# The future of renewable energies in Japan after 3.11 – identifying types of energy-business actor's perceptions

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## ABSTRACT

Research on renewable energies has repeatedly highlighted the importance of market mechanisms for further diffusion. Findings of a recent survey conducted among employees of companies related to the Japanese energy production sector indicate a strong commitment of these actors to abandon nuclear energy and to focus on the production of renewable energies instead. They are also stressing a great variety of arguments against nuclear energy, ranging from economic considerations to more ethical belief-based motivations to invest in renewable energy. This has implications for further Japanese energy policy making. By exploring the survey data with the set- theoretical, configurationally method fuzzy-set Qualitative Comparative Analysis (fsQCA) we are able to create a typology of economic actors who oppose nuclear energy based on different combinations of arguments. We can hereby demonstrate the importance of developing a variety of political initiatives to respond to actors' diverse motivations to invest in the Japanese energy transition.

**Keywords**: *Japan, renewable energy, diffusion of innovation, energy policy, energy business actors*

## 1. Introduction

The disaster at the Fukushima nuclear power plant on March 11, 2011 reinvigorated the global debate about nuclear energy and triggered an intense Japanese discussion about the nation's future energy policy. The former Democratic Party (DPJ)-cabinet planned concrete steps towards a further introduction of renewable energies and even a possible phase-out of nuclear power [1], but suffered a defeat in the election in December 2012. The new Liberal Democrat (LDP)-government under Prime Minister Abe favors a return to the pre-Fukushima energy policies, but public opinion still remains deeply divided. One contentious issue is the popular argument that investments in renewable energy can eventually help to revitalize the stagnant Japanese economy and to create new business opportunities in the sector of renewable energy production [2].

According to innovation literature, actors perceive investments in new socio-technical systems like renewable energy production as fraught with risk [3] and it is widely recognized that actors' investment decisions depend to a great extent on their risk perceptions [4]. Nevertheless, it seems that until now the scientific debate about the Japanese energy shift has not yet reflected on the perception of new opportunities by the actors in the Japanese domestic energy market themselves, even though these actors' risk perception could decisively influence the pace and direction of the Japanese energy sector transformation through their investment decisions.

Literature on post-Fukushima energy scenarios mostly bases its arguments on macro-economic and structural (policy-) features and systematically underestimates decisions on the individual actor-level [5-11]. This gap in research is hereby taken as a starting point in this article to further analyse Japanese private actors' attitudes towards a shift to renewable energy production. The Japanese public discourse about the future energy strategy and scientific accounts about the societal impact of 3.11 are contrasted to attitudinal data towards nuclear and renewable energies conducted in summer 2012 to depict business actors' investment decisions in the field of renewable energies.

The remainder of this paper is organized as follows: Section 2 summarizes elements considered to have a fundamental impact on the current Japanese discourse about the country's energy future. We briefly discuss general concerns related to civil nuclear energy usage, followed by a summary of the Japanese sociopolitical discourse after Fukushima. Section 3 introduces our thoughts on the driving forces for investment decisions in the Japanese energy sector, drawing from both the socio-political 'green energy'-discourse and actor's individual risk perceptions and moral considerations. Section 4 presents our analysis using fsQCA to identify certain types of Japanese actors' attitudes towards investments into the renewable energy sector. Section 5 closes with summary and concluding remarks.

## 2. Business actors between investment risk-perceptions and nuclear risk-perception after 3.11

Moral issues about the civil use of nuclear energy have long been debated and critics have kept pointing out the technological, economic and political uncertainties associated with it. Since the risks arising from nuclear energy cannot be thoroughly estimated, van de Poel [12] even equalizes the civil use of nuclear power to a social experiment and calls for a constitutive moral debate about the issue. Such a controversial debate never occurred on the Japanese energy policy-level and civil protests against nuclear energy stalled already since the middle of the 1950's, even though six officially acknowledged nuclear incidents have happened since 1981:

