Towards an innovation ecosystem: The case for stimulating collaboration in the Russian energy sector

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Abstract. Increasing cooperation through greater interdependency of the organizational networks structures is a topical issue for a diverse range of industries, including the energy sector. However, despite the advantages of such form of activity, Russian organizations do not tend to cooperate. An extensive analysis of the techno-economic network of the Russian power sector innovation ecosystem made it possible to identify hub-organizations which could be regarded as the catalysts for partnership development. Hence, the purpose of this paper is to elaborate the mechanisms of target network creation behind hubs’ involvement in the network expansion. Thus, it could provide a solid foundation not only for an increased number of partnerships but could also serve the purpose of embedding companies in the strategic activity ultimately enabling them to achieve competitive parity with the rest of the world.

1. Introduction
Russian energy system is characterized by constant changes in its operating models. Power Industry concepts, formed in previous decades are no longer relevant. Continuous innovation development is a worldwide trend and the Russian power sector needs to evolve in line with this trend. The progressive approaches of energy sector innovative development are based on cooperation between the diverse energy market participants [1]. One of these forms of collaboration is creation of innovation ecosystem. The ultimate aim of the innovation ecosystem as a network structure is to facilitate a mutual activity where complementary resources and competencies are provided by different actors. The benefit of the innovation ecosystem is realized by achieving synergy as a result of activity between innovation process participants. The adjusting interconnections between the innovation ecosystem actors facilitate innovation process and generally improve all innovation activity [2]. Among the core features of innovation ecosystem, we may presumably define a set of diverse participants (small and medium enterprises (SMEs), large companies, universities, financial companies etc.) and mutual connections between them, aimed at the creating new knowledge [3] (which explains why an ecosystem has a network structure).

Despite the presence of all types of participants, there is a lack of cooperation between them in Russian power industry innovation ecosystem [4,5], reflected in the underdeveloped cooperation: the insufficient number of projects does not for creation of new knowledge or innovative production; as a consequence, competitive advantages do not grow and energy sector has no chance to claim to advance to a leading position in comparison to the rest of the world. This fact evolved the question: why Russian power industry innovation ecosystem network does not influence the partnership development? How this process may be established?
The base conditions for a successful Russian energy system (as a core sector of the economy) were formed by the integration of the its participants, their involvement in mutual activity, which will take shape not only in the form of research and innovation projects, but in search for growth spurts, in elaboration of strategic plans and formulating of vision of Russian energy sector place in the world power system. Creation of a well-orchestrated innovation ecosystem, grounded in the aforementioned conditions and providing benefits for all types of the participants, including reaching their own aims and innovation ecosystem target – synergy effect – will finally result in the economic growth, population well-being, tax revenue increase etc. Thus, formation of the mechanism, which makes all innovation ecosystem elements work together will help Russian energy system achieve its development targets.

Russian innovation ecosystem is represented by plethora of large companies, which are not concerned about establishing partnerships. In the light of this fact, elaboration of a cooperative mechanism taking into consideration this specific feature, will enable to involve large business. As a consequence such organizations are able to coordinate their collaboration and increase number of partners from the ecosystem participants.

The current paper employs social network analysis and follows Callon’s [6] approach of transfer poles reveling in socio-economic networks to identify core participants of specific energy ecosystem areas. Next, by collecting accurate information about Russian energy sector ecosystem companies, including data reflecting specific projects they participate in and which competencies they possess, should allow hubs to create two kinds of databases. Each of the databases can be used by hubs to fulfill coordination function, i.e. to act as network brokers. In this manner the hubs are able to unite the organizations ready to implement projects with companies, holding resources which are required for specific projects. As a result, the hubs are involved in the network as connectors, which monitor the partnerships, integrate network participants and stimulate cooperation. Hence, the mechanism, describing hubs role and the stages of techno-economic network development is formulated. Specific stages of the mechanism and their implications are brought forward towards the end of the paper.

2. Central characteristics of a Russian energy sector innovation ecosystem

The above general description of the innovation ecosystem idea provided us with the understanding of its core features. Considering a definite innovation ecosystem, it is worth noting, that its model can substantially differentiate from the ideal one. Such problem touches upon the situation in Russian energy sector innovation ecosystem, which is characterized by the following specific features [5,7]:

- Lack of strategic vision and defined goals for the development of an innovation ecosystem;
- Substantial number of large companies – members of ecosystem;
- Misunderstanding of the mission, values and goals of an innovation ecosystem mission, values and goals by some participants (basically by SMEs).

