The research of power interconnection among China, Russia, Mongolia
Part 1
Brief introduction of Inner Mongolia grid

Part 2
The research of grids interconnection among China, Russia, Mongolia
Part 1  Inner Mongolia grid

1.1 Structure of the grid

1.2 Structure of the power source

1.3 New energy (wind and solar)
Part1 Inner Mongolia grid

1.1 Structure of the grid
Inner Mongolia power company is a special large-sized state-owned enterprise, operating the central and western grid of China's Inner Mongolia Autonomous Region (usually call west Inner Mongolia grid). The power supply area covers 720,000 square kilometers. Inner Mongolia power company at No. 217 of Fortune China 500 and the top 1 in Inner Mongolia Autonomous Region.
1.1 Structure of the grid—scale (By the end of 2016)

- 500kV Substations: 24 Capacity: 46,000MVA
- 220kV Substations: 178 Capacity: 71,000MVA
- Power lines (over 220kV): 725 Length: 26,000km
- 500kV Power lines: 71 Length: 5,900km
- 220kV Power lines: 654 Length: 20,100km
1.1 Structure of the grid—scale (By the end of 2016)

Annual power generation of Inner Mongolia grid from 2007 to 2016

Unit: billion kWh
1.1 Structure of the grid—500kV grid structure (By the end of 2016)
Part 1 Inner Mongolia grid

1.2 Structure of the power source
1.2 Structure of the power source—installed capacity (65,000 MW)

- Biomass 100 MW
- Hydro 1,900 MW
- Wind & Solar 2,200 MW
- Coal & Gas 41,000 MW
1.2 Structure of the power source—Proportion

- Solar Power: 63%
- Thermal power: 25%
- Hydro and other: 9%
- Wind power: 3%
1.2 Structure of the power source—Wind and Solar power

Wind farms: 150
Capacity: 16,400 MW
Max load: 10,381 MW
The max daily power production: 200,000,000 kWh

Solar plants: 166
Capacity: 5,600 MW
Max load: 4,400 MW
The max daily power production: 33,000,000 kWh
Part2 The research of grids interconnection among China, Russia, Mongolia

2.1 Introduction
2.2 Background information
2.3 Analysis of necessity
2.4 Interconnection plans
Part 2 The research of grids interconnection among China, Russia, Mongolia

2.1 Introduction

2.2 Background information

2.3 Analysis of necessity

2.4 Interconnection plans
2.1 Introduction

- **Research idea**
  - Planning year
  - Analyze natural resources of the 3 areas
  - Estimate cooperation direction
  - Analyze current grid and grid planning of the 3 areas
  - Estimate the time of power systems interconnection
  - Analyze different ways of grids interconnection
  - Select suitable grids interconnection way
  - Provide the near-term and mid-term grids interconnection plans, envision the long-term plan
2.1 Introduction

- **Research idea**
- **Planning year**

**2020** Near-term
- Supply power for southern Mongolia from Inner Mongolia grid

**2030** Mid-term
- Come up with the grid interconnection plans between China and Mongolia, basing on the connection of Mongolia central grid and southern grid.

**2050** Long-term
- Envision the long-term power systems interconnection plan among China, Russia and Mongolia
Part 2  The research of grids interconnection among China, Russia, Mongolia

2.1 Introduction

2.2 Background information

2.3 Analysis of necessity

2.4 Interconnection plans
2.2 Background information

- **Mongolia overview**
  - **Russia overview**
  - **Inner Mongolia overview**
  - **Current grid interconnection**

- **Basic information**
- **Current power system**
- **Power demand forecast**

- **Territorial area**: 1.57 million km²
- **Border on China in the south, border on Russia in the north**
- **Extremely rich in coal, uranium and other mineral resources**
- **Rich in wind and solar energy**
2.2 Background information

- By the end of 2013, total installed capacity: 1,090MW (coal power 90%)
- Maximum power consumption load: 1,100 MW (about 20% import from China and Russia)
- The highest voltage: 220kV. Main grid voltage: 110kV
- 5 power system regions.
- The southern grid is isolated from the main grid, relay on power supply from China.
2.2 Background information

Main problems

- Lack of power supply.
- The grid is relatively weak, chain structure grid is in the majority.
2.2 Background information

- Mongolia overview
- Russia overview
- Inner Mongolia overview
- Current grid interconnection

**Total power consumption of Mongolia (billion kWh)**

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>11.3</td>
<td>13</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>Growth</td>
<td>6.5%</td>
<td>5.5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Max power consumption load of Mongolia (MW)**

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>1080</td>
<td>2400</td>
<td>3300</td>
<td>4380</td>
</tr>
<tr>
<td>%</td>
<td>12.1</td>
<td>6.6</td>
<td>5.8</td>
<td></td>
</tr>
</tbody>
</table>

The max power consumption load of southern Mongolia grid will reach **1365 MW**.
2.2 Background information

- **Territorial area**: 17.1 million km²
- **Border on China and Mongolia in the south.**
- **Extremely rich in coal, petroleum and natural gas.**
- **Rich in wind and solar energy.**
- **Extremely rich in hydro energy.** By the end of 2014, installed capacity of hydro power is 49,000 MW, exploitation rate was only 10.9%.
By the end of 2014, total installed capacity was about 250 million kW (thermal power: 70%).

