

**Łukasz Tolak**

Collegium Civitas, Warsaw, Poland

## **JAPAN RETURNS TO ATOM. CURRENT STATUS AND PROSPECTS OF THE JAPANESE NUCLEAR ENERGY**

### Introduction

On August 11, 2015 the nuclear reactor Sendai 1 was restarted. The reactor was finally incorporated into the electricity grid in early September (*Japan Nuclear Update. Four Reactors Move Closer to Restart* 2016). The second nuclear power plant reactor – Sendai 2 started on October 15, 2015 (*Second Japanese reactor restarted* (2015)). Both running reactors belong to Kyushu Electric Power Company and power station is located in Kagoshima Prefecture in the southern part of the Kyūshū Island. In the near future it is planned to launch two further units belonging to the Corporation Kansai – Takahama 3 and 4 – in January 2016 and February 2016 respectively (*Japan Nuclear Update. Four Reactors Move Closer to Restart* 2016).

There are still more than 20 reactors in the process of verification of the security systems and improvements, waiting for the restart. In this way, has ended a two-year period of total exclusion of nuclear reactors in Japan. The decision to run the reactors, was taken despite strong opposition of the local community and ecological movements (*Japan restarts second nuclear reactor despite public opposition* 2015). After almost four years after the disaster, the process of redefinition of the Japan's energy mix, seems to come to an end.

To 2011 half hundreds of nuclear reactors that were connected to the electricity grid supplied 27% to 30% of all electricity produced in Japan. In accordance with its development strategy, share of the atom was planned to increase to about 40% in the year 2017 (*Nuclear Power in Japan* 2016). In the Government plans the expansion of atom was needed to relieve in part Japanese energy sector from the fossil fuel imports. Japanese nuclear industry ran a consistent policy of foreign investment, including the acquisition of technology and access to resources of uranium in the world. The tsunami of March

11, 2011, dramatically verified these plans. In May 2011, just 17 reactors remained connected to the network – a process of their disconnecting was completed in 2013 (*Japan. International energy data and analysis* 2015).

### Public opinion against nuclear power but the new government and industry voting for

Before the accident, opinion polls showed the advantage of proponents of the atom. About 65 percent of the Japanese supported the Government action of the further expansion of the nuclear industry (Aldrich et al. 2015). An unexpected disaster, caused a dramatic change in the perception of nuclear energy. A study of March 2013 points to only 22% support for the maintenance or the increase of the share of nuclear energy in electricity production. More than half of the respondents (53%) opted for the decrease of reliance on atom and 20% wanted total elimination of the nuclear industry (*Nuclear Power in Japan* 2016). The change of public opinion sentiment and the decline of trust in Government caused a revision of ambitious nuclear plans.

In July 2011, an Energy and Environment Council-EEC was established, which task was to prepare recommendations on the future of the Japanese energy sector by 2050. Presented in mid-September, 2012, EEC report recommended almost total abandonment of nuclear energy by the 2030s (Ban 2012). In accordance with the mentioned document the last nuclear power plants would be closed about the year 2040 (*Nuclear Power in Japan* 2016).

The document was a clear nod to public opinion, which opted for maximum reduction of Japan's dependence on nuclear energy. The deficit associated with decommissioning of production capacity had to be in the future, complemented by additional plants burning fossil fuels – LNG mainly but also coal and oil and renewables. The plan should indicate the inability to maintain the level of greenhouse gas reduction, which, in view of the large increase in the use of fossil fuels, has exceeded the established limits. Only in the period from March 2011 to March 2012, the increase in CO<sub>2</sub> emissions grew up by 17% in comparison with the similar period of 2010-2011 (Inajima, Okada 2012). In 2012, the Government introduced a support system (feed-in tariffs) for photovoltaics and wind energy. (Lambrecht, 2014) For obvious reasons, this was the long-term action, without significant influence on Japanese energy mix for the period after 2012.

