Benefits and costs of conventional and renewable power sector in Siberia

by

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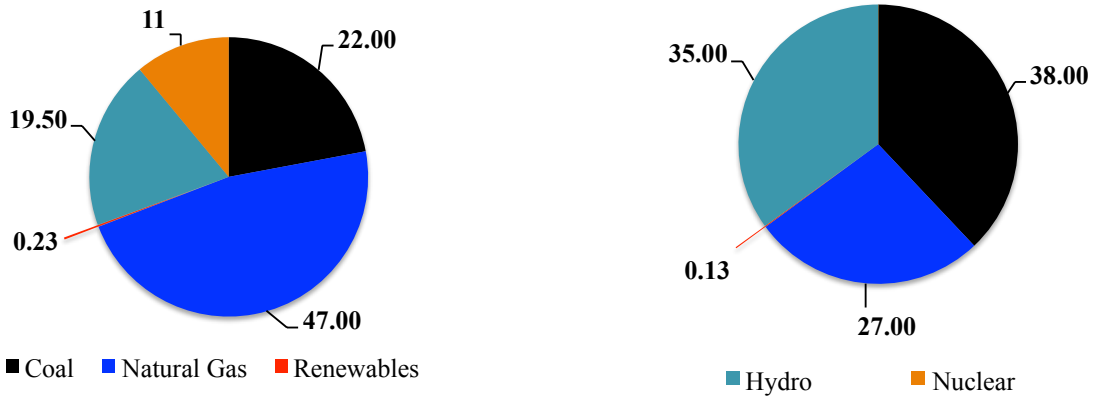
Abstract

Review and evaluation of dilemma of energy choices is urgent for Siberia as the vast region of Russia, spreading from the Urals up to the Pacific Ocean. This megaregion is abundant in fossil fuels and possesses a great capacity of renewables. Current strategy of Russia is to adjust to the New Industrial Revolution, digital economy and climate change. Such strategy stimulates the renewable energy acceleration, but renewables remain to be relatively expensive to explore in Siberia, as they need a new energy infrastructure and appear to be out of the mainstream in this megaregion. Siberia is closely connected with the Arctic by environment and climate (the taiga, tundra, rivers, etc.) and energy capacity (Vorkuta with its coal mines, wind offshore stations in Kamchatka, etc.). Global agenda on climate change makes it urgent to seek the balance between abundant conventional sources of energy in Siberia and renewables, that seem to be the real driver of new industrial&digital age and the catalysis of climate change. Interdisciplinary analysis of alternatives for energy choices in Siberia is important for effective response of Russia to new global challenges.

1 Introduction

Siberia appears to be a vast megaregion of Russia, extending from the Urals up to the Pacific Ocean. Siberia is rich in huge reserves of fossil fuels and has a great capacity of renewable energy. This megaregion, in the observed perspective, will sustain the priority of exploring and exploiting the conventional energy, which is used to be rather cheap, abundant in stock and masters the well-developed infrastructure. All these allow to produce 65% of electricity by fossil fuels in the megaregion.



a) b)

Figure 1: Installed electricity generation capacity in Russia (a) and Siberia (b), by source, 2017

However, the intention of Russia to harness the global trends of New Industrial Revolution and digital economy, and adopt to the climate change, stimulates the rapid growth of renewable energy, which is still expensive, rather small in size and modest in demand to create new energy grids in the megaregion. Comparative analysis has been carried out to examine the current and expected benefits and costs of conventional and renewable sources of electricity in Siberia due to Russian response to the global challenges.

2 Overview

New concept of Siberia as the Russian megaregion presents an opportunity to introduce a more profound analytical framework, aimed at elaborating a systematic view upon the current and anticipated processes in power generation in Siberia and Russia. Comparative analysis of benefits and costs of conventional and renewable energy is realized along five dimensions – *availability, affordability, sustainability, innovation and governing*.

