Institute of Economics
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Siberian Branch of the
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Benefits and Costs of Conventional and Renewable Power Sector in Siberia

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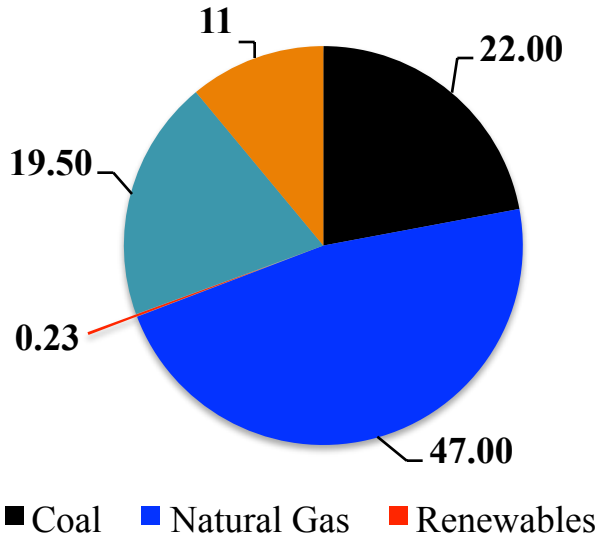
Siberia as the megaregion of Russia

Concise statistic note
(as % in reference to Russian Federation):

1. 73% territory;
2. 21% population (31 mln people);
3. 93% coal mining; 75% oil extraction; 70% natural gas extraction;
4. 39% electricity production;
5. 25% regional taxes in Siberia are received from fossil fuels and electricity production;

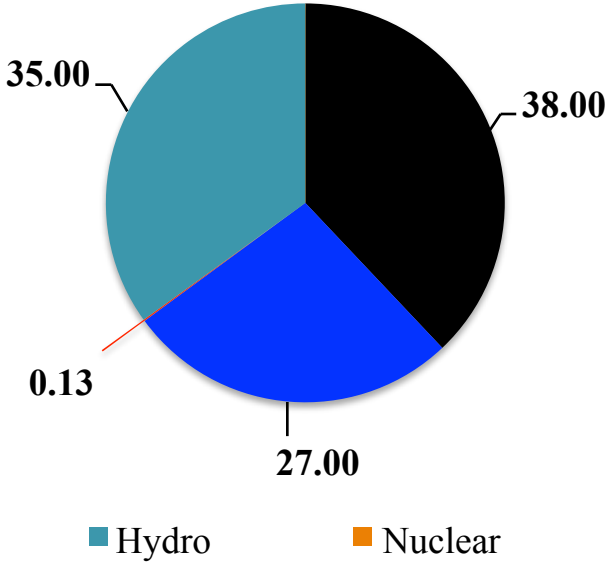
Source: Encyclopedia Britannica, Inc.

State of art in power sector of Russia and Siberia



239 812 MW

a)



92 953 MW

b)

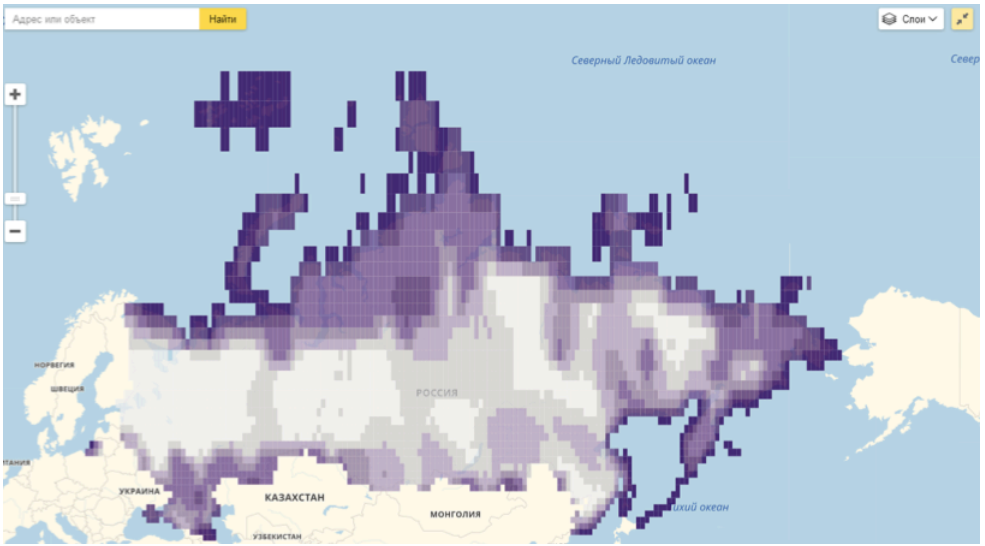
Installed electricity generation capacity in Russia (a) and Siberia (b), by energy source, 2017 (%)

