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Energy and Sustainable Development in Mongolia

A report prepared by :

Dr. M. **Badarch**,
Mongolian Environment and Nature Consortium.
mnec@imaginet.com

Dr. B. **Namkhainyam**,
Mongolian University of Science and Technology Power Engineering School.

Mongolia has tremendous potential for developing wind power generation and small hydro. Developing local renewable sources would decrease air pollutants, particularly CO_2 emissions

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Executive summary

This report has been written in 2002 for Sustainable Energy Watch (SEW) to assess Mongolian energy use in relation to its impact on Global Climate and sustainable development. SEW methodology is based on 8 indicators. For each of these indicators, the value of 1 is either the global average or the historical trend for Mongolia, while the value of 0 is the sustainability target. Both national sources and data from international organisations (World Bank, ALGAS Project) were used in the preparation of the Mongolian SEW report.

Mongolia is a large, land-locked, lightly populated eastern Asian economy sandwiched between Russia and China. Almost half of population is engaged in agriculture, particularly the uniquely Mongolian herding industry. The urban population is primarily located in the capital, Ulaanbaatar, and a few other large towns, aimag centers. The major industries outside of agriculture are cashmere processing, copper and gold mining, food processing, and the construction materials. Agriculture accounts for close to 33 percent of GDP, industry and construction for 27.5 percent, and services for about 40 percent (1998). Mining, mainly copper, provides an estimated 27 percent of the economy 's export earnings (1998).

The Mongolian transition to market economy began in 1990. By contrast with many other transition economies, especially those from the former Soviet Union, Mongolia has suffered a smaller fall in national output, with 1999 at 93 percent of 1989 according to the October 2000 *World Economic Outlook.*

Mongolian economy consumes much more energy than the world. Tendency so far was to increase energy consumption. The government has declared energy saving as a major energy strategy. However, this decision has hardly been implemented. Energy consumers lack incentives for effective use of resources. End-use consumers often pay too little or do not pay at all for the energy consumed.

Renewables are seen as one of the major way to reduce the country's dependence on energy imports. Mongolian coal is of bad quality leading to low efficiency and fast degradation of the coal-fired power plants. At the same time, Mongolia has tremendous potential for developing wind power generation and small hydro. Developing local renewable sources would decrease air pollutants, particularly CO_2 emissions. Small local renewable sources will help local authority to get independence from central electricity grid.

To summarize, most of the positive trends you might notice are misleading and are caused by the economic crisis in Mongolia. Mongolia requires urgent steps to reduce its energy intensity and develop renewable sources of energy.

General Discussion of Mongolia

Geographic Characteristics

Located in Central Asia, Mongolia is positioned between Russia to the north and the People's Republic of China to the east, west and south. With more than 1.5 million square kilometers of territory, Mongolia is the fifth largest country in Asia and ranks seventeenth among all nations. Mongolia is divided into primary natural zones that include mountains primarily in the country's north and west; basins, such as that in which the capital Ulaanbaatar is located; and a mixture of desert and steppe which together cover three-fourth of the country.

Mongolia's average altitude is almost 1,600 meters above sea level. Its higher latitude combines with the altitude to intensify the semi-arid climate. Winters are long and cold. Average temperatures fall below freezing for six months of the year. Temperatures in January average about from -25 to -40 degrees Celsius.

The Constitutional Transformation to Democracy and a Market Economy

A new Constitution embracing democracy and the market system was passed by the Baga Hural in May 1991 and adopted by the State Great Hural in January 1992. The Constitution took effect on February 12, 1992, changing the nation from the People's Republic of Mongolia to Mongolia. The Constitution makes Mongolia a democratic parliamentary state with independent legislative, executive and judicial branches; it guarantees citizens freedom of speech, religion, and other basic human rights, as well as the right to own property and engage in private business activity. The President and the Parliament are elected directly by the people.

Mongolia's Existing Structure of Government

Mongolia is divided into 21 administrative units (provinces) called aimags. The population of cities range in size from 50,000 to over 600,000 inhabitants in the capital of Ulaanbaatar. The cities are divided into districts. There are 9 districts in Ulaanbaatar. Urban population accounts for about 51 percent of the country's total population and there is a strong tendency for migration from the rural to urban areas. The aimag populations range from 40,000 to approximately 100,000 persons. They are divided into aimag centers and rural sums or districts around the centers. Sums are comprised of sum centers and bags. The latter (bags) are the lowest level rural administrative. There are a total of 333 sums and 1,564 bags in the country.

