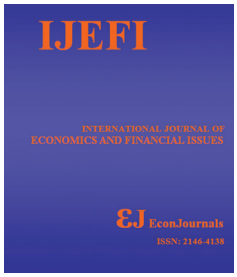

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National Policy of Japan for Stimulating Innovation Process in the Energy Industry

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ABSTRACT

The article explores the main aspects of national policy of Japan for stimulating innovation activity in the energy industry to ensure the national energy security of Japan. Japanese government has decided to renovate the strategy of energy security in a qualitatively higher level, the level of implementation of innovative projects. The following indicators were investigated in dynamics: The structure of the distribution of scientific human capital in the areas of innovative research in Japan; the number of patents in the energy field; the investment in innovation in the energy sphere in Japan. This article also highlights the components of the main areas of innovation in the energy sphere in Japan and it was elaborated the forecasting investment model in innovations in the energy field in Japan until 2025. The results were achieved within the frameworks of the governmental assignment of Russian Ministry of Education and Science in the sphere of scientific research during the researching assignment No. 26.1478.2014/K "The structural transformation of Russian Economy through the integration installation in the industrial markets of Asia-Pacific Region."

Keywords: Japan, Energy Industry, Innovation, National Policy of Japan, Innovation Project, Forecasting Investment Model in Innovations
JEL Classifications: B4, 02, 03, Q4

1. INTRODUCTION

The modern trends of economic development of the countries require a high level of energy security. However, for some countries, the independent energy production is physically impossible, and even with the development of modern technologies, and the searching for alternative sources of energy supply methods, the traditional energetic remains in priority.

Nowadays, in the condition of economy globalization in the energy sector is undergoing the significant changes. Concerning the increased attention to the depletion of hydrocarbon reserves, the risk of certain energy producing technologies, the instability of global energy markets and the volatility of energy prices, energy security, as part of national security, is becoming increasingly vulnerable to external and internal economic factors.

In Japan the energy security problems can be identified as very concentrated. The fact that the complete absence of its own energy resources because of its geographical location, the country has managed to create a sustainable energy system, which ensured uninterrupted movement of the Japanese economy to its present top position among the world leaders, is an undoubted achievement of national policy in the sphere of energy security. However, the changing international economic environment makes the Japanese government to solve emerging, often even more acute problem.

A great number of discussions which is placed in Japan about the energy issues, addressed a variety of problematic issues, such as security of nuclear power plants, disposal and processing of radioactive waste, dismantling and disposal of used reactor, the problem of non-proliferation of nuclear materials, emissions of heat energy, deregulation and liberalization of the internal market, tax policy and pricing. The challenges of the energy sector is imposed unfavorable general economic situation: The economy of this country for a long time is on the press of stagnation observed deterioration of the demographic situation, severe external economic environment, instability in global capital markets. In 2008, it began the new phase of the global economic crisis, which has exacerbated the problems of the energy complex, significantly

complicating access to the financial resources, which are necessary for the development of energy sector, as one of the most capital-intensive segments of the economy.

The issue of energy security of Japan is central problem in the society due to the fact that it is critically dependent of the imported energy supplies. Thus, according to the Report of the Japan Forum on International Relations in 2006, it was indicated that in recent years there has been a shift in the international relations caused by the escalation of the conflict of national interests in international energy markets.

In 2014, the Government of Japan for the first time after the disaster at the nuclear power plant in Fukushima, announced a strategy for energy development of the country. And despite the fact that in recent years there is a decline of energy production by nuclear power plants, the nuclear energy left as the main and most important source of the generation of electricity.

In September 2012, Ministers of Japan stated about the necessity of complete refusal of the nuclear power plants until 2030. However, in 2013, according to the speech of Prime Minister of Japan, Shinzo Abe, "Japan in the nearest future will not be able to completely eliminate the usage of nuclear energy" (New Growth Strategy, 2013). The main reasons for this decision are the high cost of alternative energy. And if the Japanese government cannot provide the country with sufficiently cheap electricity, its economic wealth will be reduced rapidly.

In such strict condition of energy providence, one of the most useful way of this situation will be development of innovation process in energy sphere. Japan has a great historical period of innovation process, and nowadays, the national policy placed supporting of innovation as one of the most important aspect of future development.

