



## Post-Fukushima performance of the major global nuclear technology providers

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### ABSTRACT

Fukushima nuclear disaster has negatively affected the attitude towards nuclear energy worldwide and has provoked certain policy responses. That is why today nuclear industry seems to be in trouble, primarily in the West: both AREVA and Westinghouse found themselves facing bankruptcy. On the contrary, Russian Rosatom has improved its performance in the recent years, aiming at settling down on the leading positions in the realm. Hence, the other nuclear companies could learn by example and focus more on what works in the industry: implementing a robust development strategy and scaling up. Losing momentum might have serious consequences such as considerable re-distribution of market shares or even dominance of one nuclear technology over the others in the long-run.

### 1. Introduction

The effect of the Fukushima nuclear disaster on the global nuclear markets and developments is hard to overestimate. The severity of the nuclear event at Fukushima Daiichi has been rated 7 on the International Nuclear and Radiological Event Scale (INES), the highest level and the same as the 1986 Chernobyl nuclear power plant accident. In March 2011, a nuclear meltdown of three reactors at the Japanese Fukushima Daiichi nuclear power plant (NPP) happened, followed after the tsunami, which damaged the emergency generators that were needed to cool the reactors. It has negatively affected the attitude towards nuclear energy worldwide and has provoked policy responses in some countries: for example, the accident led to “a progressive idling of Japan's fleet as new operating requirements were drawn up”, while “the German government ordered the closure of eight reactors and a phase-out policy for the remaining reactors was reinforced, which will see them all close by 2022” [1]. The effects of the event on the global nuclear market were severe enough for experts to start talking about the end of the “nuclear renaissance”, a brand used for the surge of nuclear power orders worldwide in 2000s.

The first look at the nuclear market situation post-Fukushima might seem quite worrisome. Nuclear industry seems to be in trouble, primarily in the West. On the one hand, major Western players in the realm such as AREVA and Westinghouse that have a long history behind them found themselves facing bankruptcy. While the former was saved with the state support, the latter has actually filed for bankruptcy in

2017. On the other hand, Rosatom State Nuclear Energy Corporation, which is the sole Russian nuclear technology provider, has improved its performance in the recent years. This is quite remarkable: “in the two years following the Fukushima disaster in 2011, Russian foreign contracts jumped up by 60%, despite the slump in the global nuclear power market”, so by 2014 the Russian corporation became the leader of the global nuclear energy market, building 37% of all new reactors in the world [2]. All in all, with the French companies struggling and the remaining long-time nuclear industry leaders, including the Japanese giant Toshiba — which now owns the American maker Westinghouse — encountering high costs and other problems, some nuclear experts see a slippery geopolitical slope [3].

With regard to the developments outlined above, the striking question is how did the major nuclear technology providers actually do in the post-Fukushima environment and what are the reasons behind the differences in their performance? It is necessary to track and compare their performance starting from 2011 in order to make a decisive conclusion whether the first look and impression are correct or overly superficial. Addressing the issue at stake and the global nuclear market developments through these lens is believed to be fruitful, since it raises several related questions that have tangible practical relevance. Specifically, what does work well in the nuclear business from the corporate point of view? Are there political implications of the market developments in the realm? Overall, comparative analysis herein allows to get an insight into the operations of major nuclear providers worldwide, while its implications go far beyond strictly academic

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**Abbreviations**

AP	Advanced Passive - designation of Westinghouse's pressurized water reactor design
BWR	Boiling Water Reactor
CANDU	Canada Deuterium Uranium – designation of the Canadian pressurized heavy water reactor design
CEE	Central and Eastern Europe
CEO	Chief Executive Officer
CNNC	China National Nuclear Corporation
EDF	Électricité de France
EPC	Engineering, Procurement, and Construction
EPR	European Pressurized Reactor – designation of the pressurized water reactor design developed by AREVA and EDF
EU	European Union
HEU	Highly-Enriched Uranium
IFRS	International Financial Reporting Standards
INES	International Nuclear and Radiological Event Scale
I&C	Instrumentation and Control

JSC	joint stock company – a type of public limited company
KEPCO	Korean Electric Power Corporation
LEU	Low-Enriched Uranium
LLC	Limited Liability Company – United States-specific form of private limited company
MOX	Mixed Oxide – designation of a reprocessed nuclear fuel that consists of blended oxides of plutonium and uranium
MW(e)	Megawatt (electrical) – a unit of power produced by a generator
NPCIL	Nuclear Power Corporation of India Limited
NPP	Nuclear Power Plant
PWR	Pressurized Water Reactor
S.A.	joint-stock company (Sociedad Anónima) – a type of public limited company
TVEL	Heat-Releasing Element – the name of Rosatom's fuel division
UK	United Kingdom
USA	United States of America
VVER	Water-Water Energetic Reactor – designation of Rosatom's pressurized water reactor design

interests. The study is capable of generating recommendations that are relevant for respective policy-makers and business actors.

