Siting of Radioactive Waste Management Facilities in Japan and Switzerland

Research Paper

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Executive Summary

This research paper provides an analysis of the siting procedure of geological repositories for radioactive waste in Japan and Switzerland from a public policy perspective. The aim is to compare the policies of the two countries to develop recommendations for site selection procedures everywhere.

The methods of analysis include a literature review and semi-structured interviews with experts from the professional and academic world in Japan and Switzerland. A theoretical framework for analyzing and structuring the case studies is established based on relevant concepts from political science and public management. The interviewees include members of public administration, research institutions and other professionals, who were chosen because of their practical experience and their insider knowledge of the procedures and challenges of the siting process.

The Japanese muddling through approach to siting has made very limited progress in the past decade: no municipality applied for the initial stage of the procedure and the institutional bodies, in particular the implementing organization, are faced with a massive loss of credibility. Since the Tohoku earthquake in March 2011, the debate reemerged and authorities are under strong surveillance by the public. Yet, the initializing step of the site selection is still discussed with calls for a more proactive government, and trust between local and regional authorities and the central government is shattered. Hence, the major challenge in Japan is building trust among the stakeholders involved based on a sustainable dialogue.

The Swiss top-down approach to site selection is working smoothly despite minor challenges like the extension of the timeframe or the discussion about regulatory capture. In particular, the regional participation guarantees the involvement of the local communities by focusing on its demands and needs to develop sustainably. The major challenge in Switzerland is the length of the procedure that implies a high turnover of stakeholders and requires continuous motivation to participate and maintaining the credibility of institutions.

From the case studies, recommendations for the characteristics of a best practice concept to successfully select a geological repository site were derived. The optimal policy is based on a stepwise, predictable and flexible procedure with an explicit institutional framework and public participation favoring a partnership between all levels. International cooperation between authorities positively affects the design of domestic policies. It promotes a stakeholder dialogue between all interested parties, which is in turn shaped by national concepts of democracy. The reciprocal communication aims at developing risk literate citizens, incorporating the values of endurance, continuity and trust.

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1. Introduction

Academics and the general public alike see the siting of radioactive waste management facilities as the stumble-stone in high-level waste (HLW) disposal. In finding an adequate approach to the site selection process, success is never guaranteed – but if the wrong approach to siting is chosen, failure is certain (Streffer, Gethmann, Kamp, Kröger, Rehbinder, & Renn, 2011).

In my research paper, I analyze the siting procedure of geological repositories for radioactive waste from a public policy perspective using the case studies of Japan and Switzerland. The goal of the research paper is to compare the policies of the two countries in order to develop recommendations for site selection procedures everywhere. To do so, I interviewed experts from the professional and academic world in Japan and Switzerland and reviewed the relevant literature. Through my research, I aim to contribute to the development of best practice examples for nuclear waste management policies.

Among radioactive waste management facilities, I focus on the site selection for geological repositories, as these are the most commonly discussed facilities for ultimate storage. I limit the discussion of the siting process to a policy perspective and do not enter into technical details. The interviewed members of public administration, research institutions and other professionals in Japan and Switzerland were chosen because of their practical experience in the field and their insider knowledge of the procedures and challenges of the siting process.

In chapter 2, I introduce the theoretical framework for the analysis of the case studies. The concepts cover different approaches to the design of a policy, as well as relevant aspects of the interaction between stakeholders. In chapter 3, I describe the siting process in Japan and Switzerland in regard to the design of the site selection process, the possibilities of public participation, public acceptance, the political debate and criticism, and future challenges. In chapter 4, I compare the policy design and the stakeholder dialogue within the two countries and develop recommendations for an optimal siting process. In the final chapter, I conclude my analysis by emphasizing the role of public acceptance and generational equity.

2. Theoretical framework

In this chapter, I introduce relevant concepts from political science and public management to establish a theoretical framework for analyzing and structuring the case studies. This includes both the design of the site selection policy, including the institutional framework and stepwise procedure, and the interaction between different stakeholders such as the central government, municipalities and local communities.

In the following, first the role of international organizations and agreements in the field of radioactive waste management is introduced. Second, the responsibilities of institutions involved in the siting process are discussed, stressing the leading role of the national

government and the polluter-pays principle. Third, three approaches to siting are introduced: top-down, muddling through and bottom-up. Fourth, the normative notions of equity and fairness that are especially important for stakeholder dialogue in the siting process are outlined. Fifth, the three most problematic issues for the public debate – the academic disagreement about implementation measures, the high mobilization and amplification potential, and the differences in risk assessment between experts and laypersons – are outlined. Lastly, the importance of two-way communication based on a fairness- and discourse-oriented balance of interests is explained.

2.1. International organizations and the Joint Convention

On an international level, mainly two organizations are generating nuclear regulations: the International Atomic Energy Agency (IAEA), a United Nations autonomous body, and the Nuclear Energy Agency (NEA), a specialized agency within the Organisation for Economic Co-operation and Development (OECD).

The IAEA enacted the first legal instrument to directly address waste management on a global scale, namely the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.* The treaty was signed in 1997 and entered into force in 2001 (International Atomic Energy Agency, 2013a). Japan and Switzerland are both parties to the Joint Convention (International Atomic Energy Agency, 2013b). The Joint Convention requires an institutional separation between the management of radioactive waste disposal and the regulation and supervision authority (Bredimas & Nuttall, 2008). In a narrow sense, radioactive waste disposal management only covers the technical aspects of the issue, and all parties of the Joint Convention respect its institutional separation from the regulatory authority. However, the principle could also be interpreted in a broad sense, where promotional and political activities are also part of radioactive waste disposal management. In this case, compliance is more questionable for some cases (Streffer et al., 2011): where responsibility for promotional and political activities is assigned to the regulatory authority, disposal issues can still become politicized and the advisory function of existing independent or separate regulatory bodies is limited. Hence, the IAEA recommends the establishment of a regulatory agency, which is independent of both the management of nuclear facilities and the promotional functions of nuclear energy (Bredimas & Nuttall, 2008).

2.2. Responsibilities of institutions

In a national context, the ultimate responsibility for radioactive waste disposal lies with the national government, which reflects the precautionary principle and the principle of inter-generational justice (Streffer et al., 2011). Still, the industry is required to contribute its share to the process by establishing organizations responsible for the management of HLW. The national government coordinates, regulates and supervises the construction and operation of facilities by the industry.

Concerning the costs of the radioactive waste management, the 'polluter-pays principle' is applied. According to the Environment Committee of the OECD (1972), "this principle

means that the polluter should bear the expenses of carrying out the above-mentioned [pollution prevention and control] measures decided by public authorities to ensure that the environment is in an acceptable state". In regard to radioactive waste, the principle implies that the nuclear industry must bear the costs of high-level radioactive waste disposal (Gaines, 1991). In general, the nuclear facility operators are obliged to ensure the coverage of the radioactive waste disposal by establishing and maintaining a designated fund (OECD Nuclear Energy Agency, 2010). A separated administration of the fund shall ensure that the money collected is exclusively available for the final waste disposal.

2.3. Three approaches to siting

Even though it is by no means a sufficient condition to reach a universally acceptable solution, establishing a basis for communication is an indispensable pre-requisite to do so (Streffer et al., 2011). In view of the challenges and conflicts in societal debates, three theoretical approaches to political decision-making are distinguished and applied to the site selection process.

2.3.1. Top-down approach

Under the top-down approach, the elected representatives in a democratic system have the sole right of decision-making in the siting process. If at all, the population participates only to a limited extent, for example by voicing opinions during hearings. The final decision is in the hands of the elected representatives. However, decision-makers must prove that all objections by society have been duly dealt with before taking a final decision, and they are obliged to disclose all arguments for and against the decision.

The legitimacy of this approach depends heavily on the trust in the power of judgment and the neutrality of legal decision-maker (Löfstedt & Vogel, 2001). Also, society must perceive the decision-making process as fair in order to accept it (Linnerooth-Bayer & Fitzgerald, 1996). Hence, a decision pushed through by a strong state against the will of the citizens would come at the high price of lost legitimacy and trust in the system. Few politicians are prepared to pay this price in order to successfully site a repository.

2.3.2. Muddling through: top-down and bottom-up mix

The approach based on a minimum consensus is called muddling through (Lindblom, 1959). In decision-making, only those options with the least societal opposition are considered. Societal groups can influence the process of political decision-making to a certain extent. Their influence depends on the ability to connect with the political system in terms of language and processing style and to mobilize public pressure. The proposal entailing the least loss of support by interest groups for political decision-makers is likely to be taken up by politicians. Depending on public pressure, the process can be slowed down or stopped in different phases: for example, sites are merely explored first, decisions are postponed or already made decisions are revoked. If the issue is as controversial as disposal site selection,

muddling through can only lead to a successful conclusion if the issue eventually dies down as a general fatigue sets in.

Again, loss of legitimacy of the involved institutions and decreased trust in the system are side effects of the muddling through approach. Also, it often leads to a solution that only satisfies a few people. Furthermore, collective acceptance behavior is often inconsistent and changes over time so that policies aimed only at acceptance will sooner or later become entangled in contradictions (Gethmann & Mittelstraß, 1992). The affected citizens are likely to eventually become increasingly weary of policies offering neither a clear course nor a claim to leadership.

2.3.3. Bottom-up approach: discursive site selection

The bottom-up or discursive approach is an attempt to fairly negotiate between different stakeholders (Renn, Deuschle, Jäger, & Weimer-Jehle, 2007). The aim is to provide constructive solutions to problems while allowing for more than one outcome. To ensure the effectiveness of the approach and to prevent strategic behavior amongst participants, the dialogue must be structured according to certain rules. Habermas (1984) identified three conditions, which legitimize collectively binding norms: agreement of all involved stakeholders, substantial justification of the statements delivered within the discourse and suitable compensation for negatively affected interests and values.

In reality, these requirements for fair discourse are difficult to fulfill. In a politically charged and polarized debate, many strategically oriented stakeholders have a strong interest in paralyzing the process, for instance by creating endless marathon sessions through countless procedural motions and peripheral contributions to the discussion (Wiedemann as cited in Renn et al., 2007). According to Weinrich (as cited in Renn et al., 2007), the dictatorship of persistence determines which arguments are eventually accepted. Society is commonly disappointed and alienated by discursive approaches that start out with high aspirations and end in trivial realizations.

