Electricity Markets: Economics, Practical Experience and Peculiarities in Their Organization in Eastern Russia and Northeast Asia

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Abstract – **The paper addresses different kinds of electricity markets with regulated and unregulated prices. The impact of electric power system (EPS) properties on the market organization is shown, in particular, the economic consequences of price deregulation. Experience of restructuring electric power industry in various countries with different kinds of market is analyzed. Special attention is paid to Northeast Asian countries including Russian Siberia and Far East. The main factors, which influence the electricity market organization are considered.**

Index Terms – electricity markets, electric power systems, reforms, costs, prices, tariffs.

I. INTRODUCTION

Starting the 1990s, many countries of the world have been conducting reforms (restructuring, deregulation, liberalization) of electric power industry. The reasons and aims of reform, as well as its depth and results differ from country to country. On the one hand, they depend on economic, social, political, and climatic conditions in every country, on the other – on the chosen model of electricity market organization.

The paper gives summarized results of the microeconomic analysis of electric power market and its different organization models, as well as the review of the practical experience of the reform in different countries. The material of the paper is based upon the monograph [1], where all these questions and problems are considered in detail.

The terms "reform" and "restructuring" will be used as synonyms in a wide sense to describe any structural transformations in electric power industry, and the terms "deregulation" and "liberalization" (also to be used as synonyms) – only in the sense of termination of the governmental (or regional and municipal) electricity price regulation. This difference is quite important to characterize the process of reforms.

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II. THE PRINCIPAL MODELS OF ELECTRIC POWER MARKET ORGANIZATION

Despite the vast variety of markets, four major electric power market models have to be distinguished [2]:

1. Regulated natural monopoly *(n*o competition). In electric power industry these are the so called vertically integrated companies embracing all the spheres of electricity production, transportation, distribution, and sale. This market model was legalized in the first half of the 20th century in almost all the countries with the market economy. Just this market form has given rise to restructuring discussed in the paper. As a rule, Independent Power Producers (IPPs) are allowed to be connected to the networks of monopoly companies. The following market models are characterized by successive separation and differentiation of the indicated spheres with formation of the corresponding generation, network, and sales companies.

2. Single buyer *(*Purchasing Agency, monopsony), when the generation sphere is divided into several separate (financially independent) power generation companies (PGCs) that start to compete with each other in electricity supply to the common Purchasing

Agency. The other spheres remain vertically integrated in the agency, and it is a monopolist with respect to consumers as before. Business of the Purchasing Agency, therefore, should be regulated by the state, including price quotation of electricity purchased from producers and sold to consumers.

3. Competition in the wholesale market, when the electricity transportation sphere is separated, the spheres of electricity distribution and sale are split into territories, and the wholesale market is organized. This leads to creation of transportation-network company, territorial distribution-sales companies (DSCs) and specialized market structures. The wholesale market prices become free and the activity of DSCs and the retail prices are regulated as before.

4. Competition in the wholesale and retail markets, when the spheres of electricity distribution and sale are additionally divided with formation of regulated distribution companies (by territory) and sets of independent sales companies. Retail electricity markets are organized with competition between sales companies (buying electricity in the wholesale market) and consumers. The retail prices are no longer regulated.

The first two models are markets with regulated prices –tariffs – and we can call them for short ***regulated*** markets, while the third and fourth models will be markets with free prices or ***competitive*** markets. For brevity sake these models will be given sometimes with numbers in the succession they were presented above (Model 1, Model 2, etc.).

Nowadays, all four models of electricity market organization in that form or another can be found in different countries. A more thorough restructuring with transition from the first two models to the third one (or the fourth one) is assumed as ***"deregulation,"*** which proved to be a rather principal stage of reform for electric power industry, connected to the appearance of many problems and negative consequences. Some countries that had introduced competitive electricity markets were forced to return to the price regulation.

III. CONDITIONS AND AIMS OF ELECTRIC POWER INDUSTRY REFORMS

The reasons and aims of reform significantly differ for the *developed* and *developing countries*.