Conclusions made by reporters on all indicators

To summarize the results for Mongolia on the indicators, it is helpful to review how the vectors were created. In each case, the value of 1 on the vector represents the 'status quo' - either by reflecting world averages in the last decade or the actual country's performance in the last decade. The value of 0 on the vector represents the sustainability goal. Move all the way to zero on a given vector means that the country's energy system is highly sustainable along that particular dimension, whether it be economic, social, environmental or technological. Vector values greater than 1 either mean that the country is even more unsustainable than the global average, or is getting worse than the performance in the last decade.

Eight indicators of energy sustainability for Mongolia

	Eight indicators of energy sustainability for Mongolia					
	1990		2000		% of change	
	Metric	Vector	Metric	Vector	Metric	Vector
1. Carbon emissions	1735 kgC/cap	1.765	1096.8 kgC/cap	0.958	-36.8	-45.7

2. Local pollutants	22.2 kg/cap	1.0	12.8 kg/cap	0.53	-42.3	-47.0
3. Household electrification	85.0%	0.15	70.0%	0.30	-17.6	+200.0
4. Clean energy investment	US$0.2mln	1.000	US$0.43mln	1.004	+125.0	+0.04
5.Resilience: energy import	133.0 PJ	0.246	92.81 PJ	0.216	-31.2	-0.12
6. Government investment	US$20.0mln	0.14	US$74.6mln	0.75	+273	+435.7
7. Energy productivity	95.0MJ/US$	9.8	88.9MJ/US$	9.17	-6.4	-6.4
8. Renewable energy	0.0015	1.098	0.0025	1.097	66.7	-0.09

The main reason for the value of CO_2/capita being 1.6 times lower than world average is:

- Low efficiency (0.2-0.5) of small capacity boilers for heating and of household stoves;
- Energy production and consumption 's obsolete technology;
- Low consumption of renewable energy.

The drop in CO_2 emissions per capita in the last decade is explained by the almost "stopped" condition of the country's industrial sector. Although, country's SO_2 emissions per capita are low, the concentration of SO2 in the atmosphere of Ulaanbaatar, capital city of Mongolia, reached a level high enough to damage human health. This is due to old cars and to households' emissions in the city. Currently, in Ulaanbaatar, there are 80 000 stoves and 50 000 cars (most of these cars are old).

The Government of Mongolia signed the United Nations Framework Convention on Climate Change on June 12, 1992 at the Rio Earth Summit and the Great Hural of Mongolia (Parliament) ratified it on September 30, 1993.

Potential options and opportunities for GHG emissions mitigation in Mongolia were identified during the preparation of the initial National Communication. The results of the analysis show that the country's main source of GHG emissions mitigation is the ENERGY SECTOR.

The Government of Mongolia already developed a national program for the reduction of GHG emissions reduction starting in 1999 and is implementing it. Reduction of GHG emissions depends on the development of conversion technologies and improved energy efficiency. In the near future the Law on Economical Consumtion of Energy will be passed by the Great Hural. This law will determine the method and its legal basis to increase the efficiency of the energy supply system and improve the technology used in the energy sector.

Almost all citizens of larger cities and rural centers have access to electricity. Mongolia is the closest to the sustainability target on the indicators for access to electricity (0.30).

There is carried out National Programme to use solar and wind mobile equipments by herdsmen. In 2001, programme to build central electric system, covering all area of Mongolia was improved by Government.

Currently, it is impossible to build large size plants harnessing renewable energy, such as hydro plants, wind generation stations due to lack of financial resources and

technological expertise in the country. This is one of the problems faced by Mongolia. In the next 4 years, Mongolia is going to give maintenance to several hydro plants, such as hydro plant of river Eg, one of the Mongolian biggest river for instance.

Today, there is no gasoline processing in country. Because of this problem, the situation of importing liquid fuels from other countries will not change in the near future. However, in the eastern part of Mongolia American, Canadian and Mongolian joint venture companies are exploring for oil. Positive results of these explorations are already evident and oil resources were found.

