Experience in NEA power cooperation development

Tatiana Shchenkova
International Projects Director, En+ Group
December 2016
The largest nickel producer in the world

The largest aluminium producer in the world

A leading ferromolybdenum and iron ore player

Five coking & thermal coal assets
Reserves exceed 4 bn tonnes

New coal deposits

Iron ore / Copper

China project
Iron and copper ore reserves – c. 1bn tonnes

New mining projects

Rare earths, rare metals, bischofite

Strategic partnerships in respective divisions

Established businesses

New Businesses

En+ Group ownership,
Business strategy

En+ Group businesses share a core geographic base and a common target market in Greater Asia

- Developing Asian countries will continue to be the dynamic leaders in world GDP growth
- Siberia and the Far East regions beneficially situated to meet Asian demand
  - Availability of energy and substantial reserves of natural resources are turning Siberia into the economic growth driver not only for Russia, but also for other Asia-Pacific markets
  - Geographic location makes Siberia the natural bridge between Russia and Asian economies
- Cross-border infrastructure development ongoing
- En+ Group focused on an integrated program of Siberian and Far East development to match Natural Resource wealth with industrial demand

En+ Group’s position as a natural bridge provides compelling rationale for an enhancing strategic partnership with a leading regionally influential counterparty
EuroSibEnergo at a glance

- EuroSibEnergo was established in 2007 to consolidate and develop power-related businesses within the En+ Group, however most of the assets were managed since 2001
- The largest private power company in Russia and one of the largest hydro power companies in the world
- Balanced portfolio of cost efficient and environmentally friendly generation assets: 77% of installed capacity – HPPs, 23% – CHPs
- Operates across the entire power sector value chain: coal mining, electricity and heat generation, transmission & distribution, power trading & supply and engineering

Key areas of expertise

- Large scale HPPs
- Coal- and gas-fired CHPs
- Transmission and distribution
- Engineering

Key operating indicators

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed power capacity</td>
<td>(MW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric power production</td>
<td>(TWh)</td>
<td>80.4</td>
<td>78.2</td>
<td>77.4</td>
<td>75.3</td>
</tr>
<tr>
<td>Electricity transmitted and distributed</td>
<td>(TWh)</td>
<td>45.4</td>
<td>46.5</td>
<td>46.3</td>
<td>45.7</td>
</tr>
<tr>
<td>Heat production</td>
<td>(mln Gcal)</td>
<td>27.2</td>
<td>28.7</td>
<td>26.5</td>
<td>25.4</td>
</tr>
</tbody>
</table>
EuroSibEnergo is a source of sustainable power for Russia’s commodities feeding global and Asian growth

- Russia owns and develops one of the richest natural resource bases globally; significant resources / production facilities are concentrated in Siberia
- Fast-growing Asian markets and, in particular, China are quickly becoming major consumers of natural resources
- Extraction and production of key natural resources (crude oil, natural gas, aluminum, timber, etc.) are very energy-intensive processes
- Therefore, reliable supply of Russia’s commodities to the global market depends on availability of sustainable and competitive power, such as that provided by EuroSibEnergo

Positioned to benefit from long term trends in China and Asia
Key assets – focus on Siberia region

**EuroSibEnergo-Engineering**
- Power engineering company providing repair and maintenance services
- Key clients: EuroSibEnergo subsidiaries (50% of Revenue in 2013) and third-party clients

**Krasnoyarskaya HPP**
- 2nd largest HPP in Russia
- 6,000 MW of installed power capacity

**Irkutskenergo**
- One of the largest power companies in Russia, located in Irkutsk Region
- 12,880 MW of installed power capacity, of which 9,002 MW is HPP-based
- Other shareholders: InterRAO, JSC (40%)

**Irkutsk GridCo**
- Owns and operates most of the electricity T&D assets in Irkutsk region
- 37,951 km of power lines (9,839 km transmission and 28,112 km distribution)
- Other shareholders: RusHydro, JSC (42%)

**Volgaenergo**
- Regional power company, incumbent in Nizhny Novgorod Region
- 580 MW of installed power capacity and 2,679 Gcal/h of heat capacity

**MAREM+**
- Independent power trading and supply company
- 3.5 TWh of electricity traded in 2013
- Trades electricity in both pricing zones

**Coal assets**
- Coal mining assets with reserves of c.1.2 bn tn and production of c. 15.7 mln tn in 2013
- Satisfied over 100% of Irkutskenergo coal requirements in 2013

**JSC «EnSer», Miass**
- Regional power company, incumbent in Chelyabinsk Region
- Total installed electric capacity – 24 MW, heat capacity - 575 Gcal.

---

*Ownership stake*
Green energy generation

Over ¾ of ESE generation portfolio comes from HPPs located on the Siberian rivers. ESE is one of the largest hydropower generation companies in the world and one of the major producers of green energy in Russia aiming at sustainable development.

- ESE operates 19 power plants with total installed capacity of 19.6 GW of which over 15 GW is hydro.
- Low average annual temperature of minus 2 °C near HPP impoundments located in Siberia provides ecological advantage in terms of greenhouse gas emissions in comparison with HPPs located in warm climate.
- High load factor of the Angara river enables to generate more carbon neutral energy without use of fossil fuels.
- In December 2015 we diversified our clean energy mix by launching a pilot solar PV power project—Abakan SPP—with elements of basic equipment produced in-house. The launch of Abakan SPP reinforced ESE leading position in green energy generation in Russia.
Stages of investigations in NEA power cooperation. Stage 1.
Grid infrastructure research on Russia territory (East Siberia) for electricity export to China (2012)

Opportunities for delivering electricity from the East Siberian regions of the Russian Federation to China were explored. Grid infrastructure layout on the territory of the Russian Federation ensuring the specified volume of export (~7 GW) was designed and estimated its approximated cost.