Table 1 Survey Items

| *Argument* | *Item* | *Survey Item* |
|---|---|---|
| Pro/Contra Nuclear Energy | Y | Japan should renounce the use of nuclear energy as of now and in the future. |
| Resource Dependency | A | Japan as a resource scarce country will depend on nuclear energy in the future. |
| Technology | B | Technology-wise it is difficult to deviate from a path that has been taken. |
| | C | Japan posesses all the technology which is needed to achieve the turnaround in energy policy. |
| Moral Argument | D | The company/organisation is convinced of sustainable energy production and consumption as a corporate social responsbility. |
| | E | The unforseeable risks of nuclear energy are too big. |
| Liberal Market | F | It's the market which should regulate the development of different forms of energy production through demand and supply. |

Source: [13]

According to the International Nuclear and Radiological Event Scale (INES) [14] the five accidents before the Fukushima disaster ranged on a lower level. INES ranges these incidents at level two and three with the exception of the Tsuruga and Monju accidents where no data exists. However, even given Japans *already* long history of nuclear accidents, it took the disaster at Fukushima to initiate a societal discourse about the country's energy future and to impact Japan's energy policy-making for the very first time. While full access to the Fukushima reactors is still not possible, some scholars think it is too early for an evaluation of the impacts of the Fukushima disaster on the future of nuclear energy [15]. Joskow and Parsons [16] for instance are surprised about the little effect the Fukushima disaster had on public acceptance of nuclear power but conclude: „While the international nuclear industry appears so far to have dodged being hit square in the head by a bullet from Fukushima, it should not expect that it will get another chance if there is another serious nuclear accident anywhere in the world." Other authors like Brooks [17] regard Fukushima to be a possible catalyst to develop a regulatory international framework for nuclear energy. This article elaborates on this point and argues that the Fukushima accident considerably changed individual actors' perceptions and re-started a vibrant discussion about the future use of nuclear energy in Japan. According to literature especially the three following dimensions decisively impact individual actors' perceptions regarding nuclear energy:

1. *Environmental degradation.* From an ecological perspective, the Fukushima accident seems to have caused severe contamination of the marine system. The exact level of radiation and its long-term effects, however, is yet unknown [18]. Scholars calculated that up to 80% of the radioactive material was released in the Pacific Ocean [19] and harshly criticized the limited availability of data sets by corresponding institutions [20]. The heavy radioactive fallout rendered the region around the Fukushima Daiichi nuclear power plant uninhabitable for the foreseeable future, while the exact long-term degree of soil contamination still remains unknown as well [21].
2. *Health impacts.* Fukushima raised concerns about health impacts not only on the local, but also on the global scale. The World Health Organization confirmed that health impacts will be restricted to Japanese territory [22] and the radiation-related mortality-rate caused by Fukushima is expected to range on a lower level than the one related to the Chernobyl accident [23]. Nevertheless, due to missing documentation about the exact amounts of radioactive material released [24, 25], other scholars are more skeptical [26]. In addition, concerns about the widespread psychological impacts have been expressed, suggesting stress disorders and anxiety not only suffered by individuals who have been directly exposed to radiation, but also caused by societal turmoil and rumours about exposure [27].
3. *Political implications*. Concerns related to the communication of the Fukushima disaster can be based on three grounds, namely the political dimension of information politics, scientific practice, and the difficulty of making the complex nature of the nuclear disaster understandable to a wider public. Industrial and political officials exercised a constant downplay of the actual consequences right after the accident happened and faced severe criticism about withholding crucial data about the scope and the spread of radioactive pollution. The radiation safety scales used by the authorities caused confusion among civil society because such scales rely on complex scientific modeling and lack descriptive qualities allowing citizens to independently value risks [28]. Since this is also true for the International Nuclear Event Scale itself, it is incapable of taking the complexity of nuclear accidents and its societal consequences into account [29]. Additionally, Calabrese [30] points to missing in-depth cesium-137 research and accuses the nuclear industry and politics of irresponsibly ignoring these research needs. Comparing the Fukushima accident with Three Miles Island and Chernobyl, media coverage profited enormously from the rapid spread of news through the internet and experiences from other accidents. However, it still demanded profound journalistic skills to report about the complex Fukushima accident correctly [31].