Poor economy is one of Mongolian urgent problems. Due to that situation no local investment is made to improve energy production efficiency, increase capacity and improve energy sector's structures. However, it is not the best solution to resolve all these problems by foreign investment, loan and aids.

Almost all energy-using systems are old (made during the communist period). The vector value of energy intensity is much higher than world average results (9.17) and cannot decrease because of this prevalent problem.

In Mongolia, plants and industries have an opportunity to save energy without cutting their production, by introducing new and safe technologies and equipment.

The Eight Indicators

Environmental sustainability

▸Indicator 1: Per capita energy sector carbon dioxide emissions

Mongolia, having undergone transformation from a socialist to a democratic form of government and from a centrally planned to a free-market economic system since 1990, is at a turning point in its history.

Until 1990, Mongolian economic development's growth and GDP were increasing slowly. From 1990 economic development faced serious challenges due to the transition period and industrial development was almost *"stopped"*.

According to this situation, energy production and combustion decreased sharply. In 1990, energy sector used 6,654,000 tonnes of coal, 1,249,000 tonnes of liquid fuel per year. But in 2000, energy sector used 5,185,000 tonnes of coal and 524,000 tonnes of liquid fuel per year. However, during this period (1990-2000) electricity production was relatively stable. 95-97% of electricity production was produced by power plants and the rest by diesel generators of rural area. The main reasons for the reduction of CO_2 emissions are that the national industry's "*stopped* " and energy rates increased rapidly.
In the last decade, a lot of efforts were done to increase the productivity of energy sector's at the Government's initiative. Also, foreign investments to implement and renew the big-sized power plants contributed to the reduction of fuel combustion.

Note: CO_2 emissions from biomass fuels are not included in the calculation.

Fuel type	1990		2000	
	Combustion Kt	Emissions, CO_2 ,Kt	Combustion Kt	Emission CO_2 ,Kt
• Coal	6654.0	9604.9	5185.0	7000.0
• Gasoline	541.2	1731.9	272.1	871.0
• Jet fuel	34.0	108.0	30.0	96.0
• Diesel	554.7	1719.6	191.7	590.0
• Residual fuel oil	63.4	183.9	30.6	90.0
Total	**7847.3**	**13349.0**	**5709.4**	**8647.0**

In 1990, Mongolia's total emissions of carbon dioxide were 3.64 MtC and population was 2 097 700 people. So, 1990 carbon dioxide emissions per capita = 1735 kgC/cap.
In 2000, total emissions of carbon dioxide = 2.64 MtC; population = 2.407 millions.
2000 carbon dioxide emissions per capita = 1096.8 kgC/cap.

Vector Value calculations:
2000 vector value = (1096.8 kgC/cap - 339 kgC/cap)/791 kgC/cap = 0.958
1990 vector value = (1735 kgC/cap - 339 kgC/cap)/791 kgC/cap = 1.765

The energy sector is the largest contributor to GHG emissions in Mongolia. Activities in this sector include fuel combustion at power and heat plants, coal production, coal and biomass combustion in private houses for heating process. The energy sector produces around 60% of the country's CO2.

The main type of fossil fuel used in Mongolia is coal. Natural gas is neither produced in Mongolia nor imported for domestic consumption. Oil products are imported and used for transport, power and heat plants. Consumption of fossil fuel is the greatest source of carbon dioxide in Mongolia. The decreased value of CO2 per capita in the last decade is due to the almost "stopped" condition of country's industrial sector.

Along this period of time most manufactures and plants, except food processing industry, closed their doors because of the economical crisis.

The main cause of reduction CO2 emissions is the diminution of energy combustion. The industrial sector is one of the largest energy users, consuming about 70% of the electricity and 30% of the heat produced. New technology and equipment have not used in energy producing and its consumption activities in period of 1990-2000.

▸Indicator 2: Most significant Energy-Related Local Pollutant

SO_2 emissions are given according to the country's statistical data of fuel consumption.

