

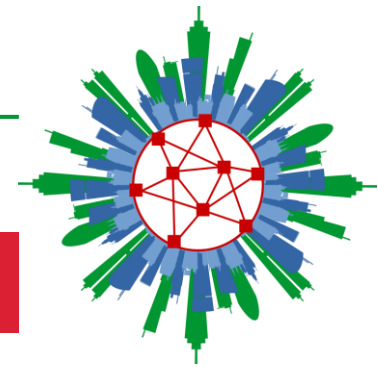


МОНГОЛ УЛСЫН ШИНЖЛЭХ УХААН
ТЕХНОЛОГИЙН ИХ СУРГУУЛЬ

MONGOLIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

SuMoCoS

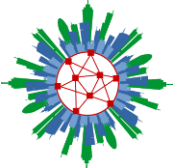
Sustainability and Mobility
in the Context of Smart Cities



Research on Public Electric Transportation in Ulaanbaatar city

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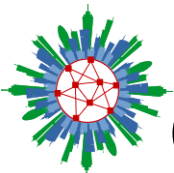
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- Current situation in Ulaanbaatar city
- What is Monorail ?
- Supplying Monorail system with renewable energy
- Magnesium battery



Current situation of public transportation in Ulaanbaatar city

For last 20 years, population of Ulaanbaatar city has been increased 2.2 times. It is assumed that total population will be 1.534 million by 2020 and 1.763 million by 2030.

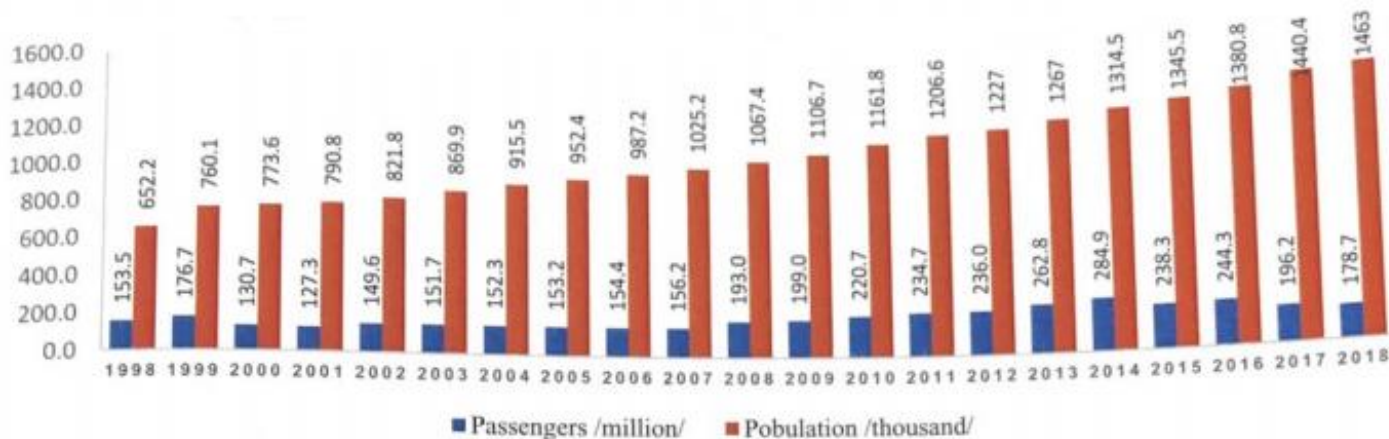
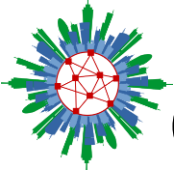


Figure 1. Population increase in Ulaanbaatar city



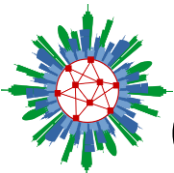
Current situation of public transportation in Ulaanbaatar city

As a result of State Technical Inspection, total number of automobiles has been annually increased on average 9.8 % for last 5 years.

