BASIC PRINCIPLES OF INTERSTATE ELECTRICAL POWER LINKS ORGANIZATION IN NORTHEAST ASIA REGION

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The Northeast Asia region countries have essentially different conditions of balancing between necessities in electric power and in-house primary power sources. As is well known, on one pole of this problem solution stands Japan, which has to import the large amounts of energy carriers from abroad, and on the other pole stands Russia possessing large reserves of mineral power carriers and unique hydro resources in the east part of it's territory.

The major part of resources in this part of Russia currently is not in use. Many of the thermal power plants (TPP) and hydro power plants (HPP), which planned to be constructed in former USSR, haven't been constructed due to the economy crises in 90-ies. For example, there were investigated and chosen power sites for six high-capacity HPP on Yenisei river and it's tributaries for the summary installed capacity of 36 GW, with summary yearly power output of 170 milliard kWh. Several HPP power sites were determined on Lena river tributaries. Still more perspective power sites suitable for high-capacity HPP construction were not investigated. On Okhotsk seacoast there are at least two power sites for the construction of high-capacity tidal power plants (TiPP).

In this part of Russian territory there are a whole series of gas, oil and thermal coal fields. The main part of perspective HPP and TiPP power sites and deposits of fossil fuel is situated on a far distance from industrially developed regions of Russia. Construction of such TPP, HPP and TiPP requires large investments, and besides the construction of long distance transmission lines is needed. Investments in such lines construction are commensurable with investments in power plants construction. Hence Russia is interested in investments attraction on the one hand and is interested in power exporting on the other.

It is necessary to mention several peculiarities of such kind power links in North-East Asia in comparison with, for example, Europe. The main peculiarities are:

1. Large distances (this is, first of all, concerned with the links between Russia power system and power systems of other countries).
2. The water barriers presence (Japan, Alaska).
3. Technical problems of large power systems integration with small transfer capacity AC power links.
4. Differences in the frequency standards (Alaska, Southern part of Japan).
5. Various power and frequency regulating conditions in different countries power systems, and also differences in control organization, language barriers etc.

Studying these problems resulted in the conclusion that it is appropriate to use HVDC power transmission lines for the power links organization in this region.

The main reasons in favor for such solution:

- The conception of "critical line length" is known. While this length being exceeded the HVDC transmission line needs lower expenses for one MW transmitting in comparison with HVAC transmission line. For overhead transmission lines “critical line length” is from 600 to 1000 km, and for the cable lines from 40 to 80 km.

- Using HVDC transmission lines eliminates completely or declines in a great extent problems enumerated in items 3-5.

Certainly the possibility and appropriateness of AC power links creation between several power systems are not excepted. For example between North and South Korea, Russia and Mongolia, may be between China and Korea. However high-capacity links of Russia power system with power systems of other NEA countries generally are to be organized using direct current.

Below, as an example, several power links are enumerated, in which exploration author took part so far.

1. Two variants of power transmission to Japan:
    a. from specialized combined-cycle TPP on Sakhalin island;
    b. from HPP in South Yakutia over the Sakhalin island.
2. HVDC line from Irkutsk province (Russia) over the Mongolia territory to China.
3. So called direct current “bus” in the form of one or two HVDC transmission lines from high-capacity HPP on Angara river within Siberia power system to Habarovsk region. It is possible to connect to this “bus” in intermediate points several futures HPP on Lena river and tributaries and large Tugurskaya TiPP. On this “bus” large potential of electrical power is concentrated, which can be used both for the local consumption and for the exporting to other NEA countries.
4. Electric power link between Russia Far East & Alaska w/ Pengenskaya TiPP connection to it.

All these links are proposed with the use of overhead or combined overhead-cable HVDC transmission lines with rated power from 3 to 10 GW each. The execution of such power links needs the utilization of latest scientific and technical advances in the power transmission technique and also concerned with large investments. According to the very rough estimation the cost electric power transmission with the using of overhead line come to $[0.3+(0.2\div0.6)\cdot L_{o.l}]$ cents/kWh, where $L_{o.l}$ — length of overhead transmission line in thousands km. This estimation does not include spending, concerned with taking aside of ground for line route, which can be very large in some regions of the NEA countries.

The cost of power transmission over using cable line come to $[0.3+(1.5\div2)\cdot L_{c.l}]$ cents/kWh, where $L_{c.l}$ — length of cable transmission line in thousands km.

These costs can be justified only with differences in electrical energy costs between sending and receiving power systems. At the same time, certainly, the other useful effects, which can be obtained through power system integration, have to be taken into consideration. Including:

- Power generation installed capacity decreasing;
- Mutual assistance in emergencies;
- Ability to utilize the ecological resources of sparsely populated regions.

The question on appropriateness of each concrete link have to be solved basing on special techno-economical feasibility study. In some cases comparison have to be performed not only between various line types but also between electric power transmission and mineral fuel transportation. In the last case the result of comparison depends on complex solution of other (not power engineering) problems, concerned with using the mineral fuel in chemical industry and in other areas.