Fuel consumption and emissions of SO_2 in Mongolia

	1990			2000		
	Consumption	Emissions SO_2 of tonne fuel	Total SO_2 emissions, kt	Consumption	Emissions SO_2 of tonne fuel	Total SO_2 emissions, kt
* Coal	6645.0	5.0	33.20	5185.0	5.0	25.9
* Gasoline	582.0	2.7	1.56	302.1	2.7	0.8
* Diesel	554.7	19.8	10.96	191.7	19.8	3.8
* Residual fuel oil	63.4	4.8	0.36	30.6	4.8	0.15
Total	**7845.1**	**32.3**	**46.1**	**5709.4**	**32.3**	**30.65**

The average percentage of SO_2 in the atmosphere of Ulaanbaatar, capital city of Mongolia, is calculated as 9-10 mg/c.m by the study. As in other countries, energy production and consumption in Mongolia has a wide range of local environmental impacts from air quality and water use to degradation of land, water and forest resources. Unlike many developed countries however, some of the most critical problems occur at the household level- from the consumption of the coal for cooking, heating- rather than mainly from large size industrial use. Similar to many developing countries, exposure to hazardous levels of indoor air pollution outstrips outdoor air pollution as a potential cause of illness.

Vector value calculations:
Mongolia's 1990 total emissions of SO2 in metric tones from fossil fuel combustion: 46.1*103 tonnes; for 2000, 30.65*103 tonnes
Population in 1990 = 2.0977 millions; in 2000 = 2.407 millions
Mongolia's 1990 SO2 emissions per capita = 22.2 kg SO2/capita; in 2000 =12.8 kg SO2/capita.
X(2000) = 12.8 kg SO2/capita.
W = 22.2 kg SO2/capita in 1990
Y = 2.22 kg SO2/capita.; Z = 19.98 kg SO2/capita.
I (2000) = (12.8-2.2) /19.98 = 0.53
I (1990) = (22.2-2.2)/ 19.98 = 1.00

Although, country's SO2 per capita is low, the concentration of SO2 in atmosphere of Ulaanbaatar, capital city of Mongolia, reached level to damage in human health. This is relevant to old cars and many households' emissions in city. Currently, in Ulaanbaatar there are 80 000 stoves and 50 000 cars (most of them old).

Social sustainability

▸Indicator 3: Households with Access to Electricity

In Mongolia, 70% of all households, including urban and rural areas, had access to electricity at the end of 2000 and 85% in 1990.

Mongolia has 335 soum centers and villages and to date 125 of these have been connected to the central power system. Mongolia is planning to connect 40 soum centers to the central electricity system (CES) by 2005. Currently soum centers that are not connected to the VES do not receive an adequate supply of electricity due to difficulties in delivering electricity to rural areas.

In the past, diesel generators have been installed to meet the demand for electricity in soums. Unreliable supply and price increases of diesel oil have caused electricity production to decrease. In many places, diesel generators are not in operation due to lack of financial resources to purchase fuel.

From 1990, during privatization of the domestic livestock industry, the number of herdsmen has increased in the last few years. Because of Mongolian herdsmen' nomadic life, the connection to CES is impossible. However, almost all households in urban areas are connected to CES.

While the number of herdsmen was 74 710 in 1990, in 2000 this number increased 2.6 times. The main reason for the reduction of households with access to electricity is the increased number of herdsmen.

A few herdsmen use wind ventilators, or sun devices for lighting purposes.

Vector value calculations
For this indicator, the value for 1 on the vector is 0% access, while the value for 0 is 100% access. The vector value for Mongolia in 2000 is therefore 0.30, and 0.15 for 1990.

Vector values for 1990: 0.15 and for 2000: 0.30

Almost all citizens of larger cities and rural centers have access of electricity. Mongolia is closer to the sustainability target on the indicators for access to electricity (0.3). There is a National Programme for herdsmen to use solar and wind mobile equipments. In 2001, a programme to build central electric systems in all of Mongolia was approved by the Government.

It is necessary to improve the technology of burning fuels and to improve effective control on it. Our actions are not sufficient in this field. The number of families which are connected to the electricity grid decreased because of the proportion of people who live in countryside. This is the main cause to decrease the indicator's value. In the next 10-15 years it will stay unchanged. It is better to supply the nomads with renewable energy sources in Mongolia.

▸Indicator 4: Investment in clean energy

This indicator is a subsitute for job creation since investment in energy efficiency and renewable energy create proportionally more and better jobs than centralised sources. Currently, for Mongolia, there is no other financial resources except governmental investments (local investments made by Government). There is no private sector, nor direct foreign investment in the energy sector. The energy sector is wholly under the supervision of Government. That is why there is no investment from the private sector.

