



Geothermal Energy Development in Iceland

Alexey Mikhaylov*

Financial University under the Government of the Russian Federation, Moscow, Russia. *Email: alexeyfa@ya.ru

Received: 02 December 2019

Accepted: 02 April 2020

DOI: <https://doi.org/10.32479/ijEEP.9047>

ABSTRACT

The article analyzes the political and legal features of the organization of renewable energy activities in Iceland. It is designed by the relevance of using renewable energy as one of the safest for the environment, natural resources, health and life of the population. The choice of Icelandic legislation in this area is based on 85% of all primary energy of Iceland are renewable sources; a full-fledged legislation has been created in Iceland. The provisions of the National Plan for the Development of Renewable Sources were studied in 2014, which determines the direction of state internal and external energy policy. The basic legislative acts that regulate various aspects of renewable energy development in Iceland: The Law on National Energy Company and the Act of electricity produced using renewable sources. The legal status and competence of state bodies is involved in the process of making and implementing energy relevant decisions in this area, namely: Ministry of Industry and Innovation and National Energy Agency.

Keywords: Renewable Energy, Energy Law, Energy Law of Iceland, Energy Origin Guarantee, Natural Resources, Icelandic Politics

JEL Classifications: C30, D12, Q41, Q48

1. INTRODUCTION

Currently, the problem of ensuring human energy and fuel, which, of course, will be preserved in the future. One of the main reasons for this situation is the rapid growth in demand of mineral fuels in the 20-21 centuries, caused by supply discovery and exploitation of huge oil and gas fields in Western Siberia, Alaska, on the shelf of the North Sea, and on the demand side.

We have a fleet of cars and the volume of production of polymeric materials. Of course, increasing the production of fuel and energy resources has led to a serious deterioration of the environmental situation, as well as cases of irrational natural use of natural and energy resources, violation of law on the favorable environment of man and citizen.

At the same time, the development of this industry continues to gain momentum; large-scale exploration work leading

to the discovery of development and development of new energy deposits. As a result, pessimistic forecasts of the lack of traditional energy raw materials. For example, it is believed that all proven oil reserves in the world will last 56 years and gas - for 55 years.

There are a significant number of scientific developments to overcome this situation: the introduction of energy-saving installations, improving the efficiency of energy efficiency, economic restructuring in the direction of reducing the share of energy-intensive industries, etc. However, in our opinion, the most a more effective way to reduce the load of minerals, as well as process of environmental destruction and conservation of natural resources (Zubakin et al., 2015).

Owls is the transition to the use of renewable energy sources. The real practice of using this type of energy is in large number of countries. For example, Germany, Norway, Spain and other states of their energy policy in this area.

2. LITERATURE REVIEW

As a positive example of the development of renewable energy, you can consider the legislative example of Iceland. Let us single out several reasons for this.

New choice:

1. Currently about 85% of all the primary energy of Iceland is provided by renewable sources, and the share of fossil fuels (mainly oil products) in 2011 amounted to 15%. As a result, by 2016 Iceland has gone 100% renewable power sector, including 75% - hydropower, 25% - geothermal energy
2. In Iceland, a full-fledged legislative framework has been established to regulate personal aspects of the development of renewable energy (Chiemchaisri et al., 2012; Gardner et al., 1993)
3. Development of energy in Iceland is the National Energy Skye Company Landsvirkjun, which is one of the ten largest pro- renewable energy producers in Europe and activities in the form of public partnership (Ahmed et al., 2014; Mikhaylov et al., 2018; Nyangarika et al., 2018)
4. Based on the historical aspect, it can be stated that already in the 1960s. Icelandic Government Creates Anti-Change Fund climate, whose goal was to stimulate further use of geothermal energy (Amini and Reinhart, 2011; Bansal et al., 2013).

In addition, it was decided to change the idea of carbon storage (CO₂) for its reuse, including for the processing of this chemical chemicals in methanol and fueling cars (Halper, 2018; Jaramillo and Matthews, 2005).

