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Long term energy plan of Mongolian with nuclear power plant using Message code

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1. Introduction

The long-term forecasting of energy supply and demand is one of the most important topics in relation to Mongolia due to the country's abundant natural resources, which offer great opportunities for achieving independent, sustainable, and green energy development, if managed properly. In this paper, an overview of the current situation of Mongolia's energy sector and its role and contribution in the country's economy and environment, and a comprehensive assessment of the sector, are provided. Most importantly, the Model for Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE) model used to forecast the future energy supply and demand and to build and compare possible scenarios that could sustain economic development, environmental sustainability, and energy security in the country. In this paper, two scenarios for long-term energy development in Mongolia by 2040 were built using the MESSAGE model, and 2010 was set as the base year. The forecasting of the energy demand and supply was shown as a build the first model of Mongolia energy system to forecast the potentials of using NPP technology in the energy mix of Mongolia energy system.[1]

2. Methods and Results

2.1 Methods

The identification and analysis of energy issues, and the development of energy policy options, are therefore, important areas of study by governments, researchers, and the development community. In this regard we were used to build a new model version that can predict the future plan of providing Mongolia by energy and how this energy can be manage by using MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impacts) model. This software designed for setting up models of energy systems (i.e. energy supplies and utilization) for optimization. MESSAGE was originally developed at International Institute for Applied Systems Analysis (IIASA). The IAEA acquired latest version of MESSAGE and several enhancements have been made in it, most importantly addition of a user-interface to facilitate its application.

The underlying principle of a model, built using the MESSAGE, is optimization of an objective function under a set of constraints that define the feasible region containing all possible solutions of the problem. The value of the objective function helps to choose the solution considered best according to the criteria specified. [2, 3]

2.2 Results

In this case following figure is result of the base scenario by 2040 and 2010 was set as the base year. But there are no changes of electricity demand to until 2020. Because first candidates power plants shall be operation in 2020. One of the big important thing is back stop in future energy demand which is to be get problem in Mongolian energy sector. Reasons are most of plants too old and energy transmission and distribution's too bad.

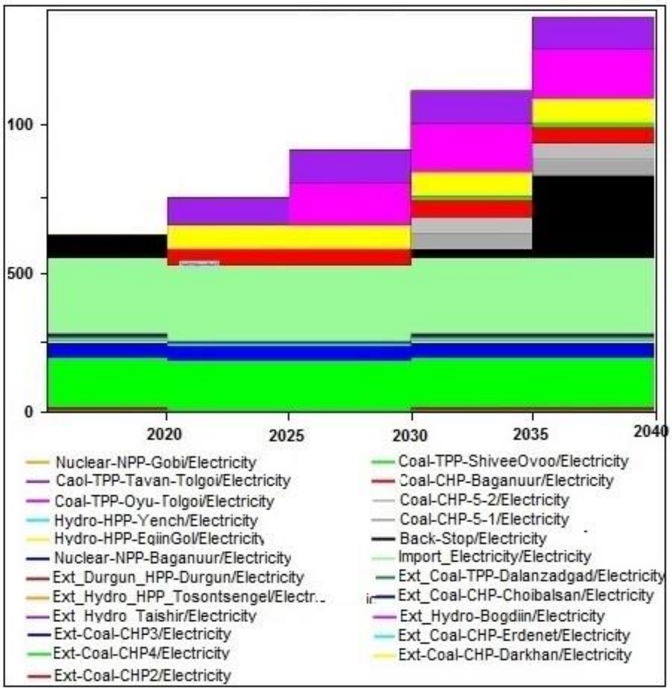

Fig.1 Results of Base scenario (MWyr)

The following table is results of individual plants contributions to the grid until 2035. There are both existing and candidate power plants individual contributions in the table. Mongolia's energy needs are mainly met by domestic generation in seven coal-fired power plants, less hydropower plants, diesel generators, small-size solar panels and wind power installations. About 13 % of the electricity is imported from Russia.

Table I: Results-Individual Plants contribution to the Grid, MWyr.