2.4. Fairness and equity as ethical considerations

Ethical principles of fairness and equity shape the discussion about radioactive waste management. The Radioactive Waste Management Committee of NEA distinguishes between two types of equity:

> "between generations (intergenerational equity), concerning the responsibilities of current generations who might be leaving potential risks and burdens to future generations; and within contemporary generations (intragenerational equity), concerning the balance of resource allocation and the involvement of various sections of contemporary society in a fair and open decision-making process related to the waste management solutions to be implemented" (Radioactive Waste Management Committee of the OECD Nuclear Energy Agency, 1995).

The principle of intragenerational equity also applies to communities affected by the construction and operation of nuclear waste management facilities.

The importance of intergeneration equity was highlighted in the 2008 Eurobarometer poll on attitudes towards radioactive waste. 93% of the interviewed Europeans responded that they see an urgent need to finding a solution to the waste issue now rather than leaving it unsolved to future generations (TNS Opinion & Social, 2008).

2.5. Problematic aspects of the public debate

Streffer et al. (2011) identify three problematic aspects of the public debate that pose challenges to the successful selection of radioactive waste management sites.

First, even though there is a general agreement within the academic community that deep geological repositories are the best currently available solution for radioactive waste disposal, some scholars and professionals oppose the implementation of repositories. They stress flexibility, in particular regarding organizational learning capacities and the ability to adapt to future scientific and technological developments. This academic debate is perceived in public as proof for the lack of maturity of the scientific research and its low reliability and seriousness. This conflict of facts hinders further research and undermines public trust in science overall (Streffer et al., 2011).

Second, there is an immense discrepancy between the perception of laypersons and the opinion of experts regarding the safety of final disposal (Streffer et al., 2011). That the scientific concept of 'technological risk' is commonly translated into 'imminent threat' and 'creeping danger' highly affects its evaluation (Renn, 2008). For example, risks with a high potential for damage but a very low probability of fully coming to bear are perceived as 'imminent threats' because of their randomness. The term 'creeping danger' explains the misperception about the causal relationships of events and latent effects. The probability of an event is interpreted as the degree of certainty for a causal relationship instead of a significant deviation from a naturally given variation.

Third, the issue of radioactive waste management entails a high mobilization and amplification potential within most industrialized countries because it touches upon fundamental convictions regarding societal development (Streffer et al., 2011). The highly emotional debate about final disposal reflects the worldwide observed stigma effects around all nuclear issues (Slovic, Flynn, & Robin, 1994). Merely mentioning the term 'nuclear' often triggers associations in citizens' minds that lead to a fundamental debate about nuclear energy in general rather than a more practical discussion of its technological viability or long-term safety (Tochiyama, 2014). The conflict about preferences and normative evaluations manifests itself in crises of legitimacy and dissatisfied justice claims. Consequently, the legitimacy of the authorized decision-makers is increasingly questioned by large parts of the population, with their decisions in fact rejected (see chapter 2.3.). Local communities and residents sometimes transfer theses conflicts into the public debate by employing the risk-adverse strategy of NIMBY, 'not in my backyard' (Fischel, 2001): in principle, they endorse the necessity for such facilities, but under the condition that they are built as far away as possible from their home (Fredriksson, 2000).

2.6. Importance of two-way communication

According to Streffer et al. (2011), there are two main requirements necessary for arriving at a solution for siting a geological repository that is not only factually sound, but also politically acceptable: dialogue-based communication with the society and a policy based upon a fairness- and discourse-oriented balance of interests.

One ultimate goal of communication is that the population should become risk literate. Risk literacy is defined as the ability to make an informed risk assessment based on knowledge regarding the factually verifiable consequences of risk-causing events. This goal can be reached through an interactive process that promotes the exchange of information and opinions of all stakeholders. In this dialogue, information regarding specific risks should be shared and concerns, anxieties, attitudes or reactions related to particular risks should be addressed.

Communication is understood as a reciprocal, dialogue-oriented exchange process. Particular attention should be paid to an increased two-way communication between all groups and institutions. In this exchange process, trust between individual stakeholders should be build by means of comprehensive understanding of problems and mutual willingness to learn in order to establish a basis for a universally acceptable decision-making.

3. Country case studies

Countries with nuclear facilities share common features such as the influence of the *Joint Convention*, a vivid international exchange including peer reviews and a gradual harmonization of regulations regarding the disposal of nuclear waste (Streffer et al., 2011). Differences appear in the political-administrative system or culture, the geological and economic conditions, and the objectives of site selection. Also, public attitudes toward nuclear energy in general and radioactive waste disposal in particular vary largely between countries.

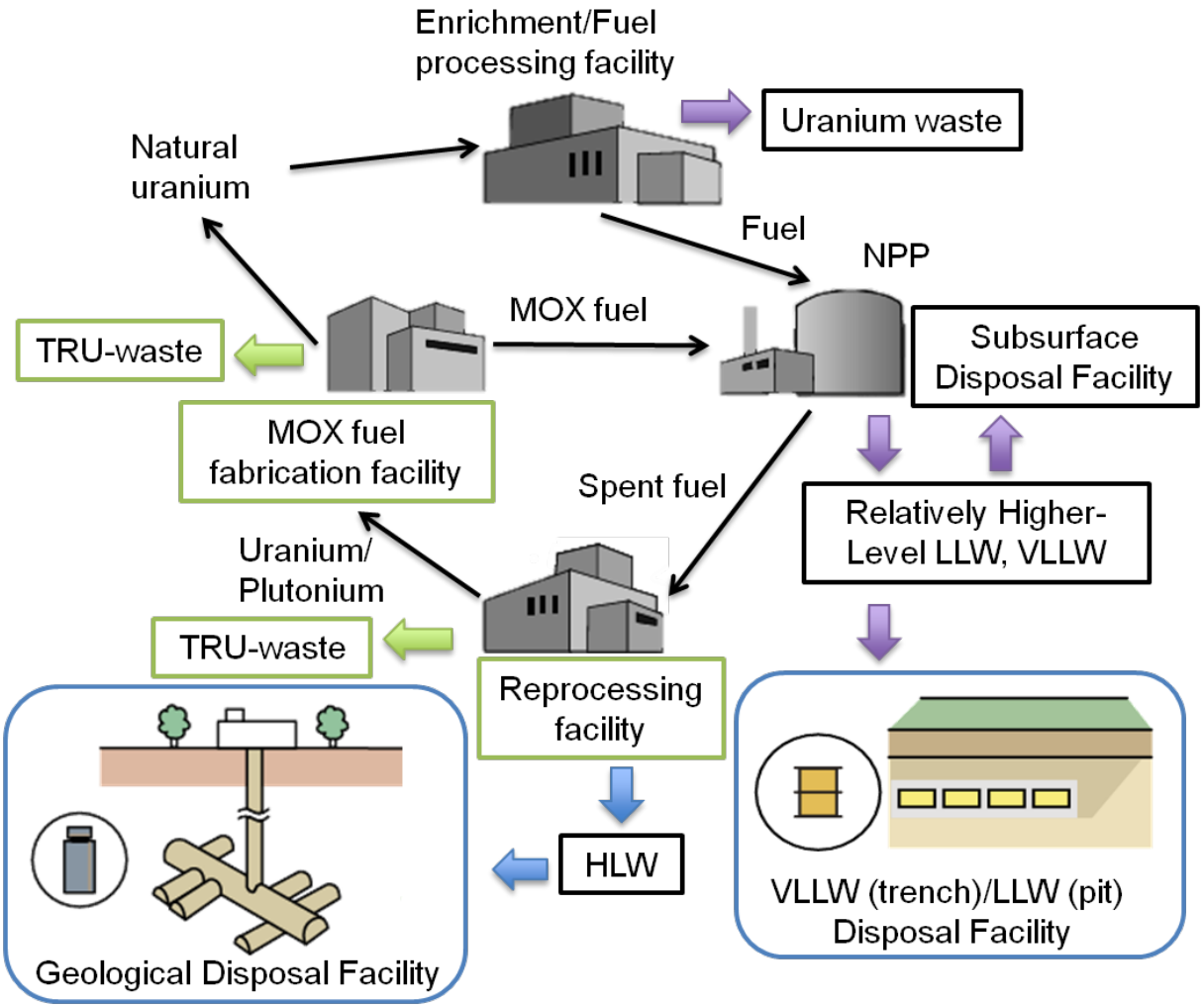
I chose Japan and Switzerland as case studies based on a most different case design. Japan illustrates a classical muddling through approach in siting, whereas Switzerland's procedure is a top-down approach. Moreover, Japan's site selection process has been stalled for a decade, while the Swiss procedure is working smoothly and already incorporates regional participation. I conducted semi-structured interviews to ensure comparability while being able to be responsive to the individual experts. I interviewed experts from the professional and academic world in Japan and Switzerland, which I selected because of their practical experience in the field and their insider knowledge of the procedures and challenges of the siting process. For the Japanese case study, I personally met four experts, who are professors at universities in Japan or working for research institutions. For the Swiss case study, I interviewed five experts by phone, who are members of the ENSI Board or working for either Nagra or SFOE. One expert was interviewed for both case studies (see the appendix for a detailed list of interviewees).

In the comparative analysis of Japan and Switzerland, I use the insights from the theoretical framework to structure the cases. In regard to the policy design, I focus on the history of siting and sources of regulation, the institutional framework, and the stages of the process. To find out about the interaction among stakeholders, I discuss the possibilities of public participation and public acceptance in both countries' site selection procedures. Lastly, I outline the political debate and controversies and identify future challenges.

3.1. Siting in Japan

Figure 1 depicts the nuclear fuel cycle in Japan. The final disposal site is designed for HLW and TRU-waste. Reprocessing spent fuel from nuclear reactors generates HLW (vitrified wastes), whereas reprocessing and MOX fabrication generates TRU-waste (Tochiyama & Masuda, 2013).