2. SPECIFIC FEATURES OF JAPANESE NATIONAL SYSTEM FOR INNOVATION STIMULATING

Japan is a unique country, but it doesn't have its own energy resources. And considering that world energy consumption will grow rapidly every year, Japan will increasingly be influenced by events taking place in the international relations worldwide. Such issues, as - the risk of oil depletion, increasing politicization of energy sector, steadily growing for a long time depending on the energy situation - makes it necessary to provide consideration of global energy security aspects for the understanding of the national policy of energy security of Japan.

Further globalization of the world economy and liberalization of the system of international economic relations may exacerbate problems of energy security of Japan. The researchers noted that the more countries involved in the global energy trade, than the smaller influence has a single country (in this case Japan) on the market. If the participating countries of the market have a heterogeneous composition (great level of diversity in their political, socio-economic structure), than the greater amount of risk threatens to the entire system (Drucker, 2012).

Japan is trying to construct a system of partnership relations with leading countries in the world, with the neighbor-countries in the region. The Japanese foreign policy demonstrates a shift from a period of "competition for the energy resources" to the period of "the energy cooperation." In this regard, for Japan it is extremely important to participate in the international ("Big6," IEA, International Energy Forum, etc.) and regional (ASEAN, APEC, East Asia Summit, etc.) organizations.

As one of the largest energy consumers in the world and it occupies the fifth place in the world for energy consumption, Japan does not have its own natural recourses, the energy industry of Japan completely focused on imports of coal, natural gas, oil and oil products.

Because of the lack of energy recourses Japan is heavily dependent on imports. Obviously, in the structure of primary energy production in Japan it has been significant changes to the reduction. Thus, in connection with the accident at the nuclear power station in Fukushima, 2011, there was in 2012 year a significant decrease in production of nuclear energy in comparison with 2008. At the same time the share of hydropower and renewable energy sources was increased.

Analysis of energy consumption in Japan from 1990 to 2010 shows that by sectors of the economy in this period the structure of the final consumption maintained stable proportions: Almost a third part of energy for industry, and a quarter part - transport, one-fifth part- the sphere of trade and services, and the other part - the private sector and the chemical industry.

However, during these years there were some structural changes. The first point is the modernization of production processes, as well as the change of nomenclature has led to the increase in energy efficiency, which led to a decrease in the share of industry from 34% to 28% in sectors of economy.

The achieved level of development of the traditional electric power provides Japan the leading position in the global economy. Japanese leading position in the field of generation of electricity is due to a new technology, solutions and the usage of cost-effective equipment in power plants. Traditionally, Japan has the lowest level of energy losses in the transmission of all industrialized regions in the world. Thus, according to Federation of Electricity in Japan, the indicator of losses in power in 2000 year was 5.1-5.2% (National Institute of Advanced Industrial Science and Technology (AIST), 2014).

Technical innovations in the field of power generation, transmission and distribution of electricity make feasible the challenges facing to the electric power industry in the field of environmental protection. According to the indicators of reduction in harmful emissions power generation in Japan is much higher than in the United States, Germany, Britain and other countries (Kisilev, 2009).

During 1960-1990s the national innovation system in Japan was mainly focused on the simulation and the improvement of products and processes developed in different countries. During this period, it was formed the innovative inter-firm relations that promote the growth of intellectual capacity, and high professionalism of the workforce in innovative firms. The national innovation system of Japan during this period, mostly constructed on the isolation and self-sufficiency of the business, a clear system of lifetime employment and promotion, as well as training of personnel in the firms. The indicators of self-sufficiency are maintained by closed system of financing, consisting of a separate bank for each of the major companies.

It should be emphasized that Japan did not participate in the process of global integration of innovation and had one of the lowest place in this sphere in the world. For example, foreign companies produced in Japan only about 4% of innovative products, while in the United States and EU countries, this proportion had increased to an average of 12%.

Accordingly, the share of foreign investment in Japanese R & D was also significantly lower than in the United States and the EU (18%).

By the end of the 1980s the government and business in Japan realized the necessity of a new strategy of innovative development.

The government of Japan actively use the experience of other OECD countries, such as the principles of innovative development of the American Competitiveness Initiative (ACI) of the President of the United States in 2006, European Competitiveness and Innovation Program (CIP) for 2007-2013 years, Innovation Support Program for Small and Medium-sized Enterprises (SME), the English Framework for Science and Innovation Investment Framework (2004-2014 years) and the OECD Innovation Strategy (OECD Innovation Strategy, 2008).