In 2013, Iceland became a state producing wind energy as a type of alternative resources. The totality of these circumstances confirms the need to study experience of Iceland in the field of legal regulation of public relations, arising in the process of using renewable energy sources (Bove and Lunghi, 2006; Cai et al., 2011).

In order to qualitatively study the features of the legislative development of renewable energy in Iceland should lease both the main characteristics of political directions, and basic normative legal acts, the subject of their regulation, including the main definition, as well as the system of government bodies involved in the process of implementation of significant decisions in the considered area (Denisova, 2019; Denisova et al., 2019). Fundamentals of state policy for the development of regenerative energy in Iceland is laid down by the National Renewable Development Plan 2014.

In accordance with which the strategic approach of Government of Iceland, and provides for specific transition measures on renewable energy by 2020. This policy document was adopted in the framework of the implementation of Directive 2009/28/EC on the development of use energy produced by renewable energy sources, adopted by the European Parliament and Commission on April 23, 2009 (Nyangarika et al., 2019b; Nyangarika et al., 2019a).

Although the requirements of European law are not mandatory for Iceland, since the state is not a member of the European Union,

the country maintains extensive cooperative relations with the European Union, including with regard to harmonization of environmental and energy legislation bodies (Mikhaylov, 2018a; Mikhaylov, 2018b).

The programmatic provisions laid down by this directive are practically correspond to the current state of the use of regenerative energy in Iceland. However, the Government of Iceland noted the main directions politicians in the area in question that are specific to Iceland (Hreinsson, 2008).

The comprehensive development of the energy sector in Iceland is due to the following directions:

- Sustainable development and energy production based on a balance of interests person, society and state
- An energy strategy supporting diversified muscle excluding the possibility of negative impact on the environment
- Orientation of the energy sector to its sustainability, as well as to equal measured development
- The development of science and technology in the direction of studying the basic properties of air-updated sources, as well as the possibility of their application (Morris and Barlaz, 2011)
- Connecting the Icelandic electricity network to the European network (Meynkhard, 2019a; Meynkhard, 2020).

Separately, data on monitoring the state of the market for renewable sources of energy. Market access, regenerative selling opportunities energy, as well as market development (Hreinsson, 2008).

In accordance with the plan, the share of energy from renewable energy sources. In Iceland, the final energy consumption in 2005 was 63.4%. In 2009, the goal is to achieve 72% by 2020, which is mainly will be implemented by increasing the use of renewable energy in the transport and fishing sectors (Mikhaylov, 2019a; Mikhaylov et al., 2019).

At the date of adoption of the Plan, the share of energy from renewable sources is about 75%. Thus, Iceland has now reached the predicted European results; it is formed and implemented in full valuable government policy on renewable energy (Figure 1). In addition, there are practical results of the implementation of political events for each of renewable sources (Moiseev, 2017c; Moiseev and Akhmadeev, 2017).

Despite a successful result in the area under review, the Government of Iceland has developed balanced policies aimed at development and transition of the state to regenerative energy in various fields power supply.

3. DATA AND METHODS

Iceland has a well-developed system of legal public relations regarding renewable energy. Traditionally, the legal system of Iceland refers to the Scandinavian group of the Romano-German legal family, i.e., the main the source of law in it is a legislative act.

Legal regulation of activities in the field of renewable energy implemented by the following laws in force on Iceland.

Figure 1: Map of energy plants in Iceland (blue – geothermal energy plants, red – hydro energy plants)

Act on Landsvirkjun National Energy governing the legal status of a company, including functions, ownership, capital, etc. Landsvirkjun is a joint venture of the State Treasury, Reykjavik and Akureyri, whose shares set at 50%, 44.525% and 5.475% respectively (Moiseev, 2017a; Moiseev, 2017b; Moiseev and Sorokin, 2018).

The activities of the National Energy Company are captives in Art. 2 of the specified legal act:

- Organization of activities of the wholesale market of electric energy, transfer energy to public energy enterprises as well as industrial enterprises in accordance with special contracts
- Construction and operation of major energy facilities, including power lines in Iceland
- Carrying out work on the implementation of efficient, energy-saving, and so-environmentally friendly technologies
- Planning and monitoring the state of new energy facilities
- Interaction with local and local energy suppliers, including renewable energy producers.