Figure 1: Nuclear Fuel Cycle and Radioactive Waste in Japan



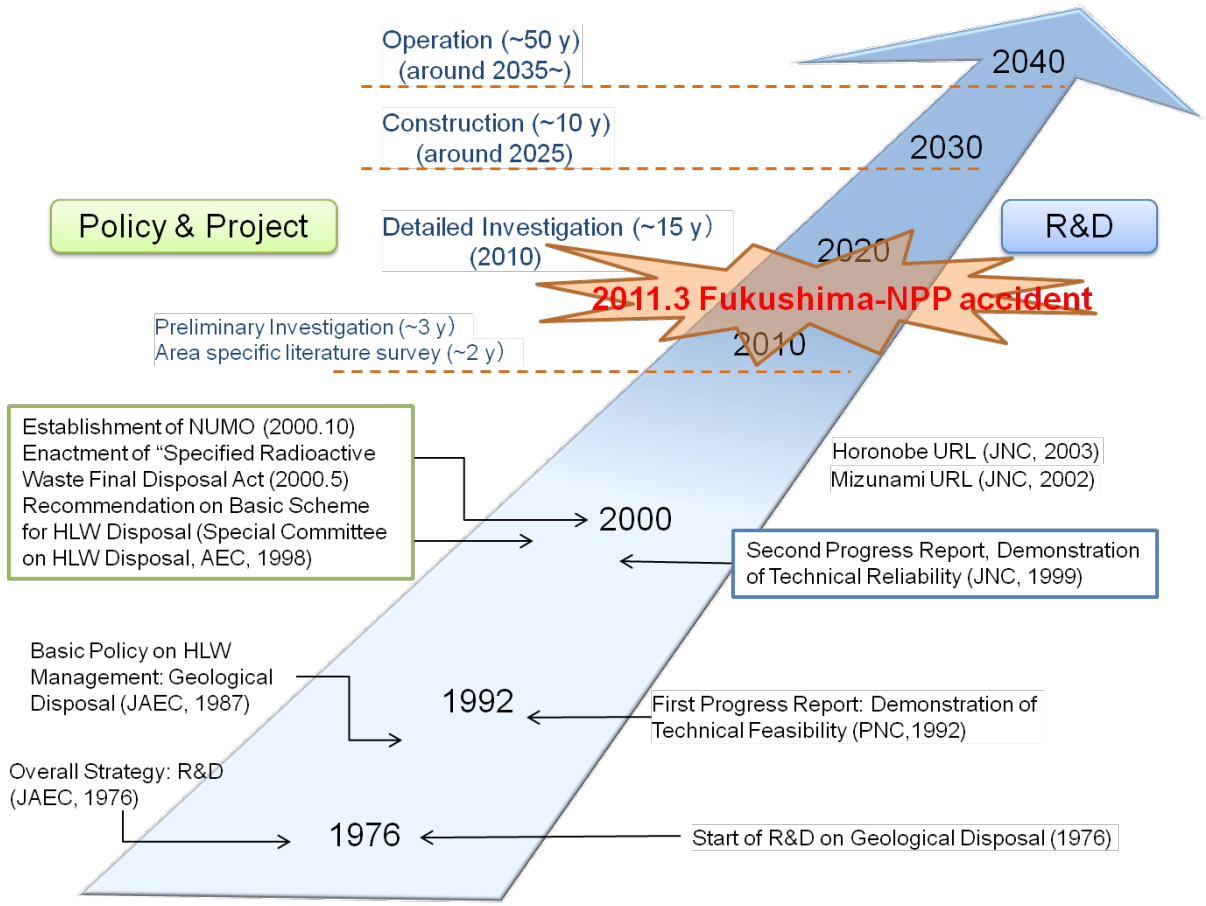
Source: own illustration, adapted from Tochiyama (2014)

3.1.1. History of siting and sources of regulation

In Japan, the debate about final disposal of radioactive waste started in the 1970s (Figure 2) (Tochiyama & Masuda, 2013). During the following decade, several feasibility studies were

published. In the late 1990s, a roundtable discussion including technical experts, economists, political scientists and anti-nuclear activists was organized in order to advance policy-making in the field (Juraku, 2014). In 1999, another feasibility study about HLW disposal, the second progress report (referred to as H12), was published und proposed a stepwise process that is also open to the public. Consequently, the *Specified Radioactive Waste Final Disposal Act* (referred to as Final Disposal Act, FDA) was enacted in June 2000. The FDA established the framework for the implementing organization, the financing and the stepwise site selection process. However, it did hardly include any of the features discussed in the roundtable debate and in discussion groups within international organizations; for example, there was no mention of generational equity (Juraku, 2014). The FDA itself was passed within a few days and even without controversial debate by the Diet, so that no deliberation could take place within society (Juraku, 2014).

Figure 2: Development of Japanese HLW Disposal Program

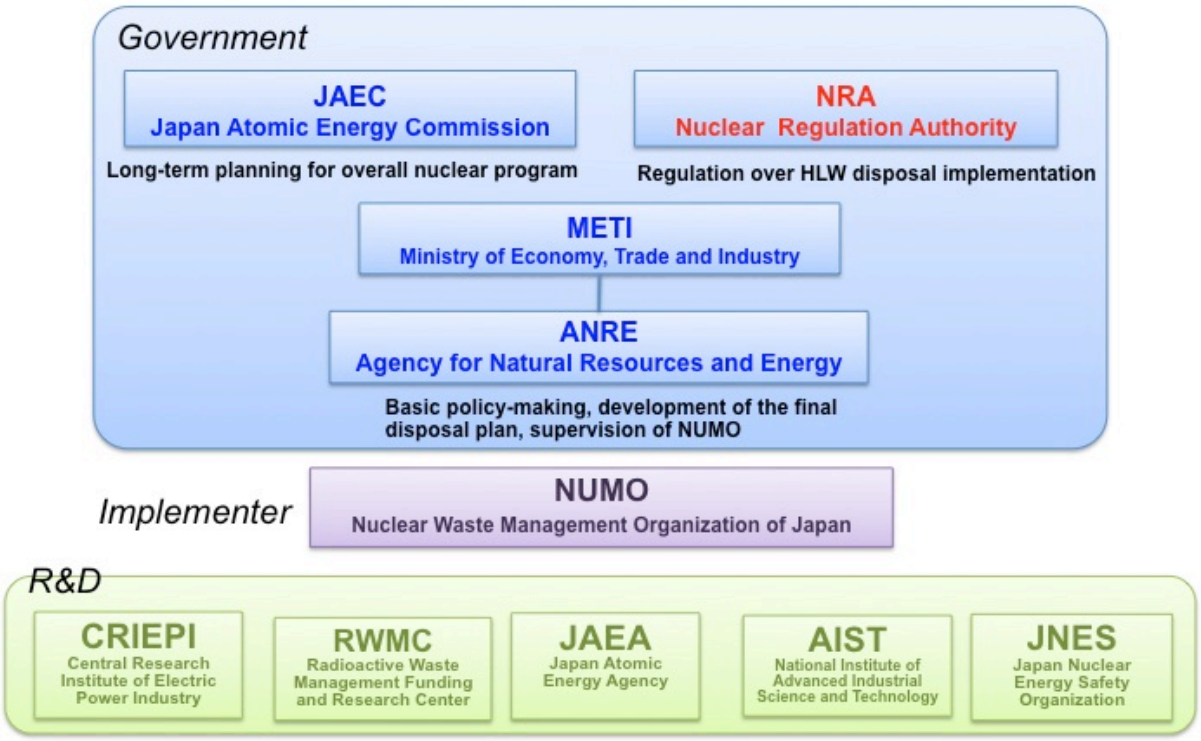


Source: own illustration, adapted from Tochiyama (2014)

Based on the FDA, the Nuclear Waste Management Organization of Japan (NUMO) was created as implementing organization in 2002 (Kusaka, 2014). In the same year, the open solicitation process started (see chapter 3.1.3. for a detailed description). Five years later, in 2007, the FDA was amended to include TRU-waste in the HLW disposal program under the responsibility of NUMO (Tochiyama & Masuda, 2013). In 2011, some municipalities prepared to officially apply for the literature survey, but then the Tohoku earthquake hit and the central government suspended the program (McKinley I., 2014). Due to limited progress

in siting and the tragic events of 2011, the Japan Atomic Energy Commission (JAEC) published a statement on 18 December 2012, asking the government to restructure the process and review the FDA (Japan Atomic Energy Commission, 2012). In consequence, the Ministry of Economy, Trade and Industry (METI) convened meetings of two subcommittees (working groups) to review its policy of final disposal and to re-evaluate the scientific knowledge (Tokunaga, 2014b).

Figure 3: Government and Organizations: HLW Disposal Program in Japan

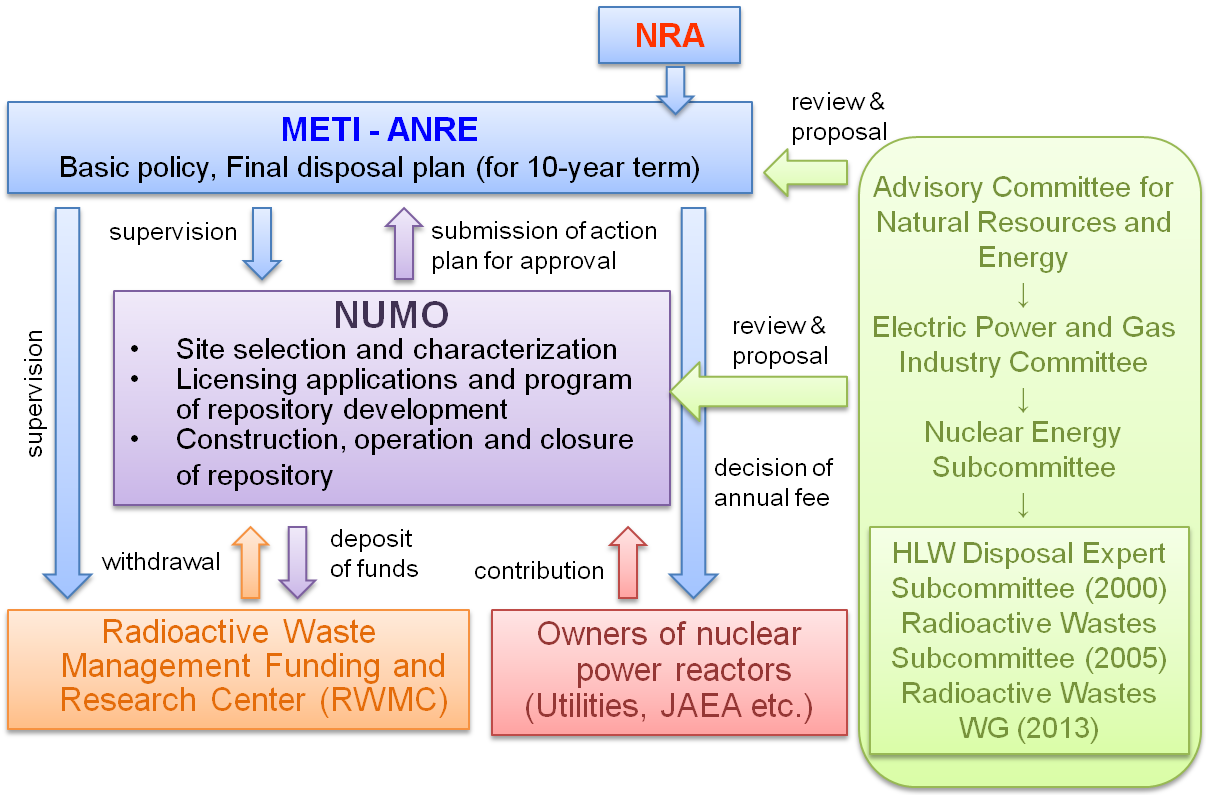


Source: own illustration, adapted from Tochiyama (2014)

3.1.2. Institutional framework: roles and responsibilities

Figures 3 and 4 provide an overview of the organizations involved in the siting of final disposal facilities in Japan and their respective roles. The JAEC supervises the HLW disposal program. The Nuclear Regulation Authority (NRA) (the former Nuclear Safety Commission, NRC) supervises all safety issues. NUMO is the implementing non-governmental organization and is supervised by METI. METI, in particular the Agency for Natural Resources and Energy (ANRE), develops the policy. The radioactive waste working groups are composed of members of the academic community and advise METI and NUMO on policy and technical questions (Tokunaga, 2014a). The operators of nuclear power plants finance the expenses of NUMO for the development, selection and operation of the deep geological repository (Streffer et al., 2011). METI annually determines the specific charge paid by the operators into the Radioactive Waste Management Fund, which is administered independently from waste generators by the Radioactive Waste Management Funding and Research Center (RWMC). Several governmentally funded organizations are active in research and development to support the decision-making (Tochiyama, 2014).

