Multilateral cooperation for power interconnection in Northeast Asia

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Abstract. Considered is experience of electric power integration in different parts of the world with emphasis on bilateral/multilateral interstate structures intended for promotion and development of interstate power grids. Analysed are Northeast Asian intergovernmental structures providing bilateral energy and power cooperation between Russia and other countries of the region. Multilateral cooperation in the field is just emerging, but should play a key role in promotion and development of Northeast Asian power grid.

Introduction

Electric power integration is a global process which has embraced many regions of the world. The interstate electric ties (ISETs) and power grids (ISPGs) have been developing in Europe, North and South America, some regions of Africa and Asia [1-10]. There are proposals on the creation of continental and intercontinental power grids: Eurasian, Trans-American, Pan-African, Asia-Pacific as well as Mediterranean, Black and Caspian seas power rings [1]. However, in some regions of the world power integration with the formation of the ISETs and ISPGs is still lagging behind for different reasons. These regions include in particular Northeast Asia (NEA).

A lot of studies of prospective ISETs and ISPG in NEA have been done [1,10-13, etc.]. Currently, transition from the stage of research and development to the stage of their implementation is nearing. It is required to form particular multilateral interstate/ intergovernmental structures in NEA to promote and develop megaproject of ISPG. International experience for South Asia and West Africa and existing bilateral and multilateral mechanisms for promoting ISETs and ISPG in NEA region are analyzed.

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1 International experience

1.1 South Asian power cooperation

South Asia is a region characterized by high economic growth. Power demand growth remains robust due to high economic growth rates. The region has huge untapped hydropower potential. Most of the countries in South Asia are facing power shortages.

Power cooperation in the region has commenced in seventies when bilateral agreements between India and Nepal have been concluded to harness Nepal hydropower potential for mutual utilization. The first power cooperation bilateral agreements in South Asia were considered separately for different groups of countries and weren't coordinated within the entire region. South Asia Association of Regional Cooperation (SAARC) dedicated to improve the welfare of the people of South Asia through economic growth, social progress and cultural development was created in 1985. It comprises eight countries, including Afganistan, Pakistan, India, Bhutan, Nepal, Bangladesh, Sri Lanka, Maldives (Afganistan joined the organization in 2007). Fifteen years later, in 2000, Technical Committee on Energy was set up by SAARC. In 2006 SAARC Energy Center was created, and in 2009 SARC Energy Ministers approved the concept of a South Asia Energy Ring. Multilateral intergovernmental framework agreement on energy cooperation was signed among the member countries in 2014. These intergovernmental agreements realize conditions for meeting the ever-increasing demand of electricity for the socio-economic development of the region by means of cooperation in cross-border power exchange and trading through enhanced transmission interconnections, and grid connectivity would mutually benefit to all participant countries.

Current status of power system interconnection and proposed interstate links are presented in Fig.1 [14].

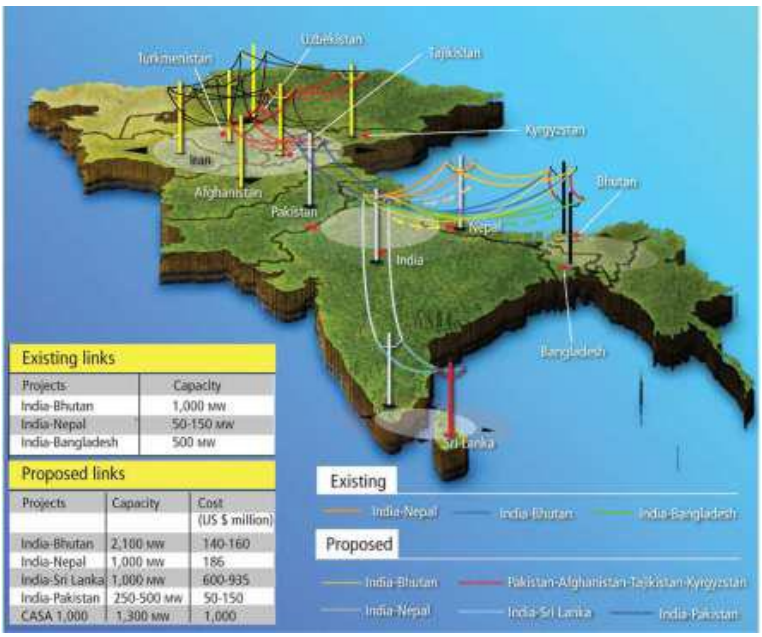


Fig. 1. South Asia power pool.