A few days after publication, the Government of the Prime Minister Noda, due to the intervention of industrial elites – affiliated mainly in the Japanese Business Federation (Keidanren), changed partly its position, acknowledging that the document is an indication of a certain direction of acting, and not a precise plan. (BAN, 2012) The Japanese community of economists have fiercely criticized the idea of liquidation of nuclear energy, pointing out the huge costs and the inevitable increase in energy prices, and hence the loss of competitiveness of Japanese goods on external markets. (Doyukai, 2012), (The Federation of Electric Power Companies of Japan, 2012)

### **The costs of nuclear energy phased-out**

According to the sources provided by government agencies and Japanese economic institutes, the increased import of fossil fuels needed to replace electricity produced in nuclear reactors, was after 2011 the main cause of a record trade deficit. Only in the financial year 2013 it was (according to the data of the Ministry of Finance) about 134 billion dollars. In the period from April 2011 to May 2014 it was 227 billion dollars (*Nuclear Power in Japan* 2016).

For comparison, in 2010, Japan recorded a surplus of 6684 bil. yen - about 60 billion dollars. (Curley, 2012) The prices of energy for entrepreneurs increased too. In the period from 2010 to 2013 – the rates per kWh for industrial customers were on average higher by 28,4% (*Japan continues to count cost of idled reactors* 2014). Despite the increases in tariffs for energy and planned further price increase – the energy corporations still record losses. Only in the 2012 fiscal year the losses reached 1 trillion yen (10 billion dollar). The Kansai Electric Power Company (KEPCO), which has been reporting losses for the fourth year in a row is the best example.

Due to the intensive use of conventional power plants in the coming years the costs associated with the maintenance and replacement of existing capacity, especially of the old power plant using imported liquid fuels, will increase, too. As was reported by the US Energy Information Administration (EIA), the main way to supplement the deficiencies associated with the exception of the reactors was to increase import of gas. The LNG imports rose 24% between 2010 and 2012, from 3.5 trillion cubic feet per year (Tcf/y) to 4.3 Tcf/y (*Japan is the second largest net importer of fossil fuels in the world* 2013). In fiscal year 2013 Japanese dependency on fossil fuels as a power source increased to 88%. In FY2010 it was 62% only. Dependence on fossil fuels in the production of

electricity in Japan, greatly exceeded the level recorded during the first energy crisis in 1973.

During the period from 2010 to 2013, expenditure by households for electricity increased by approximately 20% (*FY2013 Annual Report on Energy* 2014). Expenditure on energy was in 2014 a record, reaching a level of around 14% of the total consumer spending in households with low income. In the case of households with high income – this level was lower and stood at 6.1% of total consumer spending (Ikarii 2015). In 2015 are expected some improvements resulting from the drop in fuel prices on the international market. This has an impact on the structure of the budgets of the Japanese families, causing at the same time their spending being reduced on education, and culture. The economic situation and rising costs were, and are, therefore, among the factors stimulating action on the new Government.

### The change of the government and the return of the atom

The new Government of Prime Minister Abe, formed after the victory in the 2012 elections, has made major adjustments to energy policy and accepted the responsibility of restarting the nuclear power plants. The decision of the former authorities to resume the construction of the uncompleted reactor Ohma1 (October 2012) has been maintained in force, too. From July 2013, the process of reactivation of the nuclear power plants also began. The process was applied only to a part of the reactors that have been disabled after the catastrophe.

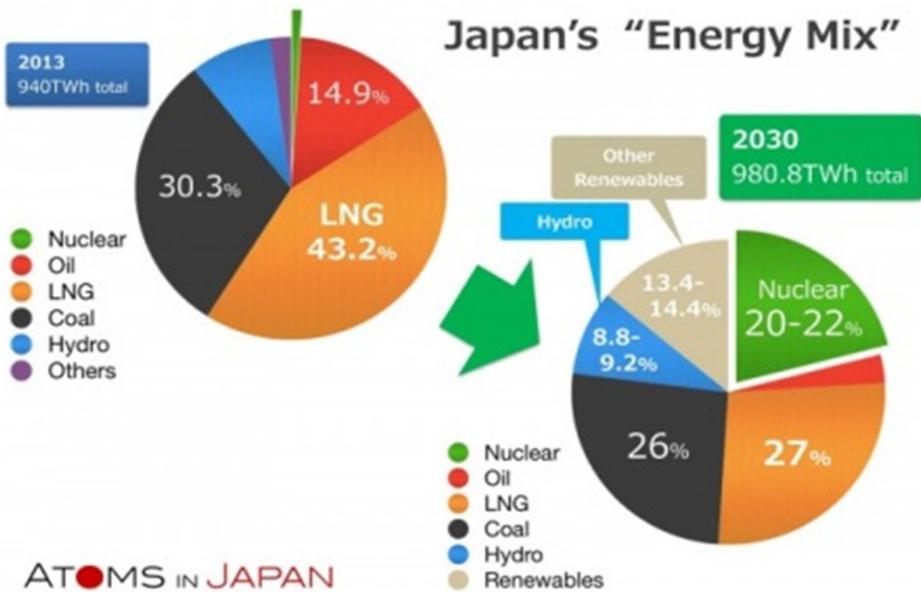
The Government's policy was met with understanding and support of industrial society. In April 2014, the Government accepted the new energy development strategy. The nuclear energy was an important part of it. At the same time, continued the processes of rebuilding institutions of nuclear supervision (NRA established in September 2012) and improving of the security procedures. Reactors are undergoing redoubled tests and verification of safety standards. The procedure initially covered 10 reactors. Currently, the process of verification and preparation to restart apply to about 25 reactors (Stapczynski, Humber 2015).