The national policy of Japan based on the following structure for innovation stimulation in the energy sphere. The innovation activities of enterprises in the energy sphere are supported by different levels of national administration in Japan. It consists of three main levels - Government level, Ministry level and Local level (Figure 1).

The Japanese government with the members of the Cabinet of Japan, has developed a set of documents governing the innovation process of the country up to 2025. There are three Councils which are responsible for controlling the main aspects of innovation process in Japan.

The Council for Science and Technology Policy (CSTP) was established in 2001 for improving the coordination in the field of science, technology and innovation. It headed by Prime Minister of Japan. The Council consists of six ministers and the president of the Science Council of Japan. It consists of seven groups of experts who develop proposals on the strategy in the priority areas for reform of the science and technology sector, biotechnology, the use of achievements in space, intellectual property management. The Strategic Council for Intellectual Property develops a policy and strategies in this area. The creation of intellectual property and its protection is the important part of the innovation process, which is fixed in the Strategy for the development of intellectual property in Japan, as well as in the strategic document "Creating of the innovation and global dissemination of information 2025."

The Council for Innovation Strategy was directly involved in the development of important strategic document of the Government of Japan "Innovation 25" - a comprehensive development strategy of the innovation economy of the country until 2025. It should be noticed that the main emphasis is placed on interdisciplinary and inter-agency coordination of the main innovative projects.

The economic security of the energy sector in Japan is largely based on the production of low-cost energy. However, the modern realities are forcing Japan to import the expensive energy issues. In this connection, during over 30 years, the government of the country, as well as private investors, invests funds in the development of the innovative technologies in the energy sector of Japan.

Thus, in Japan the support of innovation activities carried out at three levels of the government. Firstly, the innovations are supported directly by Prime Minister of Japan, who acts as the Chairman of the CSTP. The Council was established in 2001 and its main objective is to develop the key strategic directions of innovation development. The important function of the CSTP is the distribution of budget funding between subordinate organizations. Secondly, the support for innovation in the energy sector is engaged at the level of Ministries. Each ministry supports the innovations in its sphere that allows creating a complete view of national innovative projects.

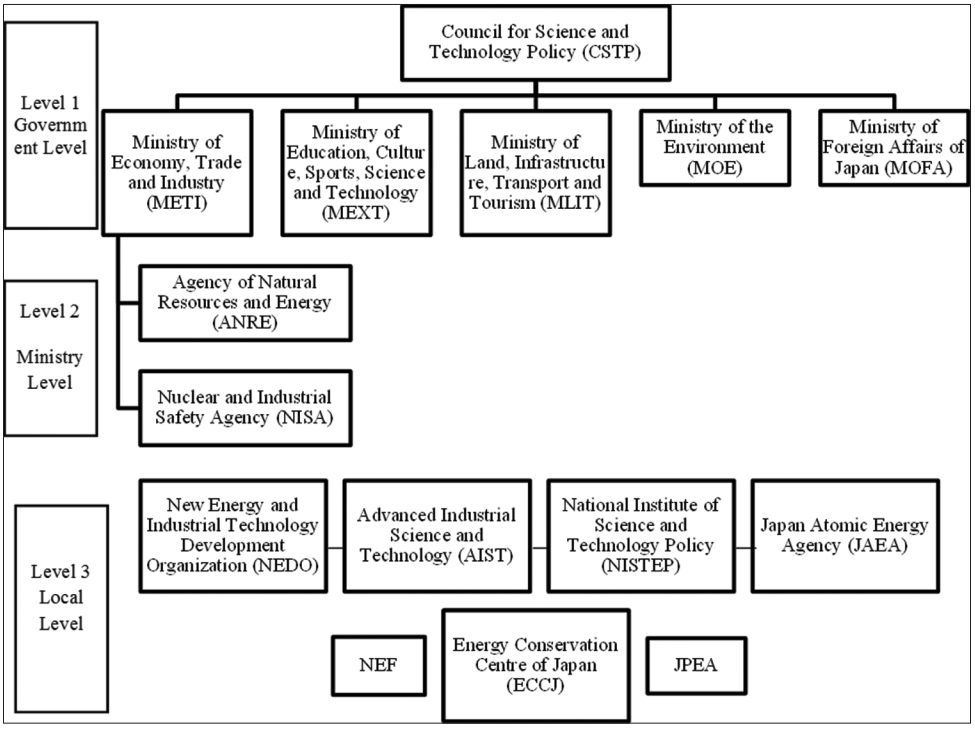
For investigating the level of support, it is necessary to evaluate the main projects for innovation in the energy sector, as well as to determine the potential for the development of innovation environment of the energy field.