For period 1995-2000, USD300 millions were invested in the energy sector by foreign countries and international organisations. This investment was spent only for renewing, repairing old techniques, equipments and implementing automatic control systems. The situation, that no dollar was spent to introduce modern techniques and technologies, is very strange. It means that foreign investment efficiency is very low.

Relative little local investment was made in the energy sector and spent for goals to repair and renew equipments. The situation, that there is no foreign investment in energy sector is maybe relevant to country's unstable legal and economic environment.

Although many Government programs required certain initiative be taken to implement and develop clean energy, there is no real results of these measures. For example, in 2000 USD30000 from Government (local), USD400000 of foreign investment made done to implement and develop clean energy.

However, in the next 3 years there is a probability that about USD100 millions will be invested in this sector.

Vector value calculations
For this indicator:

2000 non-renewable energy investment made by government is USD74.6 millions, for 1990 is USD 20 millions. Note that, it was impossible to calculate 1990 investment by present value.
1990 and 2000 clean energy government investment:
USD200 milions and 430 millions
W = US$ 200.0 thous / US$ 20.0mln = 0.01 = 1%
X (2000) = US$ 430 thous / US$74.6mln = 0.0057=0.57%
Y = 95% of the investment of the energy sector; Z = 1-95 = -94%
I (2000) = 0.57-95%/-94% = 1.004

To develop or obtain the technology and equipment which are saving it is necessary to develop a standard on energy usage. The investment in renewable energy sector is increasing but indeed it is still low. There are a lot of resources in renewable energy. But we almost do not use these opportunities. The economic condition does not allow to make a progress in this sector.

Economic sustainability

▸Indicator 5: Energy Resilience: Energy import

Mongolia, a country of rich resource of coal, does not import this kind of fuel. Currently, there are about 20 coal mines in Mongolia. Also, from 2001, Mongolia is planning to export coal to Russia.

All kinds of liquid fuels are imported from Russia and China. By today, there is no oil extraction or refining.

Usually, mazout and diesel fuel are used for energy production and also some for railway and road transport.

Gasoline is used only for air and road transport. Mongolia imports some electricity and does not export any kind of energy.

Note: The consumption of liquid fuels in transportation was indicated as energy sector's consumption.

Vector value
For this indicator, the value of the vector 1 is 100% non-renewable energy exports share of total imports, while the value for 0 on the vector is 0%.

Total imports of non-renewable energy in Mongolia in 1990 were 32.62 PJ (132.80 PJ minus 100.2 PJ renewable energy) and were dropped to19.98 PJ (92.58 PJ minus renewable energy 72.60 PJ) in 2000 by 12.64 PJ.

Total consumption of non-renewable energy in 1990 was 132.82 PJ. In 2000, it was 92.58 PJ.

Thus, the value of vector in 1990 for Mongolia:
I = 32.62 PJ / 132.82 PJ = 0.246
The vector value in 2000: I = 19.98/92.58 = 0.216
The vector value: in 1990 was 0.246 and, in 2000, it was 0.216.

Liquid fuels are only imported from Russia and China. Mazout is only used in power plants. Diesel is used in the transportation sector and also in diesel electric stations, which produce 5% of the gross supply of electricity nation-wide. Since 1992, when the demand of the electricity was cut, the import of liquid fuel decreased also. According to the study, it is likely that the need of liquid fuel will increase in the road and air transportation sector by a major amount in the next 20 years. In future we need to import and to supply transportation and energy sector with domestic liquid fuels. For this reason survey of oil deposits are made in Mongolia.

▸Indicator 6: Burden of energy investment

In 1990, Mongolia had a socialist system and any investment made in the energy sector were done from state budget. This situation is similar today. After the 1990 democratic revolution, the economic potential of our country decreased rapidly. Due to this problem, the Government cannot make large investments in the energy sector.
In the last few years, the condition of coal mining, large size power plants and electrical and heating plants worsened and became unable to perform regular work. Because of these urgent problems, all kinds of investments had to be used for repairs and to renovate major equipments in the energy sector.