The majority of the ***developed*** countries enjoyed favorable conditions at the start of reforms: vast generation capacity reserves (up to 30-40%) accompanied by the low pace of electricity consumption growth; the possibility of the wide usage of the cheap natural gas in the combined-cycle installations (CCIs); the electricity networks well developed and so on. The main cause of reforms was high electricity prices and the reforms aimed to decrease them. Competition in electricity generation and sales was expected to enhance the efficiency and decrease production costs and, hence, the prices for the final consumers. Many developed countries (England, some states in the USA, Australia, and Scandinavian countries) have deregulated their power industries and organized competitive wholesale and retail markets with free prices.

In ***developing*** countries reforms were a result of insufficient governmental funds to ensure the required power development and the main goal, therefore, was to *attract private* (including foreign) *investments*. Some countries, (for example, China and India) retained the regulation of electricity prices, i.e. did not make a transition to a competitive market. At the same time some other countries (Chile, Argentina, Brazil) created competitive wholesale electricity markets (Model 3).
The *provision of energy resources* and for the first hand of natural gas, had a significant impact on the reform (its reasonability and the market model choice) in the developed as well as in the developing countries. It was found out that given the competitive market, very high wholesale prices are necessary to construct

capital-intensive hydro (HPPs), nuclear (NPPs), and coal-fired power plants. In the countries that had made a transition to the competitive market, generation capacities development was conducted by construction of combined-cycle installations only.

IV. EPS PROPERTIES AND THEIR IMPACT ON THE ELECTRICITY MARKET

Electric power systems form the basis of the electric power industry, determine its properties and the electricity market peculiarities. It is common to speak about electric power industry restructuring, but factually the complex and technologically interrelated EPSs undergo the reform. Among the properties of EPSs that were analyzed in [1] in detail, it is necessary to note the following:

● *Specialized electricity transport* (by wires). This property leads to territorial limitedness of electricity market and existence of physical (technological) barrier to entry of new producers in the short run. Thereby, one of the principal conditions of *perfect* competition is not observed in power industry.

● *Economies of scale* that is the characteristic of the whole EPS as a system. This effect imparts the electric power industry the features of a natural monopoly. At the deregulation of the industry (transition to Models 3 and 4) on the one hand, this effect is lost for consumers, and on the other hand – producers gain the possibility to use market power.

● *The principal distinction between instantaneous (hourly) costs* of power plants which are used for the optimization of EPS operation process and *short-run (annual) costs* upon which average total costs and electricity prices are determined. The hourly costs reflect only the variable costs (not including the fixed costs) and cannot be used to set electricity prices. Therefore, the organization of the spot markets, which contemplate the real time trade, contradict the theory of Microeconomics. Electricity trade can be based only on the long-term contracts (1-3 years), whose prices reflect total short-run production costs (including fixed ones).

● *Gradual object-by-object EPS development* (by building concrete new electric power plants and transmission lines) as well as *great capital intensity, long periods of construction and service of power plants.* Taken together, these two EPS properties lead to many electricity market features:

-- the impossibility to quickly eliminate shortage if it occurs for some reasons.;
-- the need for prior planning and subsequent financing the expansion of generation capacities to avoid shortage in the electricity market;
-- power plant service life (30-40 years) exceeds “reasonable” payback periods (10-15 years) which will make private investors construct power plants (Models 2-4);
-- the emergence of a price (economical) barrier for the new producers that as shown in [1] imparts imperfection to the electricity market also in the long run under the competitive market conditions (Models 3 and 4),

● *The high level of mechanization and automation* of electricity production, transportation, and distribution. This property leads to the principal difference of average cost curves of power plants from the cost curves of “typical” firms considered in the theory of Microeconomics. In particular, average *total* costs of electric power plants achieve the minimum level with the maximum annual output, always exceeding the marginal costs. That is why electric power plants have to enter the *competitive* market with their *total* (but not marginal ones) *costs*, in order to avoid bankruptcy.

