages Korea', which introduces outstanding Korean companies and their signature products and services in new energy and energy efficiency industries. The 'Green Pages Korea' is categorized into two sectors: the New Energy Industry and the Energy Efficiency Industry. The New Energy Sector has information on companies in seven business models such as Electric Vehicles, Zero Energy Buildings, Smart Grids, ESS (Energy Storage Systems), Smart Factories, Negawatt Markets and PV Rental Services.

In the energy efficiency sector, the information on companies producing certified high-efficiency appliances can be found categorized into four sub-sectors: LED Lighting; Electrical Equipment; Boilers, Heating & Cooling; and Insulation. All the companies are actively seeking to build international partnerships. KEA will continue to add information about new and renewable energy companies and products into the 'Green Pages Korea' in the near future.

Mongolian report does not describe local producers of energy efficient technologies but there is a comprehensive list and measures the country needs to increase a level of industrial energy efficiency. The report suggests that the following considerations will help advance energy efficiency improvements in Mongolia:

- The Government is effectively subsidizing the transmission and distribution network losses and leaves no room for an incentive to reduce the losses. Energy prices should closely reflect the real cost of supply. The Government should set deadlines for a gradual energy pricing reform.
- In general, the monopolistic electricity sector is being liberalized and state owned utility companies were created. Also, spot ancillary service market was initiated within for the participants of the

central energy system. However, the ownership of the power plants still remained state. No private power plants are participating the energy system at the moment and the progress of enabling the new entrant enter the market is being extremely slow and bureaucratic. Private companies are interested in investing in the energy efficiency in Mongolia only if they are provided with the suitable conditions.

- Mongolia lacks availability of finance, technical know-how and capacity to implement large scale energy efficiency projects. It may explore the opportunities from international donors and funding agencies to set up an energy efficiency fund for financing those projects which will provide savings in energy and operation costs in various sectors including
- The investment needs for the improvement of industrial energy efficiency are just too large to be met through the Government's own resources. Accordingly, the key financing strategy is to mobilize as much finance through the PPP (Public Private Partnership) arrangements as possible. The Government is also attracting direct foreign investment and engaging with domestic enterprises for investment in the energy sector. The policy framework for private participation is already in place. Innovative financing tools need to be widely introduced to reduce the public spending on financial and fiscal incentives. Further efforts will be made to strengthen this policy in order to ensure adequate flow of private investment in energy sector.
- Consumers need to be better informed. It is necessary to simplify messages on energy efficiency to reach the majority of consumers. Demand side management should play significant role in meeting the energy demand i.e. electricity and heating. It realizes that some of the required generating capacity should come from the reduction in demand due to the efficiency improvement.
- An important challenge for the Mongolian energy sector is to develop a national integrated energy system. Currently four separate electricity grids are in operation. Therefore, the country is planning to connect these grids and expand the distribution system under the Programme on Mongolian Integrated Power System (2007-2040).
- The development of international or multi-national standards can help enhance international and regional cooperation, in addition to regional testing and harmonisation of equipment testing standards and facilities. International energy fora should be used to exchange experiences to benchmark policies and identify best practices.
- Energy research center should be set up in cooperation with the economics departments of the universities, power energy schools and participants of energy sector. It should conduct researches

focusing on the Mongolian case, development of possible scenarios in the future, feasibility studies and knowledge transfers.

- Upgrading and increasing electric production capacity are priorities for the country. According to the Statistics on Energy Performance-2017 report by ERC, the share of electricity which is being imported from Russia and China has been increasing over the past years. Due to ageing power plants, transmission and distribution power lines, it is essential to reduce losses by upgrading with energy efficient technologies, and to develop new plants to secure a reliable energy supply. New technologies offer attractive benefits and their wide introduction should be supported by policies.
- The Government is targeting to increase the share of renewables in the national energy mix and promote industrial energy efficiency. Its renewable energy capacity has increased by 7 times over the past five years, reaching around 210 MW in 2018. Energy efficiency also offers an attractive option for Mongolia trying to balance steeply increasing demand from both household and industrial consumers with the need to lower their carbon footprint.
- In order to reduce the consumption at the peak hours, more differentiated price scheme to be introduced. This was found be a viable solution in reducing the peak hour load at the load centers.
- Control over implementation and evaluation of energy efficiency policies and measures are fundamental to the policies success.
- Regulations must be regularly reviewed and strengthened. Labeling and MEPS should be regularly revised and upgraded.