1.1. Concept of Siberia as a megaregion and the state of art in power sector

Understanding Siberia as a megaregion suggests the totality of space and time, the shared perception of the unfolding history, close cultural links, the integrity of similar environment landscape and climate, integrated economy and conjugated transport infrastructure.

Modern concept of the megaregion corresponds with the historically developed view of Siberia. For instance, in the Encyclopedic Dictionary, released in Russia in 1890, there is such a definition "… By the name of Siberia, in the broad meaning of this notions, defined all the Asiatic possessions of Russia".

Contemporary Russian experts, though few in number, try an attempt to comprehend Siberia as an entire inseparable space from the Urals up to the Pacific Ocean [1]. It's worth noticing, that such an interpretation of Siberia is also present in the respectable foreign publications, such as the Encyclopedia Britannica and Americana (fig.2). For example, the latter looked upon Siberia as "the vast Asiatic part of the Soviet Union, extending from the Ural Mountains up to the Pacific Ocean" [2].

Figure 2: Siberia as megaregion of Russia

It's worth distinguishing the proposed concept from the current administrative division of Russia into regions, which makes up 85 subjects for governing, and then they form up 8 federal districts or counties. The recently proclaimed new strategy of spatial development of Russia suggests the division of entire Russian territory into 12 macroregions, taking into account the cluster connections of regional economies.

Such uncertainty in arranging regions' activities, i.e. 85 subjects-8 districts-12 macroregions, demonstrates the real demand in a more proper system approach to regional governing. In difference with this, the concept of megaregion suggests the stable, rooted in history, long-termed comprehension of Siberia as an entity, not as a set of separate units. Consequently, Siberia is vividly understood and analyzed as a complete entity, not as a number of distinct administrative items. Entity doesn't exclude particular, but particular cannot be general.

The concept of Siberia as a megaregion provides an opportunity to bestow new meanings to energy policy in Russia.

Siberia occupies 75% territory of Russia, obtains 92% coal, 88% gas and 70% oil reserves in Russia. Siberia provides 33% of national electricity, which at 38% is generated by conventional coal power plants. For comparison, in Russia only 14% electricity is produced by coal in 2017. The highest in Russia growth rate of electricity demand is expected in Siberia

in 2018-2024, i.e. 2% annual growth versus 1,22% on average in Russia. So, Siberia represents itself as an important agent of energy strategy of Russia, especially in fossil fuels.

Siberia is rich not only in hydrocarbons, but it contains 95% fresh water resources and occupies 79% forest area in Russia. There is quite a lot of sunny and windy days (optimum angle of PV modules =4.5 kWh/m^2 per year and wind power density = 1000 W/m^2), and that allows to dream of some solar and wind stations as the first modest steps towards harnessing renewable energy.

Plus to this, Siberia is closely connected with the Arctic and using energy, industrial and human potentials of the megaregion can do its own bit in realizing effective climate change policy in Russia.

Processes in energy sector of Siberia, at a considerable extent, determine "grand" energy policy of Russia. Combination of conventional and renewable sources of electricity in Siberia can shift priorities in Russian energy strategy to efficient response to global challenges, i.e. New industrial revolution, digitalization of energy and climate change.

1.2. Methodology of comparative analysis

Methodology is based on comparison between the prevailing in Siberia conventional sources of electricity – coal and gas, and the emerging renewable energy – solar and wind, across *five dimensions – availability, affordability, sustainability, innovation and governing* (tab. 1). Analytical framework for comparative analysis is based on *three methodological principles*:

- Principle of contradiction, i.e. the point counter point (vice versa) of two sources of electricity. i.e. conventional and renewable energy in the socio-economic content of Siberia.
- Principle of cost-benefit analysis (broaden approach), i.e. defining the positive and negative effects of each source of electricity along each of the five dimensions.
- Principle of inner contradiction, i.e. in every dimension the positive aspects of particular source of energy can mutilate into negative sides or vice versa.

Dimension of availability has a rather clear meaning, i.e. electricity generation should be supplied by necessary resources, such as primary sources of energy, basic and rare earth metals and minerals, water, and high quality labour force. The more various and abundant resources are available, the better for electricity generation.