The data of the number of innovation projects which developed in the field of energy sector in Japan was presented below (Table 1).

According to the topic of this research we can say that the Japanese research organizations are constantly developing the various projects for finding a new form of energy, as well as the improvement of existing ones. The largest number of projects was presented at the National Institute of Advanced Industrial Science and Technology. It has established 10 research divisions, and each of them are engaged its directions.

It is important to analyze the human capital of innovation sphere of Japan. The important place in the innovation sphere occupies the doctors of science, which in many ways have the impact on the development of innovation in the country. However, besides the internal human capital in Japan are also involved the foreign scientists who work in the country only under the contract and cannot assist in other areas of science.

Figure 1: Government support of innovation activities at different levels in Japan



(Source: Zainulin, 2012; Kisilev, 2009; Motohashi, Kazuyuki, 2011; Abe, 2009)

Table 1: Data of innovation projects developed in the energy sphere in Japan

Organization	Number of projects in energy sphere	The main aspects of researches
The NEDO	39	Fuel and hydrogen energy technologies, renewable energy technologies, energy saving technologies
AIST	147	Renewable energy projects, projects of solving the problems of Fukushima, solar energy
NISTEP	115	Projects of all types of energy sphere
NEF	28	Geothermal energy, "green" energy, renewable energy, solar energy

(Source: Anshin, 2005; Goto, 2009; Kisilev, 2009; Motohashi, Kazuyuki, 2011). NEDO: New Energy and Industrial Technology Development Organization, AIST: Advanced Industrial Science and Technology NISTEP: National Institute for Science and Technology Policy, NEF: New Energy Foundation

In 2008, Japan had over 17945 people working in innovation research sphere. It was shown the distribution of the doctors of science in the areas of innovation research in Japan (Figure 2).

According to Figure 2 in 2008 the number of researchers in the energy field in Japan amounted to only 421 people, while the share of Japanese scientists was more than 70%. It was also shown that in the industries which related with the energy development there was great number of scientists (for example, nanotechnology, information technology and communications, multidisciplinary sciences). After the disaster at the nuclear power plant in 2011, the Japanese government adopted a series of measures to increase the focus on the further development of innovative provisions in the energy sector. We compared the amount of scientific human capital. It was considered the distribution of scientific research in the areas of innovation in Japan in 2014 (Figure 3).

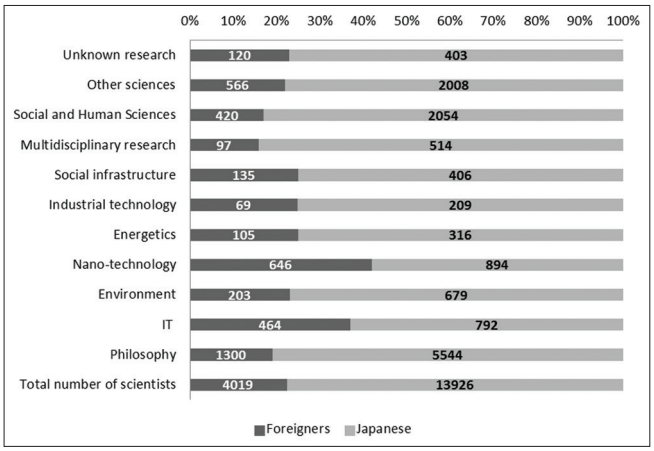
It was identified that there is not only the overall increase in the number of doctors of science in all areas of innovation, it was identified that there is a rapid growth of the number of doctors of science in the energy field (3 times in comparison with 2008). These data suggested that the Japanese government is taking some concrete measures to encourage the development of innovation technologies.

In addition, in the energy field it was a rapid growth of the number of patents in last decade. However, in Japan, the number of patents is significantly lower than in the USA and EU (Figure 4). Japan occupied third position in the ranking of the number of patents in the energy sphere in the world.