Overall, the analysis of EPS properties shows *principal differences* of the electricity market from the markets of other industries, and the most important – its *extreme imperfection*. The electricity market does not satisfy virtually all conditions of the *perfect* competition. Organization of the competitive wholesale electricity market with free prices (Models 3 and 4) without conditions for perfect competition should be considered as theoretically groundless, open to many hazards.

Noticeable to say that given deregulation, there is the increase of the wholesale electricity prices from the level of average costs throughout the EPS (under price regulation) to the level of costs of the least efficient (marginal) plant. This leads to additional expenses for consumers and extra profits (so called producer's surplus) for power generation companies (PGCs).

V. EPS DEVELOPMENT PROBLEMS

Building the new electric power plants justifies the increase of the electricity wholesale price (or tariff) equal to the value of the investment component in comparison with the costs of the operating electric power plants. As it is shown in [1,3], the financing mechanism and the value of the investment component of prices and tariffs are different for the regulated and competitive electricity markets.

Given the *regulated* markets, the investment component of tariffs for consumers includes investments into *all the new electric power plants* being built in this EPS, which are divided by the whole annual output of *all the operating* electric power plants. In this case, the investment component is not so large.

Given the conditions of the *competitive* market, the *private investments* in some particular power plant *should recoup* with the electricity sales of *just this* power plant. This significantly increases the necessary investment component in the electricity price in comparison with the investment component of tariffs in the regulated markets. According to the analysis, conducted in [1,3], with all other conditions being equal, the investment component of tariffs in the regulated markets *is always less* than the component of the price, necessary to recoup investments given the competitive wholesale market (Models 3 and 4).

At the same time, at the expense of this investment component, the price that can be offered by the *new producer* to the wholesale competitive market is significantly higher than the price of the analogous *operating* electric power plants. This creates the previously mentioned the emergence of a *price barrier* under the competitive market for new producers in the long run. Here the dilemma (contradiction) occurs:

- either with the wholesale market prices corresponding to the costs of *operating* power plants the *new* power plants will not be constructed and this will cause capacity and electricity shortage;
- or the prices have to be increased to the level at which the investments into *new* power plants will be paid back and *operating* producers will get monopoly profits paid by consumers. This level is relatively low in the countries capable of constructing new power plants with gas turbine and combined-cycle installations on cheap natural gas.

In the cases that require the construction of capital intensive HPPs, NPPs or coal-fired CPPs the contradiction can be resolved only with *the state regulation* of electricity prices and EPS expansion. High prices that are required to pay back the investments should be obtained by *new producers only*.

In the competitive market, the difficulties in building intersystem and interstate electric ties (ISETs) also occur [1,4]. One of the problems is *unprofitability* of electricity export for *consumers* in the exporting country and *producers* in the importing country since in the exporting country the demand and prices increase and in the importing country the supply rises and prices decline. This will inevitably cause *opposition* and complicate the ISET construction.

In the competitive market, it is particularly difficult to substantiate the *reverse* ISET intended for implementation of *capacity* effect of EPS interconnection, in other words, a *decrease in demand for generation capacities* with construction of such transmission lines. This is explained by *separation* of electricity generation and transportation businesses and *change in the financing mechanism* for ISET as compared to the regulated markets.

The difficulties mentioned caused the sharp curtail of the network construction in the countries that had made a transition to the competitive market.

VI. FLAWS OF THE COMPETITIVE ELECTRICITY MARKETS

There has always been opposition to transition to the competitive market (deregulation) in power industry, just from the beginning. A shining example of it is the USA and Canada where most of the states and provinces retain regulated monopoly power companies. Similar opposition exists in Russia.

In the past years, the implications and progress of reforms in different countries have been actively discussed because the problems and negative consequences have become apparent [5-9, etc]. It is stated that the reforms very often lead to a rise of electricity price, lack of investments, power shortage, deterioration of power supply reliability, etc. As a result the original conceptions of reforms are revised (reforms are reformed), the reform process drags on (and cannot be considered complete in any country), the electricity markets get even more complicated, the proposals to restore regulation are raised, and so on.