In Russia, there is a "new industrial policy" being actively developed in the country, closely linked with the development of the energy complex (terminology used in Russia meaning energy industrial sector), regional territorial development, improvement of energy efficiency, particularly in the industry itself, but also in other sectors, namely consumers of industrial products. The new industrial policy development implies reindustrialisation based on a different advanced technology platform, in contrast to catch-up strategy, which includes:

- fundamentally different use of all resources, where the target savings are not at 2-5-10%, but tens of percent from baseline[16];
- «green technologies», the best available technology (BAT), based on environmentally friendly, non-waste, recycling, renewable energy use principles;
- simultaneous growth of technological advancement and complexity in other segments

[16] «Resource revolution: Meeting the world's energy, materials, food, and water needs». McKinsey, 2011. http://www.mckinsey.com/insights/energy_resources_materials/resource_revolution

Characteristics of energy performance in the energy generation sector and other industries, including manufacturing of equipment and appliances are considered to be ever more important. In terms of identification of industrial energy efficiency technology manufacturers in Russia, there is a comprehensive web resource called "Energosovet"[17], a special thematic portal for energy and resource saving. This portal provides a catalogue/ information about energy efficient technologies of Russian manufacturers, case studies of specific projects, which helps identifying problems and finding solutions in the field of energy efficiency. The main aim of this portal is to provide up to date information on technologies and activities, application of which makes more efficient use of fuel and energy resources. The site contains legal documents, articles and visual materials, news, survey results. Technologies, leading to more efficient use of fuel and energy resources and significant reduction of financial costs in the industrial processes are divided into several basic groups, as follows:

1. **Thermal energy savings in processes of**
   - industrial production[18]
   - transport[19]
   - consumption[20]
2. **Saving electricity in the processes of**
   - production[21]
   - transport[22]
   - consumption[23]
3. **Saving water in the processes of**
   - water intake[24]
   - transporting[25]
   - consumption[26]
4. **Saving Fuel in the processes of**
   - production of electricity[27]

[17] http://www.energosovet.ru/entech.php
[18] http://www.energosovet.ru/entech.php?id=1
[19] http://www.energosovet.ru/entech.php?id=3
[20] http://www.energosovet.ru/entech.php?id=2
[21] http://www.energosovet.ru/entech.php?id=4
[22] http://www.energosovet.ru/entech.php?id=5
[23] http://www.energosovet.ru/entech.php?id=6
[24] http://www.energosovet.ru/entech.php?id=7
[25] http://www.energosovet.ru/entech.php?id=8
[26] http://www.energosovet.ru/entech.php?id=9
[27] http://www.energosovet.ru/entech.php?id=18

- production of thermal energy[28]
- consumption monitoring[29]

5. Energy audit/ preparation of energy passports

- Energy audit[30]
- Energy performance certificates[31]

6. Renewable energy sources

- Thermal energy[32]
- Electric energy[33]

7. Ecology, transport, energy efficiency propaganda/awareness raising[34]

To search a specific technology, one can use categories or the categories' basic introduction on the project, such as[35]:

- Administrative and public utility buildings and facilities[36]
- Apartments[37]
- Social institutions (schools, hospitals, kindergartens, etc.)[38]
- Heating networks[39]
- Semi-permanent, easily erectable temporary structures, including trade pavilions[40]
- Housing energy management system, including apartment buildings[41]
- Boilers, CHP[42]
- Lifts/elevators[43]
- Private houses[44]
- Substations, electrical networks[45]