Annual growth of total automobiles in capital city Ulaanbaatar has reached 7.7 % in 2017. Compared with previous year, it is increased 5.3 points.

Table 1. Total number of vehicles which covered by State Technical Inspection

Districts	2013	2014	2015	2016	2017	From this: Main types			
						Passenger car	Trucks	Buses	Special
Capital	257'498	297'008	331'564	339'626	365'819	282'182	67'669	9'924	6'014
Baganuur	1'622	2'314	2'436	2'688	2'638	1'910	581	121	26
Bagakhangai	290	435	435	548	692	532	127	28	5
Bayangol	57'291	63'918	65'522	67'658	73'090	56'781	13'151	1'833	1'325
Bayanzurkh	64'655	77'148	87'240	91'023	93'714	72'648	17'453	2'181	1'432
Nalaikh	1'946	2'419	3'073	3'184	3'563	2'557	885	97	24
SoginoKhar Khan	45'198	51'477	56'065	56'851	60'518	46'139	11'936	1'733	710
Sukhbaatar	35'815	39'780	47'746	46'906	54'341	41'593	10'027	1'607	1'114
Khan-Uul	22'208	27'036	32'344	34'444	37'954	29'367	6'386	1'370	831
Chingeltei	28'473	32'481	36'703	36'324	39'309	30'655	7'153	954	547



Current situation of public transportation in Ulaanbaatar city

In year 2017, Transportation Center of Ulaanbaatar states that there are over 3.7 thousand kilometer long roads in Ulaanbaatar city and nearby areas and Public Transportation Service operates in 121 routes.

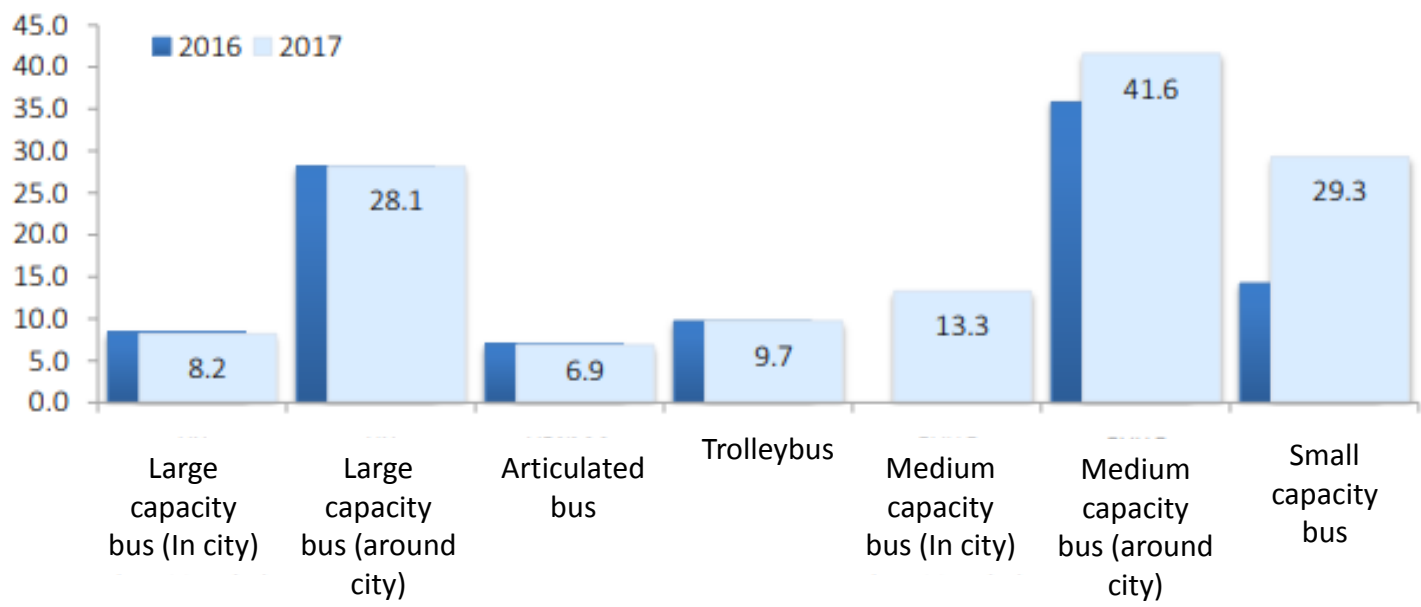
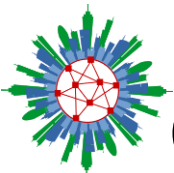