However, there are some limitations to the activity; for example for the construction of new power plants and transmission lines.

Landsvirkjun must obtain permission issued by the Ministry of Industry loyalty and innovation (Article 7 of the Law on the National Energy Company Landsvirkjun).

4. RESULTS

Landsvirkjun National Energy Company, in particular approval and the publication of an annual performance report, including information contained in the financial statements, mandatory audits, especially the conclusion of contracts with some entities (Table 1).

Table 1: Geothermal energy plants in Iceland

Station	Location	Capacity, MW
Hellisheiði power station	Hveragerði	303
Reykjanes power station	Grindavík	150
Nesjavellir geothermal power station	Þingvellir	120
Svartsengi power station	Grindavík	76,5
Krafla power station	Reykjahlið	60
Bjarnarflag power station	Reykjahlið	3
Þeistareykir power station	Húsavík	90
Total		802,5

Source: Thomson Reuters

The purpose of this legal document is to this consists in promoting the use of renewable energy or cogeneration, as well as creating conditions for trade in this type of energy, including the establishment of a guarantee of the origin of electricity produced renewable energy or cogeneration. In addition, this a regulatory act is basic and defines the basic definitions in the area in question. Therefore, in Iceland under renewable sources energy refers to all renewable non-fossil sources, including wind, solar, geothermal energy, tidal energy, hydropower, energy biomass, gas from organic waste, wastewater treatment and biogas.

The legislation in question is related to the Land-Establishment Act, which is the implementation of the transmission of electricity.

The law in question also shares two types of guarantees (Hreinsson, 2008):

- Guarantee the origin of energy extracted using renewable sources that confirms that energy is generated from
- Renewable energy sources, including wind, solar, geothermal, tidal, hydropower, biomass energy, gas from organic waste water, wastewater, treatment facilities, gas and biogas, not fossil fuel

- Guarantee the origin of electricity from cogeneration; confirm that this or that electric power is generated using methods cogeneration in accordance with established regulatory requirements.

Warranties contain the following information (Hreinsson, 2008):

- Information about the energy producer
- Type of source from which energy is extracted
- Percentage of renewable energy use of the total amount of energy produced
- Information about the issuer of the guarantee of origin, date of issue and place issuance
- The amount of electricity generated using highly efficient cogeneration
- Calculation of primary energy savings in accordance with high effectiveness; and so forth.

This act establishes a declarative procedure for obtaining this or that type of guarantee of the origin of energy. Therefore, the energy producer must send an official request to Landsknecht. In our opinion, this method of establishing energy quality is very promising, able to exclude unscrupulous energy suppliers, to read the qualitative and quantitative characteristics of energy capacities, and explore the main ways to use this energy. Certainly, list of noted facts contributes to the observance of rights and legitimate interests end users of energy (Hreinsson, 2008).

The presented act also contains the concept of renewable sources energy having a content similar to the above.

The law in question contains requirements for treatment, application, as well as providing electricity. Having examined the basic legal acts establishing regulatory provisions research on the use of regenerative energy in Iceland should be done the conclusion that, firstly, legislative conditions for a uniform legal understanding of basic definitions in the field of public relations, secondly, there are various tools (permits, licenses, guarantees), which provide a comprehensive study, determination of quality energy produced by renewable sources.

The capacity of geothermal energy plants in Iceland is 10 times more than in Russia (Table 2).

Of course, the above list of legislative acts is not exhaustive. In fact, there are regulatory documents that regulate certain various types of renewable sources, as well as defining procedural aspects, for example, the rule on guarantees of the origin of energy generated by updated sources (Hreinsson, 2008).

Table 2: Geothermal energy plants in Russia

Name	Capacity, MW	Location
Mutnovskaya	50,0	Kamchatka
Pauzetskaya	12,0	Kamchatka
Verhne-Mutnovskaya	12,0	Kamchatka
Mendelevskaya	3,6	Kunashir
Total	77,6	

Source: Thomson Reuters

5. CONCLUSION

Before considering the gangs of special competence involved in the development of energy, including using renewable sources (Lopatin, 2019a).

