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# **“Enabling” public participation in a social conflict**

**The role of long-term planning in nuclear waste governance**

ITAS-ENTRIA-Arbeitsbericht 2015-02



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ITAS erforscht im Rahmen von ENTRIA Fragen der Technikfolgenabschätzung im Themenfeld der Entsorgung radioaktiver Reststoffe unter dem Stichwort „Governance zwischen Wissenschaft und öffentlichem Protest“. ENTRIA ist ein in Deutschland neuartiges Verbundprojekt von Wissenschaftlerinnen und Wissenschaftlern aus unterschiedlichen Disziplinen, die disziplinär und interdisziplinär Bewertungsgrundlagen für drei verschiedene Entsorgungsoptionen erarbeiten. Um Zwischenergebnisse sichtbar zu machen und Einblicke in die Forschungspraxis am ITAS zu gewähren, wurde diese Berichtsreihe ins Leben gerufen. Die Beiträge geben die Meinung der Autorin oder des Autors wieder.

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## **Zitierweise**

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## 1. Introduction

The aim of the research project ENTRIA is to compare the advantages and disadvantages of three key options in radioactive waste management and discuss them also in their social, juridical and philosophical contexts.<sup>1</sup> Two of the three options, the maintenance free underground repository and the underground repository with retrievability<sup>2</sup> are long-term projects not only with regard to the wastes' lifetime, but also with regard to the planning and management of the facility: Construction will take one to two decades, operation at least four decades if something like the German amount of nuclear waste is considered.. From a social science point of view, for such projects "planning" means to think about "institutions". The types of institutions relevant here are control agencies (like the Federal Office for Radiation Protection in Germany), ministries and also regional participatory platforms (citizen conferences or regional conferences during a site selection). As public participation plays a big role in the current debate, long-term institutions will also need to have a "public component". As we will argue in this paper, in addition to those more or less traditional institutions, hybrid organizations will be needed which are capable to act as a steward in the long term. Our hypothesis is that, at least for Germany, consistent and robust long-term planning, in which institutional settings including public participation are prepared, is a central prerequisite for the public's willingness to participate in a disposal program.

With this paper we intend to open a new topic for nuclear waste research. From a socio-technical perspective, there is a lack of publications which address questions related to the early planning of long-term processes, monitoring activities and the institutional planning of stewardship-processes. Research as that from Buser (2013) and the EU-project MoDeRn pick up some problems related to monitoring and related technical and social long-term processes, but synthesize them only to a limited extent.<sup>3</sup> We first stumbled across the basic problem of long-term planning when working on an essay on monitoring in a pilot repository for radioactive waste in Switzerland (Kuppler/Hocke 2012). Our focus was, whether transparency created by monitoring was a social innovation helping in resolving the nuclear waste conflict. We will reflect the available literature and our observations of the Swiss Case in a context, in which long-term processes do not play an important role yet and, at least for Germany, institution building, including participatory components, is still ongoing.<sup>4</sup>

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<sup>1</sup> The work presented here can be classified as a scoping study and is part of the ITAS work package within the Project ENTRIA funded by the German Federal Ministry of Education and Research. ITAS is the Institute for Technology Assessment and Systems Analysis at Karlsruhe Institute of Technology (KIT). ENTRIA is the acronym for "Disposal options for radioactive residues: Interdisciplinary analyses and development of evaluation principles" ([www.entria.de](http://www.entria.de)). The number for funding is 02S9082D.

Note: For the support in finishing this paper we would like to thank Elske Bechthold (ITAS at KIT).

<sup>2</sup> In the research project ENTRIA the third option is long-term surface storage.

<sup>3</sup> MoDeRn explains the frameworks for monitoring in different international contexts, but does not consider decision-making processes in a satisfying way. They have a clear idea about the steering role of „disposal process management decisions“, but they do not explain what types of complicated situations can occur due to the "dynamic and interactive system" of geology and technological installation as well as the probabilities with which they occur. They only sketch the relevance of regulations on the one hand and expectations of experts and of lay people on the other (MoDeRn 2011: 13-27). From another perspective Buser (2013) discusses the current debate on human intrusion and marking repository sites. He concludes that there are still several open questions.

<sup>4</sup> There are first attempts at sorting the arguments relevant here for the German and the international context, but the results are not empirically robust in the context of monitoring and governance (see Streffer et al. 2011, Hocke/Grunwald 2006, Solomon et al. 2010).