[28] http://www.energosovet.ru/entech.php?id=19
[29] http://www.energosovet.ru/entech.php?id=26
[30] http://www.energosovet.ru/entech.php?id=30
[31] http://www.energosovet.ru/entech.php?id=31
[32] http://www.energosovet.ru/entech.php?id=20
[33] http://www.energosovet.ru/entech.php?id=21
[34] http://www.energosovet.ru/entech.php?id=44
[35] http://www.energosovet.ru/entech.php#rubrrr2
[36] http://www.energosovet.ru/entech.php?id=10
[37] http://www.energosovet.ru/entech.php?id=11
[38] http://www.energosovet.ru/entech.php?id=12
[39] http://www.energosovet.ru/entech.php?id=23
[40] http://www.energosovet.ru/entech.php?id=14
[41] http://www.energosovet.ru/entech.php?id=15
[42] http://www.energosovet.ru/entech.php?id=16
[43] http://www.energosovet.ru/entech.php?id=17
[44] http://www.energosovet.ru/entech.php?id=22
[45] http://www.energosovet.ru/entech.php?id=24

- Pumping stations[46]
- Other[47]
- Industry[48]
- Lighting systems[49]

While choosing any technology for any particular project, one can find a short description of named technology, its classification, past projects where this technology was applied/case studies and obtained effect from the application, including reached reduction of energy consumption and reduction in installed capacity, release of additional electric power, reduction of peak loads in the power system, reduction of fuel consumption, improvement of environmental conditions. Potential customers find contacts of the company-manufacturer or technology provider or could add their contacts and list their own technology under the appropriate category.

Recommendations for cooperation between GTI member states in industrial energy efficiency

Opportunities for GTI member states to cooperate in energy efficiency

There is a shared view among national experts that mutual regional cooperation in GTI region should be developing intensively because it is characterized by a relatively high degree of potential economic complementarity and is facilitated by the growing bilateral cooperation between countries in the region. These factors should stimulate the development of integration processes and their possible transition to an institutional format. Thus, objective economic and political reasons contribute to the development of integration processes in the region.

The Chinese expert noted that the Tumen River International Sub-regional Cooperation Mechanism is faced with a rare development opportunity because it is a territory where the three international sub-regional cooperation mechanisms are progressing. "At the time of the establishment of Asian Infrastructure Investment Bank and the entry into force of China-South Korea Free Trade Agreement, “the Belt and Road” Initiative is integrated with Mongolia’s Grasslands Road Initiative, Russia’s Trans-Eurasian Transport Corridors Initiative and South Korea’s Eurasian Initiative, creating a golden opportunity for the Tumen River regional cooperation". The region is already characterised by:

[46] h http://www.energosovet.ru/entech.php?id=33ttp://www.energosovet.ru/entech.php?id=25
[47] http://www.energosovet.ru/entech.php?id=33
[48] http://www.energosovet.ru/entech.php?id=34
[49] http://www.energosovet.ru/entech.php?id=35

- the evident improvements in the logistics channels and substantial improvements in clearance efficiency, industry cooperation level and depth, among other aspects.
- The Tumen River International Cooperation Mechanism is being transformed and upgraded into an independent international cooperation organization. This has brought about a broader development prospect to Tumen River cooperation.

Each country can contribute its core competence to the integration process. "South Korea is a developed country and thus has financial and technical advantages; Russia is a big power enjoying rich resources; China has not only a broad market but also stronger technological superiority; Mongolia has shown an obvious late-mover advantage. The Russia-dominated Eurasian economic union, South Korea's Eurasian Initiative and Mongolia's Grasslands Road Initiative can be strategically integrated with China's Belt and Road Initiative. The Tumen River Sub-regional Cooperation Mechanism happens to be an important carrier of the strategic integration".

"The four countries have deepened their political mutual trust and continuously strengthened their economic cooperation and trade ties, which will definitely keep deepening the Tumen River sub-regional cooperation. At the same time, countries within the Tumen River region have attached ever-increasing importance to interconnection and integrated their development strategies, which will bring about new historical opportunities to the Tumen River regional cooperation".

