Community acceptance of nuclear power generation in Japan and relevant influencing factors

Jordi Cravioto, Mahmoud Bakr, Saizo Aoyagi, Seungwon Park and N. Agya Utama

Graduate School of Energy Science, Kyoto University
Yoshida Honmachi, Kyoto, 611-8501 Japan
Tel: +81-075-753-5488, Fax: +81-075-753-5488
Corresponding author: cravioto@namihei.mtl.kyoto-u.ac.jp

1. Introduction

Global warming is considered one of the most serious problems facing the world in the 21st century. An example of its side effects is the change in global average temperatures and its impact on human communities with sea-level rising near coasts and limited water availability in dry areas. Over the past decades considerable efforts have been directed towards evaluating alternatives to reduce the atmospheric accumulation of greenhouse gases, particularly carbon dioxide (CO_2). Several governments have set ambitious targets and have started to implement reduction implementation programs. Japan, along with other countries, has decided to take measures to limit its CO_2 emissions. The government's goal of reductions is 25% and 80% from 1990 levels by 2020 and 2050 [1]. This target will have a direct implication on the power production since today 66% of electricity is produced with fossil combustion [2] and the relationship between energy fuels and greenhouse gases is highly correlated.

In prospective, the only options available for the substitution of fossil fuels in the electricity mix are renewables and nuclear energy, each of them with advantages and disadvantages. Some forms of renewable energy in Japan seem to have large physical and economical potentials, however constraints related to the generation patterns and land required for its expansion could limit their growth to a scale sufficient enough to fill the void left by fossil fuel substitution [3]. On the other hand, until recently increasing the share of nuclear energy was high on the policy agenda in countries around the world and Japan was not an exception to it. Many believed that nuclear power would play the key role in achieving CO_2 reductions, providing a stable electricity supply and improving national energy security but the matter is still under debate especially from the effects of nuclear accidents that have led to a distrust of nuclear power among the public. In any case an urgent question arising is how would the prospective energy system be designed and if nuclear energy remains in the agenda, how much power production would be needed by 2020 and 2050? If policy aims towards nuclear energy, one of the most important issues would be the risks of energy plants compared to other power generation forms and the way these risks are conveyed to the public (Risk communication).

Under this context, social acceptance assessment is one way of enquiring about the perception of risks of nuclear power, which according to Wunstenhagen et al. [4] the concept would include socio-political, community and market acceptance. From all, community acceptance defined as that related to residents and local governments seem to be the least favourable and the most significant barrier for the success of the projects. In Japan, over the past years, some reports have explored community acceptance of nuclear power [5,6,7], however few of that research has tried to understand community acceptance focused on the difference between locations and in association to influencing factors. Such work could shed some light on what is the main barrier for the accurate conveyance of those risks to the public. The aim of this paper, therefore, is to obtain an overall score of community acceptance and analyse statistical relationships to some factors of influence such as knowledge about it advantages, risks and principles of plants, quantity and reliance of information, incorporation in the decision making and motivations to know about nuclear power. The study has focused on three community groups related to different phases of a nuclear power project cycle.

2. Method

2.1 Information and questionnaire structure:

A survey was initially designed to obtain the following information:

- A general perception about nuclear power plants (NPP) expansion (overall acceptance)

Complementary information about:

- The shift of acceptance opinions when NPP is confronted with fossil fuels plants under a renewables-constrained scenario.

And four influencing factors:

- Factor 1: Knowledge about advantages, risks and principles of NPP
- Factor 2: Quantity of information received, sources and trust over it

- Factor 3: Motivation to know more about NPP
- Factor 4: Incorporation in the decision making of stakeholders

This information is distributed in the questionnaire sheet (annex A) in the following way: the overall acceptance obtained by enquiring about the willingness to expand, maintain or reduce nuclear power through question 3. Factor 1 through questions 1, 2 and 4 by asking individuals to choose among a set the best advantages of nuclear power they can identify, how they think fuel is used in the power plant and what sort of risks associated to nuclear power they perceive. Factor 2 covered through question 5 where individuals are asked about how much information they have received, their source and their reliance on it. Factors 3 and 4 related to question 6 and 7 respectively, exploring the willingness to know more about nuclear power and how much their opinion has been listened regarding the commissioning process. And finally, the complementary section obtained through question 8 that focused on how perception is changed when individuals are confronted to choose among fossil fuels and nuclear energy on a renewable constrained context.