By the end of 2013, the max power consumption load was 130 million kWh.

Generally, Russia is a power export country.

The highest AC voltage: 765 kV. The power system consists of seven grids. Except for the east grid, the other 6 grids have already realized synchronously interconnection.
By 2020, Russia’s overall power consumption will reach 1,268 billion kWh, 2012～2020 the AAGR is 2.3%. By 2030, Russia’s overall power consumption will reach 1,508 billion kWh, 2020～2030 the AAGR is 1.7%.
2.2 Background information

- Inner Mongolia autonomous region border on Russia and Mongolia in the north. The length of borderline is 4,200 km.
- Rich in coal, petroleum and natural gas.
- Extremely rich in wind and solar energy. Exploitable wind power more than 380 million kW, account for more than 50% of China.
2.2 Background information

- **Basic information**
- **Power demand forecast**
- **Grid planning**

**Total power consumption of west Inner Mongolia (billion kWh)**

- 2015年: 184, 9.1%
- 2020年: 285, 6.5%
- 2025年: 391

**Max power consumption load of Mongolia (MW)**

- 2015年: 22,600, 9.7%
- 2020年: 35,900, 7.1%
- 2025年: 50,500

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- **Background information**
  - Russia overview
  - Inner Mongolia overview
  - Current grid interconnection

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**Power demand forecast**

- 2015年: 184, 9.1%
- 2020年: 285, 6.5%
- 2025年: 391

**Max power consumption load of Mongolia (MW)**

- 2015年: 22,600, 9.7%
- 2020年: 35,900, 7.1%
- 2025年: 50,500
By 2020, Inner Mongolia grid will form “4 lengthwise and 5 transverse grids.”

To satisfy new energy transmission, Inner Mongolia power company has planned to construct 6 500kV transmission and transformation projects in north Inner Mongolia.
By 2020, Inner Mongolia grid will form “4 lengthwise and 5 transverse “500kV main grids.”
Currently, some southern port areas of Mongolia import power from China.

There are already two 220kV power lines, two 35kV power lines and four 10kV power lines between China and Mongolia.

2016, Inner Mongolia power company export power to Mongolia 1.1 billion kWh. (OT project account for 99%)

Inner Mongolia power company export power to OT project, the maximum power load is 154 MW, cumulative export power was 3.8 billion kWh.

Inner Mongolia GuoHe power company (a wholly-owned subsidiary of Inner Mongolia power company) and Mongolia state grid corporation signed a new Six-year PPA on May 12 2017, the expected maximum power load will reach 260 MW.
2.2 Background information
Currently, some port regions of Northeast China import power from Russia.

Now, there are one 220kV, two 110kV AC power delivery channels and one 500kV back to back project (750MW) between China and Russia, the total transmission capacity is 1000MW.

2014, China import power from Russia was 3.5 billion kWh.
2.2 Background information

- Mongolia overview
- Russia overview
- Inner Mongolia overview
- Current grid interconnection

Map showing the Northeast China border regions, with connections to Russia and other countries.
### 2.2 Background information

- **Mongolia overview**
- **Russia overview**
- **Inner Mongolia overview**
- **Current grid interconnection**

<table>
<thead>
<tr>
<th>China and Mongolia</th>
<th>China and Russia</th>
<th>Russia and Mongolia</th>
</tr>
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- Some regions of Mongolia import power from Russia.
- Currently, there are several 220kV/110kV/10kV power delivery channels between Russia and Mongolia.
Part 2  The research of grids interconnection among China, Russia, Mongolia

2.1 Introduction

2.2 Background information

2.3 Analysis of necessity

2.4 Interconnection plans
2.3 Analysis of necessity

Near-term

(1) Supply power for South Mongolia mining enterprises

The southern region of Mongolia is planning to develop several mines and the saynshand development zone. Mongolia power supply capacity is insufficient; its southern grid is weak and remote from Mongolia central grid, unable to meet the needs of the region’s power load. Supply power from Inner Mongolia grid could satisfy the needs of new load in the near future.

(2) Supply power for port regions

The China-Mongolia borderline in Inner Mongolia is 3103 km. In west Inner Mongolia, there are existing 7 ports open to Mongolia. The continuing growth of bilateral trade scale will lead considerable growth of power.
## 2.3 Analysis of necessity

### Near-term

- **(1) Promote the Belt and Road Initiative**
  
  Enhance the grids interconnection will promote the Belt and Road Initiative.

