INTER RAOUES

energy without borders

Current and Perspective Power Exchanges in the Region.

February 2014
Saint Petersburg

Inter RAO At Glance

Inter RAO:

- Leading Russian export/import operator;
- One of the largest national power generators with total installed electricity capacity of 33.4 GW(1);
- Ranks among the largest European integrated utilities by overall installed capacity;
- Operates and manages 46 thermal, 13 hydro power plants and 2 wind farms;
- Largest Russian electricity supplier with 15% market share;
- Business in more than 15 countries including Russia, Finland, Lithuania, Belarus, Turkey, Georgia, Kazakhstan, Moldova, Latin American countries, etc.

Inter RAO in BASREC region:

Inter RAO owns experience and expertize, required to perform cross-border power trading between Russian and European wholesale power markets:

- Cross-border power supplies to Finland, Lithuania, Norway;
- Trading activities in almost all countries of BASREC (except for Germany, Iceland, Denmark).
- Trading offices in Finland, Sweden, Lithuania, Latvia, Estonia, Poland.

source: worldatlasbook.com

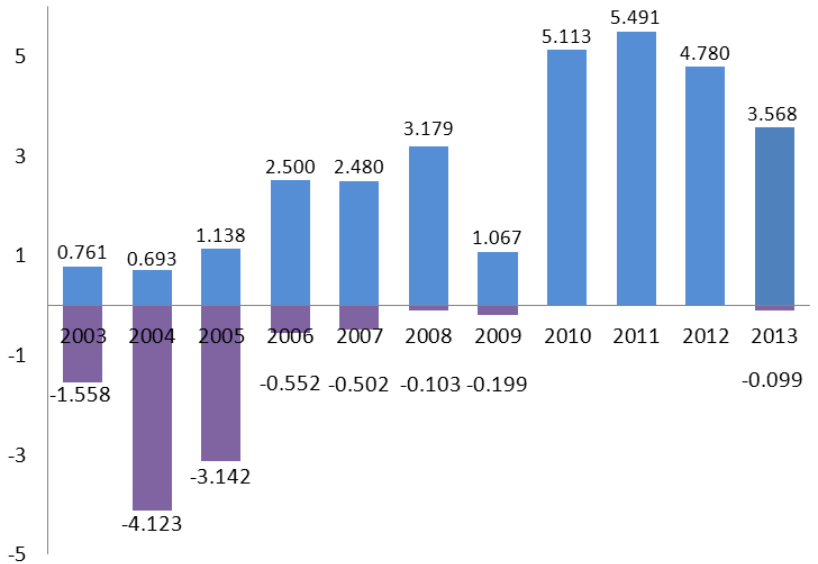
(1) INTER RAO's installed capacity includes Russian generation assets, Bashkir GenCo and foreign generation assets (updated on 2nd of September, 2013).

Retrospective of Electricity Exchange Between Russia and BASREC Countries

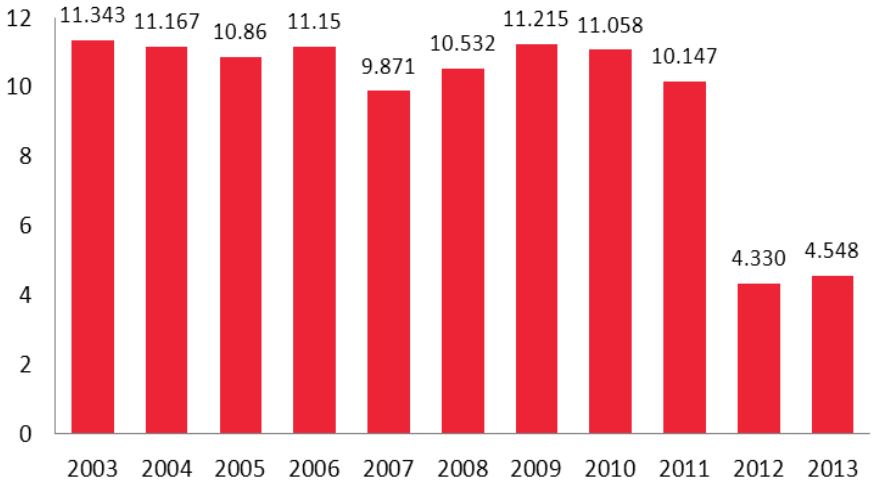
Evolution of power exchanges reflects both the market prices trends and the power systems development :

- Ratio of Russian market prices and Nordic market prices (which strongly depend on hydro reserves in Nordic power systems) affects the scheduled programs and volumes of cross-border supplies.
- Imports from Baltic states decreased significantly, exports increased after the shutdown of the Ignalina NPP and commissioning of CCGT units of the Kaliningrad CHP-2.