Plants name	**2015**	**2020**	**2025**	**2030**	**2035**
Ext_Coal-CHP2	10.70	0.00	0.00	10.70	10.70
Ext-Coal-CHP4	182.5	182.5	182.5	182.5	182.5
Ext_Coal-CHP3	53.64	53.64	53.64	53.64	53.64
Ext_Coal-CHP Darkhan	10.79	0.00	0.00	10.79	10.79
Ext_Coal-CHP Erdenet	10.16	10.16	10.16	10.16	10.16
Ext_Hydro-HPP Bogdiin	0.80	0.80	0.80	0.80	0.80
Ext_Hydro-HPP taishir	2.64	2.64	2.64	2.64	2.64
Ext_Hydro-HPP tosontsengel	0.10	0.10	0.10	0.10	0.10
Ext_Hydro-HPP Durgun	4.80	4.80	4.80	4.80	4.80
Ext_Coal-CHP Choibalsan	3.78	0.00	0.00	3.78	3.78
Ext_Coal-CHP Dalanzadgad	2.40	0.00	0.00	2.40	2.40
Import_electricity	280.20	280.19	280.20	280.20	280.20
Back_stop	82.33	0.00	0.00	30.05	301.64
Coal_CHP5-1	0.00	0.00	0.00	60.00	60.00
Coal_CHP5-2	0.00	0.00	0.00	60.00	60.00
CHP-Baganuur	0.00	60.00	60.00	60.00	60.00
Coal_TPP ShiveeOvoo	0.00	0.00	0.00	16.56	16.56
Nuclear_NPP Baganuur	0.00	0.00	0.00	0.00	0.00
Hydro_HPP Yench	0.00	0.36	0.36	0.36	0.36
Coal-TPP Oyu-tolgoi	0.00	0.00	155.46	180.00	180.00
Coal-TPP Tavantolgoi	0.00	98.84	12000	120.00	120.00
Nuclear NPP Gobi	0.00	0.00	0.00	0.00	0.00
Total	**644.69**	**781.88**	**958.50**	**1172.32**	**1448.91**

All old coal-fired power stations in the Central energy system (CES) grid are of Russian design. They are cogeneration plants for producing base-load electricity, hot water for district heating (DH) and process steam for industry. The CES is unable to meet the daily system demand with these plants due to their poor peaking capability. Table II is results of existing plants installed capacities. There are no between difference for 2015 and 2035. Reason is all existing coal power plants old and technologies not good to generate electricity. Another thing is hydro power plants and diesel generators size too small which isn't possible to increase the size. Because there is no big lake and rivers in Mongolia. And also all oils are imports from Russia and China.

Table II: Results-Existing plants Installed Capacity

Plants name	**2015**	**2020**	**2025**	**2030**	**2035**
Ext_Coal-CHP2	10.70	0.00	0.00	10.70	10.70
Ext-Coal-CHP4	182.5	182.5	182.5	182.5	182.5
Ext_Coal-CHP3	53.64	53.64	53.64	53.64	53.64
Ext_Coal-CHP Darkhan	10.79	0.00	0.00	10.79	10.79
Ext_Coal-CHP Erdenet	10.16	10.16	10.16	10.16	10.16
Ext_Hydro-HPP Bogdin	0.80	0.80	0.80	0.80	0.80
Ext_Hydro-HPP Taishir	2.64	2.64	2.64	2.64	2.64
Ext_Hydro-HPP Tosontsengel	0.10	0.10	0.10	0.10	0.10
Ext_Hydro-HPP Durgun	4.80	4.80	4.80	4.80	4.80
Ext_Coal-CHP Choibalsan	3.78	0.00	0.00	3.78	3.78
Ext_Coal-CHP Dalanzadgad	2.40	0.00	0.00	2.40	2.40
Total	**282.16**	**254.49**	**254.49**	**282.16**	**282.16**

Among the energy sources, coal is the most important fuel in Mongolia. Its share in 2013 was 66.3%, which accounts for slightly less than a half of the total prime energy supply. Coal still accounts for the largest share in Mongolia's total primary energy demand. The fig.2 is results of the coal resource demand. It shown coal energy resources will be increase in the Mongolian energy sector.

But Climate scientists have observed that carbon dioxide concentrations in the atmosphere have been increasing significantly over the past century, compared to the rather steady level of the pre- industrial era. The 2012 concentration of CO_2 (394 ppmv) was about 40% higher than in the mid-1800s, with an average growth of 2 ppmv/year in the last ten years. Among the many human activities that produce greenhouse gases, the use of energy represents by far the largest source of emissions