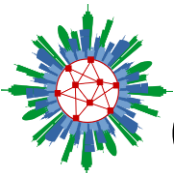
Figure 2. Waiting duration, minutes



Current situation of public transportation in Ulaanbaatar city



Figure 3. Overlap map of public transportation routes



Current situation of public transportation in Ulaanbaatar city

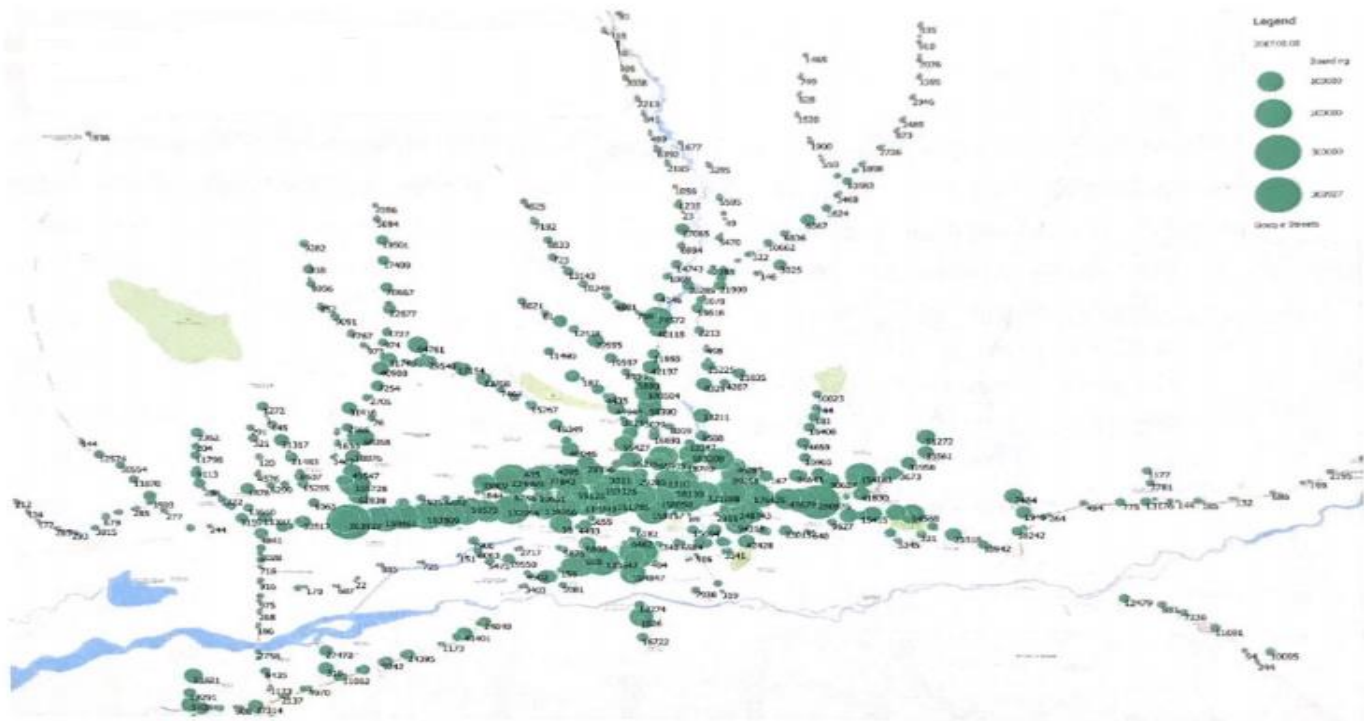
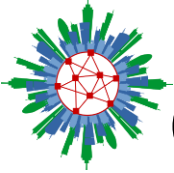
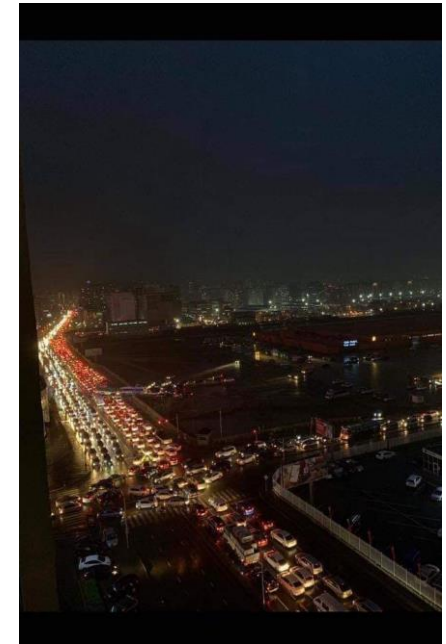