A primary concern of the Russian energy sector innovation ecosystem is the lack of understanding of its nature by the participants. The large companies consider it as a mechanism, which can be leveraged to resolve such problems like destruction of administrative barriers, lobbying of the companies’ interests, support in promotion of new technologies and production abroad etc. The state authorities expect the companies’ involvement in cooperation and production of new knowledge. As opposed to delivering a competitive advantage, SMEs often rely on “artificial” support in the form of contracts with the government and large companies to supply them with customers and resources. Despite the fact that Russian authorities encourage cooperation between various actors of Russian energy system and broadcast the benefits and need for acting together inside the innovation ecosystem, the widespread appreciation of the innovation ecosystem is not presented. To sum up, the situation around the Russian energy sector innovation ecosystem can be considered as requiring for changes. Formulated differently, Russian energy sector innovation ecosystem, on the one hand, is characterized by a sufficient number of diverse types of participants, established infrastructure and market. On the other hand, the actors are very heterogenous, so their operations do not produce the synergy effects: collaboration does not grow, there is no increase in exchange of the resources and the attempts to
create the space for strategic development. This situation negatively affects the prospects of reaching the leading positions in the world energy system.

3. **Conditions of the partnership development and growth of interconnections inside innovation ecosystem**

The problem of Russian energy sector innovation ecosystem connections development leads us to the necessity for the research, aimed at clarifying the principal issues, assisting in elaboration of the mechanism, which provides the growth of cooperation. We are faced with the question: how the problem of stimulation of ties in innovation ecosystem can be resolved?

From the perspective of the existing literature, we can strongly assert that similar problems were considered by many scholars and practitioners.

Innovation ecosystem is a network structure by its nature. Callon [6] discovered that the network approach can be successfully applied to describe the trends driving the innovation development in the power industry (by the example of techno-economic network of FMEA (French Energy Agency). The primary issue of techno-economic network is that project genesis might start at any part of the network. As a result, network participants may join the project due to diverse reasons, transforming configuration of the network simultaneously. Each network contains a number of clusters: in case of techno-economic network they are called scientific, technical and market poles. Also there is a transfer pole between science and technology, which contains organizations, capable to establish interrelations between science and technology. Development pole is situated between production and distribution. Despite the presence of the poles in techno-economic network, each network has its unique structure.

Success or failure of interorganizational structures strongly depends on the presence of some key factors such as: motivation and expectations of the participants and capability of network intermediaries to create interactions and to exchange of resource between the actors, to initiate mutual contacts.

There are two primary motives for cooperation discussed in the literature: the resource interdependence (“resource approach”) and [8,9,10] the possibility to create interrelations inside the network, which develop basing on previous experience of participation in similar networks (network capability) [11,12].

The motivation of innovation ecosystem participants involvement is a topical question for many scholars. What kind of benefits and profits can an ecosystem actor obtain? Why should the company join the cooperation inside the ecosystem? How can the network multiplier effect be developed? All these discussions drove us to the conclusion that the following prerequisites are required for the ties extension in innovation ecosystem:

- Comprehension by the ecosystem participants of the demand for cooperation as a source for reaching the common goals. Besides this fact, collaboration gives major number of specific benefits, in comparison with separate activity.

- Conceiving of the possibility of access to wide range of resources: distributed network of actors leads to the mutual transfer of competences and resources. As a result, different spheres tasks may be resolved: technological, marketing, social and other types.

- Presence of specific actors in the innovation ecosystem, grouped around the poles (technical, scientific, transfer, marketing and others) of techno-economy network inside the innovation ecosystem.

The presented conditions are somehow starting point for the partnerships development. However, neither these described conditions, nor the approaches, demonstrated in the academic papers provide us with the understanding of the mechanism – a step-by-step guideline – for the organization of innovation ecosystem cooperation. Which companies may be included in the partnerships? By which organization the partnership coordination suggested to be carried out? It is our view that such activity may be fulfilled in the frames of target network organization mechanism, aimed at attraction of the network participants, possessing certain resource and competence. Such network structure could probably provide the activity directed towards the joint projects implementation.
4. Suggestions

Following the course of the current paper, we believe, that the resolving the problem of creating a target network elaboration mechanism will ensure involvement of the organizations into cooperation, resulted in joint project activity and upturn of innovation ecosystem and industry development.