Thus, in Japan there is some growth of granted patents in the energy sphere, which means a positive effect for stimulating innovation activities in the energy sphere in Japan. It was also considered the amount of investment in innovation in the energy field in Japan (Figure 5).

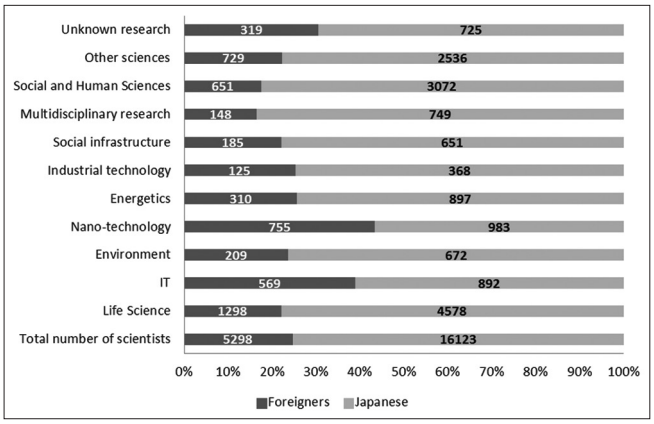
It was suggested that in total aggregate investments of innovation the share of public investment in the energy field is inconsiderable, but the foreign investments and investments from the private sector are more significant (Figure 5).

Figure 2: The distribution of the number of doctors of science in the areas of innovation research in Japan, 2008



(Source: White Paper on Science and Technology, 2011)

Figure 3: The distribution of the number of doctors of science in the areas of innovation research in Japan, 2014



(Source: Main Science and Technology Indicators, 2013; Highlights of Science and Technology Indicators, 2015)

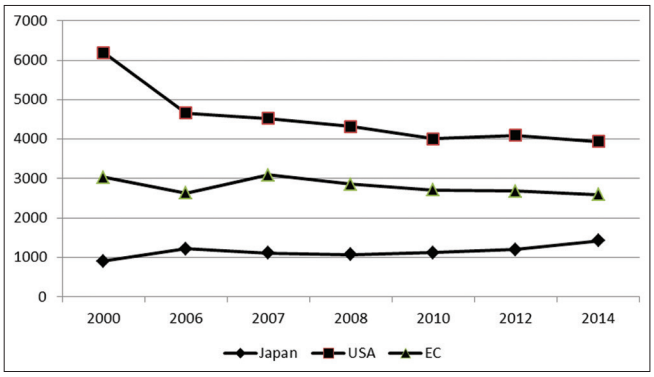
In general, the volume of investments in innovation has grown by almost 8 times, while the share of government investment has increased by more than 2 times. The Japanese government reached such significant investment in innovation by providing incentives and subsidies to business by using energy-saving technology which does not require substantial government funding.

Thus, we can note a positive trend in the stimulation of innovation in the energy sector in Japan.

3. FORECAST OF INVESTMENT DEVELOPMENT IN INNOVATION IN THE ENERGY INDUSTRY OF JAPAN

For the analysis of future trends in the field of innovation in the energy industry, it was created the forecast model of investment in innovation in the energy sphere in Japan. For creation of the model we used the method of extrapolation, which is based on the average absolute growth. For calculation of the forecasting trends we calculated the average absolute growth of investments (Table 2).

Figure 4: Dynamics of the number of patents in the energy field in the world, 2000-2014



(Source: Energy Security, 2006; White Paper on Science and Technology, 2011; Japanese Science and Technology Indicators, 2013; AIST, 2014)

Figure 5: Dynamics of investment in innovation in the energy sphere in Japan, 1981-2012

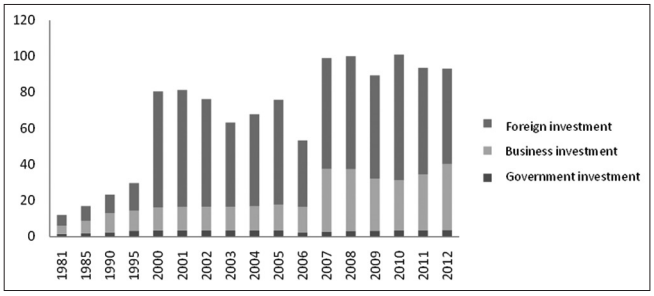


Table 2: The calculation of absolute increase in investment in innovation in the energy sector of Japan, 2000-2012