Figure 4: Implementation Framework in Japan

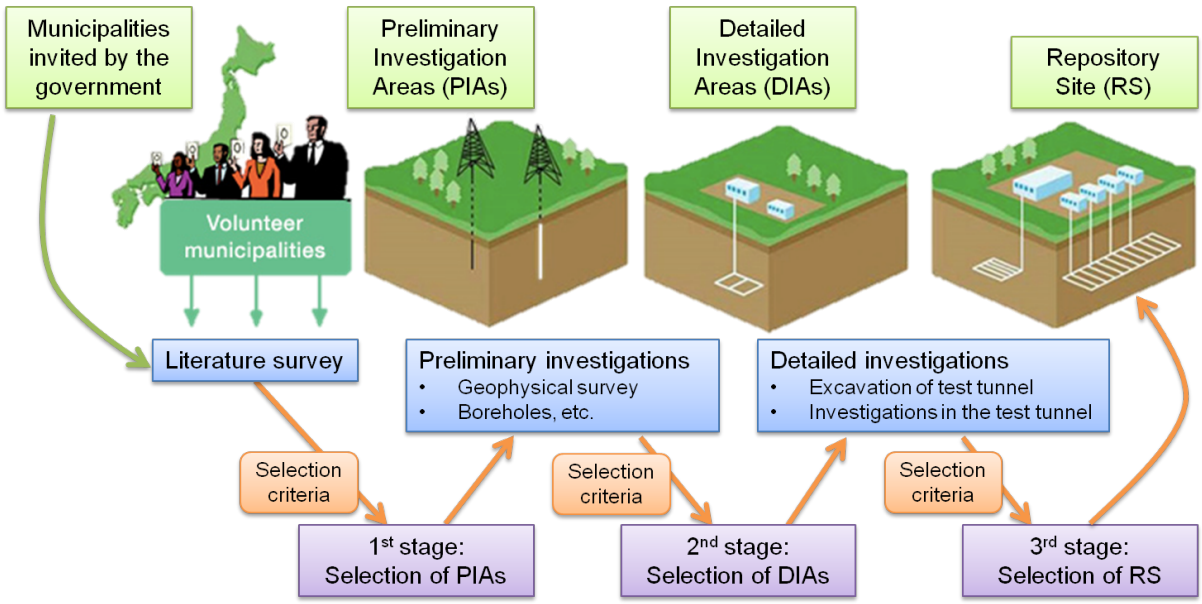


Source: own illustration, adapted from Tochiyama (2014)

3.1.3. Stages of process and strategy in siting

After it was preliminarily stopped in 2011, the site selection process was amended in 2013 and is today divided into three stages (Figure 5). To seek out areas to carry out feasibility studies on the possible location of a final repository, NUMO conducts open solicitations of municipalities to voluntarily apply for the literature survey, a procedure aiming at determining the long-term stability of the geological environment (NUMO, 2014). In addition, the government actively approaches suitable municipalities and invites them to participate in the literature survey. In the first step, preliminary investigation areas (PIAs) are chosen based on the submitted literature surveys by municipalities. Surface-based investigations are conducted in the PIAs about geological characteristics. Secondly, the stability of the host formation and its vicinity is tested in the detailed investigation areas (DIAs). In addition to the surface-based investigations, underground research facilities are constructed and investigations and experiments take place. In the third step, the repository construction site is selected by confirming the physical and chemical characteristics of the geological formation. METI approves all steps during the selection process and also takes the ultimate decision on the site selection in consulting with local authorities and the population (Streffer et al., 2011).

Figure 5: Three Stages of the Site Selection Process in Japan



Source: own illustration, adapted from NUMO (2014)

Concerning the strategy of siting, the selection process in Japan appears as a muddling through approach: on the one hand, the municipalities are supposed to apply for the literature survey, which represents a bottom-up strategy, on the other hand, METI, not even representing elected politicians, takes the final decision.

3.1.4. Regional participation

Municipalities as the future repository sites are key players in the Japanese selection process. Yet, the details of their role are rather unclear. Kusaka (2014) states that municipalities generally do not apply for the literature survey because they do not know 'the whole package'. To encourage more voluntary applications, Kusaka assumes that the central government would need to act more proactively, for example by offering political support to the municipalities in preparing their applications (Kusaka, 2014).

One municipality, which plays an important role in the history and probably also the future of nuclear energy in Japan, is Rokkasho in Aomori Prefecture. It is a community inhabiting the area on the Northeastern tip of Honshu. Because of alliances during the time of the Meiji Restoration, its inhabitants are said to be more suspicious of the central government than in other parts of Japan (Juraku, 2014). This distrust was exacerbated during Japan's double-digit growth years, when the national government broke its promise to Aomori Prefecture to site heavy industry in the area although an industry park was already planned and real estate was bought (Kusaka, 2014).

In light of these difficulties, it is surprising that today Rokkasho is a gathering place for many energy-related facilities, including radioactive waste management facilities (Aomori Prefectural Government, 2008). McKinley I. (2014) explains this with the fact that the facilities generate employment. Yet, the municipality continuously stresses that its acceptance is conditional on the fact that Rokkasho and Aomori Prefecture as a whole are not

considered as final disposal sites (Kusaka, 2014). However, because Rokkasho has already been an interim storage facility over the past twenty years, the prefectural government worries that it is a de facto final disposal site and increasingly pressures the central government to speed up the siting process.

3.1.5. Public acceptance

Whereas the importance to engage and interact with the local community is stressed by Japanese scholars and advisory committees, there is no agreement on a procedure to achieve this goal. In Japan, the siting of deep geological repositories opens up two types of questions: a technical, scientific one and a psychological, political one (Kusaka, 2014). In addition, the Tohoku earthquake created new fears in the public and increased anti-nuclear sentiments. From a technical and scientific perspective, citizens are worried about the geological structure of Japan and question if scientists will be able to find a stable site. Politically, there is increasing NIMBY activism in the rural areas (Scalise, 2013). Citizens in rural areas do not see why they should assume the role of a final disposal site for the sake of economic development in urban areas (Kusaka, 2014). Overall, becoming the site of a final disposal is not at all an enticing outlook.

3.1.6. Political debate and controversial issues

Following the 2011 accidents in Fukushima, the site selection policy was suspended in order to discuss and amend it. The followings paragraphs outline the debate inside and outside the two METI subcommittees on radioactive waste, which met as preparation for a ministerial meeting on final disposal on 17 December 2013. The strategy adopted in the meeting is presented as well as further controversial issues mentioned by the interviewees.

Overall, most criticisms regarding the process were and still are targeted towards the slow progress in waste disposal under the leadership of NUMO (Kusaka, 2014). Anti-nuclear activists question the credibility of NUMO by comparing the status quo to the operation of an apartment without a toilet. Kusaka (2014) accordingly describes the credibility problem of NUMO as the Achilles heel of nuclear power generation in Japan: because of the limited space in the pools for spent nuclear fuels (SNF) on the power plant sites, SNF must be removed and transported to an interim storage facility in case the pool is full. The improvement of the implementation structure, especially the role and responsibilities of NUMO, was also a fiercely debated topic within the subcommittee on radioactive waste (Tokunaga, 2014a).

In the preparatory meetings for the ministerial meeting, the METI subcommittee debated the general approach to HLW disposal including alternative options to deep geological repository (Tokunaga, 2014a). The subcommittee proposed a societal deliberation about what kind of disposal is suitable for HLW, arguing that the public should have a choice between different strategies. In the ministerial meeting, it stated that a geological repository is the best option, although alternative options should be explored as well. The notions of generational equity and fairness were also touched upon in the subcommittee, where two

strands of argumentation were voiced (see chapter 2.5.): one called for immediate action by the government to move ahead in the concrete issue of waste disposal, the other demanded a general debate about the future of nuclear energy in Japan.

Eventually, the ministerial meeting agreed that the concepts of reversibility and retrievability in the siting process should be explicitly stated and institutionally implemented in order to preserve options for future generations. In this context, reversibility refers to the decision-making during the project implementation phase and ensures that the implementation process and technologies are flexibly designed to make a reversal or modification possible (OECD Nuclear Energy Agency, 2011). Retrievability is defined as the ability to retrieve waste. Such a stepwise and reversible decision-making process aims at building trust between stakeholders (Tokunaga, 2014a). In addition, the ministerial meeting decided to review scientific research regularly in order to implement the best available technology. Regarding the concept of reversibility, the flexibility to switch technology at a later stage in the progress should be maintained.

To improve the site selection process, the possibility of the government to request participation was added to the existing but under-used option of initial applications by municipalities. Tokunaga (2014a) explains that the previous open solicitation process implied that deep geological repositories were possible all over Japan. However, as Tochiyama (2014) describes, basing the process on excluding geologically unsuitable sites rather than on finding suitable ones resulted in about 70 percent of Japan being eligible for final disposal – an overly large area. This approach undermined NUMO's credibility and ability to rely on scientific information. The requested participation approach is modeled after the 'EIC' strategy: engage, interact, cooperate (OECD Nuclear Energy Agency, 2012). Scientifically suitable sites are selected in cooperation with the technical subcommittee on radioactive waste based on siting factors that ensure sufficient geological stability (Tokunaga, 2014a). Furthermore, the government proactively provides information to the suitable municipalities and engages the local authorities and citizens in a dialogue about the site selection process, geological characteristics of a site and other issues. This is an improvement over the past, where the mayor had to explain the project to the inhabitants, the governor of the prefecture and other stakeholders, even though he or she might not be knowledgeable about all issues concerning final disposal (Juraku, 2014). Juraku therefore suggests that NUMO, the central government and national politicians should further support the mayor in this task in the future.