As can be seen from the above, power cooperation has been developing for decades and was moving upwards from low level of simple bilateral agreements to upper level of complicated multilateral arrangements. As result, SAARC institutional/organizational multilevel hierarchical system has been created to help promote and develop mega-project of regional-wide power interconnection. It is important, that power cooperation was developing under the auspices of regional-wide organization (SAARC), and this made easier overcoming barriers impeding power interconnection.

SAARC countries have been establishing transmission links among each other and with the countries outside the region, through which the trade of electricity realizes. The opportunities for Cross Border Electricity Trade (CBET) in the region has amplified energy safety and has become a political priority for all the state governments.

1.2 West African power cooperation

West African countries are among poorest countries in the world. Nonetheless they also pursue power cooperation policy which brings about system integration benefits including generating capacity and cost saving, reliability improvement, environmental impact reduction, etc.

In Africa, interconnections and cross-border electricity exchanges have been in existence for nearly half a century. Most of these interconnections originated from the development of some of the major hydropower projects. The West African Power Pool (WAPP) was formed in 2000 in taking due account of lessons learned from the establishment and development of the South African power pool.

Long before WAPP creation, Treaty on Economic Community of West Africa States (ECOWAS) was set up (in 1975), comprising fifteen countries (Benin, Burkina Faso, Cabo Verde , Côte D'ivoire, the Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo). Thus, WAPP was set up under the auspices of ECOWAS.

Current status of power system interconnection and proposed interstate links are given in Fig.2 [15].

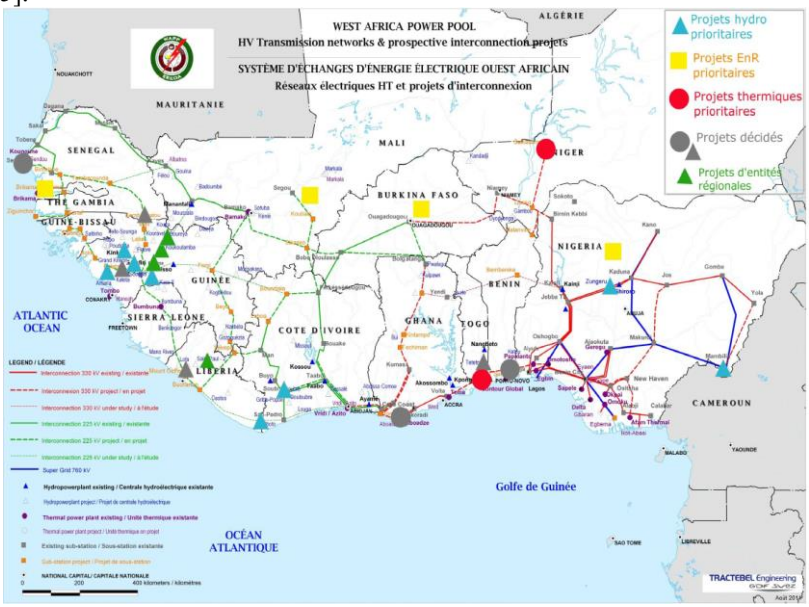


Fig. 2. West Africa power pool.

Soon after setting up WAPP, in 2001, ECOWAS Energy Ministers approved regional-wide master-plan which indicates that an estimated investment in the order of US$ 10 billion would be required for the construction of new power plants and upgrading and building new high voltage transmission lines over the next 15 years.

2 Northeast Asian power cooperation: Russia's case

Russia and NEA countries actively contact in power sector on the level of Governmental officials, bilateral intergovernmental commissions and working groups, industry and academic representatives. As a result of these activities multiple MOU and agreements signed. In the cases of Mongolia and China these activities resulted in construction of transboundary transmission lines and power trading.

Electric power trade between Russia and Mongolia has started in seventies years of twentieth century. Initially Russia-Mongolia's electric power cooperation was regulated within the framework of The Council for Mutual Economic Assistance. This Council comprised East European socialist countries, USSR, Mongolia and some others. Mongolia's power system has been operating in parallel with Unified Power System of USSR/Russia since those times. Mongolia was part of a large power system interconnection embracing countries mentioned above. This interconnection exceeded power system interconnection of West European countries in terms of installed generating capacity and power generation.