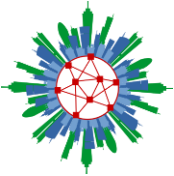
Figure 4. Map of passengers are compared to bus routes



Current situation of public transportation in Ulaanbaatar city

Therefore, Traffic congestion is the biggest problem that the people facing in Ulaanbaatar city. Non official claims that 450'000 vehicles participate in Ulaanbaatar city daily.





Types of Electric Public Transportation



Trams

- Rail vehicle that runs on tramway tracks along public urban streets



Trolleybus

- An electric bus that draws power from overhead wires using spring-loaded trolley

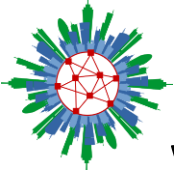


Metro System

- Type of high capacity electric public transport. Usually operates on exclusive right-of-way and grade separated from in tunnels or on elevated railways.



Monorail



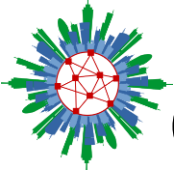
What is Monorail?

Monorail is a type of railway that transports passengers in urban areas.

Elevated rail transportation is much more cheaper that building metro system and is environmentally friendly. Also it can reduce traffic congestion and air pollution.

Monorail system is more like social project that supports city and regional developments than a business model



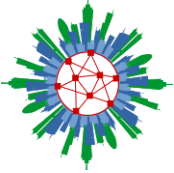


Current situation of public transportation in Ulaanbaatar city

Monorail system is suitable for city that has weak urban planning and public transportation services such as Ulaanbaatar city. It is 3 to 4 times cheaper (1.5 billion \$) and takes shorter period of time than building a metro system.

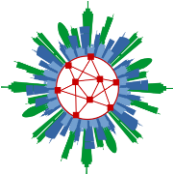
Totally appropriate to develop this system with current infrastructures in city. It can be also termed as a trolleybus that run on elevated track





Benefits of Monorail

- The primary advantage of monorails over conventional rail systems is that they require minimal space, both horizontally and vertically. Monorail vehicles are wider than the beam, and monorail systems are commonly elevated, requiring only a minimal footprint for support pillars.
- Environmental impacts (snow, rain, dust etc.) on monorail are minimal especially In winter times, it is resistant from storm and other natural disasters.
- They are quieter, as modern monorails use rubber wheels on a concrete track. (Some non-monorail subway systems, like certain lines of the Paris Métro and all of the Montreal metro, use the same technique and are equally quiet.)
- Monorails are capable of climbing and descending steeper grades than heavy or light rail systems.
- Unlike conventional rail systems, straddle monorails wrap around their track and are thus not physically capable of derailing, unless the track itself suffers a catastrophic failure, which is why monorails have an excellent safety record.