Exports (imports) to Baltic countries, bln kWh**



Exports to Finland*, bln kWh



Exports to Norway, bln kWh

**direct supplies of JSC «TGC-1» are not included*
***Supplies of JSC «Inter RAO»*

Russia – Finland ELECTRIC INTERFACE

Interconnections Russia – Finland

1. Russia-Finland Power Transmission;

- Vyborg back-to-back station, 4x355 MW;
- One of the units of North-West CHP, 450 MW;
- 330 kV, 400 kV power transmission lines;

2. Power transmission from Paz river HPPs;

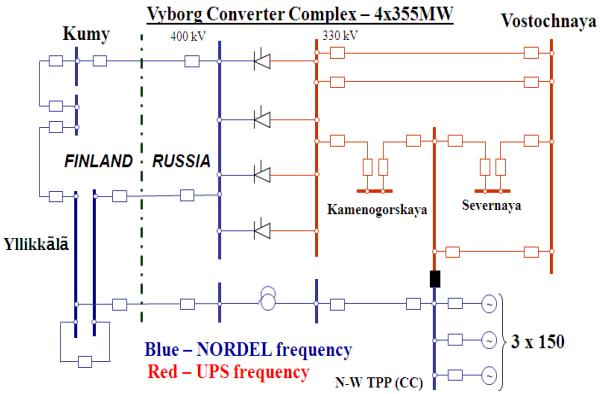
source: ENTSO-E

Historically, Finland is one of the main directions of Russian electricity exports.

Besides the exports, Finland power system operator has the possibility to operate remotely the Vyborg Converter Station within the limits of up to ±100 MW for purposes of frequency control.

Up to now power supplies were possible only from Russia to Finland, as Vyborg Converter Station (commissioned in the beginning of 80-s) has been non-reversible.

Fruitful cooperation of the *Working group on market*, comprised of Fingrid from the Finland side and SO UES, FGC UES, Inter RAO from the Russia side.



Cross-border power trade development:

- The so-called "Direct trade" scheme, launched in 2011, provides possibilities to optimize cross-border trade programs on intraday period;
- The first stage of trial operation of the 4th Unit of the Vyborg Converter Station in reverse mode was successfully finished in 2013, next stages will be held in 2014. Reverse mode will enable electricity imports from Finland up to 350 MW. Currently, regulatory framework for imports is under development.

330 kV interconnections Russia – Baltic States
Transmission Capacities of BRELL Power Ring

Tie-lines 330 kV Russia – Baltic states:

1. Leningrad region – Estonia:

- Kingisepp – Eesti;
- Leningrad – Balti;

2. Pskov region – Estonia:

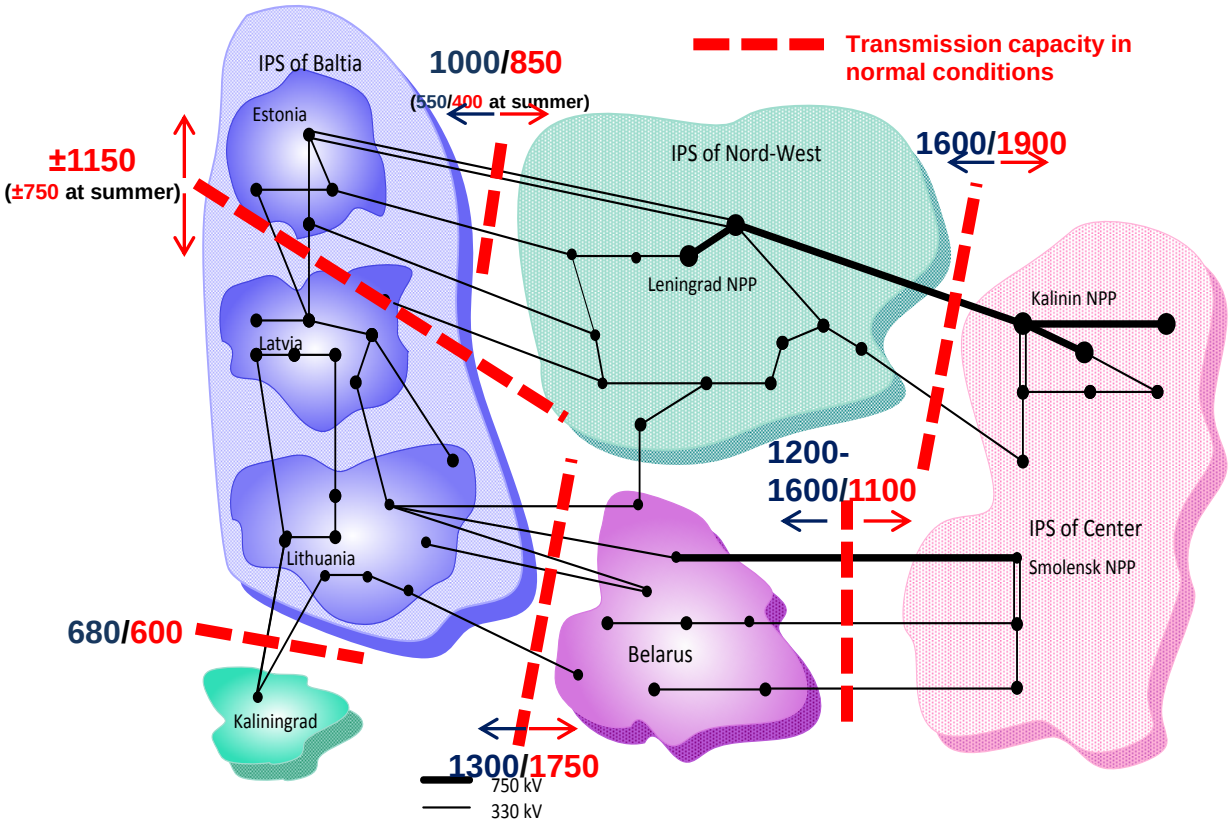
- Pskov – Tartu;