Not changed in the meeting was the compensation mechanism for municipalities. In 2000, the compensation for the application to the literature survey was increased from two hundred million to one billion Japanese Yen. However, Tokunaga (2014a) argues that rather than awarding a fixed amount of money, the compensation should be focused on promoting local development and seen as cooperation between the local community and the government. As an example for successful cooperation, McKinley I. (2014) points out that Aomori Prefecture benefited significantly from the siting of nuclear facilities because the

negotiations of the compensation scheme were tough. Currently, the municipality has no need for further financial assistance, yet if its income decreases and the compensation for a final disposal site increases, it might step forward. As the local community is already familiar with the nuclear industry, there are no reservations like in other areas, which might facilitate communication between the relevant stakeholders.

In summary, Tokunaga (2014a) stresses that even though the subcommittee debate led to very similar conclusions as the report already published by JAEC in 1999, the deliberation process itself is crucial for the future progress of the HLW disposal program. He suggests that the most important step were the bilateral discussions among the members of the subcommittee. Debating the final disposal also raises awareness in society and emphasizes the need to find a solution soon. However, even though the process is helpful, he adds that it might take a long time to increase acceptance in society (Tokunaga, Siting of Radioactive Waste Management Facilities in Japan, 2014a).

3.1.7. Future challenges

The nuclear debate is currently very high on the agenda in Japan. The government and parliament are driven by the desire to restart the nuclear power plants and are under major pressure at the same time due to the slow progress in siting (McKinley I., 2014). Society also follows the site selection process closely and evaluates governmental assurances more critically, as many have lost credibility in the authorities since the Tohoku earthquake. In this context, it is essential for the authorities involved in HLW disposal to increase public acceptance, to build up trust between stakeholders and to not throw off the municipalities and local communities by pushing ahead with the process too fast.

To increase public acceptance, Juraku (2014) suggests that a nationwide deliberation process about nuclear waste needs to take place. Yet, neither the authorities nor parliamentarians seem to raise the issue, as it offers no possibility to win votes.

In regard to building confidence between the local communities and the authorities, the stepwise nature of the selection process – that the community has the possibility to stop further investigation at every step – is not yet known and trusted in enough (Kusaka, 2014). The same is true for the benefits of hosting a final disposal site (McKinley I., 2014): NUMO has not yet made it clear enough that the major advantage is not the financial compensation but the generation of jobs. In areas experiencing depopulation, population aging and where communities have suffered damages from the tsunami in 2011, employment opportunities and building infrastructure could increase public acceptance. In this context, the differences between a geological repository and a nuclear power plant need to be pointed out to face the increased fear of radiation.

The safety during the operation period is a topic, which requires further research (Tochiyama & Masuda, 2013). In particular, the safe transportation of radioactive waste from the power plants or the storage facilities to the repository needs to be tackled (Juraku, 2014). Traditionally, radioactive waste was shipped, as most power plants are located on the

coastline. The overland transportation of waste through noninvolved municipalities might fuel NIMBY activism. Hence, only a final disposal site on coastline might be acceptable, narrowing down the number of suitable municipalities.

Juraku (2014) and Kusaka (2014) point out the curious fact that although Japan is very active in international organizations dealing with the issue of radioactive waste review, the lessons learned from international experience are not transferred into domestic legislation and implementation.

In conclusion, NUMO's muddling through procedure has made very limited progress in the past decade: no municipality submitted an application for the literature survey and the institution itself is faced with a massive loss of credibility. Since the Fukushima accident in March 2011, the debate about radioactive waste management reemerged and authorities are pressured to move ahead. Yet, the initializing step of the site selection is still discussed, and trust between local and regional authorities and the central government is shattered. Hence, the major challenge of the site selection process is building trust among the stakeholders involved based on a sustainable dialogue.

3.2. Siting in Switzerland

The final disposal site in Switzerland will hold all types of radioactive waste, including vitrified waste, spent nuclear fuel, waste related to future decommissioning and waste from a reactor accident in 1969 (McKinley I., 2014). Currently, Switzerland has no disposal site for any type of radioactive waste. Interim storage is located at the nuclear power plant sites as well as the centralized storage facility ZWILAG. The ongoing siting process will result in the proposal of tow or one combined site for low- and intermediate- (L/ILW) and high-level waste (HLW).

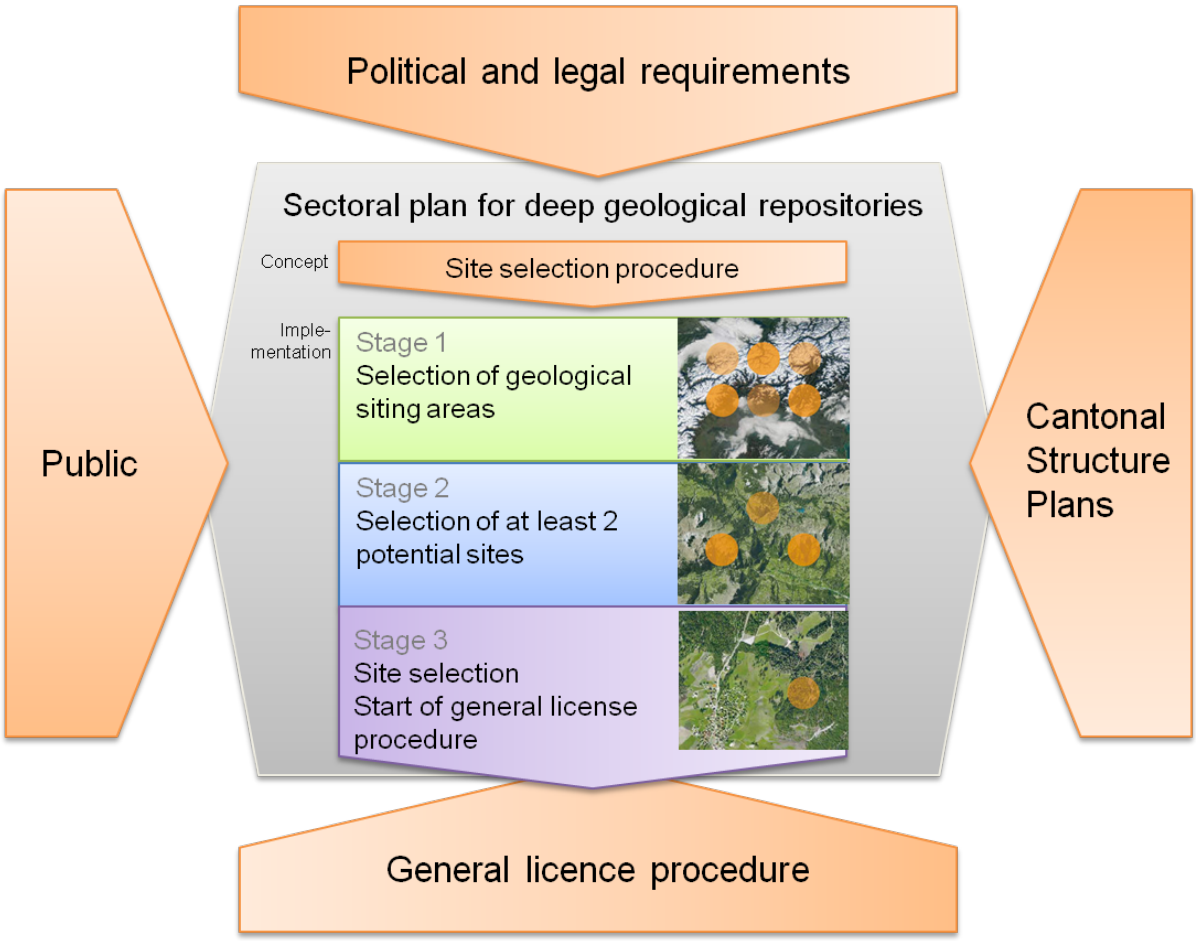
3.2.1. History of siting and sources of regulation

In 1972, the National Cooperative for the Disposal of Radioactive Waste (Nagra) was established by the nuclear power plant operators and the federal government and entrusted with the task of waste management (McKinley L., 2014). Nagra presented a first concept for radioactive waste management in 1978 and started location investigations in 1981. In 1994, it applied for a general license for the construction of a repository for low- and intermediate-level waste, but the voters of the respective canton denied the concession. The site selection procedure was subsequently changed to a staged process and Nagra submitted another application for a concession for an exploratory drift at the same site in 2001. However, the cantonal voters also rejected the second application.

After the two failures, a nationwide deliberation process started about the final disposal of radioactive waste (Schmid, 2014). Even though the possible sites for selection are limited to a few municipalities from the outset, final disposal is a national, not a local concern. Consequently, the Swiss parliament enacted the *Nuclear Energy Act* and the *Nuclear Energy Ordinance* in 2003 and 2004, which entered into force on 1 February 2005 (Bühlmann, 2014). The Ordinance states that the objectives and requirements applying to disposal of waste in

geological repositories have to be specified in a sectoral plan, a spatial planning instrument used for the siting of large infrastructure projects (McKinley L., 2014). Using this instrument, the federal State (Swiss Confederation) has the competence to site infrastructure projects neglecting the cantonal competences in spatial planning, particularly the canton's veto power (Bühlmann, 2014). This amendment of the spatial planning regulations ensures legal certainty and predictability in the selection procedure, enabling the cantons, municipalities and communities to voice their opinions without a possibility to decide.