A profound analysis of deregulation experience was made in [8]. The authors on the basis of an extensive review of 114 publications found eleven difficulties, flaws and negative consequences in organization of the competitive electricity markets. Many of them were also pointed out in other publications. Summing up these publications as well as the material of the preliminary sections of this paper, it is possible to point out the following ***basic drawbacks of competitive electricity markets*** (Models 3 and 4):

1. Considerable costs for organization (creation) and operation of competitive markets that amount to several hundred million dollars.
2. Increase in the wholesale electricity prices from the level of average costs for EPS as a whole (at price regulation) to the level of costs of the least economically efficient (marginal) power plant.
3. Extraordinary volatility (and unpredictability) of prices in the spot electricity markets.
4. Problems in investing in generation capacity expansion due to emergence of the price barrier for new electricity producers.
5. Freedom of electricity producers from regulation and creation of conditions for them to form oligopoly and use market power by manipulating the prices or forming power shortages, in particular by ceasing to build new power plants.
6. Decrease of power supply reliability.
7. Challenges in substantiation of constructing intersystem electric ties that realize a capacity effect of EPS interconnection.
8. Electricity export ceases to be mutually advantageous.
9. The deregulation effect, if any, is obtained mainly by electricity producers, not consumers.

The indicated drawbacks are revealed by the theoretical analysis and proved by practical experience of operation of competitive electricity markets. In the following Sections they will be illustrated in a greater detail.

VII. THE REFORM EXPERIENCE IN THE DEVELOPED COUNTRIES

Among the developed countries, the majority of the US states and Canadian provinces, France and Japan *did not conduct electric power industry reform* (retain regulated monopolies). In addition, South Korea stopped reforming on the Single-buyer market (Model 2). These countries (states, provinces) denied electric power industry deregulation. The main reason for that in the US and Canada is supposed to be *relatively low electricity tariffs* in the corresponding states and provinces. The main reason for the rest three countries was their own *poor energy resource base* and the necessity to build capital intensive electric power plants including NPPs. In the competitive market, this would sharply increase wholesale electricity prices.

In these countries, no serious problems with electricity supply including generation capacities development were noticed.

The countries *conducting electric power industry deregulation,* (the majority of Western Europe countries, 13 states of the USA, 2 Canadian provinces, and Australia), had a very difficult and prolonged reform process despite

the favorable starting conditions. The flaws which were discussed in the previous section showed up, in some places crises or somewhat similar events occurred, conceptions are reconsidered, electric power markets get more complicated, and so on. Among the most important events were the following:

-- energy crises in the USA state of California and Ontario province in Canada that forced them to return to regulation;
-- crises phenomena caused by capacity shortage in the states of South Australia and Victoria in Australia that were accompanied by the spot prices bounce and consumer base shrinkage;
-- the construction of HPPs and NPPs stopped everywhere and in some countries the construction of coal-fired CPPs ceased as well;
– in the 1990s England and in the early 21st century the USA saw a boom in construction of power plants with gas-fired combined-cycle installations. The over-investing occurred which was previously considered a drawback of regulated monopolies only;
-- the increase of electricity prices in Finland, Sweden, Germany and other countries (outpacing a general index of consumer prices);
-- large system blackouts in the Northeastern part of the USA, Italy, Sweden, Denmark, and England in 2003 as well as the rolling blackout in Texas in 2006;
-- the basic change of the initial conception in Great Britain with the denial of the spot day-ahead market and transition to the trade via long-term bilateral contracts (introducing NETA conception in 2001 and BETA in 2005).

Finally, one can expect further negative consequences of the transition to the competitive electricity market, especially after the reduction of power reserves to the unacceptable level, the possibilities to use natural gas exhaust or its price rises and the need emerges to revive the construction of “traditional” capital-intensive power plants.

VIII. THE ELECTRIC POWER INDUSTRY REFORMS IN THE DEVELOPING COUNTRIES

The majority of the developing countries in Africa, Middle East, and Asia preserve regulated monopolies (Model 1). The reform of the electric power industry was conducted by many South American countries as well as China, India, and several Asian countries. The reform conceptions sufficiently differed even though the high pace of economic development and energy consumption and the shortage of state funds to invest the power systems expansion were the characteristics of all these countries.