3. Pskov region – Latvia:

- Velikoretsk – Rezekne;

4. Kaliningrad region – Lithuania:

- Bitenaj – Sovetsk (2 curcuits);
- Kruonio PSPP – Sovetsk;



Synchronous operation of UES of Russia, power systems of Estonia, Latvia, Lithuania and power system of Kaliningrad region.

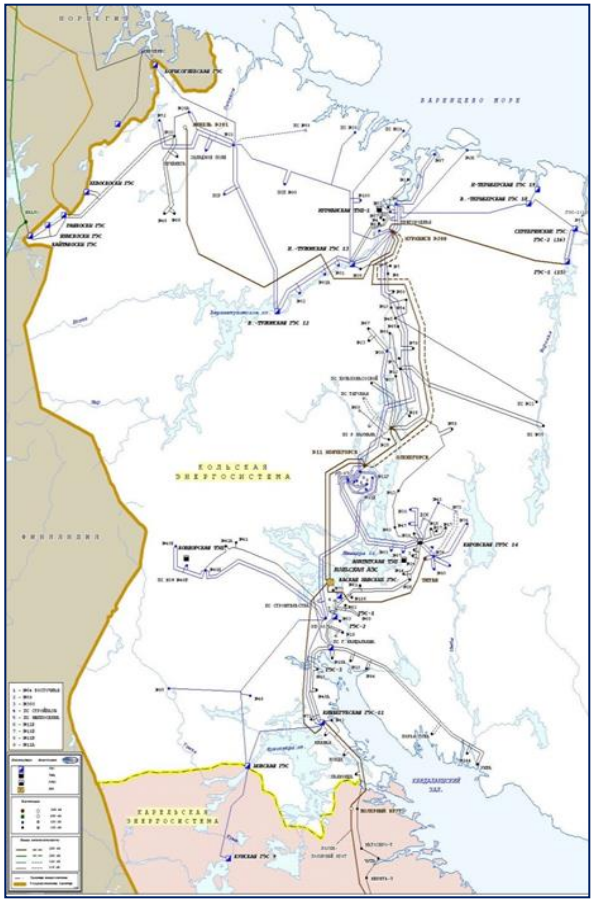
Large-scale cross-border electricity exchange, reliable and efficient operation of power systems is assured due to "strong" interconnections between countries.

Kola Power System (Murmansk Region) in Brief

Kola power system is a part of North-West IPS.