Monorail system planning in Ulaanbaatar city



9.5 kilometer rail along the Peace avenue is suitable for planning this system (From 1st Khoroolol to Amgalan area which along the heaviest traffic happens)

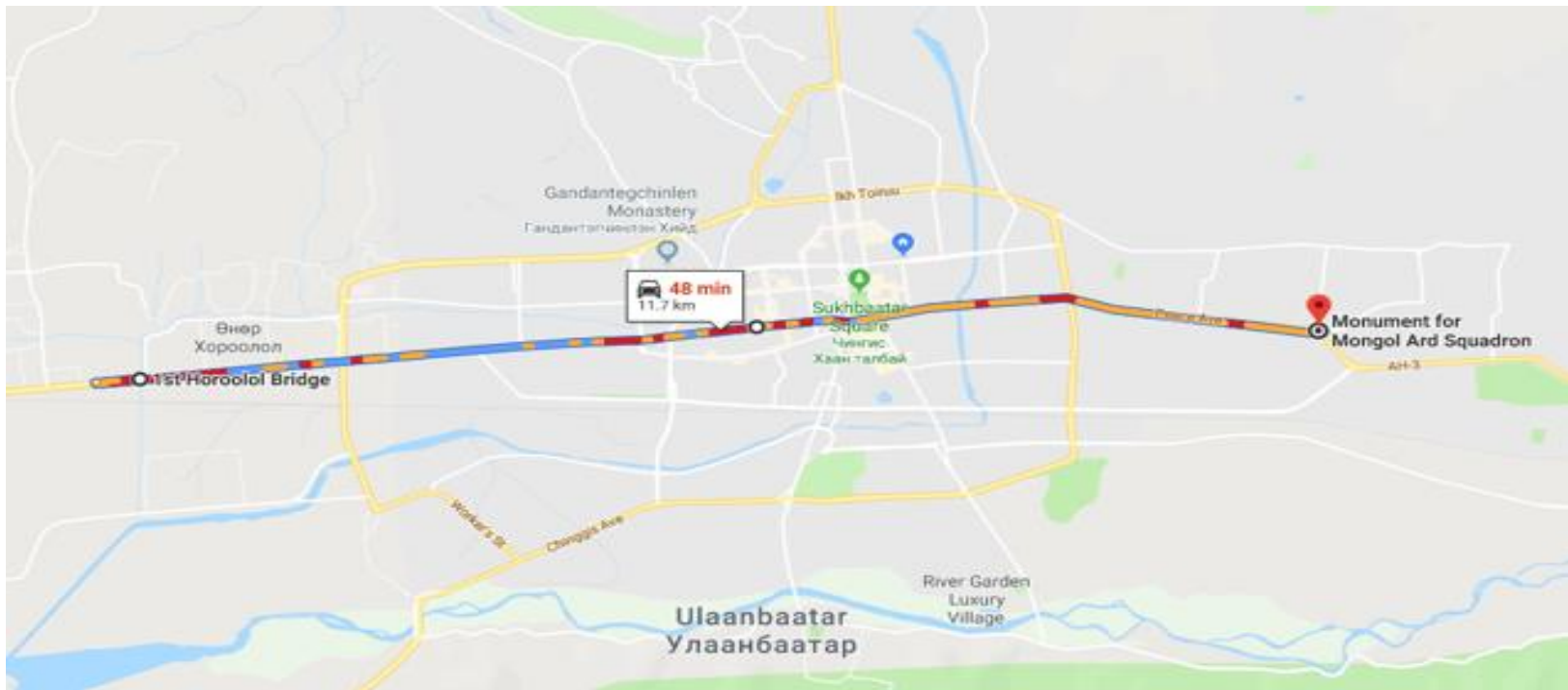
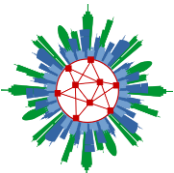