Considering the discursive effect of Fukushima, it can be expected that the perception of the accident as an outcome of the usage of a risk-associated technology impacts investment decisions of Japanese business actors as well, especially since serious moral questions arose from the further use of nuclear energy.

Literature highlights the importance of private sector investments in renewable energy on a national basis like the importance of policy frames to attract vital investments [32] or public-private partnership ventures [33]. Similar studies highlight investment criteria of the private sector such as energy efficiency, annual exploitability, regional energy potentials, finance technology, energy payback ratio, but especially government policy and consumption markets, influencing cash flows in the renewable energy market [34, 35]. Aslani et al. [34] consequently point to the fact that until now little systematic research has been conducted on investment decisions of private actors in the renewable energy field. However, according to prevalent literature risk perception of economic actors seems to play a crucial role influencing investment decisions. Especially technical innovations - like in the field of renewable energies - are considered to be fraught with uncertainties [3, 4, 36, 37]. In their study focusing on risks regarding investments in renewable energy projects, Komendantova et al. [38] identified three classes of risks: regulatory risks, political risks and *force majeure*, while the most important seemed regulatory risk. Sarasvathy et al. [39] describe their entrepreneurial cognitive approach in a study about risk taking of entrepreneurs and bankers as follows: “Entrepreneurs accept risk as given and focus on controlling outcomes at any given level of risk, they also frame their

problem spaces with personal values and consequently assume greater personal responsibility for influencing outcomes." This argument suggests entrepreneurial risk-taking as a constant factor and highlights the importance of value-driven decisions, leading to responsible decisions of business actors.

In the following chapter we briefly highlight the current socio- economical discourse that is framing business actors risk perceptions and investment decisions in the aftermath of the Fukushima disaster.

## 3. The post-Fukushima energy discourse in Japan

In the first months after 3.11, Japan did not only have to cope with the impacts of the earthquake, the tsunami and the nuclear accident in Northeast Japan but was also facing a severe energy shortage spreading all over the country. Initially, due to the gradual shut-down of the nations 54 nuclear power plants, many politicians publicly demanded a return to the pre-Fukushima energy strategy and dismissed the nuclear meltdown as a mere tragic but unforeseeable 'accident' [40]. In the months following the disaster, polls slowly started to point out the diminishing public support for nuclear energy in favor of a gradual transition towards renewable energy production [1]. The DPJ-governments under the former Prime Ministers Kan and Noda took first steps towards a gradual energy shift, partly based on the assumption that investments in renewable energy could help to invigorate the stagnant Japanese economy and create new business opportunities in the sector of renewable energy production [41, 42]. In August 2011, one of the highest feed-in tariffs (FIT) worldwide was introduced, which extended the previously existing FIT for solar power generation from 2009 to other forms of renewables [43]. In September 2012, the government announced the national goal of a gradual phase-out until the end of the 2030s [44], even though it had to withdraw the plan just a few days later after immense pressure from Japanese business organizations and local communities that are hosting power plants [45]. It also started to address other issues considered crucial for successfully implementing the energy transition and deregulating the electricity market, in particular breaking up the monopolist structure of the Japanese energy production sector and the separation of power generation and transmission operations.

However, the landslide victory of the LDP in the lower house elections in December 2012 changed the course of Japans energy strategy yet again. All parties – including the ruling DPJ – trying to capitalize on an anti- nuclear stance failed to gain considerable influence. The new government quickly declared its intention of reviewing the former government's policies and aimed not only at the gradual re-start of the nation's nuclear reactors, but also at the possible construction of nine new ones [46].

But the Fukushima-shock also initiated a vast amount of local legislations, initiatives and networks of cooperation in regard to energy saving and renewable energy production all over the country. It caused many Japanese firms to invest in the development of renewable energy technologies or renewable energy production, either for the sake of utilizing the high government subsidies or to become more self-sufficient in dealing with future energy shortages [47]. Japanese public opinion and the energy market have profoundly changed in the wake of the Fukushima disaster, but the question remains, whether Fukushima will be regarded as a mere historical 'hiccup' or if it left a permanent impression on Japanese attitudes towards energy production. Especially the myriads of small and big decisions taken by Japanese business actors are decisive in shaping the nation's future energy system and the fate of the vital but yet marginal 'green energy' market.