## 2. History and context matter

In Germany, the call for public participation in nuclear waste governance has been part of the debate between environmental organizations, civil movements, the interested public, the nuclear industry and responsible government organizations ever since explorations for a disposal site for high-level waste started at the Gorleben salt dome in the late 1970s (Appel 2006, Hocke/Kallenbach 2015). It is one central conflict line in the public conflict on nuclear waste management in Germany. As a current analysis of the historical development of nuclear waste management in Germany shows, in-transparency and a flawed site selection procedure fuelled public protest from the beginning on.<sup>5</sup> An attempt to install a new site selection procedure in the beginning of the 2000s failed as the government did not implement the plan suggested by an expert committee it had installed for this purpose (Hocke/Renn 2011: 49). This failed re-start again increased the public's scepticism towards the government's openness in the investigations of the Gorleben salt dome. Even with the new site selection law (BMU 2013), which prescribes a new site selection procedure, this scepticism could not be fully revoked. The support of the power industry and the anti-nuclear German opposition for the new procedure is not stable, as the answers to a number of fundamental questions regarding the quality and the extent of participation have not been clearly defined (e.g. *Parlamentskorrespondenz* 2015).

Official politics and the public discourse on energy issues and issues of nuclear disposal were confronted with and challenged by anti-nuclear campaigns, social movements, the politicization of established national interest groups and the severe nuclear accidents at Chernobyl (Ukraine) and Three Mile Island (USA) (see Rucht 2008, Flam 1994). The dissent in the public discourse did not stop with the new law from 2013. In all scientific arguments and public discourses that took place since, it was considered obvious that an extended process including public participation and stakeholder involvement was without alternative. In a number of studies (for Germany see e.g. Barth et al. 2007) it was unanimously argued that pro- and anti-nuclear actors would have to be systematically integrated into the decision-making process. It was argued that if this was not the case, experiences from comparative analyses and evaluation research showed that the chances of finding a consensus at the national level, which would remain stable over time, were negligible. The argument used that resulted in this broader support for such activities was the need for a societal "dialogue" (like citizen panels and similar events), aiming at "civil" forms of conflict management and hence at reducing the probability of in the worst case having to force dissenters to tolerate the mainstream position (Grunwald 2010a). Thus, over time, public participation as a tool became very popular at different levels: within European institutions, at experts level and in the socio-cultural milieu, which stood for "green ideas" and an interest in establishing sustainability as a new central concept (Quental et al. 2011, Elliott 2006).

In particular the Swiss case shows that organizing public participation needs to be organized in a way that takes national democratic traditions into account, while at the same time not being afraid of "social innovations". The "Sectoral Plan"<sup>6</sup>, which guides the site selection procedure in Switzerland, is based on an established national planning procedure, but includes a type of public participation, which is new to Swiss decision-making processes (Hocke/Kuppler 2015). This way, administrative staff, the industry and the public could accept the procedure. During implementation it proved to be

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<sup>5</sup> See Hocke/Renn 2011 and for the context of German Energy politics after Fukushima see Schreurs 2014.

<sup>6</sup> See SFOE 2008 and SFOE 2011.

essential that the plan was flexible within certain boundaries so that the Swiss authorities were able to react to new challenges with an adjustment of the plan. Transparency is a leading concept in the implementation of the Sectoral Plan and strong programmatic positions for the future development and the construction of a certain type of repository were published by the responsible federal ministry and the implementer. Those publications show a general intention to plan ahead as precisely as possible – also regarding generic aspects for collective action in the future. One example for this is the sketching of a pilot plant and a test laboratory within an underground repository, which is currently the favoured disposal option (see Kuppler/Hocke 2012).

Organizing a site selection procedure with public participation is not an easy task – even if only taking into account the near future. Depending on the disposal concept, institutional control will though be necessary for at least 100 years from now, i.e. until closure of the repository. In case that site monitoring is implemented and the option to retrieve the waste is planned for after closure, the time-span will be even longer. The open research question is, how such institutional control with public participation can be organized over such a long time-span, what the minimum requirements for a functioning institutional control are and what challenges such a control needs to meet. One concept dealing with future management of nuclear sites is the long-term stewardship program implemented by the United States Department of Energy (US DOE). The usefulness of this concept for radioactive waste management will be reflected in the next chapter based on governance theory.

### **3. Long-term Stewardship and Nuclear Waste Governance**

The term “long-term stewardship” is used by US DOE to institutionalize and consolidate management of military and other nuclear sites (such as from Uranium production). As a concept it was developed at military sites, where cleanup has been completed, but which still require management and control.