### Mid-term & Long-term

- **(2) Realize complementary advantages**
  
  Through the interconnection of the power grids, it will realize resource complementation and meet the common interests of China, Russia and Mongolia.

- **(3) Improve the reliability of Mongolia grid**
  
  By strengthening the power grids connection between China and Mongolia, it will improve the reliability of Mongolia grid.
Part 2  The research of grids interconnection among China, Russia, Mongolia

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2.4 Interconnection plans
2.4 Interconnection plans —Inner Mongolia grid and Mongolia grid

- **Near-term**
  - Plan1: Several 220kV power delivery channels

- **Mid-term**

- **Long-term**
  - Plan2: Single 500kV power delivery channel
2.4 Interconnection plans — Inner Mongolia grid and Mongolia grid

**Near-term**
- OT Mine
- TT Mine
- Saynshand1
- Saynshand2
- TT Plant
- Mark Mine
- Hanji Port
- Mandula Port
- WHQ
- GuoHe
- WZQ
- YuLong

**Mid-term**

**Long-term**

**Grid plan**

- 200kV power lines

**Plan 1**
- East Gobi plant
- 200kV power lines
- XM Grid
- BT Grid
- BM Grid
- WM Grid
- Hohhot Grid
2.4 Interconnection plans — Inner Mongolia grid and Mongolia grid

**Grid plan**

**Near-term**

**Mid-term**

**Long-term**

- OT Mine
- TT Mine
- Saynshand1
- Saynshand2
- East Gobi plant
- TT Plant
- Mark Mine
- Hanji Port
- Mandula Port
- WuZhongQi
- GuoHe
- 500kV power lines
- WHQ

**Plan 2**

- XM Grid
- BT Grid
- WM Grid
- BM Grid
- Hohhot Grid
Through detailed demonstration, the two types of grids interconnection meet the demand for power system stability analysis.
2.4 Interconnection plans — Inner Mongolia grid and Mongolia grid

Grid plan

- **Near-term**
- **Mid-term**
- **Long-term**

**Investment estimation**

- **Plan 1**: Gross investment: 3 billion ¥
- **Plan 2**: Gross investment: 3.3 billion ¥
Three types of power system interconnection

- AC synchronous interconnection: form a larger synchronous grid.
- DC asynchronous interconnection: form an asynchronous grid, including grid with different frequency.
- Synchronized AC/DC hybrid system: form a smart synchronous grid which takes advantages of the high flexibility of DC power system.
2.4 Interconnection plans — Inner Mongolia grid and Mongolia grid

- **Grid plan**
  - **Plan 1**
  - **Plan 2**

**AC synchronous interconnection**

- **Near-term**
- **Mid-term**
- **Long-term**

**Case 1**
- Inner Mongolia grid
- Mongolia south grid
- 360km

**Case 2**
- Mongolia main grid
- Mongolia south grid
- Inner Mongolia grid
- 400km
- 360km
- 240km
2.4 Interconnection plans — Inner Mongolia grid and Mongolia grid

- **Grid plan**
  - **Plan1**
  - **Plan2**
  - DC interconnection

- Near-term
- Mid-term
- Long-term

![Map of Interconnection Plans](image-url)
2.4 Interconnection plans — Inner Mongolia grid and Mongolia grid

- **Near-term**
- **Mid-term**
- **Long-term**

**AC synchronous interconnection**

**Grid plan**

- **Plan1**
- **Plan2**

**Mongolia main grid**

- 360km
- Mongolia south grid

**Case 1**

**Mongolia south grid**

- 400km
- 360km
- 240km

**Case 2**

**Inner Mongolia grid**
2.4 Interconnection plans — Inner Mongolia grid and Mongolia grid

- Near-term
- Mid-term
- Long-term

Grid plan

Plan1

Plan2

AC synchronous interconnection

Mongolia main grid

420km

Mongolia south grid

Inner Mongolia grid

Case3
2.4 Interconnection plans — Inner Mongolia grid and Mongolia grid

**Grid plan**

- **Plan 1**
  - Near-term
  - Mid-term
  - Long-term

- **Plan 2**
  - DC asynchronous interconnection
    - Mongolia main grid
    - Mongolia south grid

**Interconnection options**

- **Case 1**
  - BTB converter station

- **Case 2**
  - BTB converter station

**Distances**

- 400km
- 360km
- 240km
- 360km
2.4 Interconnection plans — long-term

The future orientation of Inner Mongolia grid: power distribution center among China, Russia, Mongolia, Power delivery hub of China, Russia, Mongolia
Question and Challenge

- **Policy**: Each country has its own national condition policy and law, how to coordinate with each other is a big challenge.

- **Security**: How to keep security and stability after the interconnection and the problems of operation and dispatching need to be further studied.

- **Economy**: Grids interconnection is a huge project, how to ensure investment economy and achieve mutual benefits need our joint effort.
Thank you!

- Strong Grid
- Splendid Culture
- Excellent Service
- Lean Management
- Scientific Management