## 4. The Japanese business community and the 'green energy' discourse

The major Japanese business organization Keidanren still firmly supports nuclear energy, but various surveys indicate that the Japanese business community in general seems to be divided on this issue. A survey among 123 'influential' companies conducted by the newspaper *Sankei Shinbun* in August

2012 [48], showed that only 5 percent supported a phase-out, while over 70 percent backed the gradual re-start without imposing strict conditions on the power companies. Another study by Reuters [49] among 400 Japanese companies, however, found that 55 percent supported abandoning nuclear power as long as alternative energy resources were available and 18 percent were even in favor of its immediate abolishment. Although Japanese companies are worried about their international competitiveness, there seems to be a growing awareness among business actors that alternative forms of energy production are feasible and could also help to revive the Japanese economy [50, 51, 52].

The different positions on nuclear energy – and consequently on renewables – in Japan's business community can be summarized as follows:

1. *Proponents of nuclear power* like to point out that Japan is lacking natural fossil fuel resources and that it is completely detached from other nations' energy grids, which means that a nuclear phase-out would imply costly imports of fossil fuels and raise new questions of energy security [40]. Among these popular arguments against renewable energy are also their alleged unreliability and the high costs that are associated with a transition of the Japanese energy system [53]. This is not only posing a huge challenge for Japan's high-tech industries, but is also jeopardizing Japan's self-declared greenhouse-gas emission reduction targets [54]. In addition, a new energy system would also be difficult to establish, as certain infrastructural key projects like high-voltage grids, dams or wind farms often meet local resistance [55].
2. *Opponents of nuclear power* argue that the technology is too risky, especially in a country based on many active tectonic fault lines. The next accident might just be a matter of time, given Japan's long history of accidents and subsequent cover-ups [56]. Besides pointing out unpredictable future risks and costs of nuclear energy, opponents of nuclear power also accuse industries and politics of promoting nuclear energy as modernist *panacea* [57]. Opponents also contest the claim that the shift to renewable energy is too expensive by referring to the real costs of nuclear power production, like those arising from 'unforeseeable' accidents and the funds needed for the dismantling of old power plants and for the final storage of nuclear fuel rods [58, 59]. A decline in energy costs could also be achieved by breaking up the monopolist structure of the Japanese energy production – and transportation market [60]. Japanese companies and research institutes could lead the way in future green energy development and create new jobs and export opportunities along the way [42]. Even though Japans renewable energy output is still only a fraction of the total demand, it has significantly increased since the Fukushima disaster and as of November 2012 was roughly equivalent to the output of one nuclear reactor [61]. More than 95 percent of renewable energy is currently generated by solar power, implying a high potential for the development of other renewable energy sources like wind, biomass or geothermal energy [62]. Since Japan's economic growth rate has been low for nearly two decades, the net effect of 3.11 on the global economy is estimated to be relatively small [63]. Post-3.11 reconstruction efforts are, however, considered to re-vitalize Japan's suffering economy at large [64].

In summary it can be said that proponents of nuclear energy would argue with *Japan's resource scarcity*, *path-dependency* and *technical belief.* On the other hand, opponents of nuclear energy would rather highlight the immense *economic potential* of renewable energies, *risks* associated with nuclear techniques and *moral considerations*. Though, actors' risk perceptions and moral considerations represent rather normative than rational bases for investment decisions. Consequently, it can be argued that rational arguments for investment decisions of Japanese private business actors are always accompanied by moral considerations regarding risks of civil nuclear energy usage. The following analysis pursues to identify the reasons for actors' investment decisions in the Japanese renewable energy sector.