Basing on the Callon [6] idea of the target network creation in the frames of techno-economic network, we came to the conclusion that it is necessary to point out the stages of its creation. Callon’s paper merely describes the idea of the poles, constituting target techno-economic networks and gives no guidance on the creation of mechanism to elaborate such networks inside the innovation ecosystem. That is why it is so essential to demonstrate the detailed description of hub’s activity - as a core Russian energy sector innovation ecosystem participant - during the mechanism stages. Our own contribution will include not only general guideline during the target network creation phases, illustrated by the particular example, but will also take into consideration the context of Russian reality.

First and foremost, it is worth to make identification of the poles. Each network includes a wide range of actors, which fulfil different functions. The companies are grouped in the poles according to the functions they perform. Presence of the participants in each pole is a foundation for normal work of techno-economic network of innovation ecosystem. Creation of the target network could be considered as a driver of development of specific area in energy system.

The next important milestone during the elaboration of the target network is a determination of an actor – a hub, which can initiate and “orchestrate” this network. Presence of a hub in techno-economy network is a background for target network creation. The hub-actors can be appointed to the role of key player in the poles. Such core participants may be assigned to resolve the problem of target network organization. According to Callon [6], the hubs are the organizations which possess the competencies, providing growth of interconnections by facilitation of the marketing or technology activity. They provoke start of strategic development and discussion of other questions between the network actors.

It is crucial to realize how to define hub-actor. Hubs of the techno-economic network can be described in terms of network analysis. Assessment of such indicators as degree centrality, closeness centrality and betweenness centrality ensure the hubs detection. Using the network approach allows to formulate the steps towards the creation of the mechanism of target network collaboration.

The right choice of the hub-organization tends to have continuation in a proper identification of the rest of the participants of the network. The actors involved in the network need to possess specific resources and competences, necessary to implement the projects or other tasks of the target network. On the assumption of the fact that for a concrete project the specific characteristics are required, the hub will need to have enough data about the hypothetical network member to make appropriate choice of the actor. Eventually all the target network participants will find their niches. As the consequence of the selection process the need for, as we called it beforehand, “artificial” support of the SMEs (when they rely on large companies or state to support their business model) will disappear, because the target network participants become the real partners.

To sum up, the process of target network elaboration can be represented (or approximated) as a multi-stage process. Creation of a working mechanism in Russia is a big challenge due to the special character of innovation ecosystem energy sector performance. As we mentioned above, there are large companies, which are quite dynamic in comparison to SMEs. On the one hand it can be considered as a problem, because large business may deny SMEs access to the market and ecosystem. On the other hand, as an advantage – the companies can be involved in cooperation with SMEs stimulation and become hubs, which organize target network and take proactive participation in strategic development of the energy sector. The second approach to the role that large businesses could play is more reasonable, that is way, we feel that, it is worth to illustrate how the mechanism of target network elaboration might be applied to Russian practice.

Mechanism of the target network performance organization includes the stages, described later in points 4.1 and 4.2.
4.1. Determination of the network configuration inside the poles

This operation consists of two main steps:

- Distribution of the organizations inside the existing network of innovation ecosystem according to the clusters, belonging to specific pole.
- Assessment of the network parameters to identify the hubs inside the network poles.

In respect to distribution of the companies and organizations around the poles, this process requires collection of the data in regards to the actors’ activity – types of their performance and the contacts with each other. It is fair enough to suppose, that collection of all the data about the actors of ecosystem is quite complicated task. That is why the sample will consist of the actors available for monitoring. As far as there is a huge number of the organizations in the innovation ecosystem, they must be distributed according to the poles (the poles of techno-economic network).

Considering the Russian energy sector innovation ecosystem, the example of the participants, involved in an “Intellectual energy system” Technology Platform will be studied. Technology platform is an element of the state energy innovation system, working as a part of the innovation infrastructure, aimed at the creation of a community of the energy sector participants, which are involved in the joint innovation projects and so on. Advanced feature of this community analysis is that its participants are simultaneously active agents in other industry structures: they present scientific, technology, marketing spheres. Hence, the sample data of companies’ activity will cover different areas of power sector and will provide us with the relevant results.