Main characteristics:

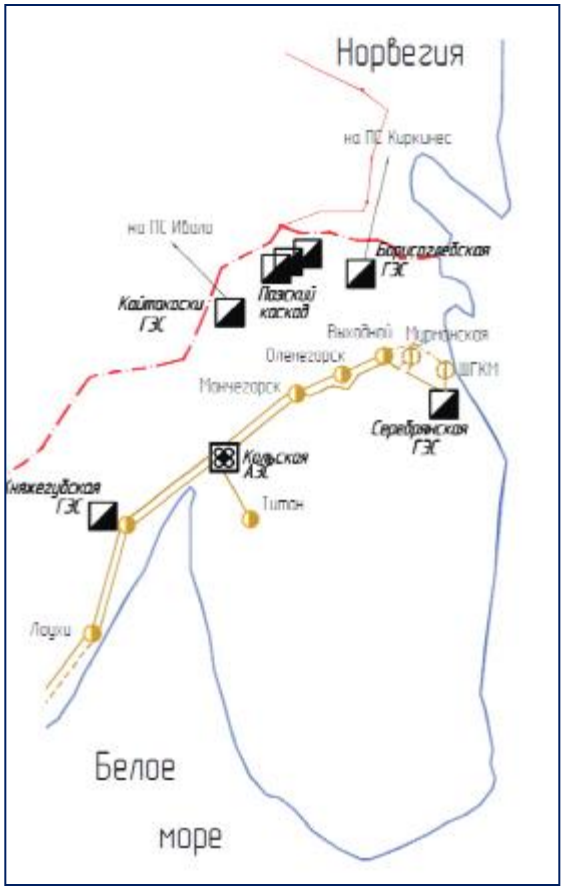
- Total generation installed capacity is 3734,7 MW.
- Peak load in 2012 was 2063 MW.
- Consumption - 13,2 GWh.
- Production in 2012 – 17,2 GWh.
- 162 power transmission lines of 110 kV, 150 kV, 330 kV voltage level;
- 147 substations (including switchgears of power plants) with total capacity 10654,5 MVA.



Specifics of the Kola power system:

- **"Locked" generation capacity (about 400 MW) in the southern part, deficit in the northern part of the Kola power system;**
- **Peripheral location and weak electric links Kola – Karelia.**

External Power Links of the Kola Power System



Kola power system is connected with power systems of:

- **Karelia** (two 330 kV OHL Knyazhegubskaya – Loukhy, 110 kV OHL Knyazhegubskaya HPP-11 – Loukhy);
- **Finland** (110 kV OHL Kaitakoski – Ivalo). Power transmission to Finland is carried out from separated Paz river HPPs or to Finland pocket ("islanded load") in the region of substation Ivalo;
- **Norway** (150 kV OHL Borisoglebsk HPP – Kirkines). Export to Norwegian PS is carried from separated HPP units (1 or 2 x 28 MW) of Borisoglebsk HPP-8.

The volume of electricity exports is about 550-750 mln. kWh/year, maximum capacity of power supply is 75 MW to Finland and 56 MW to Norway.

Paz HPPs can be returned to Kola power system in the case of lack of generation reserves on Tulom HPP-12, HPP-13.

Challenges and Trading Development Prospects

Main market trends

Convergence of prices between the Russian Market and NordPool:

- **Exports are becoming economically feasible in fewer hours;**
- **Smaller spread between the market prices in "profitable" hours;**
- **In some cases Russian market prices exceed NordPool prices.**

Trading decisions are more price-driven, exports are performed only in certain hours (as opposed to base-load full-time exports a few years ago).

Development prospects:

- **Development of transmission network** provides opportunities to optimize power system balances and to increase system reliability using mutually advantageous power exchanges, based on specifics of power systems – surplus in the Kola PS, existence of notable hydro reserves of Norwegian PS, etc., provision of emergency assistance in special cases (Projects Estlink-2 ±650 MW; NordBalt ±700 MW; LitPol ±500-1000 MW are examples of mutually beneficial international cooperation in the region).
- **Development of derivatives market** opens new perspectives to hedge commercial supplies**.**
- **Modernization of 4th Unit of Vyborg converter station** enables reverse supplies, provides opportunities for electricity import from Nordic countries, allowing flexible management of commercial cross-border power exchanges under changing price conditions and technical states of power systems.
- **Overcoming difficulties resulting from differences of market rules of Russia and other BASREC countries** would provide additional possibilities**.**

New Interconnection between Russia and Norway. "Pechenga Power Bridge" Project

- **Pechenga Power Bridge Project will unlock the potential of power trade between the countries and will become a prominent breakthrough in Arctic cooperation between Russia and Norway**
- **The Project is developing by Inter RAO in cooperation with SO UES, FGC UES from the Russian side and Statnett SF from the Norwegian side.**
- **The Project will provide "green" energy exchanges between the countries.**
  Share of RES in the total annual generation in the Murmansk region is about 40% at present (RES include mainly HPPs of installed capacity more than 25 MW) and it is expected to grow significantly due to the development of HPP generation and implementation of renewables supporting measures by the government.