Concurrent with the policy of the Government is also a report published at the beginning of 2015, by the Institute of Energy Economics, Japan (IEEJ). The report concerns the Japanese energy development to 2030. Under the scenario considered, the 25% share of nuclear energy in the future Japan energy mix was recommended by the experts of the Institute. This level should be achieved until the end of the third decade

of the 21st century. This scenario enables the achievement of self-sufficiency in the production of electricity at 28% level and guarantee lower average rate per kilowatt hour. Estimated price level in relation to the “nuclear-free” scenario would be 16,4 Yen/kWh compared to 21.0 Yen/kWh (Akira, Aoshima, Ito 2015).

Implementation of the recommended scenario, providing for equal participation of the atom and renewable energy sources should also, in the opinion of the specialists of the Institute, have a significant impact on improving the negative trade balance of Japan. Savings associated with reduced purchase of gas (LNG), have been estimated at about \$ 18 billion a year (*Japan will prosper from nuclear restarts* 2015).

Fig. 1. The future energy mix of Japan



Source: Ishii 2015.

In the same direction goes a report approved at the beginning of June 2015 by the Advisory Committee for Energy and Natural Resources. After public consultations, the report is formally accepted by the Minister of Economy Trade and Industry (METI) (Ishii 2015). It is based on the Government's plan of reintroduction of nuclear energy

to the energy mix. This forecast assumes an increase in Japanese demand for energy to the level of 980 TWh (terawatt-hours) by 2030, from the current 940 TWh (2013).

In accordance with the proposed shape of the Japanese energy, the share of nuclear energy should be approximately 20 to 22% of the total volume of electricity production. At the beginning of the process the government was seeking a nuclear share target of 15 percent (Johnson 2015).

The level of 22% should be reached by reactivation of existing installations and by the completion of the ongoing investment. The forecast indicates the need to accelerate the implementation of renewable energy sources in the Japanese energy mix, assessing the possible participation of “green” energy at 22 to 24% level in 2030. This should allow to limit the share of fossil fuels in electricity production to about 56% (Ishii 2015). Formal acceptance of the plans presented and the already initiated process of restarting nuclear power, clearly points to the return of the atom in Japan.

### What is the real future of nuclear power in Japan?

An open question remains whether there is a real possibility of achieving such high share of nuclear energy in the volume of electricity production. The first obstacle is the current state of existing reactors and the problem of the construction of new nuclear power plants. Theoretically chances to restart in next 5 years have over 30 units. Since the disaster 11 reactors (including 6 in the Fukushima Daiichi) have been definitively closed. They are mostly reactors built in the late 1960s and early 1970s (*Japan* 2015). Power plant operators must carry out a difficult operation to close down these installations. The final costs will be known after the completion of the operation, but the process is already in progress (*Hitachi-GE signs BWR decommissioning agreements* 2015).

Even today it is known that not all reactors controlled by Japanese Nuclear Authority have a real chance to be restarted. It is not clear whether all tested units pass the extremely demanding technical verification process on time. This is very unlikely – the problem is insufficient number of nuclear specialists responsible for carrying out the nuclear safety reviews process. Costs are also important. According to the assessments of the World Nuclear Association (WNA), the restoration of one of the reactors to work in networks, will mean expenses from 700 million to 1 billion dollars (*Nuclear Power in Japan* 2016).