China and India, as it has been already noticed, retained regulation over electricity prices and gradually stepped into the Single-buyer market (Model 2). Both countries experienced the generation capacity deficit, lacked enough natural gas resources and developed electric power industry at the expense of coal-fired CPPs, HPPs, and also NPPs and renewable energy sources (RESs).Given these conditions, liberating the wholesale prices would have led to their uncontrolled bouncing with negative consequences for the economy and population. Now, the regulation made possible the construction of capital intensive power plants and maintenance of moderate prices (tariffs) for the end users.

Meanwhile, the group of countries in South America (Chile since 1982, Argentina since 1993, Brazil since 1999) have introduced the competitive wholesale electricity markets (Model 3). Chile and Argentina initially were able to achieve a substantial positive effect in terms of increasing production efficiency and lowering electricity prices, as well as attracting private investments. The latter became possible owing to the cheap natural gas in Argentina that was also exported to Chile. The power system development there has been provided by the construction of gas turbine and combined-cycle installations, the investments in them paid off at the present level of the wholesale electricity prices.

The situation sharply changed in Argentina in 2001 connected to the severe political and economic crisis in the country, and in Chile in 2004 due to the termination of the gas supply form Argentina. The government of Argentina was driven to introduce the electricity price regulation (as one of the measures to overcome the crisis), thus liquidating the competitive market. In Chile, with the continuous electricity consumption growth, the deficit of the generating capacities appeared, and the spot prices grew up to 30 ¢ per 1 kWh. The government made some amendments to the concept of reform – introduced the state regulation of the market for distribution-sales companies with transition to the long-term contracts, concluded upon the auction results.

In Brazil, the reform started with the low electricity prices (thanks to the large share of HPPs). Building new electric power plants ceased, and the energy crisis occurred in the country in 2001. The government undertook the set of measures including the organization of the regulated sector of the wholesale market with the trade conducted upon the long-term bilateral contracts. The auctions are being held periodically among the operating and new energy producers, which spark competition between the producers. Actually, in Brazil now, a variant of Model 3 is realized in the regulated sector, where the most volume of electricity is sold.

Summing all above, electric power industry deregulation is virtually impossible in the developing countries. It was an obvious mistake in Brazil. In Chile and Argentine before the reform due to some reasons there were high wholesale electricity prices and opportunities to use natural gas. This allowed to develop generation capacities and drop the prices for a while. However, the flaws of the competitive market inevitably showed up which caused the return to regulation.

IX. THE REFORMS OF THE ELECTRIC POWER INDUSTRY IN RUSSIA

With the country's transition to the market economy at the beginning of the 1990's, privatization (creating joint stock companies) of electric power industry took place. Owing to the efforts of energy experts the economic integrity of the Unified electric power system (UPS) of Russia and regional power systems was preserved. A two-level structure of regulated markets was created: the Single-buyer market at the federal level managed by RAO "EES Rossii" and regulated vertically integrated companies at the regional level (AO-Energo).

The general economic crisis created a very difficult situation in the industry. Inflation, non-payments, depreciation of assets, etc. interfered with the financial and economic activity of energy companies. All the indices of the industry gradually deteriorated and reached a critical level.

Change of the top management in RAO "EES Rossii" in 1998 unfavorably influenced the ways of overcoming the crisis in electric power industry. The energy experts were replaced by managers (economists, lawyers, etc.) whose main concern became business. Instead of concrete measures aimed at enhancing the effectiveness and re-equipment of the industry the new administration of RAO began elaborating suggestions on its further restructuring, postponing the measures on overcoming the crisis for 5-10 years more.

In December 2000 it submitted for approval by the Government of the RF the Concept of Restructuring RAO "EES Rossii" that would provide for transition to a competitive market in the industry. The Concept was thoroughly discussed and criticized. About 10 alternative conceptions were proposed. However, the Government of the RF approved "The Main Directions of Electric Power Industry Reform" by the Decree No. 526 of July 11, 2001 which virtually completely coincided with the Concept of Restructuring RAO. This Decree initiated a new stage of reform.