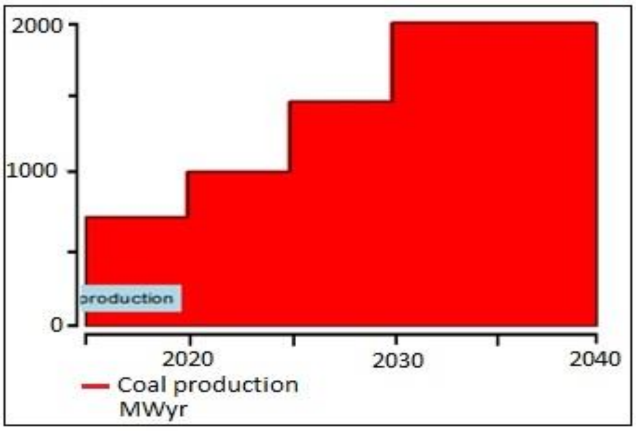

Fig.2 Results-Coal Resource Demand

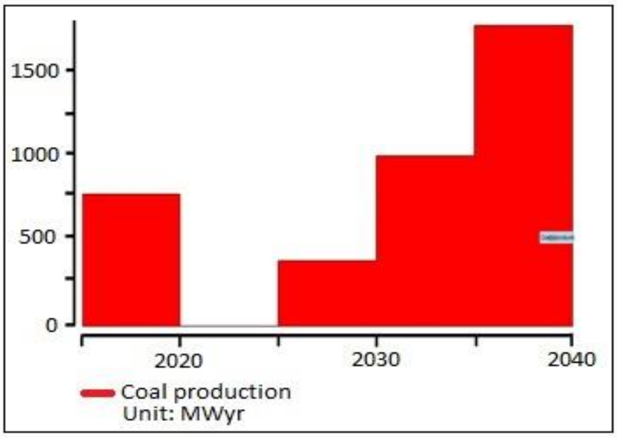

Fig.3 Results Coal resources demand with 600 MW nuclear power plant

2.3 Mongolia's decision to reduce CO2 emissions

The Government of Mongolia signed the United Nations Framework Convention on Climate Change (UNFCC) on June 12, 1992 at the Rio Conference and the Great Khural (Parliament) of Mongolia ratified it on September 30, 1993. The Government of Mongolia ratified/accessed the Kyoto Protocol on 15 December 1999. Mongolia doesn't have binding targets under the Kyoto Protocol, but is still committed under the treaty to reduce emissions. [5]

Under the Protocol, emissions of Mongolia are allowed to grow in accordance with their development needs. The estimated CO_2 emissions from fuel combustion are 13.0 million tones in Mongolia, 2010 which were referred from IEA energy data with the default methods from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Following table shows how many CO_2 Mongolia is emitting in consideration for population, GDP and a unit of electricity.

Table III: Comparison of CO_2 emissions [6]

Criteria	world	Asia	Annex I	Non-Annex I	Mongolia
CO_2/GDP (kg/USD in2005)	0.60	1.06	0.37	1.11	**3.65**
CO_2/KWh (gram/KWh)	529	730	426	647	**947**

Making an assumption of reduction target of CO_2 emissions is necessary because Mongolia doesn't have binding target. Most of Annex I countries have 20% of total 2010 emissions as binding target. For Mongolia, 10% of total 2010 emissions which are 1.3 million tone of CO_2 have determined as reduction target.

International emissions trading could be another reason to reduce emissions because it allows developed countries to trade their commitments under the Kyoto Protocol. They can trade emissions quotas among themselves, and can also receive credit for financing emissions reductions in developing countries. This is known as the "carbon market'. As a result, the carbon tax has calculated as following: [7]

63 ($/kWyr) = 7.50 ($/t) x 8.4 (t/kWyr)

3. Conclusions

The industry and mining project sectors are expected to remain as the main energy consumers in the next decades. The demand of the sector will be three times of the total energy demand by 2040. The development of big mining projects and the increasing number of vehicles in Mongolia are the main factors that will contribute to the increased demand.

Coal still accounts for the largest share in Mongolia's total primary energy demand. MESSAGE result shown in fig.2, which shows an exponential increase in coal resources demand in the future. It will be big issue to environmental impact (e.g., CO_2 emission). The estimated CO_2 emissions from fuel combustion are 13.0 million tones in Mongolia, this should be mitigated significantly, to meet the CO_2 reduction target.

The MESSAGE results presented above are based on the base case scenario and other scenarios factoring in alternate sources of clean energy should be explored as further studies. In the Mongolian renewable and green energy target 20% of the total installed capacity by 2020 can be achieved assuming that there will be more renewable and green energy deployment in the power generation industry. Based on MESSAGE results shown in fig.3 which suggest the use of nuclear power plants in future energy mix system mainly due to anticipated rise in CO_2 emissions tax in future [8].

In the base case scenario as shown in figure one, 13% of total electricity capacity is imported from Russia, this is a big problem to the energy security supply system. We need to reduce electricity imports from overseas countries in the future to avert emergencies in case of bilateral disagreements. This can be achieved by alternative energy sources such as nuclear power plants and renewable sources are considered.

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