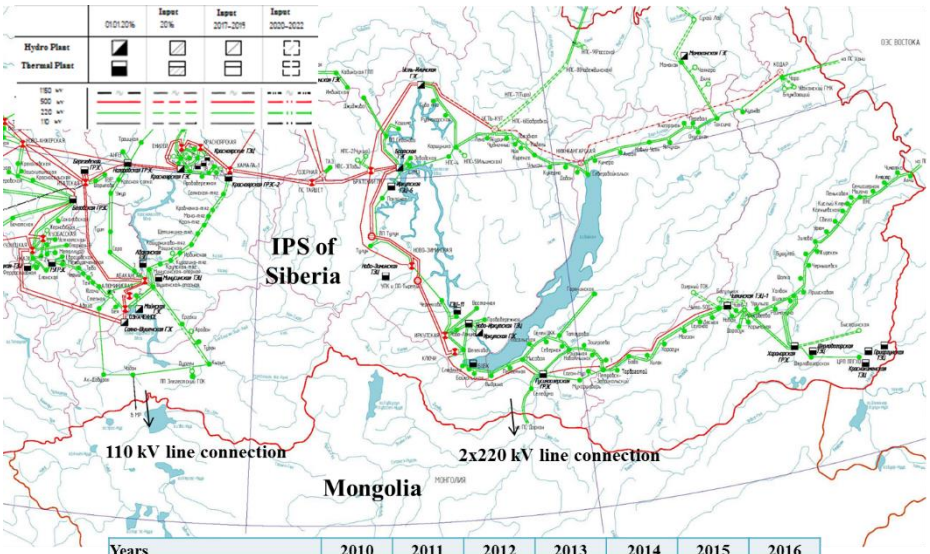
There exists Russia-Mongolia intergovernmental commission on trade, economic, scientific and technical cooperation, which also determines cooperation in power sector between countries. It prepares and issues documents which regulate activity of the countries in electric power.

Currently electric power cooperation and trading are based on Agreement between Governments of the countries on economic and near-border cooperation (1999). This Agreement is followed by Agreements between state owned power companies (between Russian and Mongolian System operators on parallel operation, dispatching and technical data exchange, 2008, and between Inter RAO EUS (Russia) and Power grid company of Mongolia on power supply, 2015). New Agreements concluded between both governmental and non-governmental companies (in particular, Eurosibenergo, Russia, and Just Group, Mongolia, 2010) consider development of Russia-Mongolia power trading and export to other countries, particularly to China.

As result of the bilateral activity, interstate transmission infrastructure with voltage up to 220 kV was created (Fig.3) [16,17]. There is power exchange between Mongolia and Russia (Fig.3). Russia mainly exports power to Mongolia, but in periods of minimum loads, Mongolia exports power back to Russia. This is due to Mongolia lacks peaking capacity which meets ever changing load, and existing Mongolian base-load thermal power plants have limited adjustment range for power output.

Russia and China have very intensive cooperative activity in power sector. There exists Russia-China intergovernmental commission on energy cooperation. Besides special Russia-China joint working group (WG) on cooperation in electric power is formed. Intergovernmental Agreement between these two countries on trade and economic cooperation, 1992, launched interstate power interconnection and trade. In this year 110 kV transmission line was put in operation and power export from Russia to China commenced, Fig.4 [16,17]. The Agreement was backed by the Intergovernmental Agreement on energy cooperation in 1996. Further, intergovernmental Agreements were followed by Agreements between power companies which now regulate technical details of power export from Russia to China (Agreement between RAO EES of Russia and China State grid corporation, 1999, 2005-2006; Agreement between Federal State company of Russia and China State grid corporation, 2010, 2014; Contract between East power company, Russia, and China State

grid corporation, 2012; Agreement between Federal grid company and System operator, Russia, and Northeast China grid company, 2012).