In February 2003 after the debates that went on for more than a year the State Duma adopted the Law "On the electric power industry" that was also based on the Concept of Restructuring RAO "EES Rossii". Some changes and supplements were aimed primarily at strengthening the role of the State and

Government in the reform. In the Law there was a *transition period*, the end of which was planned on July 1, 2005, not earlier.

Analysis of the goals of reform that were officially included in the Decree No. 526 and the Law "On the electric power industry" has shown that *not a single* stated goal will be actually achieved [1]. This relates to ensuring energy security of the country and stable operation and development of the economy and social sphere, to attracting investments in the area of electricity generation, etc.

The process of reform proved to be difficult, expensive and long. The transition period was not over either in 2005 or 2006. *An inevitable rise of the wholesale electricity prices* was the main problem caused by their deregulation. A new concept of the wholesale power market (NOREM) was urgently worked out and came into effect on September 1, 2006. It provides for conversion of all electricity trade into regulated bilateral contracts, formation of spot markets, etc. The share of regulated contracts will be gradually *forcedly* reduced and then brought to zero by the end of 2010. Therefore the price rise will last several years.

At the same time the state of the industry continued degrading. After 1998 the annual commissioning of new capacities averaged 1 GW. The energy equipment continued to wear and get out of date. This continued until Moscow blackout in May 2005 that initiated elaboration of plans for updating and construction, investment programs, etc. The time, however, was lost, the volumes of work increased manifold. Therefore, the possibility to implement these plans and programs causes doubt, in particular due to degradation of the construction complex of the industry, energy-machine building and design organizations. The electricity and capacity shortage observed in several regions threatens to become common in the nearest future.

On July 1, 2008 RAO "EES Rossii", after completion of its restructuring, ceased to exist, leaving electric power industry unbundled in hundreds of companies, huge plans of construction and investment programs which should be financed and implemented by somebody else.

The key problem in the future period is *prevention of generation capacity shortage*. It requires investments and capacity commissioning that should be higher by ten times and more than those in the recent years. It seems practically unreal and the fact of shortage has to be accepted as inevitable.

In the case of competitive market the shortage will lead to multiple rise of prices in the wholesale electricity market, which will be inadmissible for the economy and social sphere of the country. Therefore, the Government of the RF is likely to *introduce price regulation.* This will cause the problem of attracting *private* investments in new power plants that are possible only at very high prices. Hence, along with the price regulation the other sources of financing UPS expansion will be needed. An *investment component* of consumer tariffs can be one of such sources. The calculations performed have shown that in this case the wholesale prices will be lower than in the competitive market.

On the whole, in the coming 5-8 years the competitive market in Russia might be expected to suffer failure and the state regulation in electric power industry is likely to be restored. Then it is reasonable *to return* (with proper adjustments) to *the two-level structure* of regulated markets of the 1990s with *improvement* of the regulation methodology.

X. THE PECULIARITIES OF THE ELECTRIC POWER INDUSTRY REFORM IN THE NORTH-EAST ASIAN REGION

From the electric power industry reform viewpoint, the common characteristic of the countries in the given region that is important, is the lack of cheap natural gas resources for electricity production. The generation capacity development in the region is conducted mainly by building capital intensive coal-fired, hydro and nuclear plants. In the recent years, the usage of renewable energy sources increased which are also relatively expensive so far.

Among the peculiarities of different countries in the North-East Asian region (NEA), it is necessary to note the following:

-- a very high pace of electricity consumption in China and its continuing growth in Japan and South Korea;
-- the poor energy supply in Japan and South Korea that import almost all fuel for electric power plants;
-- the separation of the regional power network of the Russian Far East from the Unified Power System (UPS) of Russia and the absence of conditions there to introduce the competitive market;
-- the low electricity cost in Siberia because of the large share of HPPs and cheap coal supply;
--the poor electric power industry development of Mongolia;
-- the great electricity deficit in North Korea.