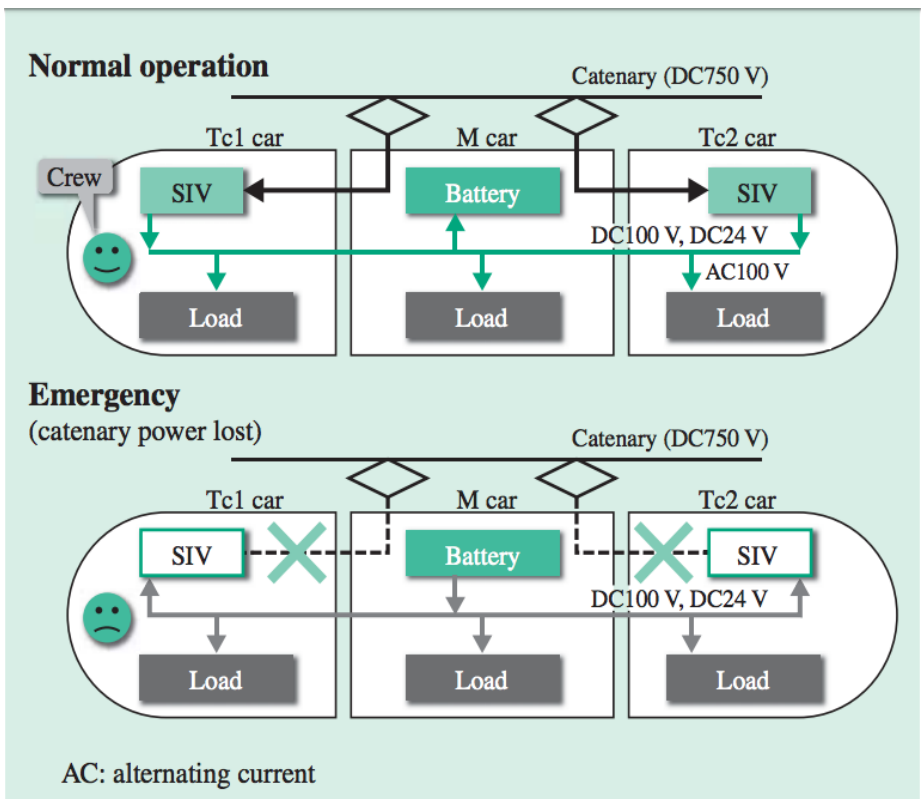
Figure 5. Projection of Monorail system



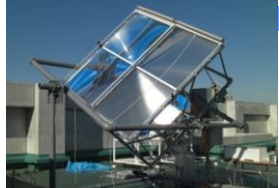
Electrical Power Supply of Monorail

In order to ensure Monorail system more reliable, Dual power sources (Grid and battery) are utilized to supply them .

Furthermore, renewable energy can be used to supply Monorail system due to the immense resources in Mongolia.



Magnesium Recycling Society



Sunlight Laser

Magnesium Reduction
Sunlight, Geothermal
Wind Power+ Lasers



Semi-conductor Laser



MgO

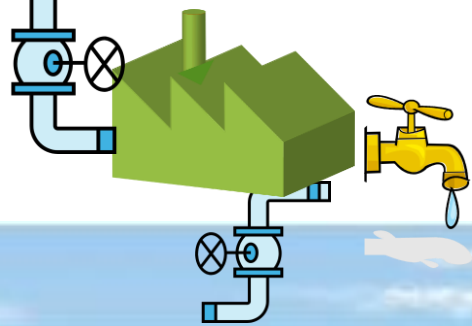
Recycle

Magnesium Battery
& Engine



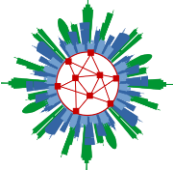
Reuse

Mg



Desalination

Ocean : 1.8×10^{15} tons Mg



Towards Sustainable Development Goal



How to proceed?

Coal used in Ger is replaced.