Years	2010	2011	2012	2013	2014	2015	2016
Export to Mongolia, GWh	214	263	393	414	390	284	300
Import from Mongolia, GWh	21	21	21	23	30	54	34

Fig. 3. Russia-Mongolia power interconnection (IPS – Interconnected Power System)

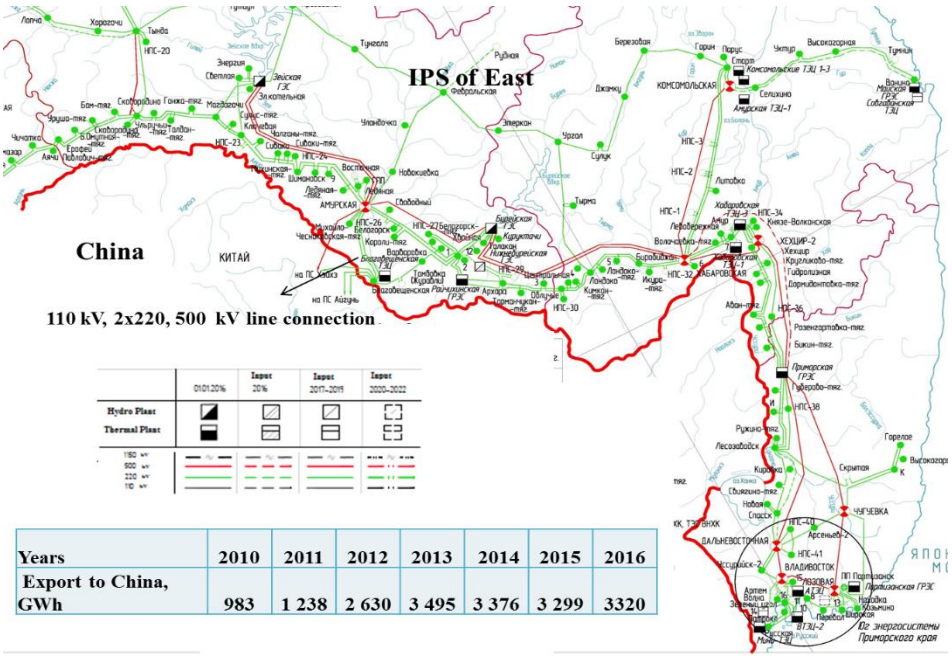
According to the above Agreements Russia-China interstate transmission infrastructure was expanded at the cost of 220 kV transmissions, and at last 500 kV transmission line was put in place in 2011 with back-to-back facility constructed on Chinese territory (Fig. 4). Sharp increase of power export from 2011, when line 500 kV was put in place, can be seen from Fig.4. As a result, power export to China reached about 3,5 TWh/year in 2013, and than was slightly reducing.

Wide scale export of power from Russia to China also has been considered starting since 1999. It was supposed to be realized in three stages. Upon completion of the third stage the export will reach 60 TWh/year. On the first stage export should be about 3,5-4 TWh/year. Thus, in terms of quantity the first stage has already been virtually realized.

Russian companies like Eurosibenergo, Synthesis, RusHydro, RusTech appear in the playground recent years. They conclude Agreements with Chinese counterparts on electric power cooperation, especially on export of power to China, during 2010-2014.

There exists Russia-Democratic People's Republic of Korea (DPRK) intergovernmental commission on trade, economic, scientific and technical cooperation, which determines also cooperation in power sector between countries. Additionally joint WG on cooperation in electric power is formed. Concerted activity in power sector between Russia and DPRK is held within the framework of the Commission and the WG.

Agreement between RAO UPS of Russia and Ministry of electric power and coal industry of DPRK has been concluded in 2001. It determined bilateral inter-country activity in electric power, particularly conducting study of Russia-DPRK interconnection with extension to Republic of Korea (RoK) and power trading among these countries. Later on (in 2015), Intergovernmental Agreement on cooperation in electric power was put in force. It provided contemporary basis for Russia-DPRK cooperation in this field.



Years	2010	2011	2012	2013	2014	2015	2016
Export to China, GWh	983	1 238	2 630	3 495	3 376	3 299	3320

Fig. 4. Russia-China power interconnection.

Russia-DPRK interconnection proposal has long history since eighties. It was proposed to connect South of Russian Far East (RFE) and Northeast (NE) part of DPRK by alternating current (AC) transmission line. As far as DPRK power system operates at frequency of 60 Hz, NE part of DPRK power system should be disconnected from the rest DPRK power system and synchronized with Russian power system at frequency 50 Hz. Russia was supposed to export power to DPRK load island through this AC line. But after USSR dissolution the project was abolished, and it was renewed in post-soviet period, however its future is still uncertain.

Thus, DPRK demonstrated its intention to interconnection with USSR/Russia and even ROK. And this intention is present in the mentioned Agreements.