It is worth to point out, that presence of multiple connections makes Technology Platform “Intellectual energy system” a structure, containing so called network effects and consequently might be considered a techno-economic network. On top of all, diversity of state, business and educational interrelated organizations result in the effect of new knowledge and innovative production and services. The synergy effect is expected from the Technology platform performance which is why such the platform network may be regarded as an innovation ecosystem with the technology network inside.

Current network of Technology Platform “Intellectual energy system” counts nearly about 200 actors, involved in dozens of projects. However, development of technical partnerships mostly in technical sphere is still a challenge for the platform, accordingly the problem of companies’ involvement in diverse projects is quite topical. More importantly, many organizations, participating in platform projects are not included in the list of platform actors. Out-of-platform companies are the members of platform projects. Such fact again substantially underlines the research problem of the paper (lack of the interconnections in a given network). To sum up, the necessity of network ties identification interrelates with the understanding which poles the companies belong to.

All the organizations in a given sample operate in a specific area of activity. As it was mentioned above these types may constitute the poles. That is why we might assume that these kinds of companies’ performance can be considered as the criteria for the pole identification. The actors were studied according to the following criteria:

- Type of actors’ activity (University, research organization, state authorities, project companies, industrial sector etc.)
- Particular characteristic of actors’ activity (research, commerce, IT and so on)
- Service providing (expertise, consulting, mechanical engineering, standards creation etc.)
- Industry specialization of a company (infrastructure, nuclear power, electric-power etc.)
- Role in the value chain creation of the network (energy consumers, market operators and other participants, power generation companies, electric grid companies)

As a result of companies’ activity analysis, we were provided with a huge volume of information in regards to the diversity of their business functions. To regulate and put it in order, the necessity for right classification arose. In case of universities, their operations are quite typical, so the difficulty of their identification does not exist. However, many organizations are involved in a multiple activities simultaneously – production, research, marketing and expertise. To avoid this inconsistency, method of factor analysis was applied. The purpose of this method is elimination of the basic number of
variables and search for the complex factors, which would completely explain the interrelationships between the variables. In our case, we suggest that each type of the activity may be considered as a variable. The factors present the poles of the network, explaining a certain number of the correlating variables (type of the activity). Factor analysis was carried out with the help of SPSS Statistics.

Each of the organization was assessed whether it matches any of the 40 variables-criteria (equal to 1) or do not matches them (equal to 0). The data for variables was collected from the official websites of the companies and Annual reports of the Platform. After the data analysis in SPSS the task was to select the factors, which might be interpreted as the explanation to some part of the research question (identification of the poles). Using Varimax method, we defined a component matrix which helped us to select only the significant factors (see figure 1). The selected factors may be considered key poles’ characteristics.

Figure 1. Network structure, describing the interactions between the poles in technology platform "intellectual energy system".

notes: It was created by R.Yaremchuk, graduate of NRU HSE master’s programme Project management: Project Analysis, Investments, and Implementation Technologies.

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position of the key nodes might be described by a range of attributes: degree centrality (reflects the structure of information distribution in the network); closeness centrality (characterizes key actors’ possibility and velocity to distribute the information); betweenness centrality (describes level of control and number of paths, which a key node controls). The values of these parameters for each of the network nodes are presented in Table 1 below.

The results of the assessment highlight the following issues:

- The principal node of the network is FSK EES the point lying on the 1870 paths connecting any pair of nodes and surrounded by 37 direct neighbors. The next several key nodes are the companies Asteros, Rosseti with the 1311 and 656 level of betweenness and 24 and 30 degree centrality respectively. Such numbers illustrate the independence of these actors due to their sufficient access to the resources and projects.

- The lack of interconnectivity between the participants (the connections are absent or fragmentary) is observed. There are likely two underlying reasons for this: competition between the actors of specific pole and “Self-sufficiency”.