As discussed in the report of the Korean expert, the four GTI countries have a common need to cooperate on power supply, energy efficiency, the distribution of renewable energy, and GHG reduction, in order to meet their own Intended Nationally Determined Contributions (INDCs). However, it was rightly noted, it may not be realistic to organise NEA countries into a single economic system equivalent to the EU, but it is necessary to make collaborative efforts to remove administrative barriers in a sustainable and effective manner. Cooperative mechanisms can be aimed at addressing common challenges such as energy efficiency, and organised at the implementing agency level. GTI member countries should prepare for the possibility of greater cooperation over the long-term and implement pilot cooperative projects within the GTI region between countries which have similar economic conditions. For example, energy auditors from GTI member countries could conduct cross-energy audits and exchange their know-how. There would be value in implementing a pilot ESCO project with the results from such an exchange program. Based on the outcomes of the pilot project, there would be a need to implement second-phase projects which might consist of regular workshops, information exchange, and standardisation facilitated by energy experts from GTI member countries. Once this cooperation becomes established and consolidated through the first few phases, it would become necessary to move toward a further phase where GTI consumers would be able to choose the technologies and products they prefer by establishing a set of common standards.

In the report of the Mongolian expert an important issue of project financing is discussed. Mongolia lacks availability of finance, technical know-how and capacity to implement large scale energy efficiency projects. It may explore the opportunities from international donors and funding agencies to set up an energy efficiency fund for financing those projects which will provide savings in energy and operation costs in various sectors. Therefore, Mongolia is pursuing cooperation on industrial energy efficiency-related activities with GTI member countries bilateral and multilateral formats. Considering that not all of the technical investment potential will be accessible due to various barriers, the potential energy efficiency market will be adjusted using the current annual market sizes of equipment which can be applied across different commercial and industrial end-use sectors.

Challenges for GTI member states in energy efficiency cooperation

Challenges discussed by the national experts are divided into two major groups, those of the worldwide level, which nevertheless apply to all countries in the region and regional GTI level. Global challenges call to rethink global institutions and systems and think long term to assess the quality of economic growth in the region. Problems of a new and global character influencing international relations and contributing positive or negative factors shaping the perspectives of the region are the following:

- In-depth development of world multi-polarisation, economic globalisation, cultural diversity and social informatisation
- Interconnected traditional and non-traditional security threats
- Changing investment and trade rules

There are also currently existing significant local differences, which form challenges for closer cooperation such as:

- Access to energy resources
- Energy policy objectives
- Administrative systems, differently structured regulatory systems and incentive measures
- Level of technology development and mutual competitiveness
- Insufficient amount of energy efficiency industrial equipment
- Different industrial standards

- Market barriers
- Lack of access to appropriate financing mechanisms

Certain bilateral agreements in the energy sector between GTI countries do not remove a barrier for cooperation unless regional cooperative mechanisms for the electric grid standardised throughout the region will be developed. This will allow for the operation of a single market system, which in turn will increasingly intertwine other systems from financial to communications, to supply chain.

Conclusion / Recommendations for the industrial energy efficiency cooperation among GTI member countries

The continuing importance not only of GTI countries geographic proximity but also of cultural, administrative, and, to some extent, economic proximity factors are interrelated. Those similarities should be intensified through various channels so that constructive and realistic cooperation between states based on decision making that consider all stakeholders interests in the region is applied. Members should develop international cooperative mechanisms including sectoral agreements, coordinated policies and measures, cooperation on R&D, development-oriented activities, financial mechanisms, and capacity building as a long-term strategy for meeting the energy and efficiency related challenges, which would include several types of initiatives:

Cross-cutting initiatives

- Propose regional energy agreements, solutions and promote joint industrial energy efficiency activities because of the complex methodologies for setting up baselines and monitoring, which increase the transaction costs of any projects in the field
- Revise regional Energy Efficiency and Energy Saving Potential in Industries and range of economically viable Energy Saving Opportunities
- Discuss sector specific significant innovation in current and emerging technologies to realise further industrial energy reduction potential; revise internal barriers to uptake of energy saving opportunities
- Address these barriers and discuss industrial standards to facilitate development of insurance products for energy savings guarantee
- Promote and facilitate further potential for resource sharing among regional industrial clusters

Investment and Trade in advanced energy efficiency technologies and projects activities growth

- Free trade agreements, *Regional* trade preferences or tax treaties
- Private industry collaboration in the context of an expanded commercial regime
- Multilateral development banks

- Involvement of governments as a customer, information provider, and policy maker to promote ESCOs and facilitate market development.
- Appropriate mechanisms development to remove barriers for energy efficiency financing and ESCOs
- Development of specialised energy efficiency financing windows in appropriate financial institutions, development of skills for energy efficiency project appraisal and design of specialised financial products accelerating the diffusion of energy efficiency
- Create public-private partnership initiative platforms, dedicated to the projects taking place in GTI region and finding ways for combining private investments with public financing

Energy Efficiency Policies

National energy efficiency policies should capitalise on synergies and positive externalities with existing measures and correlated policy fields. Analysis of co-benefits such as improved health and reduced public spending related to energy efficiency can strengthen the case for cooperation.

- Promote policies to make energy efficiency imperative, create mass awareness and incentives for industrial energy efficiency; produce case studies of good policy practice carried out in GTI states; provide market feedback from experts, business stakeholders, and local and regional actors
- Work towards regionally accepted product definitions, metrics for energy efficiency, test protocols, and better information provision throughout the region

Research and development

- Initiate joint research and innovation projects specific to the regional needs, focused on energy efficiency in general and industrial energy efficiency unambiguously
- Work towards comparable data, policy analysis and energy efficiency standards as well as perform cross-country comparison on energy efficiency indicators and facilitate efforts towards a common methodology development

R&D, industrial cooperation and capacity building

- Harmonise or create all-region minimum energy performance requirements for buildings or building units and discuss rules of complying with energy performance requirements depending on the countries' minimum efficiency standards for new-builds or major renovations.
- Discuss the possibility to create databases containing information on building certification and systems inspections as a potential source of information on the energy performance of buildings. Such databases and schemes could help in assessing regional market investment needs of the

construction industry, see the barriers for the industry rapid growth and address incentives for financiers and real estate market actors

- Discuss the possibility to develop a joint regional ICT platform and databases on smart buildings to accelerate energy market transformation
- Discuss the possibility to create a regional joint platform for energy audits professionals to set good practice examples, create energy efficiency networks and a harmonized benchmarking system.
- Discuss new technologies or innovative solutions for the industrial waste treatment
- Setting up local projects on energy efficiency usually involves a considerable amount of human and financial resources in the pre-project phase. Set up project development assistance (PDA) facilities under GTI to support public authorities and to develop effective energy projects.

Financing

Deploying energy efficiency measures is capital intensive. It requires up-front investments in the form of equity from businesses, or debt financing from lending institutions. Energy efficiency cannot be financed purely from public funds as benefits are predominantly private and there will never be sufficient public funds to do so. It is necessary to create joint mechanisms to encourage the more effective use of public funds, in particular through financial instruments and investment platforms such as:

- Loan schemes co-financed by public funds
- Risk-sharing instruments
- Grant and tax schemes
- PDA to support the implementation of Energy Performance Contracts
- Supporting capacity building and stakeholder dialogue
- De-risking energy efficiency – creating the market

It is important to make energy efficiency attractive for institutional investors to the region and create a large-scale pipeline of bankable projects. The energy efficiency investment cycle needs to be standardised in the region so that both the supply and demand side of finance know what to expect. A re-financing market for energy efficiency investments needs to be created in order to allow investors or lenders to refinance their assets and invest their money into new projects

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