In the final analysis, the pinpointed peculiarities make deregulation of the electric power industry of NEA nations unreasonable. According to the review made in the previous sections of the paper, this did not occur so far (except for Siberia, probably, where the transition to the competitive market is planned now). Noticeable to point out the well-thought electric power industry reform in China and Japan and make a remark towards South Korea.

Competition among producers at the Single – buyer market is organized in South Korea through the day-ahead market (DAM) with an additional payment for capacity. Meanwhile, as experience showed, power producers have the possibility to increase the total price of electricity over their costs, and get excess profits by manipulating their DAM bids (and getting payment for the capacity). Such a situation took place, in particular, in Great Britain in the 1990s, resulting in the liquidation of DAM and transition to the long-term bilateral contracts in 2001. It is possible to recommend the change of the electricity market conception in South Korea based on Chinese and Brazilian experience where the competition of producers in the Single-buyer market is organized differently (using long-term contracts).

Due to some reasons, in NEA region there is no Interstate electric power interconnection (ISEPI) analogous to those formed in many other regions of the world. There are only separate transmissions for the by-border electricity trade. At the same time, many research projects performed during the last 10-15 years in Russia, South Korea, and other countries of the regions showed great effectiveness of certain interstate electric ties (ISETs). The results of these studies are somewhat referred to in the monograph [4].

The most effective ones (and primary) are considered to be two ISETs:

-- “Russian Far East – DPRK – Republic of Korea”;
-- “Northern China -- Siberia” (through Monglolia with its possible connection);

Particular efficiency of these ISETs is conditioned by the fact that they connect the countries with different *seasons* of the *annual maximum load*. In Russia and DPRK –it is in winter, and in the Republic of Korea and Northern China – in summer. This gives an opportunity to reduce the capacities of new electric power plants to be put to operation in the countries united by building the new ISET. Every country in its peak season can receive electricity from the *operating* electric power plants of the neighboring country where there is minimum load in this season. Working in the *reversible* mode, such ISETs can economize up to 2MW of generation capacity (1 MW per country) upon 1 MW of their transfer capability. Specifically, the studies on the efficiency of the ISET “Russian Far East – DPRK – Republic of Korea” have shown that in 2020 decrease in the coincident maximum load of the three EPSs to be interconnected will provide the total saving of investments in generation capacities $13.4 billion at the ISET cost of $1.5 billion [4].

Practical realizing the project of the first ISET encounters difficulties because of the tension in relations between DPRK and the Republic of Korea. The second ISET project is not thought over well enough especially from the Chinese side. Moreover, problems may arise while elaborating the financial effectiveness of this

ISET in the case of Russian complete transition to the competitive electricity market [1, 4]. Overall, the interested countries should take all possible efforts in order to realize these highly efficient projects that will initiate the formation of an ISEPI in the North-East Asia.

XI. CONCLUSIONS

1. Certain properties and specific features inherent in electric power systems cause an *extreme imperfection* of the electricity market and its *principal distinctions* from the markets in other industries. The electricity market does not satisfy virtually all conditions for *perfect* competition. Deregulation of the electric power industry without conditions for perfect competition should be considered as theoretically groundless and open to many hazards.
2. A multitude of *drawbacks* of the competitive electricity markets (with free prices) has been revealed by the theoretical analysis and proved by the practical experience of their operation. Due to these flaws, several countries have already faced the energy crisis that forced them to return to regulation.
3. The *investment problems* in generation capacities expansion should be considered as "devastating" for the competitive electricity market. With the pace of time, they will lead to the crises (similar to those in California, Brazil, and Chile) after the capacity reserves decline to an unacceptable level, the opportunities of the cheap natural gas usage deplete, and the need to revive the construction of the "traditional" capital-intensive power plants emerges.
4. On the whole, *deregulation of electric power industry* (transition to a competitive market) *should be considered erroneous*. Flaws and consequences of the competitive market can be eliminated only by *restoring state regulation in the industry.*

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