Dimension of affordability means the possibility of producing electricity owing to the well-established grid infrastructure and reasonable prices for business and society. If to "plug and play" is easy, fast and cheap, then such a source of energy seems to be affordable [3].

Dimension of sustainability presumes the impact on health of inhabitants, environment and climate due to electricity generation by particular source of energy. The less harm to the nature and health, the more desirable is such source of energy.

Dimension of innovation is determined by the level of breakthrough technologies in energy sector because of emerging New industrial revolution and digital economy [4]. These two new phenomena demand innovative activities and shift energy sector from the inept, capital intensive one with medium-low R&D expenditures into the dynamic industry with intensive R&D, energy start-ups and high qualified specialists. Innovative activity is defined by the capability of energy sector to create novel technologies on the basis of R&D in the track to New industrial revolution and digital economy. As a rule, the higher R&D expenditures on technological innovations in this or that sources of energy, the more innovative appears to be this or that type of electricity generation.

Dimension of governing seems to be the most synthetic parameter for comparison, which accumulates and influences upon the affordability and availability of energy, effectiveness of innovative activity and purposefulness of ecological regulation. At the same time, huge reserves, extended grids, unique nature and mode of R&D activity, in their turn, predetermine the pattern of governing [5]. The dimension of governing is vividly realised in the performance of government agencies, business and NGOs to manage the processes of electricity generation for the sake of getting benefits for society as a whole. The more predictability, flexibility, quickness in response to electricity fluctuations are present, the more governed is this or that source of energy.

Firstly, current costs and benefits of conventional and renewable energy are examined along each of five dimensions in the socio-economic content of Siberia. Secondly, expected effects are derived from different final purposes of electricity generation in Siberia, i.e. serving the well-established resource economy or taking up a track towards New industrial revolution and digital economy.

3 Data collection

Methodology is based on the collection of statistics from 15 specialized data bases, which provide figures and information in mining and electricity industries from 24 regions of Siberia for five years, 2013 – 2017 years. In general, more than 50 indexes have been examined and here are represented the most evident and conspicuous indicators, which provide the vivid picture of positive and negative effects, especially, for the conventional sources of electricity in Siberia.

As for renewables, there is the shortage of regional statistics. The sector of renewables is still emerging and going thru the stage of becoming. It produces only 0,13% electricity in the megaregion Siberia. The information is lacking, but on our behalf, case studies have been examined for making evident positive and negative effects of solar and wind stations in Siberia. These cases demonstrate the capacity for scaling-up new endeavours.

In addition to the primary data collection there has been done a comprehensive survey of scientific literature, analytical reports of government bodies, annual reports of energy companies, regional newspapers, releases and memos of NGOs.

4 Results and discussion

In this section there is represented the research results obtained along five dimensions for comparative analysis of conventional and renewable energy in Siberia. Each section focuses on positive and negative aspects of conventional and renewable energy according to five dimensions, i.e. availability, affordability, sustainability, innovation and governing.

4.1. Availability dimension.

By this dimension the conventional generation has a comparative advantage due to abundant reserves of fossil fuels, which can last for a few next generations in Siberia, and a well-developed infrastructure for fuel supply (railways and pipelines) [6]. But this advantage can be devaluated owing to the distraction of other conventional resources – fresh water and soil, which are aggressively exploited not only by the conventional power plants and mining companies, but also by local agriculture industry and companies, that export bottled spring water from the Altai and the Baikal lake to China.

Figure 3: The largest proven reserves of natural gas in Russia, 2016, bcm

Figure 4: The largest proven reserves of coal in Russia (basins), 2016, billion tons

Solar capacity of southern regions is well supplemented by the wind potential of eastern coastal regions in Siberia [7]. But this advantage is difficult to realize, because of the lack of extracting rare earth metals necessary for scale-up domestic production of solar and wind equipment and, then, solving the problem of utilizing toxic components [8].