## 5. Analysis using fuzzy set Qualitative Comparative Analysis

A survey was designed to elaborate on attitudes of actors working in the Japanese energy sector towards renewable and nuclear energy. To test if actors would actually argue as reflected in the Japanese media after 3.11, an explorative approach followed. Since policy makers tend to treat whole sectors as entities, a cross-sectional survey addressed the broad sector of Japanese energy production which included energy producers as well as component suppliers, service providers and consultants in the field of energy production. Furthermore, it aimed at companies engaged in the nuclear, the fossil and in the renewable energy sector. The survey was dispersed among the members of a Japanese-German business network (n-512) and sent to department chiefs, directors and managers of energy companies. Due to the specific character of the survey, the response rate was expected to be low from the start. However, with 35, 84% 183 companies from the energy sector eventually responded to the questionnaire.

The items of the survey considered in this analysis are summarized in Table 1. The question of interest (outcome or dependent variable Y) is whether the actors approve the immediate abandonment of nuclear energy. This attitude towards nuclear energy is considered to be constituted by different arguments. The first argument refers to Japanese resource dependency, i.e. that nuclear energy is crucial for the Japanese energy security as Japan has no domestic fossil resources such as oil, gas or coal (item A). The next two items address arguments which consider technological aspects of a change in energy production. First, it might be argued that technological path dependencies hinder the abandonment of nuclear energy as of now (B). Secondly, it might be questioned whether the technology for the energy turn is at disposal at all (C). Then, two items refer to moral arguments to abandon nuclear energy, i.e. that it is a social responsibility to produce energy in a sustainable way (D) and that the (environmental and social) risks of nuclear energy production are too high (E). The seventh item captures the liberal argument, which stipulates that market mechanisms should decide whether nuclear energy is abandoned and renewables are fostered or not (F).

The subsequent analysis empirically investigates which perceptions – resource dependency related, technological or moral – influence the decision/conviction of actors in the Japanese energy market to abandon nuclear energy. Therefore we apply the method Qualitative Comparative Analysis (QCA) which was invented by Charles C. Ragin in 1987 with the aim to "integrate the best features of the case-oriented approach with the best features of the variable-oriented approach" [65]. It was through the enhancement of QCA with fuzzy sets (fsQCA) that the method gained a broader recognition in various sciences in the last ten years [66]. QCA as an analytic method is grounded in set theory and the corresponding Boolean algebra. In QCA, cases are not operationalized in terms of variables but with conditions or sets: "The basic intuition underlying QCA is that cases are best understood as configurations of attributes resembling overall types and that comparison of cases can allow a researcher to strip away attributes that are unrelated to the outcome" [67]. In other words, QCA argues in terms of combinations of different sets as causal conditions of the outcome. This equifinal causality contrasts with the unifinality of regression analysis where independent variables stand in competition to each other and do not offer alternatives in combination [68, 69].

The aim of this analysis is to determine which (combination) of the aforementioned attributes towards nuclear energy constitutes the decisive arguments for an actor's decision to abandon nuclear energy as of now.

In a first step, the fuzzy sets are calibrated, i.e. the arguments are rescaled into fuzzy sets ranging from 0 to 1 (Table 2). The number of possible combinations of the sets rises exponentially with the number of sets (k). The six sets of this analysis yield a total of 64 possible configurations ($2^k$), we limit this analysis to the 30 configurations that have empirical evidence though. The reduction process applies the Quine-McClusky algorithm to minimize the configurations. The resulting configurations are sufficient for the occurrence of the outcome. Two configurations are obtained, they are shown in Table 3.

Table 2 Fuzzy Set Calibration

| *Item Scale* | Fully Agree | Partly Agree | Partly Disagree | Fully Disagree |
|---|---|---|---|---|
| *Fuzzy Set Value* | 1 | 0.66 | 0.33 | 0 |

Table 3 Final Reduction Set

| *Set* | *Raw Coverage* | *Unique Coverage* | *Solution Consistency* |
|---|---|---|---|
| a*b*c*D*E*f | 0.412 | 0.062 | 0.866 |
| a*b*C*E*F | 0.637 | 0.286 | 0.857 |