Figure 6: Position and Interrelationships for the Sectoral Plan for Deep Geological Repositories in Switzerland



Source: own illustration, adapted from Swiss Federal Office of Energy (2008)

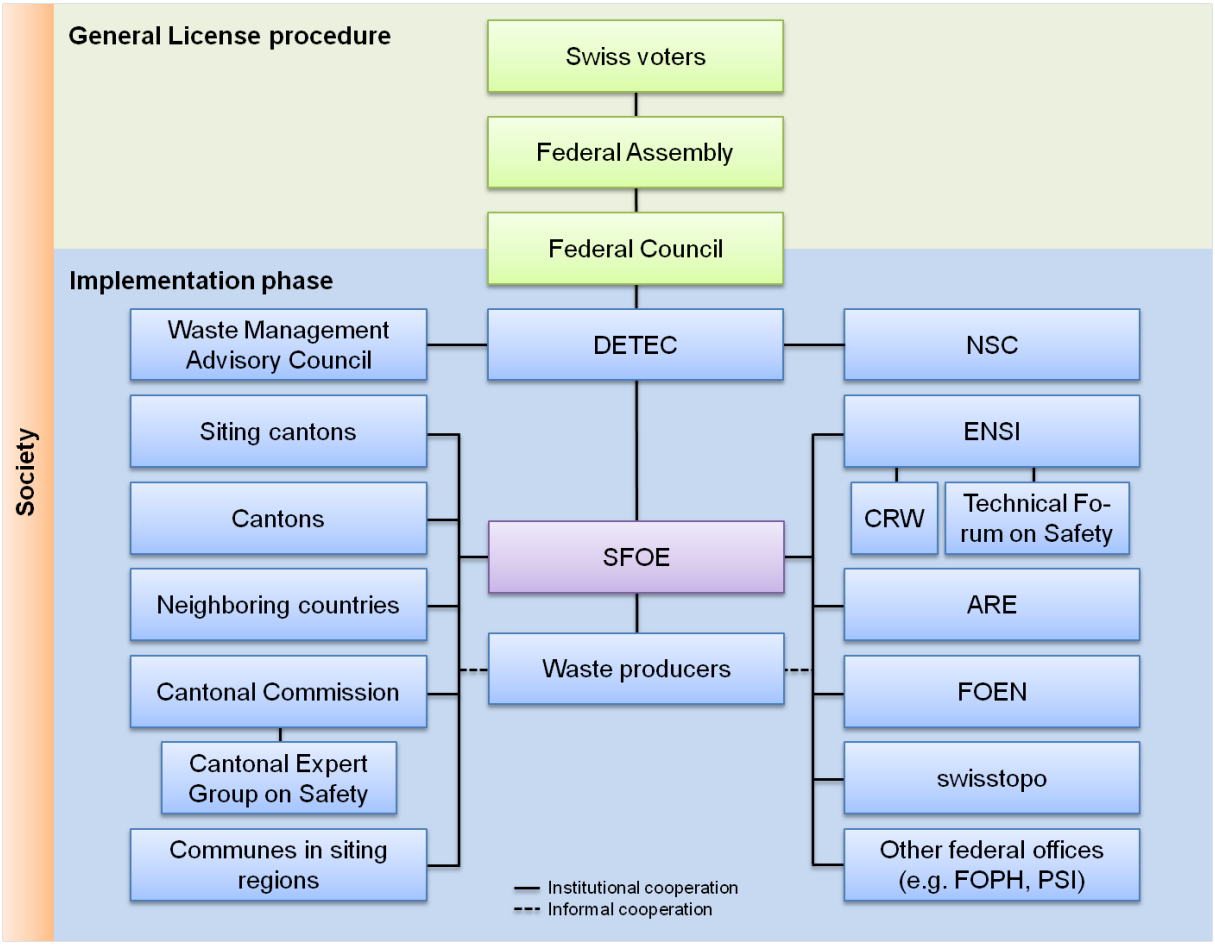
In 2006, the preparations for the conceptual part of the sectoral plan started, setting out the sectoral goals of the federal government and the procedures and criteria applying to the site selection process (Swiss Federal Office of Energy, 2008). Over two years, an extensive consultation process took place involving multiple stakeholders, including neighboring states (Eckhardt, 2014). Figure 6 depicts the position and interrelationships of the sectoral plan for final disposal.

3.2.2. Institutional framework: roles and responsibilities

The federal State bears overall responsibility for the siting, as is shown in Figure 7. The Federal Office of Energy (SFOE) bears the responsibility for operational aspects (Swiss

Federal Office of Energy, 2011a). The Swiss Federal Nuclear Safety Inspectorate (ENSI) focuses on technical issues of safety and the Technical Forum on Safety discusses and answers questions about technical safety from the public. There is a clear division of responsibilities between SFOE as the leading authority and ENSI as the safety assessing institution that ensures compliance with the regulations in the *Joint Convention* (Bühlmann, 2014). Securing the required cooperation between official representatives of site cantons, neighboring cantons and neighboring countries is the role of the Commission of Cantons (Swiss Federal Office of Energy, 2011a). The Siting Cantons Co-ordination Committee is responsible for the coordination between the siting cantons. The Waste Management Advisory Board assists in the site selection procedure by contributing an outsider's perspective.

Figure 7: Division of Roles in Switzerland



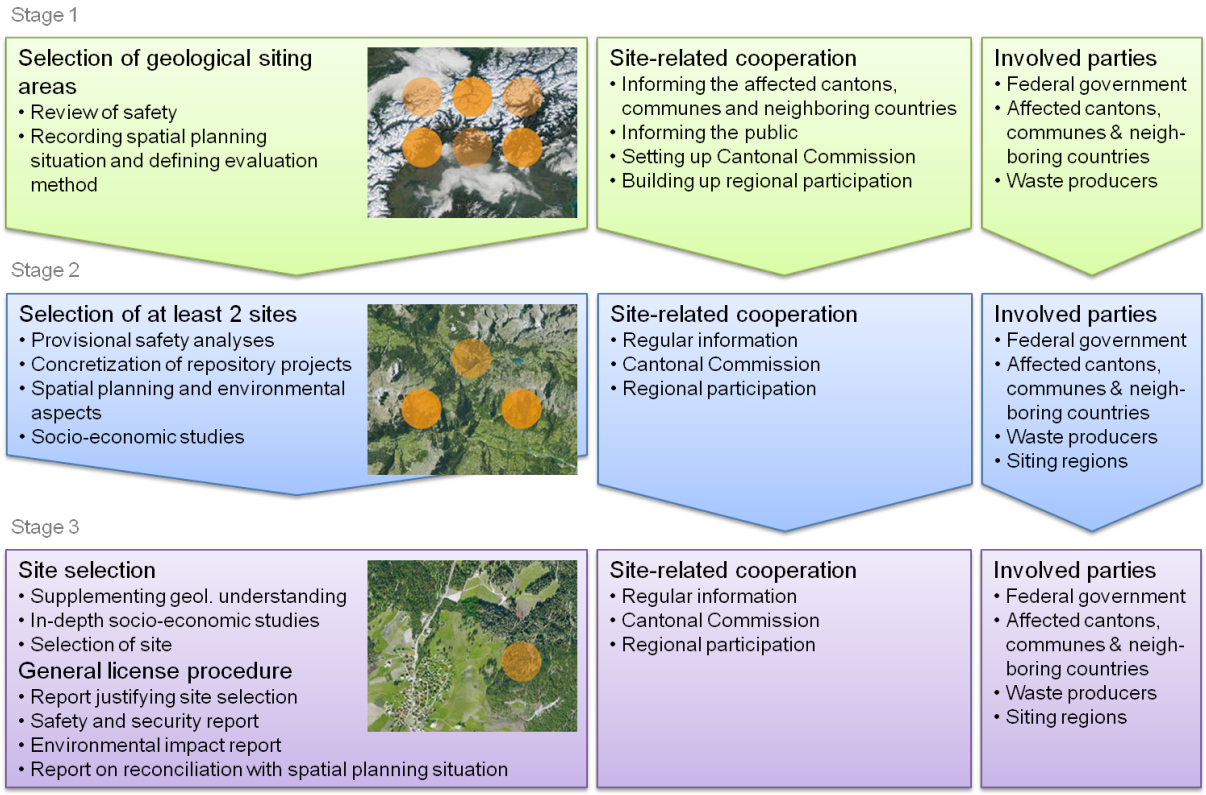
Source: own illustration, adapted from Swiss Federal Office of Energy (2008)

Based on the polluter-pays principle, nuclear power plant operators are responsible for the disposal of spent fuel elements and radioactive waste resulting from the operation of the plants, as well as the decommissioning and break-up of these facilities (Swiss Federal Office of Energy, 2011b). To finance the disposal of nuclear waste, operators pay annual contributions into two separately established funds, a decommissioning fund and a waste disposal fund.

3.2.3. Stages of process and strategy in siting

Figure 8 and 9 depict the stepwise process and the timetable for the selection of a final disposal site. In April 2014, the SFOE decided to extend the timeframe for the siting procedure by approximately ten years due the high complexity of the process, its pioneering nature and the willingness to allocate more time to the participatory elements (Swiss Federal Office of Energy, 2014b).

Figure 8: Selection of Sites in Three Stages in Switzerland



Source: own illustration, adapted from Swiss Federal Office of Energy (2008)

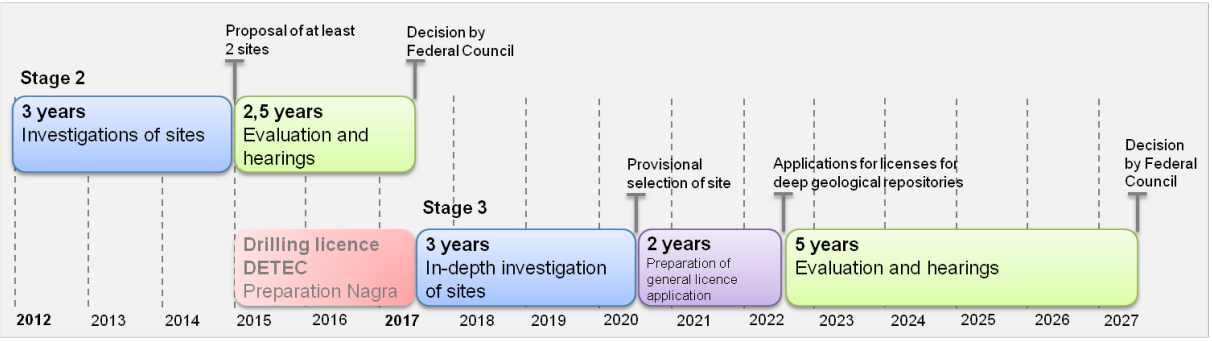
In the first stage, the waste producers propose geologically suitable areas based on safety criteria to the federal government (Swiss Federal Office of Energy, 2008). The spatial planning and safety situation is assessed before the siting areas are integrated into the sectoral plan. A cantonal commission is established that prepares the groundwork for regional participation in the second stage. In November 2011, this stage was concluded by selecting six siting regions, all situated in the Northern, German-speaking part of Switzerland (Swiss Federal Office of Energy, 2011c).