The Icelandic Administration is a government body and government institution, whose main responsibilities include (Hreinsson, 2008):

- Advising the Government of Iceland on energy issues and related topics
- Promotion of research in the field of energy and administration development and exploitation of energy resources (Hreinsson, 2008)
- Regulation of electric transmission and distribution of electric system energy
- Promotion of research in the field of energy (Hreinsson, 2008).

At present, valuable government policy on renewable energy points. In addition, there are practical results of the embodiment political events for each of renewable sources (Hreinsson, 2008).

Having examined the basic legal acts establishing regulatory provisions in the field of the use of regenerative energy in Iceland, we come to the conclusion that the legislative conditions for a uniform law and order have been created need of basic definitions in the field of public relations in question (Hreinsson, 2008).

In addition, there are various tools (permits, licenses, guarantor), which provide a comprehensive study, determining the quality of energy renewable sources (Meynkhard, 2019b; Lopatin, 2019b).

Management system for the use and development of renewable energy has a clear vertically built organization model activities of state bodies in compliance with a strict hierarchy. In our opinion, this is one of the reasons for clearly divided powers, as well as the lack of the problem of expanding the bureaucratic apparatus, which excludes corruption cryogenic factor. The experience of Iceland is a positive example of the legal regulation of the sphere to be torn (Milbrabdt et al., 2014; Morgan and Yang, 2001).

REFERENCES

Ahmed, S.I., Johari, A., Hashim, H., Mat, R., Lim, J.S., Nagadi, N., Ali, A. (2014), Optimal landfill gas utilization for renewable energy production. *Environmental Progress and Sustainable Energy*, 34(1), 289-298.

Amini, H.R., Reinhart, D.R. (2011), Regional prediction of long-term landfill gas to energy potential. *Waste Management*, 31(9-10), 2020-2026.

Bansal, A., Illukpitiya, P., Singh, S.P., Tegegne, F. (2013), Economic competitiveness of ethanol production from cellulosic feedstock in Tennessee. *Renewable Energy*, 59, 53-57.

Bove, R., Lunghi, P. (2006), Electric power generation from landfill gas using traditional and innovative technologies. *Energy Conversion and Management*, 47(11-12), 1391-1401.