Prevailing type of electricity generation in Siberia

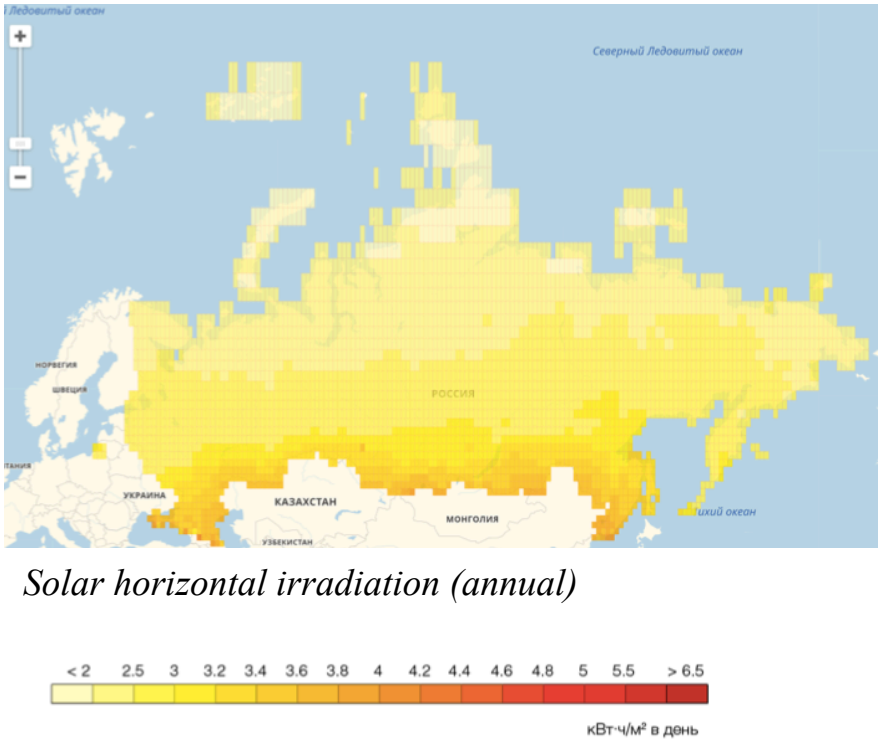
prevailing gas-fired power generation

prevailing coal-fired power generation

Renewable energy potential in Siberia



Annual wind power potential (height 120 m)



Solar horizontal irradiation (annual)

Source: Popel O., etc. Atlas of renewable energy resources of Russia, 2015

The most advanced solar power station in Russia, located in the Altai

Visit to Maima HJT PV power plant (25 MW), Altai Republic, Hevel Group, April 2019

Methodology of Cost-Benefit Analysis (CBA)

1. **Cost-benefit Meta-analysis**, i.e. the general logic of reasoning to justify the criteria inference, and use of standards and norms in order to reach evaluative conclusions.
2. **Qualitative Cost-Benefit Analysis**, i.e. a flexible set of approaches, using absolute (grading, rating, scoring) or relative (ranking, apportioning) systems for determining costs and benefits.
3. **Quantitative Cost-Benefit Analysis**, i.e. a collection of methods and rules for assessing costs and benefits of alternative public policies in monetary values.

Five dimensions for comparison of sources of energy

- **Dimension of Availability.** *Do we have enough resources to provide this or that type of energy?*
- **Dimension of Affordability.** *Can we easily, fast and cheap "plug and play" with this or that source of energy?*
- **Dimension of Sustainability**. *Which source of energy is less harmful to health and nature?*
- **Dimension of Innovation.** *Which source of energy creates new breakthrough technologies? Does this or that source of energy promise the society a better future with dynamic energy sector, energy start-ups, high qualified new jobs ?*
- **Dimension of Governing**. *Can this or that type of energy be more predictable, flexible, reliable from the performance of governments, business and NGOs?*

Empirical evidences: semi-structured interviews, statistics from 15 special databases, reports of energy companies, documents of regional and federal governments, releases of local NGOs, literature overview.

Dimension of Availability

Availability	
Conventional energy	
Benefits	**Costs**
Enormous deposits in Siberia	Major water and land consumer (up to 60% of Russia's fresh water is consumed by Siberian electricity sector; up to 80% of Russia's industrial waste is buried in Siberian ground, mostly in the form of coal ash)
Well-developed fuel supply (especially, coal)	Gap between owners' profits and employees' wages (25% versus 10% of value added, generated by energy industry in Siberia)
Main employer in some regions and monocities	Inequality at the workplace (10% of the highest paid employees get at 6-35(!) times higher salary, than 10% of lowest paid workers in energy industry)
Renewable energy	
Benefits	**Costs**
Sufficient energy capacity	Oversupply and curtailment costs
Create more jobs per 1 kWh (5.8 jobs per 1 MWa *versus* 0.81 jobs per 1 MWa of fuel-fired power generation)	Twice smaller wages at solar power stations than at fuel-fired power stations