The power export to China took into account:

- Large-scale deliveries in the amount of 6.9 GW collected through the network of 500 kV from newly constructed export-oriented power plants of the Russian Federation, and transferred with the bridge DC +600/800 kV from collection points in the Republic of Buryatia and Zabaykalsky Krai to the Northern China districts and Beijing;
- Local small-scale supply of electricity to border areas in amount of 350 MW through the existed power network 110-220 kV.
Stages of investigations of NEA power cooperation. Stage 2.
Investigation of electricity supply options from Siberia and Far East of Russia to China (2013-2014rr.)

Research model:

Supply options that were analyzed within the research:

1. Isolated operation of power systems of Russia and China (used as reference model to compare with other options);
2. Joint operation of power systems of Russia and China in the one-way export of electricity from Russia to China via the interstate electric bridges DC +600/800 kV:
   1) Far East – Northeast China - 4 GW
   2) Eastern Siberia – North China - 6 GW;
3. Joint operation of power systems of Russia and China in the bilateral transfer of energy regime through the interstate electric bridges: transmission volumes to be optimized depending on daily, seasonal irregularities of demand and supply, irregularities of renewable energy sources, implementation of systemic effects of the interstate power systems association (effects of scale);
4. Local supply of electricity to border areas.

Main conclusions

Efficiency of the two sides interconnection increases in case of bidirectional flows of electricity and realization of integration effects of combining annual and daily load curve, improving the modes of power plants, compensating irregularities production of renewable energy and other systemic effects (option # 3). This is true without possible ecological payments which can change the picture.
Stages of investigations of NEA power cooperation. Stage 3. Development of optimal routes of electricity delivery from Russia to China, the Republic of Korea, Japan and DPRK (2014-2015)

- A joint study was conducted in the framework of cooperation between Skolkovo Institute of science and technology (Skoltech), EN+ Group (Eurosibenergo) and Korean KEPCO Corporation
- A structure of power grids in North-East Asia with the aim of establishing optimal exchanges of electricity between Russia, China, DPRK, ROK, Japan was developed
- The study confirmed high efficiency in the formation of interstate energy associations due to appearing synergetic effects of optimizing the integrated power systems

Some systemic effects resulting in the formation of Interstate interconnected power systems in the North-East Asia

- savings of operation expenditures of joint power system (including the costs in electric grid infrastructure) - more than $ 17 billion./year;
- substitution of new generating capacity by flows from other countries (displaced mostly coal and nuclear generation) - more than 38 GW;
- savings investments - more than $ 50 billion;
- savings compensating heating and pumped storage power plants capacity for compensating irregularities of renewable energy – up to 16 GW.
Other studies for energy cooperation in North-East Asia

**Gobitec project**

Gobitec Project (2011) considers the transport of electricity from wind - and solar-energy complex in the Gobi desert with a total capacity of 100 GW on the basis of wind and solar power (in equal proportions) through high-voltage DC bridge to China, the Republic of Korea, Japan and Russia.

**Korea’s projects**

The projects NEAREST (2008) and Korea-China Grid Interconnection explore high voltage inter state bridges for the transfer of energy from renewable sources (wind and solar) and nuclear power plants from China to the centers of electrical load of Korea (Seoul, Incheon). The project covers the Korean Peninsula, Japan, Mongolia, China and partially the Russian Far East, including Sakhalin.

**Global Energy Interconnection (GEI)**

Explores energy cooperation on a global scale on the basis of renewable energy sources and modern and perspective technologies of power transmission on the basis of extra - and ultra high voltage lines. The North-East Asian Regional Power Interconnection and Cooperation (NEA RPIC) can be considered as a regional segment of the global power integration.
**General approach**

There are two general approaches for developing cooperation:
- developing independent projects of power supply between two interested parties or points
- Integration on the level of power systems of participant countries

The researches show that only systems interconnection gives high economic and technical efficiency for all participants due to synergetic effects of optimizing the integrated power systems

**Political issues**

Systems interconnection approach requires interstate regulation and approval. Even though NEA countries are actively discussing the power cooperation project, only Russia and Mongolia have confirmed it on the state level and included real activities in the governmental agendas.

It is necessary to promote political decisions in all participant NEA countries to approve and support real activities in developing power integration processes, prepare related intergovernmental agreements and create specialized Working Groups

**Commercial issues**

Commercial structure of the future cooperation space is closely related to the general approach of cooperation development. System approach allows companies and organizations from different countries to get involved in the project. Direct sales contracts between them seem to be not effective and difficult. Organizing the relationships between the cooperation participants on the base of an open market structure is considered as the most optimal.

A joint market space for energy trading should be established across the NEA region. Market structure could be developed on the basis of similar structures:
- The Eurasian Economic Union (EEU)'s power market – creation in progress
- The Scandinavian power market “Nord Pool” – exists since 1993
- A new designed mixed power market system of the NEA countries
Thank you!

En+ Group
+7 495 642 7937
www.enplus.ru