There also exists Russia-RoK intergovernmental commission on economic, scientific and technical cooperation. Legal basis for electric power cooperation provides Intergovernmental Agreement on cooperation in energy (2000). Memorandums of Understanding (MOUs) signed (2005, 2015) between Russian and ROK power companies on cooperation, in particular on potential power interconnections among countries.

Although there exists Russia-Japan intergovernmental commission on trade and economic issues. Russian and Japanese companies were actively discussing the potential projects of power interconnection between countries. At the turn of 2000 large study of Russia-Japan power bridge project was conducted. Only recently (2016) company's activity was backed by intergovernmental decision taken by Russia-Japan intergovernmental commission to study Russia-Japan power bridge project.

Just recently bilateral cooperation in NEA region advanced at the level of multilateral cooperation among industrial, governmental and international partners in NEA-wide scale. Particularly, signed in 2013 was MOU on Study of Gobitec and Asian Supergrid. It united Energy Economics Institute (RoK), Ministry of Energy (Mongolia), Renewable Energy Foundation (Japan), JSC "Institute of Energy Systems" (Russia) and International body, Energy Charter. One more MOU on Study of NEA-wide grid prospects was signed by

Russian grids company (Rosseti), Korea Electric Power Corporation (KEPCO), China State Grid Corporation, Soft Bank (Japan) in 2016.

Intergovernmental multilateral cooperation in NEA region falls behind so far.

3 Organizational and institutional system for development of NEA power interconnection

What was said above can be generalized in the following multilevel system (Fig.5). Now the system is developing from bottom to up - bottom-up approach is dominating. There exist two lower levels (governmental and non-governmental bilateral activities). The third level is just appearing (non-governmental multilateral activities), and the forth level (NEA-wide multilateral intergovernmental arrangements) is absent. It is needed to strengthening the third level by multilateral Agreements and creating the forth level – multilateral intergovernmental NEA-wide body.

As a result, the bottom – up approach will be complemented by top – down approach, because top-level NEA-wide intergovernmental body will generate signals which will stream downwards to country's level to shape concertedly all-region power interconnection.

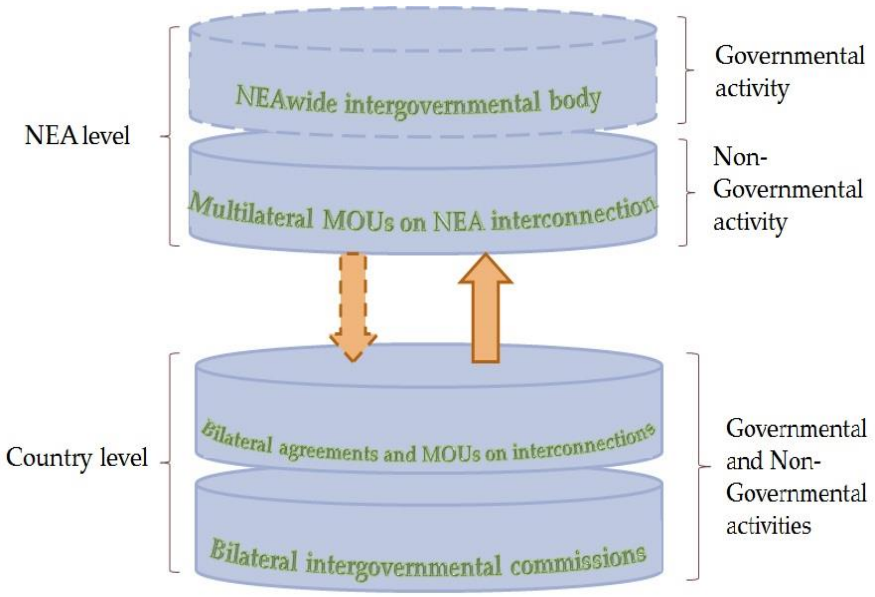


Fig. 5. Organizational/institutional multilevel hierarchical system for promote and development of NEA power interconnection.

Formation of this organizational and institutional infrastructure will help promote and develop mega-project of NEA-wide power system interconnection.

Conclusions

Electric power cooperation in NEA region is currently proceeding based mainly on bilateral intergovernmental and inter-company agreements.

Multilateral cooperation in the region is just emerging.

The world experience witnesses that electric power cooperation succeeds when special multilateral intergovernmental bodies promote interstate power cooperation.

Such a body needs to be established in NEA to make NEA-wide electric power cooperation more effective and intensive and to promote and develop power interconnection in the region.

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