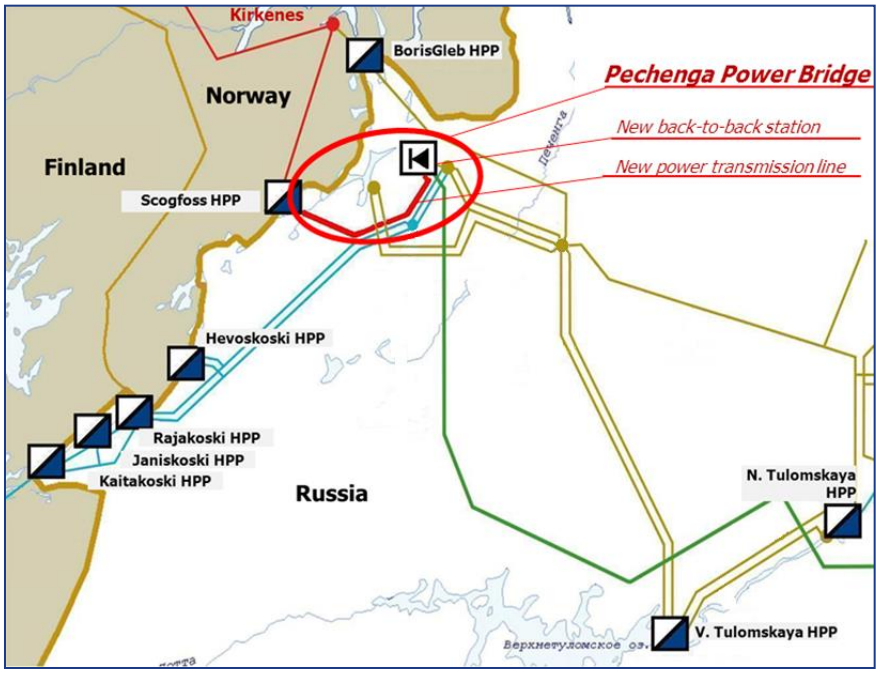
Main parameters of the project

Transmission capacity	200 MW
Direction of supplies	Rus → Nor, Nor → Rus
Volume of supplies	up to 1,5 bln kWh/year

The Project involves construction of reversible converter station (back-to-back station) in conditions of non-synchronous operation of Russian and Norwegian power systems.

Required construction works:

- **Construction of 132 kV cross-border power transmission line;**
- **Construction of reversible converter 200 MW installed capacity;**
- **Upgrade of the power transmission line Vikhodnoy-Nikel – increase of voltage level from 150 kV to 330 kV** *(the line has been built for nominal voltage of 330 kV, but is operated at 150 kV)***;**
- **Additional measures** (*reactive power compensation, etc.*)**.**



From the current stage of the project, Pechenga Power Bridge could be commissioned in 2016-2017.

On the level of companies:

- **Russian-Norwegian Working Group is formed to develop the "Pechenga Power Bridge" project. The Working Group is composed of Inter RAO, Statnett and SO UES.**
- **The Working Group developed the preliminary technical concept of the Pechenga Power Bridge. The project is acknowledged as technically feasible. The technical concept is supported by SO UES and FGC UES.**
- **Inter RAO has ordered a feasibility study of Pechenga Power Bridge (preliminary design-engineering of the project), currently, the first stage is finished. Results have confirmed possibility of power exchange between the countries in agreed volumes.**

On the intergovernmental level:

- **The Pechenga Power Bridge project is noted on Sessions of the Russian-Norwegian Intergovernmental Commission in 2012 and 2013.**
- **The Pechenga Power Bridge project is included in the Russian-Norwegian Declaration on Partnership for Modernization.**

Pechenga Power Bridge
Benefits

- A new cross-border interconnection between the Russian and Norwegian power systems will provide possibilities for large-scale power trading between the countries and for markets convergence.
- Reversibility of Pechenga Power Bridge will increase security of customers' power supply in Troms, Finnmark regions of Norway and Murmansk region of Russia and improve operability of both power systems.
- Reversibility of Pechenga Power Bridge will enable power trading in both directions (from Russia to Norway and from Norway to Russia), depending on hourly spot market price signals.
- The project provides an opportunity to cover immediate power shortage in Finnmark area and create a stable power source for growing energy-intensive industries in the region for the next decades.
- The Power Bridge will be used to exchange renewable energy, produced by the windfarms, HPP-s and other facilities which are planned for construction and are currently in operation in the northern territories of Norway and Russia.

INTER RAOUES

THANK YOU
FOR YOUR ATTENTION!