4.2. Affordability dimension.

Conspicuous benefits of coal&gas in Siberia are reasonable price for electricity and heat and deep integration into the existing energy grids, which creation in Siberia goes back as far as the 1920s, the time of launching GOELRO plan. All these allow to decrease operation costs of producing electricity thanks to economy of scale in power sector, but this impossible to do for renewables.

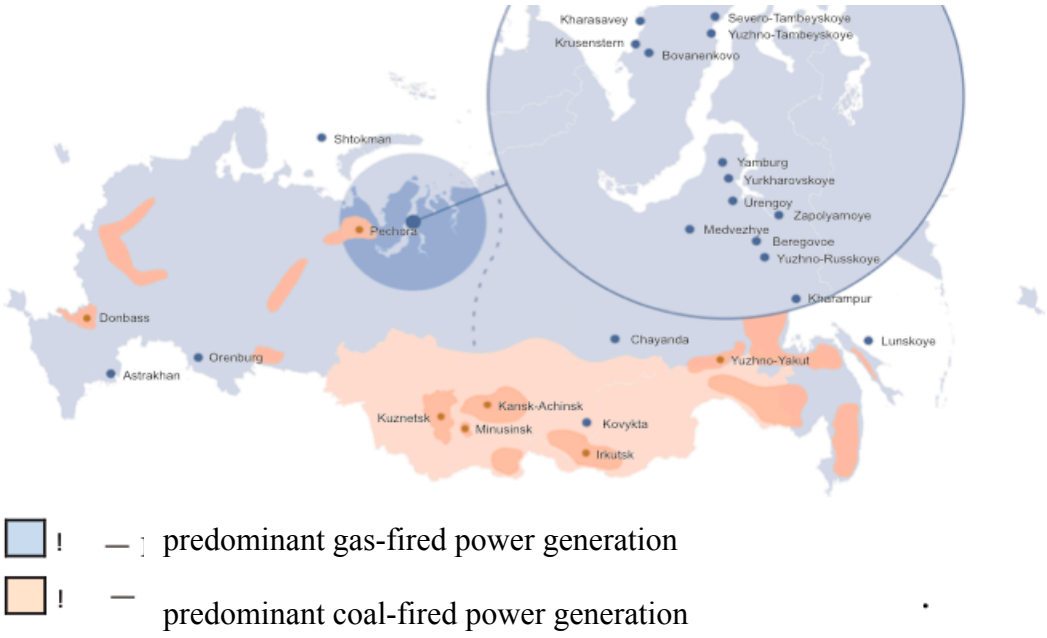


Figure 5: Predominant type of power generation in Siberia as megaregion of Russia

It doesn't mean that renewables don't have a future, in Siberia transmission losses from depreciating and theft are 20% of electricity output. For comparison, in Russia this figure is only 10%. These costs for conventional energy convert to opportunity benefits for renewables. Newly arrived decentralized energy grids and affordability for the isolated power system make renewables attractive for Siberia [9].

4.3. Sustainability dimension.

As it is well-known, coal is the dirtiest energy in the world, and megaregion Siberia isn't the exception. Coal-fired power plants lead to pollution of rivers and lakes, the most hazardous to ecology in Russia. The richest water region in Russia – Siberia has the dirtiest rivers in a country. So, all these are disadvantages of coal use.

The renewable energy seem to have all the advantages along this dimension of assessment, as their use can lead not only to environment improvement and climate stability, but also preserve the unique nature of Siberia. But these strong advantages are devaluated by public perception of the ecological and climate problems in Siberia. "We value what we see" and in case of great biodiversity in Siberia it is hard to recognize true impact on environment. Plus to that, in Russian scientific community there are polarized opinions about the causes of climate change and some expert groups have a doubt that CO_2 emission can be the cause of climate change.