Table 1. Indicators of the actors network positions, occupying the most central positions.

| Network actor   | Indicators of centrality |
|-----------------|--------------------------|
|                 | Betweenness centrality   | Closeness centrality | Degree centrality |
| FSK EES         | 1 870                    | 2,05                 | 37               |
| Asteros         | 1 311                    | 2,21                 | 24               |
| Rosseti         | 656                      | 2,31                 | 30               |
| E4              | 443                      | 2,55                 | 11               |
| Streamer Msc    | 432                      | 2,57                 | 9                |
| INTER RAO       | 414                      | 2,40                 | 15               |
| …               | …                        | …                    | …                |
| Telekor-Energetika | 235                   | 2,86                 | 5                |

The fact of perhaps hub-actors “self-sufficiency” requires further explanation as well. Several key participants could not be classified as part of specific pole. Simultaneously, these hub-actors are the connectors between two or more poles. Such actors’ position brings some benefits to them: primary access to knowledge transfer, technology exchange and mutual consumption of other types of the resources. More importantly, the central hub-actors’ position enables them to control over the resource transfer in the network. Hence, such advantageous position does not require extra efforts to stimulate cooperation, as far as such actors occupy the central places in the network. Besides the hub-organization it is critically important to consider the isolated actors: conversely, such organizations possess limited access to resources. Consequently, they may not to rely on the support from the network and act separately. The isolated companies are situated outside the network activity, so they cannot be considered a source of growth of the Technology Platform ecosystem network.

To sum up, the hub-organizations, presented in the network are not associated with the definite pole, but participate as connectors. Connector-function is a kind of natural hub’s activity, but it does not suggest that network fragments gravitate to a specific pole. As might be expected, inevitable competition between the actors does not favour the establishment of partnerships. However, well-organized hub activity might bring a lot of benefits, including creation of the principles of network management and establishment of target networks, which fulfil specific tasks. That is why, the primary concern should be aimed at encouraging pole development, creating partnerships, planning network configuration and integrating the hubs into the administration and management of the network.

4.2. Composition of the target network
Before the systematization of the activity, which will be described in this section, it is important to put a lot of emphasis on the motives of the actors for the cooperation: motivation due to the “resource approach” (each actor gets access to different kinds of the resources) and motivation including the possibility to increase the social capital (number and quality of ties inside the network). Finally, in reference to the stages of target network creation, we suggest completing it according to the guidelines which describe the process for choosing appropriate network participants (see figure 2).

**Figure 2.** Mechanism of target network development.

The stage of network participants determination, may be completed by the creation of actors’ database collected according to a variety of criteria (attributes) including: the list of potentially required resources, provided by the actors of the network and the list of projects, which are expected to be launched or are already implemented, when a particular kind of resources or competences is in demand by the organizations - project initiators. We offer creation of a tool, which might be adopted by hubs during the process of their connector role implementation. Attributes databases may help to choose the potential participants of the future projects or other types of activity. Project data base presents information about the activity, where the companies may be involved. Consequently, hypothetical target network might be created. Following the selection process, some of the expected actors may reject of participation due to any reasons, and that is why the target network will be restructured. As a result, the final network will be created and a hub can coordinate the network.

5. Conclusion
This paper puts forward the analysis of cooperation development problem inside the techno-economic network of Russian energy sector innovation ecosystem. The research makes contribution to the range of methodological approaches, which have the potential to stimulate the collaboration in the energy system of the country and will be useful for the energy policy makers. The synergy effect emerging from the cooperation may have a positive impact across several key areas: development of partnerships, new knowledge and new production creation, growth of organizations’ embeddedness. Eventually, creation of an environment favourable to strategic development of the power industry will lead to a more competitive position of the Russian energy sector on the global arena.
The results obtained may be validated by the application of the mechanism of target network development to particular parts or to the whole energy sector of the country. The adoption of mechanism was illustrated using the example of Technology Platform “Intellectual Energy System”.

Besides the elaborated mechanism the study presents the following key findings. Process of companies’ integration is a difficult one, so consideration of the context is significant for the application of new approach. First, Russian energy system is characterized by the presence of great number of large companies. This fact brought us to the conclusion, that identification of hub-organization roles’ in the techno-economic network, using the tools of social network analysis, is crucial for the mechanism creation. The situation of absence of hubs domination may require other approaches to collaboration development: the process of self-organization may take place. Second, despite the structure of techno-economic network offered by Callon [6] and the functions of transfer poles presented in the network, content of Russian ecosystem network actors varies: the hub-companies do not belong to specific pole and act like connectors between other organizations. Although the situation underlines the “self-sufficiency” of the hub, such hub’s positions allow them to play the key roles in the network, accumulate information and influence SMEs involvement and their positions in the target network. As a result, SMEs may have no need for “artificial” support of their business-models by state or large companies. Thus, creation of a target network resolves the aforementioned problems, by enabling mutually effective participation in the target network.

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