Test production of battery

Dawn of industrial activities(Training engineers, enhance technology etc.)

Desalination and/or purification of water

Battery for Medical Use

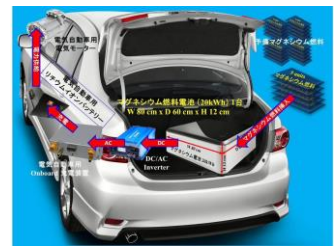
Small size Power Generator



Battery for Drone and flying car



Battery for electric vehicles

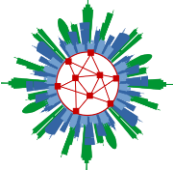


Magnesium recycle by laser

Wind-Power coupled to lasers

Dawn of Magnesium Recycling Society





Example: Tokyo Monorail 1000

This monorail has 6 sections (a capacity of 584 people)

Rated voltage-750V

Maximum speed-80 km/h

Rated power-70 kW

This example utilizes 84 kW two magnesium Batteries

(64 kWx2.6 hours, 168 kW*hour)





Wind Resources in Mongolia

In Mongolia territory, 160000 square meter area is usable for generating electric energy

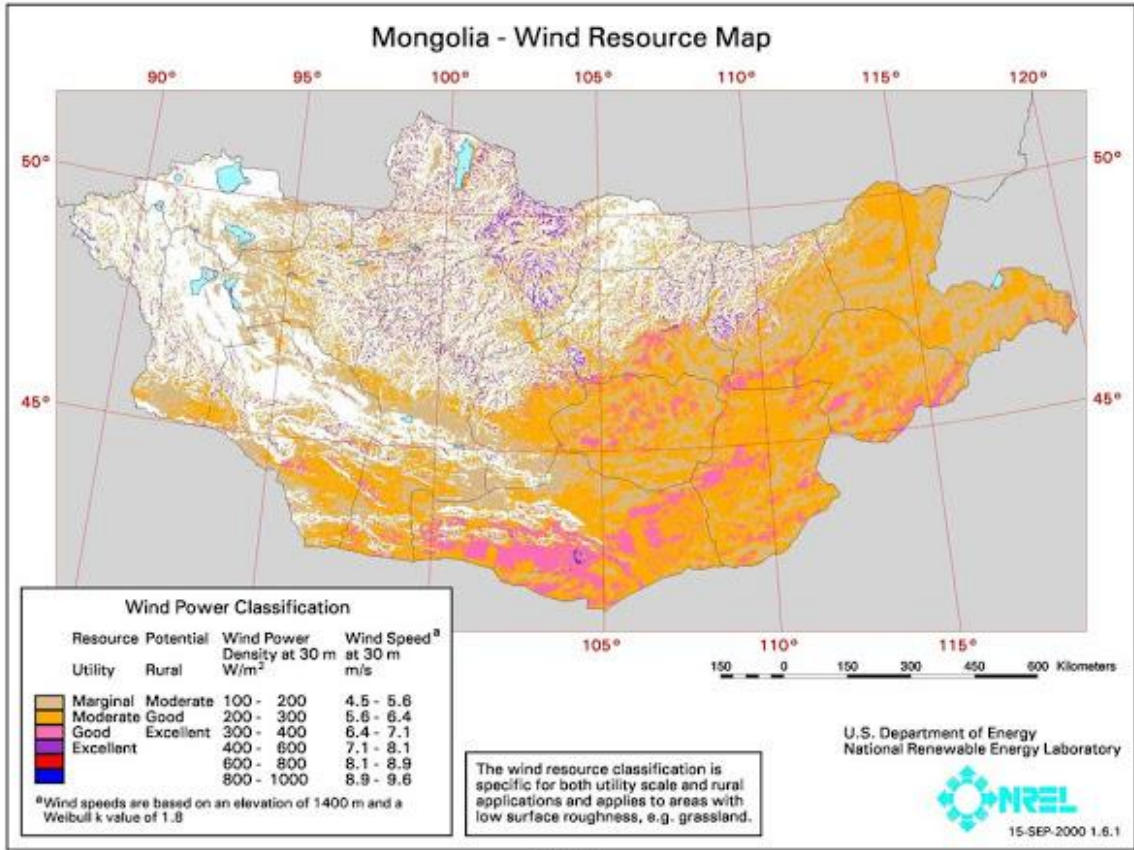
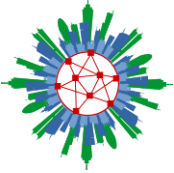