Dimension of Affordability

Affordability	
Conventional energy	
Benefits	**Costs**
Cheapest source of energy, especially coal (LCOE is 24 US dollars per MWh)	Obsolete energy equipment, up to 60-80% of utilities and grids in Siberia
Quickly “plug and play” with well-developed energy grids	High transmission losses (twice higher than in the rest of Russia, i.e 20% versus 10% of electricity output)
High capacity factor (60% and 58% for coal and gas-fired power plants)	Expensive maintaining fuel generation under indling regime (one third of coal power plants operates under indling regime and wholesale market pays for it 309 thousand roubles per 1MW monthly)
Renewable energy	
Benefits	**Costs**
Affordable in far-off, isolated from unified power systems, districts	High capacity costs (installed capacity of renewables cost 2-3 times more than conventional one, i.e. 2.5-3 *versus* 1-1.2 mln roubles per 1 MW a mounth)
Low operational costs (0.5-0.8 roubles per 1 kWh)	High wholesale market price (34-36 roubles per 1 KWh *versus* 4-5 roubles from fuel generation)

Dimension of Sustainability

Sustainability	
Conventional energy	
Benefits	**Costs**
Soft ecological permissions and regulations (75% of violations for harmful emissions are registered in Siberia)	Dirtiest source of energy, especially coal (41% of country SO_2 emission, 29% NO_2 emission, 23% of CO emission)
Low ecological fines (460 billion roubles in 2017 or 0.5% national GDP)	High death rate per million due to air pollution (economic costs are 447 mln dollars or 12.5% national GDP)
	High climatic costs because of wide-scaled floods and wildfires with smouldering peats soils. The territory in fire is huge, in 2018 it was 8.5 mln hectares of tayga, i.e. it's bigger the territory of Slovenia more than 4 times.
Renewable energy	
Benefits	**Costs**
Very low hazardous emissions	Utilization problem of toxic elements from solar and wind equipment
No CO_2 emission in the process of electricity production	Skeptical public perception towards climate issues (34% of scientists consider the problem as not urgent and 39% of population believe that "climate is blown up fake problem")

Dimension of Innovation

Innovation	
Conventional energy	
Benefits	**Costs**
Major agent of R&D expenditures in Siberia	Small amount of spending on corporate innovation programmes (0.1-0.2% of revenue of power energy companies)
High demand on education programs and research scientists (68 universities, 75 000 scientific researchers and 170 000 graduates are involved in energy field)	No breakthrough research projects, e.g. ultra-supercritical power generation technologies, combined-cycle gas power generation technologies, CCS
Renewable energy	
Benefits	**Costs**
Rather high R&D expenditures (4% of company's revenue)	Monopolization of industry and 'technological lock-in' (solar industry is divided between two companies Hevel and Solar Systems)
Newly born industry with emerging export potential	Export limitations on electric equipment, manufactured by joint enterprises with foreign companies, because the re-export is banned (Russian NovaWind with Dutch Lagerwey, Rusnano with Finish Fortum and Danish Vestas)

Dimension of Governing

Governing	
Conventional energy	
Benefits	**Costs**
Reliable electricity and heat supply to the population of Siberia thanks to good organization and quick responses to challenges (electric power consumption is 12200 per capita)	Dangers of crony capitalism (government bodies, state banks and top-managers of energy companies are interconnected)
Significant fiscal revenues for federal and regional governments and profits for energy companies (25-40% tax revenues for regional budgets and 20-30% medium annual profitability of energy companies)	Risks of corruption (Big energy companies in Siberia have got one of the lowest index of business transparency in Russia, e.g., Siberian Generation Company has got 0.9 index from max 10 score)
Main benevolence agents in the megaregion (40% of megaregion's expenditures on charity, and coal company SUEK is the main philanthropic company in Russia)	Policy of "revolving doors", when the former bureaucrats become top-managers of energy companies and the former CEOs become government officials
Renewable energy	
Benefits	**Costs**
Diversification and energy independence	Low network activity and NGOs participation (132 NGOs dealing with energy industry, and most of them are interested in the hydrocarbons affairs)
Big profits for business (profitability of renewable electricity companies in Altai, Buryat and Khakassia Republics are 369% , 344% and 75% correspondingly in 2017)	Crony capitalism and risks of corruption

Conclusion – three alternatives

Alternatives	
If	**Then**
Energy as a common good	Conventional energy. *Benefits*: availability and affordability < *Costs*: ecological, climatic, governing. Renewable energy. *Benefits*: ecological, innovation, governing benefits < *Costs*: availability and affordability.
Energy serving business interests	Conventional energy. *Benefits*: availability, affordability, governing > *Costs:* ecological and climatic Renewable energy. *Benefits*: availability, ecological, governing > *Costs*: innovation and affordability
Energy serving state interests	Conventional energy. *Benefits:* availability, affordability, governing ≈ *Costs:* ecological and climatic Renewable energy. *Benefits:* availability, ecological, governing < *Costs:* innovation and affordability

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