4.4. Innovation dimension.

In Siberia R&D expenditures comprise only 0,55% of regional GDP (in Russia 1,1% GDP), despite the fact, that in Siberia there is concentrated a significant part of research institutes, laboratories and centres for higher education. Even having such modest R&D budget in Siberia, the fossil fuels provide major share of innovation product, i.e. 52% innovation product in 2016. Conventional energy becomes a real driver for innovative activity and the main customer of R&D in the megaregion. Research and education centres work in this field for tens of years, e.g. Coal scientific centre in Kuzbas, Research centre for oil&gas in Krasnoyarsk, etc. Many education programmes train up to 170 thousand conventional engineers annually in Siberia. All these strengthen the innovation image of fossil fuels in the megaregion.

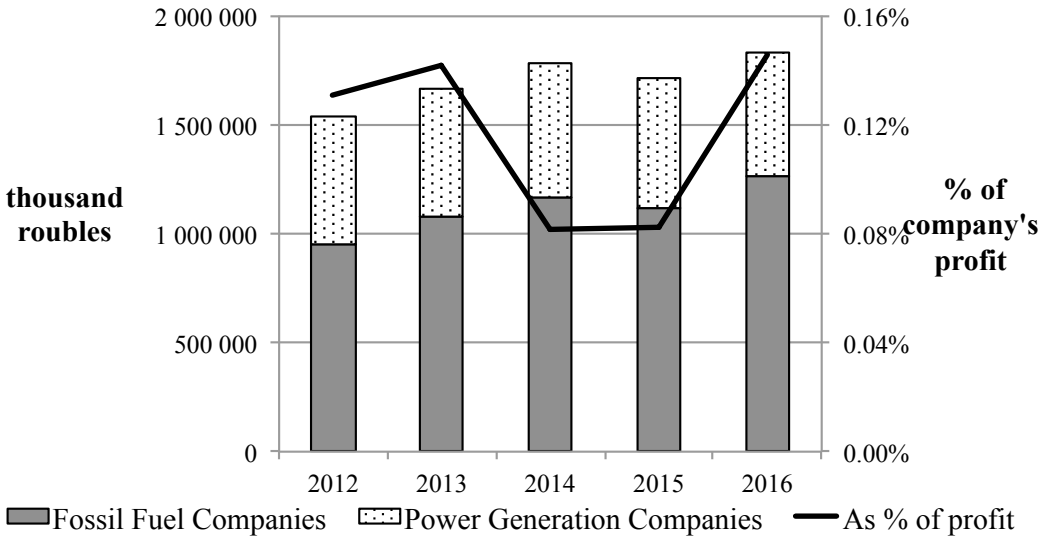


Figure 6: Expenditures of energy companies on training courses for employees in Siberia, 2017.

The renewables seem to be behind on this track. Renewable energy companies spent too little on R&D, e.g. largest Russian solar company "Hevel", that has assets in Siberia, spent only 4% of its revenue on R&D, much less than its competitor – American company SunPower with its 11% revenue on R&D. The joint ventures such as Danish company Vestas and Russian company Rosnano, localize production for renewables without addressing strong R&D support and fundamental science.

4.5. Governing dimension.

An important achievement in governing the conventional power sector in Siberia consists in the rapid response to emerging challenges, predictability and reliability of management on behalf of government and energy companies. A few big energy companies, being affiliated with the state, are capable to maneuver and change their strategy towards solving new tasks and act quickly, e.g. in case with the accelerated implementation of the gas pipeline project "Power of Siberia", exploring new reserves of gas on the Yamal and coal in Yakutia, elaborating the Northeast Asia Supergrid together with Japan and China [10, 11]. Joint and quick actions allow to increase the tax payments and foreign currency for government and financial profits for companies.

But there are also disadvantages for citizens and environment. High profitability of black coal export to China makes it's use unattractive for domestic supply in Siberia. So, shift to brown coal in power sector means health and ecological costs in the megeregion.

It seems that these actions might be undertaken thanks to the coordinated actions between Siberian energy companies, state banks and regional governments. Perhaps, it is the manifestation of the so-called "*crony capitalism*". It's necessary to keep in mind such

accidents as the cases of costs of such blended governing.