2.2 Locations:

The locations selected have a relationship with different phases of nuclear power generation; Planning, operation and consumption of nuclear power generation:

1. For the planning stage: Kaminoseki-cho in Yamaguchi prefecture with a NPP project under construction by Chugoku Electric Co. .
2. For the operation stage: Hamaoka-cho in Shizuoka Prefecture near Chubu electric's Hamaoka NPP in operation since the early 90's.
3. For the consumption stage: the city of Kyoto with no nuclear power facilities in its vicinity.

2.3 Analysis:

From the three sites a total of 141 answered questionnaires were collected in January 2011: 61 from Kyoto and 40 from Kaminoseki and Hamaoka respectively. Overall acceptance scores are aggregated from the survey results and to reveal differences among the answers of the three sites a one-way ANOVA (analysis of variance) as well as a test of independence have been conducted for each question. To analyse the relationship between overall community acceptance and its factors a correlation analysis has been done.

3. Results and Discussion

3.1 Community acceptance towards nuclear power

a) Overall Community Acceptance

Overall community acceptance to expand nuclear power generation scored less than 20%. However, community acceptance to "at least" maintain the current power plants working was the preference of around 50% of the respondents. Figure 1 shows these results.

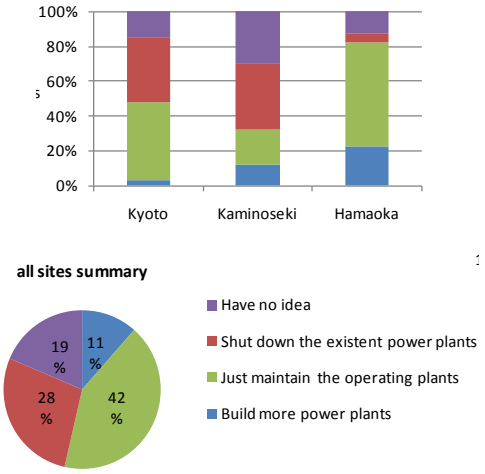

Figure 1 Opinions for construction or decommission of NPP

In comparison to a report by the Japanese government [5], these results show similar number of nuclear power advocates (11% to 9.7%), but larger number of opponents (28% to 16%) and a smaller number of respondents accepting to "at least" maintain the current NPPs working (53% to 80%). It is suggested that overall scores have shifted to find people more sceptical or opposed to NPP and almost no change in the people supporting it. A difference in the methodology, however, may also influence the results since samples from [5] have larger populations from regions without contact with NPP, and samples in this research are coming mainly from regions with close contact with it. In fact, one of the regions has specially shown a slight polarization of acceptance, possibly influencing the overall scores. In the following

section, this difference between locations in different phases of nuclear power generation is presented.

Regional Difference:

By region, the results show the planning stage and the operation considerably different to the average but the consumption site quite similar. Figure 1 also shows the operation stage (Hamaoka) as the most favourable towards maintaining and expanding nuclear power, the planning (Kaminoseki) as the least favourable and the consumption (Kyoto) as a neutral similar to the average. This regional difference of community acceptance is statistically significant ($p<0.05$) according to our test of independence.

Also, as the preference to "Shut down" decreases, the one to "Built more" rises from consumption through planning and operation (Kyoto-Kaminoseki-Hamaoka). This might mean the consumption centres seems to have a more polarised reaction towards nuclear power, and in places near NPPs the longer plants have remained without trouble the better acceptance it tends to have among residents. Particularly in our case, this could possibly be because large accidents have not occurred at Hamaoka giving people nearby a constant flow of benefits such as governmental subsidies or promotion of regional employment without demerits. In contrast, Kaminoseki where the initial stage bears less confidence because there is no connection to previous experience, scores are lower.

Next, constant contact with a successful project may positively influence the standpoint of citizens towards it. The percentage of people choosing "no idea" about what position they have towards nuclear energy is the lowest in Hamaoka, it increases slightly in Kyoto but is significantly larger in Kaminoseki. It seems like the lack of reference to previous experience with projects may create confusion about what is the outcome of having a NPP nearby and therefore a lack of clear preference to accepting or rejecting the project. In addition, the preference to "just maintain" current NPPs is quite small in Kaminoseki which confirms a larger polarization of acceptance in this site.