The Mongolian Government took discounted loans, large amount of aids from the World bank, the Asian Development Bank and the Japanese Government for purposes to renovate large plants such as the 3rd and 4th power plants of Ulaanbaatar City, the power plant of Choibalsan City, the heat network of Darhan City, coal mining in Baga Nuur and Shivee Ovoo.

Vector value calculation
The value for 1 on indicator 6 is 10% of the government investment in non-renewable energy as a fraction of GDP, and 0 is 0% of the same.

For this indicator, 2000 total government investment in energy sector is USD74.6 millions, USD27.2 millions of which is allocated to fuel. 10 percent of total investment, USD7.6 millions is local investment. USD40 millions of local investment were spent for renewing power plants and building new heat networks. GDP of 1990 and 2000 were USD1400 millions and USD1044 millions. In 2000, 33.44% of GDP were allocated to agricultural sector and 23% to industrial sector.

1990 vector value is I = 10*20.0/1400 = 0.14
2000 vector value is: I = 10*74.6/1044.0 = 0.715

In the period of 10 years related to the study, the investment in the energy sector increased 3 times. But the GDP only increased by 40%. It shows that the efficiency of the investment is bad. In Mongolia, the investment is mostly provided to the restoration and maintenance of the old plants and equipments, instead of building new efficient plants and obtaining new technologies friendly to the environment. This mistake must be corrected in the future.

Technological sustainability

▸Indicator 7: Energy Intensity (energy consumption/GDP)

The period 1989-1990 was Mongolian economic top point. Since this period, period of transition to free-market economic conditions, the country's GDP production did not increase, in some years it even decreased. In other words, in the nineties the production in Mongolia was falling down sharply.

After 1995, industrial production increased a little and agricultural production decreased a lot. However, agricultural sector's automation rates relatively low in comparison with other countries in terms of energy use. In the last 10 years, final energy consumption per GDP dropped by 60MJ/USD. This is not the result of using modern technology.

The main reason of this relative high energy consumption per GDP is:

- the planning of production to produce a specific number of products (not considering quality or demand)
- the lack of economic incentives to reduce production costs, use of raw materials and energy.
-

There are only two big consumer plants like the copper enrichment factory Erdenet, and the factory of metallurgy Darhan. Others are small consumers such as food industry, construction industry and some mining plants.

Vector value calculation:
Mongolia is an agriculture-based country. In 2000, 33.4% of GDP was coming from agriculture, 23% from the industrial sector. The value added of this sector is 23.2% of total GDP. Mongolian 2000 total GDP was USD1044.6 millions, 1990 GDP was USD1400 millions.

The value for in this indicator is the 1990 global average energy intensity of 10.64 MJ/US$. The value for the 0 on the vector is 1.06 MJ/ US$, or 10 percent of the 1990 world average.

For this indicator, the total consumption of energy for 1990 and 2000 were 133 PJ = $133*10^9$ MJ and 92.81 PJ = $92.81*10^9$ MJ. Mongolia GDP in these years: in 1990 USD1400 millions, in 2000 USD1044 millions.

Thus, energy productivity in 1990 = $133*10^9$ MJ/USD$1400*10^6$ = 95 MJ/US$;
in 2000 = $92.81*10^9$ MJ/USD$1044.6*10^6$ = 88.9MJ/US$
The vector value in 1990: I = (95.0-1.06)/9.58 = 9.8
The vector value in 2000: I = (88.9-1.06)/9.58 = 9.17

When the nation adopted the common market system, the interest in saving electricity increased. It explains the reduction in indicator value. Now most of the plants, industries and offices located urban centers have a heat meter.

▸Indicator 8: Renewable energy deployment

Herdsmen are generally not provided with electricity. There are several ways to solve this problem. It is possible to construct small capacity hydro power plants, which are without adverse impacts to the environment, in order to supply some local centers. Also, there are over 40 hot springs with a temperature range of 21-96C. Mongolia has 2250-3300 hours of full sunshine annually and the average solar energy per year amounts to 1.400 kW/sq.m. In the southern part of the country, the solar activity during the day is 4.3-4.7 kWh/sq.m. However, only about 3% of the rural herdsmen currently use solar panels of 9-40 W for lighting purposes.

The potential reserve of wind energy in Mongolia is 836.8 billion KW/h, and it is usable for a period of 3.5-4.6 thousand hours per year. The average velocity of the wind in the southeast part of the country is 4-5 m/s, has wind energy reserve of over 100W/sq.m.
From 2003, Mongolia has planned to invest in the renewable energy sector and to build several hydro plants with a capacity 10-40 MWt.