In a few cases, it will be almost certainly impossible for geological reasons. This applies in particular to Tsuruga 2. The reactor is located on active seismic fault. Higashi-

dori and Shika Nuclear Power Plants may be in the same situation. It rather excludes the possibility of their restart. Several other reactors, due to age, the opposition of the local authorities and other legal reasons, may not be reported to the process of restarting (*Energy Mix 2030. Reality Check: Japan's Collapse in Nuclear Power Generation 2015*).

Some of the reactors prepared to restart are likely to be closed in the first half of the next decade – for the sake of achieving operating limits. Current plans foresee the closure of at least 9 reactors. In some of the cases, life extension of service is expected (*Nuclear Power in Japan 2016*). This process continues and will continue, as it is in other countries with developed nuclear industry. This is currently the only way to maintain the production capacity and buying time in expectation of the new investments. The risk, however, is serious, because the age of most of Japanese reactors are approaching dangerously to the 40-year limit. It is possible to extend the license for operating reactors by 10-20 years, but it is not known whether, taking into account the significantly raised safety standards, it will be economically justified.

An excellent example is the Sendai 1, which currently has over 31 years of service. Therefore, in order to maintain production capacity, it will be necessary to resume the process of investment, which was stopped after the crash in Fukushima. The construction of the reactor Shimane 3 – almost completed in 2010 – was stopped after the tsunami. The decision whether to continue the construction will not occur earlier than in 2016. The construction of the Ohma1 continues. In the list of planned and proposed new investments, there are currently 12 reactors. Their planned capacity of electricity production is about 17 GWe (*Nuclear Power in Japan 2016*).

The introduction of new reactors in the second half of the next decade would solve the problem of replacing the production capacity. In all cases, however, the decision-making process and the start of the construction have been deferred indefinitely. This is due to the need to adapt the projects to new, more stringent safety standards. Moreover it is difficult to quantify the cost and timing of new investments. What complicates the situation is not the best experience with the latest generation reactors. None of all four ABWR (Advanced Boiling Water Reactor) – constructed between 1996 and 2006 – have reached the projected efficiency. Their average capacity factor to fit from 28,7% to 61,3% – is significantly below expectations (*Japan 2015*). Nine out of twelve planned reactors have to be based on the same technology.

Energy companies must take into account the social and political risk as well. The process of life extension of operating reactors and their re-entry into service, cause serious social protests – apparent clearly in Sendai 1 case (*Japan restarts first nuclear power*

*plant since Fukushima 2015*). The new investments will cause even stronger protests, both of the local communities and of a large part of the Japanese public opinion. This means serious business risk – possible delays in the construction schedule, and hence the inability to plan real investment costs. All of this makes a 20% contribution of nuclear energy in the energy mix in 2030, without new investments, unrealistic. To a certain extent, the scenarios presented by opponents of the return of the atom are more probable.

According to these evaluations, the real share of nuclear energy will be between 2 and 14% (*Energy Mix 2030. Reality Check: Japan's Collapse in Nuclear Power Generation 2015*). Without a recovery of confidence in the Government and industry, it is difficult to forecast the prospects of nuclear energy in Japan in the long run. The reluctance of the public opinion to continue the support for development of nuclear energy, seems to be an enduring phenomenon. Opinion polls in October 2014 indicate the distinct advantage of opponents of atom. About 60% of the respondents are against a rapid return to nuclear power, only 31 percent accept this process (McCurry 2015).

However, it should be borne in mind that the current ruling party won the parliamentary elections in December 2012 and July 2013, not hiding their position on the future of nuclear power.

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**Łukasz Tolak**

### **Japan Returns to Atom. Current Status and Prospects of the Japanese Nuclear Energy**

In a year and a half after the events of March 2011, Japan excluded all their nuclear reactors, returning to fossil fuels as a basis in the energy field. The shock associated with nuclear disaster seemed to indicate an ultimate end of Japanese adventure with the atom. The situation has, however, significantly changed during the last several months, and the first nuclear reactor connected again to the electric network, is a proof of the change of the energy policy. The article aims to identify the current state of knowledge on the future of nuclear energy in the Japanese energy sector and adjustments proposed in the future energy mix. At the same time, it is an attempt to analyze the reasons that led the current Government of Prime Minister Abe to take very unpopular decisions to return to nuclear energy.

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E-mail contact to the Author: [lukasz.tolak@civitas.edu.pl](mailto:lukasz.tolak@civitas.edu.pl)