In summary, these results suggest that construction of NPPs is more difficult in a place that has no plants operating before, and it may be easier for people in sites with a successful project to accept further expansion.

b) Community acceptance under a renewables-constrained scenario

Community acceptance results may change if the individuals are set in a constrained scenario conflicting the limitations of renewable energy expansion and fossil fuel environmental impacts. Figure 2 shows a summary of answers to the choice between nuclear and fossil fuels when renewable energy expansion in Japan is limited to a certain percentage. The results show that about 80% of the respondents chose nuclear power, suggesting that a large number of people´s preference is to avoid environmental impacts from fossil fuels and even moderate their perception towards nuclear power only if renewables cannot supply the future energy needs.

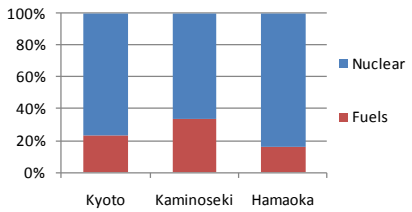

Figure 2 Choice of a main energy source for the future.

Regional Difference:

Figure 2 also shows that there are some differences between the three sites. Nuclear acceptance in Kaminoseki is again the lowest, possibly related to the standpoint conflict hypothesis described before. Nevertheless, according to the ANOVA results this difference is not statistically significant to the overall acceptance scores.

3.2 Factors Influencing Community Acceptance

The four factors influencing community acceptance are studied next through correlation analysis. The coefficients between their score, overall acceptance and acceptance under a renewable-constrained scenario are presented in table 1.

The results show that few factors have significant correlation to the overall acceptance, and only *Knowledge about advantages of nuclear power* and *Trust over the information from companies* have been found significantly related to acceptance under a renewables-constrained scenario .

Table 1 Correlation coefficients and test of significance scores of selected variables

Factors	Overall acceptance R^2	Overall acceptance p	Acceptance constrained scenario R^2	Acceptance constrained scenario p
(1) Knowledge about advantages				
a. Generate electricity at high efficiency	0.03	0.39	0.07	0.70
b. Reduce CO2 emissions	0.21	0.42	0.07	0.01*
c. Reduce the reliance on fossil fuels	0.09	0.13	0.13	0.31
(2) Quantity of information received				
a. Company	0.14	0.65	0.04	0.09
b. Trust	0.29	0.91	0.01	0.00**
c. Government	0.06	0.32	0.08	0.50
d. Trust	0.17	0.57	0.05	0.05*
e. NGOs	0.05	0.64	0.04	0.53
f. Trust	0.01	0.18	0.11	0.87
g. Mass Media	0.00	0.83	0.02	0.91
h. Trust	0.13	0.22	0.10	0.11
(3) Motivation to know more about NPP	0.07	0.17	0.00	0.99
(4) Incorporation in the decision making of stakeholders	0.12	0.68	0.01	0.95

*: p<0.05, **:p<0.01

It was confirmed therefore that knowledge about nuclear power increases acceptance to build NPPs but information needs to be from trustworthy and reliable sources since as ordinarily expected, information has null effect if it is not trusted by people. Moreover, the reason why incorporation in the decision making is not related to acceptance is quite ambiguous. One answer could be the regional context, since not so many people seems to be incorporated in the decision-making process in Japan (Fig. 3). Hereafter, this section will focus on the two significant factors in detail.

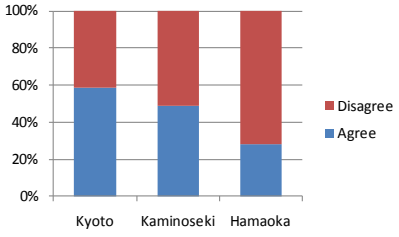

Figure 3 Incorporation in the decision making of NPP.

a) Knowledge about advantages of NPPs

From 60% to almost 80% of respondents can identify advantages from NPPs. Figure 4 show whether people know three types of advantages of nuclear power generation. The most well-identified advantage is "nuclear power plants contribute to reduce CO2 emission" which is known by about 75% of respondents, and it has statistically significant correlation to community acceptance ($p< 0.05$). The other two types of advantages of NPPs, which range from 50% to little over 60% of respondents, have no significant correlation to community acceptance.