During the second stage, the Federal Offices undertake a spatial planning assessment of the proposed siting areas in cooperation with the siting cantons (Swiss Federal Office of Energy, 2008). Also, socio-economic studies are prepared together with the siting regions. Working together with the siting regions, the waste producers draft proposals for the configuration and design of the surface infrastructure, decide on the layout of the underground components of the repository and select at least one site per siting area. In May 2014, Nagra submitted the last report about the surface infrastructure, which was written taking into

account the proposals of the responsible Regional Conference (Swiss Federal Office of Energy, 2014c).

In the third stage, the remaining sites are investigated in depth to find a site for which an application for a general license is eventually submitted (Swiss Federal Office of Energy, 2008). To do so, the repository projects are specified in collaboration with the siting regions and socio-economic implications are analyzed in greater detail. The siting regions propose projects for regional development and prepare the background information in order to establish compensation measures and to monitor socio-economic and environmental impacts. Then, compensation measures are negotiated and made transparent. Finally, the waste producers submit applications for a general license (one each for HLW and L/ILW or one for a combined repository). The SFOE expects that Nagra decides on the provisional sites in 2020 (Swiss Federal Office of Energy, 2014b).

Figure 9: Timetable for Site Selection in Switzerland



Source: own illustration, adapted from Swiss Federal Office of Energy (2014b)

At the end of each stage, the responsible federal authorities conduct a review, followed by a three-month consultation phase before the Federal Council makes its decision (Swiss Federal Office of Energy, 2008). The general license granted in the last stage has to be approved by parliament and is subject to an optional national referendum. In case the municipalities and cantons concerned support the siting of the repository, the referendum should be adopted – a likely scenario according to McKinley L. (2014).

The Swiss sectoral plan is clearly a top-down approach to siting. The designated authorities and parliament have the sole right of decision-making in the process. The final decision is in the hands of the elected representatives. The possibility of an optional referendum is a regular part of the Swiss legislative process and thus does not challenge the assessment as a top-down approach in itself. Still, the population is able to participate to a large extent in the decision-making, adding important elements of the bottom-up approach.

3.2.4. Regional participation

In the regional participation procedure, municipalities, organized interest groups and local population of the siting areas have the opportunity to bring regional aspects to bear in the siting process (Swiss Federal Office of Energy, 2014a). For each siting area, a Regional Conference with about one hundred members from elected representatives for the

communes, organized interest groups such as businesses or associations and members of the local community were established (Aebersold, 2014). In the bordering regions, local German authorities participate in the Regional Conference as well (McKinley L., 2014). The goal of the Regional Conferences is to propose the specifications of the surface facilities, discuss the impact of a repository on the region and suggest measures to promote sustainable development within the regions. The SFOE also accompanies in the Regional Conferences to build trust between stakeholders and provide information (Aebersold, 2014). Additionally, the members of Regional Conferences have the opportunity to build up their own expertise on the issue of final disposal and call on experts from different organizations to answer technical or safety questions (McKinley L., 2014). Trainings about safety, ethical considerations, storage of waste and other topics take place and the SFOE provides personnel and monetary resources to the Regional Conferences (Aebersold, 2014).

The SFOE emphasizes the importance of the Regional Conferences as policy instrument to satisfy the demands of the local communities wherever the sectoral plan provides the flexibility (Aebersold, 2014). It also creates a level playing field between the communities affected and experts, as it promotes their risk literacy. According to Bühlmann (2014), the SFOE is very satisfied with the process, as the members of the Regional Conferences are highly involved and interested in the topic.

In the third stage, the regional participation will propose a compensation mechanism for the siting areas. Up to now, there is no previous experience concerning compensation for repository hosting (McKinley L., 2014). Yet, McKinley (2014) pointed out the successful compensation measures for the interim storage facility ZWILAG. The concentric compensation mechanisms benefits not only the hosting commune, but also other municipalities within a certain radius.

3.2.5. Public acceptance

In the international comparison, Switzerland is rather advanced in its siting procedure and encounters high public acceptance (Eckhardt, 2014). Eckhardt (2014) stresses that the authorities have learned from past experiences and established the participation procedure to ensure public acceptance. Still, this process requires endurance by all stakeholders and society has to be motivated to participate over a long period.

Concerning siting of nuclear power plants in Switzerland, there is one prominent case of NIMBY activism during the late 1960s. The occupation of the site of the planned Kaiseraugst power plant in 1975 marked the high point of activism (Swiss Federal Office of Energy, 2008). Consequently, the members of the Federal Assembly voted to abandon the Kaiseraugst project in 1988. Hence, the possibility that citizens block the decision exists, but such a scenario is rather unlikely regarding the siting of nuclear waste management facilities (Bühlmann, 2014).

3.2.6. Political debate and controversial issues

All interviewees in Switzerland stressed the good functioning of the siting procedure. As advantages of the sectoral plan, Aebersold (2014) pointed to the predictability of the procedure, which allows the involved stakeholders to build up confidence. The transparent process defines steps and the corresponding decisions to be taken at certain points in time. Nevertheless, the sectoral plan only provides a general outline, but does not fix all the details at the beginning. It maintains the flexibility to adjust to time constraints and new scientific or technical knowledge and to determine the details of every step at the outset. Schmid (2014) especially praised the flexibility of SFOE to extend the timeframe because it illustrates the importance of public participation and trust building. However, he cautions that extensions need to be proportional to avoid that opponents strategically block the procedure. Eckhardt (2014) positively emphasized that the siting decision is not made politically and thus is not subject to arbitrariness. Schmid (2014) finally highlights the participatory element in the siting process. Public participation such as the Regional Conferences takes more time, but it ensures a sustainable decision. As the only disadvantage of the chosen process, the interviewees mentioned the high resource-intensity for all stakeholders involved.

Concerning the roles of the institutions involved, a clear division is in place yet not always perceived as such by the public. The debate about regulatory capture in 2012 demonstrates that the distinct division of roles and responsibilities needs to be improved (Federal Department of the Environment, Transport, Energy and Communication, 2012). In this context, SFOE faced some challenges at the beginning of the siting procedure (Aebersold, 2014). In the past years, SFOE thus increased its lead towards Nagra by building up expertise and resources in order to sufficiently plan ahead. The scientifically oriented ENSI also faced initial challenges in satisfying the information needs of the society because the ENSI staff was inexperienced in public communication (Eckhardt, 2014). As consequence, ENSI organized communication trainings for its staff and increased the available resources for this purpose.

3.2.7. Future challenges

There are several challenges to the successful implementation of the sectoral plan and the institutions involved. First, the length of the procedure implies a high turnover of stakeholders and requires continuous motivation to participate (Bühlmann, 2014). Representatives of communes and cantons, which participate in Regional Conferences, are usually elected for four years. Hence, the process has to be open to integrate new participants and provide room to build up knowledge on nuclear safety.

Also, political support has to be guaranteed in order to ensure public acceptance (Aebersold, 2014). Although politicians are less likely to promote a particular site due to a possible loss of voters, their support for the procedure as a whole is essential. Similarly, the involved institutions need to enhance public acceptance by credibly implementing tasks and assuming responsibilities (Bühlmann, 2014). Eckhardt emphasizes (2014) that ENSI for instance needs to maintain its role as independent organization and therefore publish its own information

material. As trust is tied to persons rather than organizations, changes in publicly exposed staff might erode credibility (Bühlmann, 2014). Hence, changes in human resources, especially in the SFOE, need to be planned well ahead to ensure a sustainable transfer of knowledge and allow juniors enough time to build up relationships with other stakeholders. The SFOE has already intensified its research in the field of knowledge transfer and attempts to be as transparent as possible to prevent information loss (Aebersold, 2014).

In addition to acceptance, possible changes in public opinion regarding the future of nuclear energy in Switzerland might challenge the successful implementation of the sectoral plan (Bühlmann, 2014). Institutions like SFOE and ENSI need to anticipate the demands of society and shift their focus accordingly: according to Aebersold (2014), SFOE is sometimes confronted with citizens' demands for information that is not yet available due to the early stage of the process.

In conclusion, the Swiss top-down approach to site selection is working smoothly despite smaller challenges like the extension of the timeframe or the discussion about regulatory capture. In particular, the regional participation guarantees the involvement of the local communities by focusing on its demands and needs to develop sustainably.

4. Analysis of the country case studies

The goal of the site selection process is a successful choice of a final disposal site resulting from the legislative procedure. This decision should not be influenced by arbitrariness or political considerations. The procedure paves the way for a factually sound and politically acceptable solution. Public acceptance, meaning consensus of all governmental levels and the local community, should support the decision. Although public acceptance is a key element for the successful siting, it is only a necessary, not a sufficient criterion. This chapter analyzes how to achieve public acceptance using the case studies of Japan and Switzerland.

Even though public acceptance is to a certain degree dependent on the political culture of a country, some features in the process can be considered general best practice. Following the theoretical framework, the analysis of the country cases of Japan and Switzerland is divided into two parts: policy design and stakeholder dialogue. The concepts are interrelated: a sound policy based upon a fairness- and discourse-oriented balance of interests lays the foundation of public acceptance and thereby opens room for a dialogue involving all stakeholders. In chapter 4.3., recommendations are derived on how to establish reciprocal communication as the basis for universally acceptable decision-making.

4.1. Policy design

The *Joint Convention* demands an institutional separation between the management of the waste disposal and the regulation and supervision authority (see chapter 2.1.). Defining management in a broad sense includes any promotional and political activities. Therefore, IAEA recommends the establishment of a regulatory agency independent of the

management of facilities and promotional functions of nuclear power. Although the regulatory entity was separated from the Swiss Federal Department of the Environment, Transport, Energy and Communications (DETEC) and ENSI was established in order to fulfill this requirement, discussions about regulatory capture still emerged in 2012 (see chapter 3.2.6.). NUMO's slow progress since its establishment in 2002 is also linked to unclear responsibilities (see chapter 3.1.6.). Therefore, a successful institutional framework created to conduct the site selection procedure needs to clearly specify the roles of the respective bodies and sharply divide the responsibilities in order to guarantee the credibility and independence of all institutions.

In Switzerland, the votes against the two proposed sites in 1994 and 2002 emphasized the need for predictability during the siting process (see chapter 3.2.1). Additionally, the flexibility to adjust the timetable of siting process by ten years and the possibility of Regional Conferences to propose characteristics of surface infrastructure were stressed as essential characteristics of the stepwise process (see chapter 3.2.3.). In Japan, the METI subcommittee on radioactive wastes suggested explicitly implementing the concept of reversibility and retrievability as it allows adapting to new situation and technologies (see chapter 3.1.6.). A stepwise procedure should thus guarantee predictability without losing its flexibility: being able to respond to demands without changing the rules of the game increases confidence.