Total Coverage = 0.698
Solution Consistency = 0.865

Both configurations pass the consistency threshold of 0.85. In set-theoretic relations the consistency score gauges "the degree to which the evidence is consistent with the argument that a set relation exists" [70]. As a second figure of merit, the coverage gauges the degree of the configurations' empirical relevance [70]. The distinction between raw and unique coverage is pertinent to set-theoretic relations. The raw coverage displays the ratio of the cases representing the configuration, but since sets or configurations can overlap the measure, unique coverage gauges the ratio which is uniquely explained by the specific configuration. In this measure the two configurations differ considerably. While the first configuration (a*b*c*D*E*f) represents only 6.2 percent of the outcome, the second configuration (a*b*C*E*F) denotes 28.6 percent of the cases with the outcome. Hence, the second configuration has more exclusive relevance in explaining the outcome.

The two configurations resemble two distinct types of actors with different sets of arguments as of why Japan should resign from nuclear energy. First, both types of actors agree on the following: that the Japanese energy policy could succeed without nuclear energy although Japan has no abundance in other conventional energy resources (a), that it is not too difficult to change a chosen path (b) and that Japan should therefore abandon nuclear energy. Furthermore, they would agree on the conviction that the risks associated with nuclear energy are too high (E). However, the actors of the two configurations differ in other attributes:

1. *Type one-actors.* Actors representing type one would argue that Japan does not have the technology for the energy change at its disposal (c) and that a market-led development of the energy sector is not the desirable nuclear energy exit strategy (f). It is much more a social-responsible imperative according to which these actors would resign from nuclear energy (D).
2. *Type two-actors.* On the other hand, actors of type two would argue that Japan has the necessary technology in renewable energy production at their disposal to achieve a change in the energy policy (C) and therefore should abandon nuclear energy. They would favor a market-led development of renewable energy production (F), which might be due to their believe in the competitiveness of the renewable energy technology.

## 6. Summary and concluding remarks

In section one we argued that only little research has been conducted about the perception of private business actors pushing the development of renewable energies in Japan in the aftermath of the 3.11-disaster. Both sections two and three identified constitutive elements, influencing investment decisions of actors in Japan's private business sector. Section four then provided method and data and presented our analysis.

Two different sets of perceptions of Japanese private business actors in regard to nuclear and renewable energy were identified. Both types seem to neglect the dependence on nuclear energy and

path-dependencies and would also agree that the risks posed by nuclear energy are too high to continue its civil usage. These are important findings since they highlight the generally path-independent thinking of business actors active in the Japanese energy sector. This also sharply contrasts the tendency found in the Japanese socio-political discourse on renewable energy, to be either for or against the withdrawal of nuclear energy as shown in section two of this article.

But actors differ in their perceptions of technical capabilities for the production of renewable energies, their perceptions on responsibility regarding nuclear energy and their perception of the market as a decisive force to constitute Japan's renewables market as shown in section three:

1. *Actor-type one* is skeptical about the possession of renewable energy-technologies. He stresses social responsibility and refuses the market as a driving force to determine if renewables should enter the Japanese energy market. We conclude that such an actor would support market regulating measures to achieve a responsible, future oriented energy supply in Japan. However, further research about which regulating measures are preferred by those actors is needed to design appropriate policies.
2. *Actor-type two* has a positive perception of Japan's renewable-technology capabilities and therefore considers the market to be the decisive factor in the future development of Japan's renewable energy sector. This actor would consequently not introduce policy measures as he has a strong belief in the regulating mechanism of a liberal market. Interestingly, this actor is indifferent whether or not it is a social responsibility to abandon nuclear energy.

Our study has taken an explorative approach and the findings are therefore not meant to be representative for the perceptions of the whole Japanese private business sector. We also could not address the interdependencies of the perceptions and the socio-political discourses on both, nuclear and renewable energy. Additional representative datasets and statistical measures would enable a more precise identification of a) differences in actor-constitutions and b) their perceptions.

Nevertheless, we were able to show that Japanese private business actors who are active in the Japanese energy sector do not share such polarized positions on nuclear and renewable energy usage, as the political discourse in the Japanese and international media would suggest. These are optimistic news if Japan should chose to further pursue renewable energy-policies in the future.

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