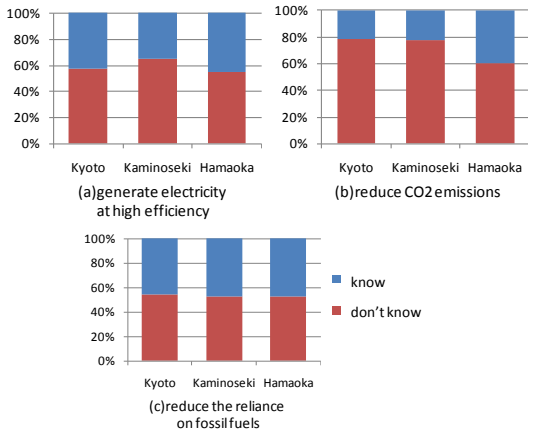

Figure 4 Perception about some advantages of NPP.

b) Trust to information sources

Overall scores regarding trust in the information received are low (60% highest) but among the sources the most reliable one is the power company. For each information source people were asked to give a score of how much they trusted the information, answers are summarised in figure 5. It is clear from the figure that trust in general is low but electric companies have the highest scores. Trust to information from companies and government have significant correlation to community acceptance but information from NGO and mass media do not. The number of people who received information from the companies is about two times larger than that of the government but based on the results the most critical factor for increasing acceptance would be increasing reliance on the provided information.

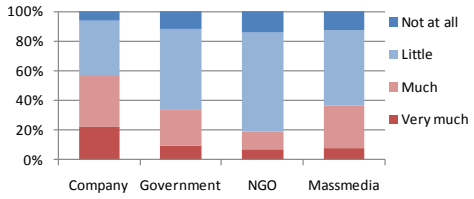

Figure 5 Trust to each information source.

c) Recommendations

Trust to the information from the Power Company and government is a highly correlated factor to community acceptance. Therefore it is one key area for the promotion of NPP. Transmission of information showing the advantages of NPPs through campaigns and community programs with regular feedback from community leaders, as well as trust building measures, such as disclosure of information regarding risks of plants and safety measures (e.g. Local Civic Forum [8]) could enhance acceptance of NPP.

4. Conclusion

Acceptance for NPP in Japan was approximately supported by half of the population. This was composed by 11% in favour of expansion and 42% in favour for at least maintaining the current plants in operation. In comparison to previous reports, there is virtually no change in the percentage of those supporting NPP expansion but the remaining have shifted to a more sceptical or opposed view towards NPP.

By region, people leaving near planning sites were found to be the least favourable to NPP, while those living near operating sites more supportive, and those near consumption sites similar to the overall average. From these results it seems quite difficult to have successful promotion of NPP at new locations and limited acceptance where there is a plant already in operation. In comparison with fossil fuels, nuclear power had better scores for its promotion increasing the acceptance rates to 66.7 % at the planning site and 83.9 % in the operation one.

Two factors have been found to have close relation to community acceptance: "Knowledge about advantages of nuclear power plants" and "trust to information sources". Consequently, measures aimed to increase community acceptance should be related to them. Better information campaigns showing the advantages of NPPs could be one example or initiatives to build community trust particularly regarding credibility on the operation of plants and disclosure of internal safety measures. The importance of the risk communication process has been confirmed by these results.

5. References

1. Japanese Cabinet. “The Global warming countermeasures basic bill”. Policy proposal approved on March 12, 2010 (in Japanese).
2. Takase K. et al. (2010) The Japanese energy sector: Current situation, and future paths. Energy policy, Article in press.
3. Geoffrey H. (2007) Review of Environmental Economics and Policy. Association of Environmental and Resource Economists, volume 1, issue 1. Oxford University Press.
4. Wungstenhagen R., Wolsink M., Burer M. J. (2007) Social acceptance of renewable energy innovation: An introduction to the concept. Energy Policy 35 pp. 2683–2691
5. Cabinet Public Relations Office. “An overviewof special public opinion survey on nuclear power”. 2009 (in Japanese).
6. Onisawa T. et al. (1986) Fuzzy measure analysis of public attitude towards the use of nuclear energy. Fuzzy sets and systems, 20, pp. 259-289.
7. Kimura H. et al. (2003) Psychological Factors Affecting Public Acceptance of Nuclear Energy : Comparative Analysis Focusing on Regional Characteristics and Degree of Knowledge, Transactions of the Atomic Energy Society of Japan 2(4), pp. 379-388.
8. Yamano et al. (2008) Local Civic Forum: An experimental study promoting public acceptance on nuclear energy. Progress in Nuclear Energy, 50, pp. 709-711.