Cai, X., Zhang, X., Wang, D. (2011), Land availability for biofuel

- production. *Environmental Sciences Technology*, 45(2), 334-339.
- Chiemchaisri, C., Chiemchaisri, W., Kumar, S., Wicramarachchi, P.N. (2012), Reduction of methane emission from landfill through microbial activities in cover soil: A brief review. *Journal Critical Reviews in Environmental Science and Technology*, 42(4), 412-434.
- Denisova, V. (2019), Energy efficiency as a way to ecological safety: Evidence from Russia. *International Journal of Energy Economics and Policy*, 9(5), 32-37.
- Denisova, V., Mikhaylov, A., Lopatin, E. (2019). Blockchain infrastructure and growth of global power consumption. *International Journal of Energy Economics and Policy*, 9(4), 22-29.
- Gardner, N., Manley, B.J.W., Pearson, J.M. (1993), Gas emissions from landfills and their contributions to global warming. *Applied Energy*, 44(2), 166-174.
- Halper, M. (2018), Forget storing carbon; re-use it: A company in Iceland is turning CO₂ into methanol to power cars. *Renewable Energy Focus* 12(1), 56-58. Available from: <https://www.science-direct.com/science/article/pii/S1755008411700230>.
- Hreinsson, E.B. (2008), Renewable Energy Resources in Iceland Environmental Policy and Economic Value. Vaasa, Finland: Nordic Conference on Production and Use of Renewable Energy, 9-11 of July.
- Jaramillo, P., Matthews, H.S. (2005), Landfill-gas-to-energy projects: Analysis of net private and social benefits. *Environmental Science and Technology*, 39, 7365-7373.
- Lopatin, E. (2019a), Methodological approaches to research resource saving industrial enterprises. *International Journal of Energy Economics and Policy*, 9(4), 181-187.
- Lopatin, E. (2019b), Assessment of Russian banking system performance and sustainability. *Banks and Bank Systems*, 14(3), 202-211.
- Meynkhart, A. (2019a), Energy efficient development model for regions of the Russian federation: Evidence of crypto mining. *International Journal of Energy Economics and Policy*, 9(4), 16-21.
- Meynkhart, A. (2019b), Fair market value of bitcoin: Halving effect. *Investment Management and Financial Innovations*, 16(4), 72-85.
- Meynkhart, A. (2020), Priorities of Russian energy policy in Russian-Chinese relations. *International Journal of Energy Economics and Policy*, 10(1), 65-71.
- Mikhaylov, A. (2018a), Pricing in oil market and using probit model for analysis of stock market effects. *International Journal of Energy Economics and Policy*, 8(2), 69-73.
- Mikhaylov, A. (2018b), Volatility spillover effect between stock and exchange rate in oil exporting countries. *International Journal of Energy Economics and Policy*, 8(3), 321-326.
- Mikhaylov, A. (2019), Oil and gas budget revenues in Russia after crisis in 2015. *International Journal of Energy Economics and Policy*, 9(2), 375-380.
- Mikhaylov, A., Sokolinskaya, N., Lopatin, E. (2019), Asset allocation in equity, fixed-income and cryptocurrency on the base of individual risk sentiment. *Investment Management and Financial Innovations*, 16(2), 171-181.
- Mikhaylov, A., Sokolinskaya, N., Nyangarika, A. (2018), Optimal carry trade strategy based on currencies of energy and developed economies. *Journal of Reviews on Global Economics*, 7, 582-592.
- Milbrabdt, A.R., Heimiller, D.M., Perry, A.D., Field, C.B. (2014), Renewable energy potential on marginal lands in the United States. *Renewable and Sustainable Energy Review*, 29, 473-481.
- Moiseev, N. (2017a), Forecasting time series of economic processes by model averaging across data frames of various lengths. *Journal of Statistical Computation and Simulation*, 87(17), 3111-3131.
- Moiseev, N. (2017b), p-Value adjustment to control Type I errors in linear regression models. *Journal of Statistical Computation and Simulation*, 87(9), 1701-1711.
- Moiseev, N. (2017c), Linear model averaging by minimizing mean-squared forecast error unbiased estimator. *Model Assisted Statistics and Applications*, 11(4), 325-338.
- Moiseev, N., Akhmadeev, B. (2017), Agent-based simulation of wealth, capital and asset distribution on stock markets. *Journal of Interdisciplinary Economics*, 29(2), 176-196.
- Moiseev, N., Sorokin, A. (2018), Interval forecast for model averaging methods. *Model Assisted Statistics and Applications*, 18(2), 125-138.
- Morgan, S.M., Yang, Q. (2001), Use of landfill Gas for electricity generation. *Practice Periodical of Hazardous, Toxic, and Radio Waste Management*, 5(1), 14-24.
- Morris, J.W., Barlaz, M.A. (2011), A performance-based system for the long-term management of municipal waste landfills. *Waste Management*, 31(4), 649-662.
- Nyangarika, A., Mikhaylov, A., Richter, U. (2019a), Influence oil price towards economic indicators in Russia. *International Journal of Energy Economics and Policy*, 9(1), 123-130.
- Nyangarika, A., Mikhaylov, A., Richter, U. (2019b), Oil price factors: Forecasting on the base of modified auto-regressive integrated moving average model. *International Journal of Energy Economics and Policy*, 9(1), 149-160.
- Nyangarika, A., Mikhaylov, A., Tang, B.J. (2018), Correlation of oil prices and gross domestic product in oil producing countries. *International Journal of Energy Economics and Policy*, 8(5), 42-48.
- Zubakin, V.A., Kosorukov, O.A., Moiseev, N.A. (2015), Improvement of regression forecasting models. *Modern Applied Science*, 9(6), 344-353.