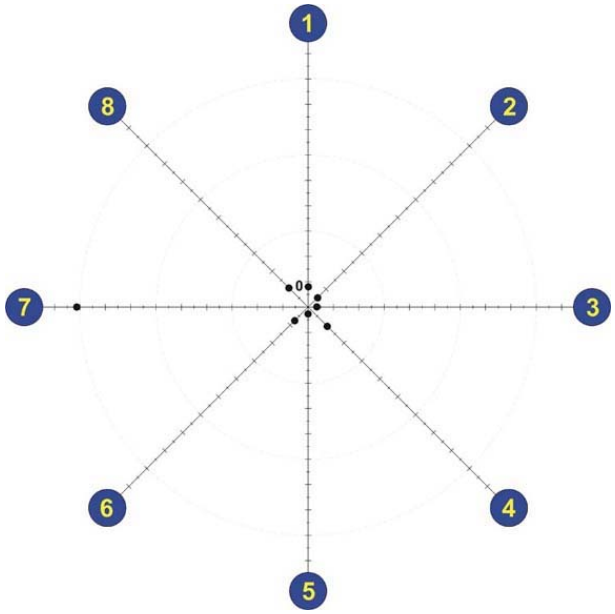
Vector value calculation:
For this indicator, the value for 1 on the vector is the world average renewable energy supply as share of total primary energy supply (TPES) in 1995, which was 8.64% (HELIO International 2000). The value for 0 in the vector, which is our sustainability goal, is 95%.

Total consumption of renewable energy in 1990 was $0.2*10^6$ GJ; in 2000, $0.23*10^6$ GJ.
Total consumption of primary energy in 1990 = $132.82*10^6$ GJ; in 2000 = $92.81*10^6$ GJ.
The renewable proportion of energy is,
in 1990: X = $0.2*10^6$GJ/ $132.82*10^6$GJ=0.0015
in 2000: X = $0.23*10^6$GJ/ $92.81*10^6$GJ=0.0025

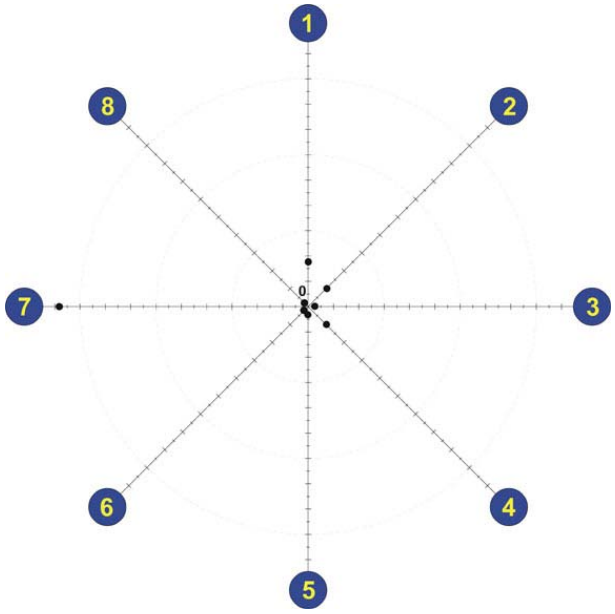
The vector of Mongolia for 1990: I = (0.95-0.0015)/0.8636 = 1.098
For 2000 it is : I = (0.95-0.0025)/0.8636 = 1.097

Mongolia stars

1990



2000



Recommendations

In the near future it is necessary to take the following decisions to improve all indicators parameters in Mongolia:

1. **Rehabilitation and refurbishment of existing combined heat and power plant (CHP).** The efficiency of the CHPs operating in Mongolia is low, especially because of the internal electricity need which is very high (about 20-24% of the gross generation).

2. T**o increase the efficiency of small and medium capacity boilers up to 75%.** Small and medium capacity boilers use 2.5 millions tonnes of coal annually for heating over 340 residential areas all over the country. Their efficiency is quite low (40-45%) because of the outdated, inefficient design of the buildings.

3. **To develop a programme and legal documents to take actions which are encouraging renewable energy source use.**