It seems to be high time to make an analysis of the developments on the global nuclear market, since this issue has not yet received the attention it deserves. Unlike news reports, analytical studies rarely focus on the major nuclear technology providers, not to mention their comparison, Rosatom being the special case. Given the increased attention to the role of Russia on the global energy markets and its political repercussions (see Refs. [4–8]), there are some studies addressing Rosatom's operations, especially in the context of Central and Eastern Europe (see Refs. [9–12]). Yet, none of them tackled the issue of Rosatom's performance and position on the global market.

For convenience of narration, the analysis is divided into the following sections: first, the research design is presented, explaining the methodological choices that were made in the process of working on the study herein. The challenges encountered are also covered in detail therein. Then, the analysis itself follows, examining the global performance of three major nuclear technology providers – Rosatom, AREVA and Westinghouse – after the Fukushima disaster. The results section summarizes the analysis, highlighting the findings and general trends revealed. Then, the discussion section draws on the comparative analysis, dealing with the reasons behind the differences in companies' recent track records as well as the implications of the current situation on the market and its political relevance. At last, the conclusion provides an answer as to what are the contributing components to the success on the nuclear market of today.

## 2. Research design and methodology

In order to answer the aforementioned research question, the article focuses on the comparative analysis of the performance of the major global nuclear technology providers in the post-Fukushima environment. This implies a 'small N' cross-case research design [13] that is suitable for testing a hypothesis. Accordingly, based on the outlook of the global nuclear market developments and concerns raised in some Western mass media, the hypothesis can be formulated as follows: "Rosatom is outperforming its competitors, becoming the leader of the global nuclear market, and could be regarded as an example to follow".

It is clear that the case selection is crucial for the purpose of the study within the chosen research design. While the population of cases would be comprised of all the nuclear technology providers, it is necessary to focus on a small sample of the most prominent ones that would be representative. The typical case selection technique [13]

explicitly addresses the issue at stake, drawing attention to three major nuclear technology providers worldwide that are Rosatom, AREVA and Westinghouse, which have years of experience with nuclear technology and its exports.

Indeed, these three companies are the major players on the global nuclear market, being involved in various sectors of the nuclear business and having projects overseas. This does not mean that there are no other providers rather than those have minor shares on the market and are not involved in the nuclear technology exports on a considerable scale. For example, China National Nuclear Corporation (CNNC) focuses on the domestic market, while technology has been drawn from France, Canada and Russia, with local development based largely on the French element [14]. Overall, the Chinese industry is only beginning to break into the export market, with a plant under construction in Pakistan and a deal under discussion in Argentina [3]. In its turn, Canadian technology stands out, since the CANDU design is has a heavy water reactor and has a very specific market niche. Another recent player on the global nuclear market, who joined the club in 2009 is the Korean Electric Power Corporation (KEPCO). However, so far it has only been involved in one overseas project for four nuclear power plants in the United Arab Emirates [15], and it relies on Westinghouse for the supply of some key elements of a NPP through their joint venture [16]. Nevertheless, given the oligopoly nature of the nuclear market, in the mid-to long-term perspective these minor actors might start playing a more considerable role on the market, but not quite yet.

In terms of the temporal dimension, the study focuses on companies' performance after the Fukushima disaster. As it has been outlined before, it is hard to overestimate the influence of the stated event on the nuclear business worldwide. In a way, it was a real game-changer and had profound effect on the market players, which needs to be accounted for herein. At the same time, due to the availability of data and companies' reports, the study covers the period up to the end of 2016 – the beginning of 2017.

Furthermore, since examining companies' performance in a static way does not seem to be fruitful, the study strives for unveiling the dynamics of Rosatom's, AREVA's and Westinghouse's track record in the post-Fukushima environment. For this purpose, a set of indicators had been devised, while their values are compared for the years 2011 and 2016 (or 2015 owing to the availability of data). Moreover, some intermediary dynamics are outlined with the help of additional data, for example, on year-to-year changes, etc.

The indicators that had been chosen for comparison are meant to cover various segments of the global nuclear market and various aspects

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