Figure 6.1

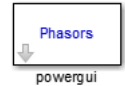
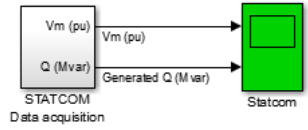
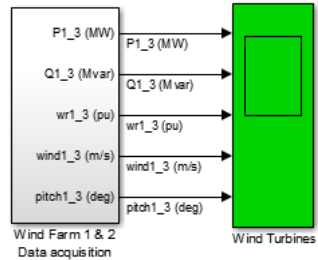
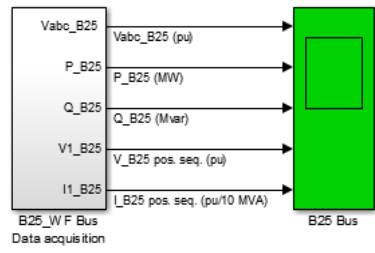
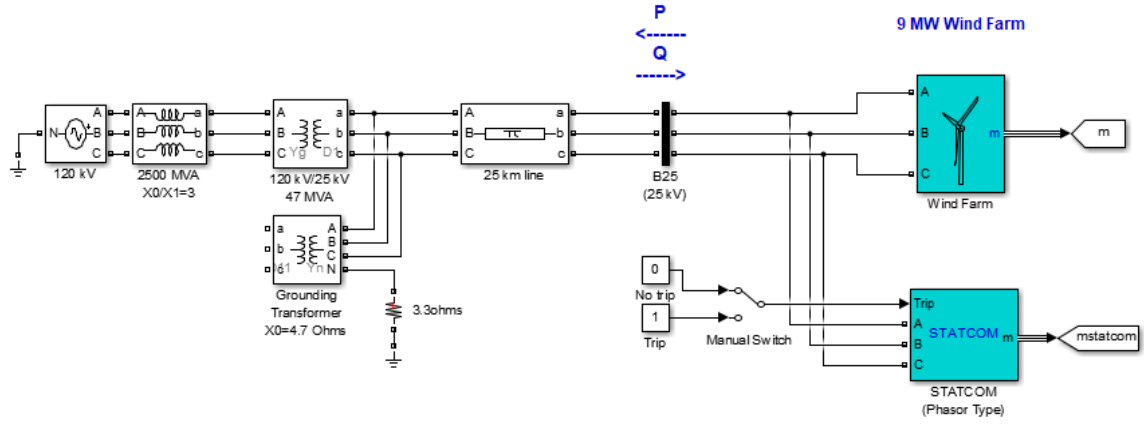
Figure 6. Wind Resource Map of Mongolia



Modeling on MATLAB Simulink

Mongolia holds 10 percent of world's total wind energy resource.

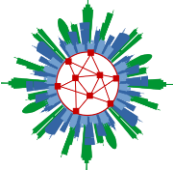
Consequently, Modelling is made on MATLAB software utilizing wind turbines for the electrical power supply of Monorail system



Wind Farm (IG)



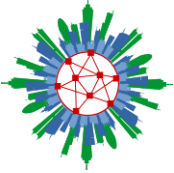
Figure 7. Simulation model on MATLAB Simulink



Monorail in Seattle, Washington USA



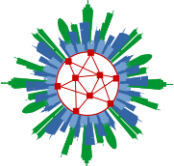
Source: Luke Starkenburg Youtube Channel



Successful monorail system in China



Source: Vocative Youtube Channel



Thank you very much for your attention



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