Years	Amount of investment, trillion yen	Absolute growth, trillion yen	Growth rate, %	Growth of increasing the rate, %
1995	29.76	-	-	-
2000	80.59	50.83	270.80	170.80
2001	81.38	0.79	100.98	0.98
2002	76.3	−5.08	93.76	−6.24
2003	63.32	−12.98	82.99	−17.01
2004	67.92	4.6	107.26	7.26
2005	75.96	8.04	111.84	11.84
2006	53.32	−22.64	70.19	−29.81
2007	99.1	45.78	185.86	85.86
2008	100.06	0.96	100.97	0.97
2009	89.52	−10.54	89.47	−10.53
2010	101.02	11.5	112.85	12.85
2011	93.67	−7.35	92.72	−7.28
2012	93.2	−0.47	99.50	−0.50

We calculated the indicators of the average growth of increasing the rate (Formula 1).

$$\overline{T_{np}} = \overline{T_p} - 100\% = \sqrt[m]{k_1 \times k_2 \times k_3 \times \ldots \times k_m} - 100\% \qquad (1)$$

$\overline{T_{np}}$ - Average growth of increasing the rate

$\overline{T_p}$ - Average growth rate

k_1-k_m - Coefficients of growth rate
m - Number of periods.

Thus, the average growth of increasing the rate of investments calculated below (Formula 2).

$$\overline{T_{np}} = \sqrt[11]{3,1372} - 1 = 0,109 \quad (2)$$

And then we made the extrapolation method by using the indicator of the average growth of increasing the rate (Formula 3).

$$S_t = S_0 \times \left(1 + \overline{T_{np}}\right)^t \quad (3)$$

$\overline{\Delta}_X$ - Average absolute increasing of rate
S_0- Amount of investments at the beginning of forecasting period
t - Number of forecasting periods.

Using these formulas we perform the forecast of investment in innovation in the energy sector for 2015, 2020, 2025. The results of this calculation are presented at Figure 6.

Thus, the calculations showed that if the growth rates of investment in innovation of the energy sector are unchangeable by 2025, they will grow up to 357.71 trillion yen.

The main areas for stimulating the innovation in the energy industry in the country are a specially developed "Program of preferential electricity (feed-In Tariff program)" (Green Evolution, 2014). The essence of this program is to provide subsidies and tax stimulations for manufacturers of solar energy, as well as producers of renewable energy.

Nowadays, the researchers in Japan are developing several perspective innovation projects in the energy sphere. In 2012, it was announced about the construction of the largest photovoltaic power plant in Japan. The construction will be engaged in the corporation "IHI" and "Mizuho Corporate Bank Ltd" (World of innovation, 2012). The project area covered by the new power plant will be about 314 acres, and much of it will be located on the water surface. According to the project, the plant will produce 70 mvt electricity, which is enough, for example, to power 22,000 homes. The construction cost will be 25 billion yen, while corporations are going to take advantage of preferential rates for those using renewable energy.

Another innovation project in Japan is considered to launch a space energy station. "Mitsubishi" and "IHI" corporations plan by 2040 to launch the first space power plant (Cosmic electricity, 2010). The cost of this project is estimated at 21 billion USD. The estimated area of the solar cells for space power plant will be 4 km^2.

Nowadays, CSTP has selected 235 projects as the most perspectives which will be supported in near future perspective.

The main directions of innovation activities in the energy sector, which selected by the Japanese government for implementation until 2050 are presented in Figure 7.

Figure 6: The forecast of the amount of investments in innovation activity in the energy sector of Japan, until 2025