Fossil fuels in Siberia become *"too big to fail*" and the task for this business to preserve the insured revenue for stakeholders – government bodies, commercial banks and top-managers and owners of energy companies.

The policy of *"revolving doors"* makes the governing of conventional energy sector the matter of the narrow circle of "selected and trusted", serving only their interests, but not the community and citizens in Siberia.

Governing energy as common good must be performed in the interest of society to be included in discussion of the future of fossil fuels, i.e. not only their market prices and wages, but also environment, climate and health.

Plus to that, fossil business uses also "soft" instruments of governing, such as charity, grants, tips to trade unions and non-profit organization. It's interesting to notice that the main philanthropic company in Russia is the coal company SUEK, leader of coal mining and coal-fired power plants in Siberia. *Philanthrocapitalists* from fossil business, at modest expenses, i.e. less than 1% of their profit, try their best to get or buy much bigger slices, i.e. loyalty of society and authorities, their tolerance to the "dirty" electricity generation. At the same time, the headquarters of major energy companies from Siberia are located in Moscow and management is remote from their "dirty" assets – coal pits, power stations, gas pipelines, and local problems in Siberia.

Labour unions were historically main force for bargain power of energy workers, but now they don't activity oppose fossil barons, as they try to save the generation of miners and engineers, who are in jeopardy of losing jobs, because of enforced automatization and invasion of robots, especially, in monocities of Siberia, where survival depends on conventional energy industry. This position only maintains and encourages the gap between profits and wages in energy sector and creates a "great risk shift" in Siberia.

Some NGOs forcefully support fossil fuels and spread skeptical views about climate change. By the data, collected by the Ministry of Justice of the RF there are only 132 NGOs dealing with energy industry, and most of them are interested in the hydrocarbons affairs.

Renewable energy have benefited from the flexible governing, such as diversifying energy basket, building up networks effects, intensifying international cooperation and developing third sector of economy, i.e NGOs and philanthropy. However, these strengths haven't been explored to the full and worked upon in the megaregion Siberia, because the *NGOs* dealing with the renewables and environment are too scarce and they lack any influence. There is an evident discrepancy with the world practice supporting the renewable energy. The most influential renewable energy NGOs are located in Moscow and St.

Petersburg, and in Siberia they devote their activity mainly to “pure” ecological problems.

As for independent or even dependent think-tanks in Russia and especially in Siberia, they are surprisingly very rare. But they are really in great demand to carry out profound analysis and transparent information about energy choices in Siberia.

No one Siberian region or city participates in *global energy collaborations*, though some other Russian cities take part in Clean Energy Ministerial, C40 Group и Global Covenant of Mayors, etc.

5 Conclussion

Within the rapid electrification of world economy, Siberia, which is rich in conventional and renewable sources of energy, appears to be a crucial megaregion for providing economic growth and preserving energy independence for Russia.

There has been done the comparative analysis of electricity development in Siberia along five dimensions – affordability, availability, sustainability, innovation and governing. This research demonstrated, that emerging of renewable energy in this megaregion won’t impede getting economic benefits from fossil fuels, including reliability of electricity and heat generation for citizens, above average wages for energy workers, employment in monocities and some charity assistance to NGOs, etc.

But such a monostrategy can produce important costs, i.e. the absence of diversification of energy sources in the megaregion, increase of damage from ecological and climate impacts, monopoly and technological lock-in of perspective energy developments, lobbing on behalf of energy companies the governing decisions in energy sector, etc.

It’s too early to draw up the balance of costs and benefits, but it becomes evident, that the perspectives of electricity sector in Siberia are connected with technological innovations, proactive role of Russia in climate change agenda, and opportunities for international cooperation and scientific collaboration concerning energy stocks in this megaregion.

In the world where electricity has become the main energy carrier, the benefits and costs for each source of electricity should be weighed up and measured, accepted or neglected. But this should be done through fair analysis, discussed judgement and proper decision. It is important because it concerns a vast and abundant megaregion Siberia, full of uncertainty and promises.

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