The open solicitation process in Japan was heavily criticized because of the passive role of the government (see chapter 3.1.4.). Other authorities did not support the municipalities in their role as key players. In response to this criticism, the subcommittee suggested the requested participation process, a joint initiative by the central, prefectural and local government (see chapter 3.1.6.). Regional participation in Switzerland already involves all interested stakeholders, even from neighboring states (see chapter 3.2.4.). The cases thus show that sustainable public participation needs to be based on the cooperation of municipalities, regional administration and local communities – partnership between all levels.

The provision of a final approval of the site selection by the Swiss parliament and an optional referendum provides additional democratic legitimacy to the siting (see chapter 3.2.3.). If a democratic institution takes a final vote, either in the parliament or in a nation-wide referendum, this positive effect could also be achieved elsewhere.

The compensation mechanism in Japan creates the impression that paying a municipality for accepting the radioactive waste promotes sustainable development (see chapter 3.1.6.). McKinley I. (2014) instead suggests emphasizing the benefits of hosting a final disposal site such as the newly created employment opportunities (see chapter 3.1.7.). In Switzerland, regional participants are in charge of proposing a compensation mechanism tailored to the needs of each municipality (see chapter 3.2.4.). If the compensation mechanism focuses on infrastructure and other needs of the community instead of financial resources, it could promote the development of the affected region more sustainably.

An external element influencing the policy design is international cooperation. Although Japan is very active in international organizations dealing with the issue of final disposal, Juraku (2014) and Kusaka (2014) criticize that the lessons learned from international experience are not transferred into domestic legislation and implementation (see chapter 3.1.7.). Engaging in international cooperation is crucial to promote the technical expertise of the institutions and to review domestic siting policies by implementing established best practices.

4.2. Stakeholder dialogue

The inefficacy of the siting process in Japan best highlights the need for an interactive, cooperative approach to siting as proposed by the METI subcommittee (see chapter 3.1.6.). Communication is defined as a reciprocal, dialogue-oriented exchange process, focusing on an increasing two-way communication between all groups and institutions. Comprehensive understanding of problems and mutual willingness to learn builds trust between individual stakeholders (see chapter 2.6.).

Challenges and conflicts in society have the potential to hinder communication between stakeholders (see chapter 2.5.). The increased NIMBY activism in rural areas of Japan illustrates the high mobilization and amplification potential of the topic (see chapter 3.1.5.). The societal conflict might cast doubt on the legitimacy of the authorized decision-makers and undermine public trust in scientific expertise. Risk literacy of the population is one of the goals of communication to avoid these conflicts.

The stakeholder dialogue needs to be based on the values of endurance, continuity and credibility in order to build confidence between them (Schmid, 2014). Credibility of the persons working for the institutional bodies is essential to ensure public acceptance (Bühlmann, 2014). According to Bühlmann, it is a skill, which can be acquired over the years, but it involves a large degree of personal engagement for the cause.

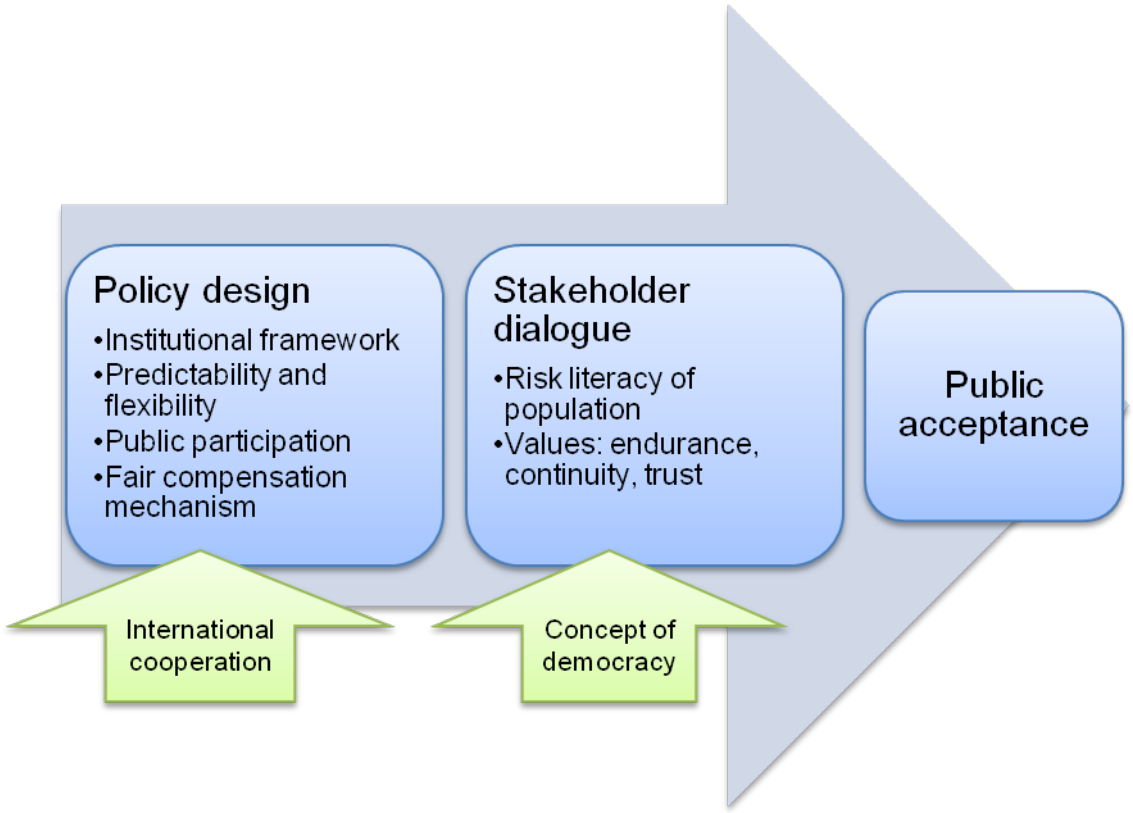
As an external factor, the overall concept of democracy in the respective country influences the course of action of a stakeholder dialogue and thus needs to be duly considered. It goes beyond issue politics and is defined by the political culture of a country.

4.3. Recommendations

Figure 10 summarizes the best practice concept for the policy design and stakeholder dialogue derived from the analysis of the case studies. It shows that a sound policy includes a distinct institutional framework promoting credibility and independence of the bodies, a stepwise procedure focusing on predictability and flexibility, public participation favoring a partnership between all levels, a final decision by a democratically legitimized institution, and a compensation mechanism promoting the sustainable development of the affected regions. International cooperation between authorities positively affects the design of domestic policies. Such a policy guarantees a stakeholder dialogue between all interested parties, which is in turn shaped by national concepts of democracy. The reciprocal

communication aims at developing risk literate citizens, incorporating the values of endurance, continuity and trust.

Figure 10: Optimal Policy for Site Selection



Source: own illustration

5. Conclusion

Japan and Switzerland both started discussing radioactive waste management for the first time in the 1970s. How complicated the issue is can be seen in the fact that the currently enacted policy for the site selection of a geological repository dates from 2002 in Japan and 2008 in Switzerland. Both countries chose a stepwise process to siting, but Japan's approach is mostly muddling through, whereas Switzerland chose a top-down approach.

When investigating the current situation and the future challenges of the siting processes in Japan and Switzerland, I found that the site selection in Japan has been stalled for about a decade because of the large reliance on the role of municipalities, the passive central government and the recent Tohoku earthquake. Japan faces the challenge to amend or restart the process and build confidence between all stakeholders in the coming years. In contrast, the extensive regional participation contributes significantly to the progress in siting in Switzerland. Anticipating the demands and questions of the public and accordingly shifting the institutional focus is one of the major challenges in Swiss procedure. Both countries highly value the possibility to exchange best practices in international organizations.

From the case studies, I derived recommendations for the characteristics of an optimal policy to successfully select a geological repository site following the legislative procedure. The optimal policy is based on a stepwise, predictable and flexible procedure with a clear institutional framework. It promotes two-way communication between all stakeholders, which establishes the basis for a universally acceptable decision-making.

Throughout the analysis, public acceptance, meaning consensus of all governmental levels and the local community, emerged as a key element for the successful siting as the result of an optimal policy design and a well-balanced stakeholder dialogue. It is related to the values of equity and fairness: intragenerational equity concerns influence acceptance of a siting decision by all stakeholders. And a fair and open decision-making process involves various sections of contemporary society and balances the resource allocation. It also emphasizes equity towards communities affected by the construction and operation of nuclear waste management facilities.

The perspective of the local communities and local and regional authorities on the siting in Japan and Switzerland appears promising for future research. For instance, the viewpoints of mayors and active citizens on the current status of the site selection and the future challenges could add a valuable perspective that is not yet heard often in academic research.

I hope that my research paper can contribute to advancing the discussion by raising awareness of the importance of appropriate procedures to deal with the final disposal of radioactive waste, one of the biggest challenges in energy policy today.

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Appendix

List of interviewees

Last Name	First Name	Title	Position	Organization	Advisory Function	Date	Place	Topic
Aebersold	Michael	Dr.	Head, Disposal of Radioactive Waste	Swiss Federal Office of Energy		6 May 2014	Phone	Switzerland
Bühlmann	Werner	Dr.	Member	ENSI Board		12 May 2014	Phone	Switzerland
Eckhardt Scheck	Anne	Dr.	Chair	ENSI Board		5 May 2014	Skype	Switzerland
Juraku	Kohta	Prof. Ph.D.	Assistant Professor, School of Science and Technology for Future Life	Tokyo Denki University	METI subcommittee on radioactive waste	9 May 2014	Tokyo	Japan
Kusaka	Kazumasa	Prof.	Professor, Graduate School of Public Policy	University of Tokyo		16 April 2014	Tokyo	Japan
McKinley	Ian G.	Dr.	Partner	MCM Consulting	NUMO International Technical Advisory Committee	1 May 2014	Skype	Japan and Switzerland
McKinley	Linda		Coordinator of Information and Translation Services	Nagra		1 May 2014	Skype	Switzerland
Schmid	Jürg V.		Vice-Chairman	ENSI Board		5 May 2014	Skype	Switzerland
Tochiyama	Osamu	Dr.	Director, Radioactive Waste Disposal Safety Research Center	Nuclear Safety Research Association	METI subcommittees on radioactive waste	2 May 2014	Tokyo	Japan
Tokunaga	Tomochika	Prof.	Professor, Department of Environment Systems	University of Tokyo	METI subcommittees on radioactive waste	1 May 2014	Tokyo	Japan