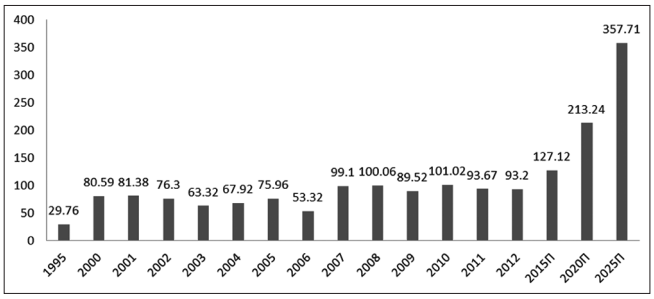
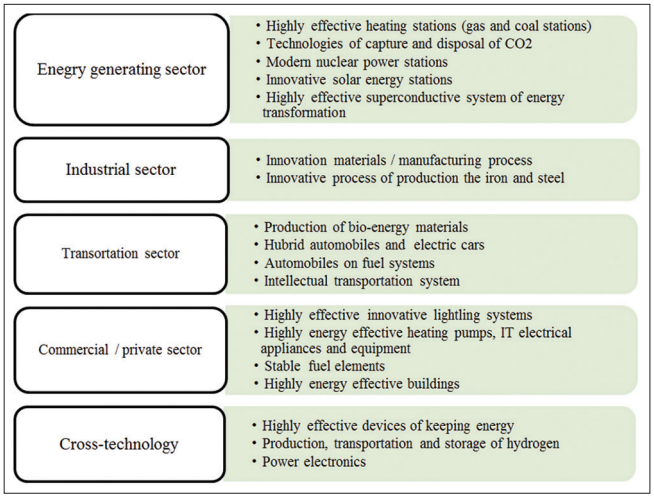


Figure 7: The main directions of innovation activities in the energy sector, supported by Japanese Government



(Source: New Growth Strategy, 2013; White Paper on Science and Technology, 2011; New Energy Foundation, 2014), Energy White Paper 2013

Generally, it can be concluded that the modern Japanese energy strategy looks very positive. The measures, presented in the New Energy Development Plan of the country, were evaluated in aspects of efficiency. It was used the method of paired comparisons. And also the research of the main strategic directions of energy development revealed that Japan provides a special attention to promotion of innovation in the energy sphere. During our research we evaluated the investment in innovation in the energy sphere, and provided the forecast by extrapolation method.

It was analyzed that the most important issue of Japanese policy of energy security is the minimizing of the negative impact of the unstable situation of some foreign countries and regions of the world. According to this, the priority for energy safety of the country is a geographical expansion of energy supplies, and the penetration of Japanese companies in the extractive industries.

The research of main issues of the energy security, as a part of Japanese national security policy, determined that, despite the conducted measures, nowadays, Japan is still one of the most volatile countries in the world. The share of imports in the consumption of energy is about 85%, and the national energy sector is completely oriented to import of liquefied gas, coal,

oil and uranium. Analysis of the energy balance of Japan clearly shows that as the process of globalization, the volatile economy will have constant increased impact of the events taking place in foreign countries.

In modern global conditions, the Japanese government decided to upgrade the national strategy of ensuring energy security in more quality level. In 2002, it was passed the law of "Principles of Energy Policy," and Japanese government has developed the National Energy Strategy 2006 and the Basic Energy Plan 2007, The concept of international energy security in 2010. The new program documents establish the principle of the "Three E," however, it has focused attention on energy security.

The estimations of the world experts suggested that in case of positive results of Japanese scientists in the programs which developed by 2050, the country will achieve the double reduction of air emissions (Tokyo Electric Power Company, 2013).

In 2010, a new document has been formed in the area of energy innovation in Japan, titled "Green Innovation." This document contains three major projects:

Project 1 "Rapid spread of renewable energy sources"

Project 2 "City of the Future" ("low-carbon" society due to the modernization of urban infrastructure)

Project 3 "Distribution, development, revitalization of forestry."

These projects will help to create more than 1.4 million jobs by 2020; to receive an income of about 50 billion yen; to receive the growth capacity of the market of renewable energy to 10 billion yen.

4. CONCLUSION

The research of Japanese policy in the energy sphere over the past decade leads to the conclusion about the importance of innovation in the energy sector in order to ensure national energy security.

Nowadays, the success in innovation development in the energy field can be the impulse for the resumption of economic growth in Japan, because for Japan the energy security is the key issue to enabling the existence of the whole economy of the country in the future periods of development.

Therefore, the support for innovation in the energy industry in Japan is a priority for the government, especially after the disaster at the nuclear power plant in 2011. Nowadays, there are 1207 employed doctors of science in the innovation sphere and more than 1420 projects in the energy industry. The investments in the energy innovation is constantly growing and, based on calculations in the near future it will continue the growth. In this regard, it is the increasing relevance of the future development of mutually beneficial cooperation between Japan and Russia in the development of new energy projects.

5. ACKNOWLEDGMENTS

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