*“By ‘long-term stewardship’, DOE refers to the physical controls, institutions, information and other mechanisms needed to ensure protection of people and the environment at sites where DOE has completed or plans to complete ‘cleanup’ (e.g. landfill closures, remedial actions, removal actions, and facility stabilization). This concept of long-term stewardship includes, inter alia, land use controls, monitoring, maintenance, and information management.” (US Department of Energy 1999: A-2)*

The tasks defined in this definition, such as monitoring and information management, are of active nature, i.e. they require human action. According to U.S. federal regulation, active institutional controls cannot be assumed to be active any longer than 100 years after disposal, but should be kept active as long as possible (U.S. Government Printing Office 2006).

This places strong requirements on the institutional controls.<sup>7</sup> Even when disruptive events, such as war, are not taken into consideration, 100 years is a long time-span for an institution to exist and remain able to act at a concrete site. The large amount of waste and the considerable radioactivity make it even more difficult. On a general level it can be argued that the responsible collective actors and their institutions need a clear structure of responsibilities and sufficient funding for carrying out the required tasks. It is thus surprising that the institutional setup required for carrying out such

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<sup>7</sup> For institutional stewardship as a concept see also La Porte 2004, pp. 3-8, and Tonn 2001; Bruce E. Tonn evaluates six institutional designs including an non-profit stewardship organization and local community organizations (Tonn 2001: 267-269).

functions is not described in the corresponding reports, but only the tasks to be carried out and some measures to be taken. Examples for such measures and tasks<sup>8</sup> are

- ensuring land ownership,
- installing public records and
- enforcing access restrictions.

Long-term stewardship is considered to help getting an overview over all contaminated sites and harmonizing management over those sites (US Department of Energy 1999).

As this short summary shows, the concept of long-term stewardship has been developed with a rather managerial question in mind and does not address questions of institution building, such as how an institution should be organized in order to be prepared for fulfilling such a long-term task for a number of decades. Also public participation is not taken into account. What can be learned from experiences with the concept is that defining what measures will need to be taken in the future and what costs are to be expected is a difficult task (US Department of Energy 2001).

On top, experiences for example with the German Asse mine, but also with other problems in nuclear power plants show that actions “behind closed doors” without public accountability can lead to errors and problems (Möller 2009; Vorholz 2009). For the U.S., Probst & McGovern (1998) question the capability of DOE to successfully implement a long-term stewardship program due to its “institutional legacy: multiple missions and a culture of secrecy” (p. 14). They highlight the difficulty of substantive change in an institution that has been built up for another purpose than creating transparency and involving the public and has already been operating over a long period of time. Responsible organizations in Europe usually do not have the history DOE has. Still, they do usually not have extensive experience in public participation either. The question how organizational change can take place is also valid for those organizations.

For thinking about institutional requirements and public participation for long-term tasks, it is helpful to take a look at governance literature. The debate on governance in general focuses on how public services can be provided and how problems in a society can be solved in a “collaborative manner” and by innovation policy (Mayntz 2009). In governance arrangements the problem solving or the provision of services is not carried out by the state alone, but in a “network of actors” (Mayntz 2009, Grande 2012). In this case, “network” means that not only authorities, the government and established stakeholders from industry are involved in decision-making. Additionally also advocacy interest groups (like Friends of the Earth or Greenpeace), local initiatives and associations from civil society or social movement organizations are or can be integrated. Particularly in nuclear waste governance, the state will still play a strong role in this as it sets the rules according to which other actors are included in the network and takes ultimate responsibility for the waste (“shadow of hierarchy” – Torfing 2006). The hope in this context is that an early integration of stakeholders can moderate social conflicts, which can otherwise be expected to erupt. Examples for such conflicts are the anti-nukes-movement or the protests against genetically modified food. The idea behind this is that in balanced round table discussions, no-go issues can be identified and a constructive dialogue about acceptable solutions can be strengthened. In such a context, solutions can be found regarding

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<sup>8</sup> E.g. US Department of Energy 1999.

problems which occur due to political cleavages in connection with the issue managed in the concrete case.

Often, an analytical focus is put on the efficiency of a governance arrangement, i.e. in how far it manages to fulfil its function with a minimal input (Michelsen / Walter 2013: 188). This focus can be helpful when thinking about long-term tasks. The reason is that a minimal resource input seems helpful in providing a service over a very long time-span. At the same time, it poses the risk of depoliticization (Mayntz 2004, Haus 2010). This means that a pure focus on efficiency does not allow for political debate as it aims at the “right solution”. Such a “right solution” does not exist when the complexity of the task of long-term nuclear governance is taken into account. This complexity manifests itself in phenomena such as the “expert dilemma” (Grunwald 2010: 154-159) and in the uncertainty and non-knowledge inherently embedded in any decision taken on nuclear waste management. It is impossible to tell whether nuclear waste governance is efficient as it is impossible to know the effectiveness of any management measure to protect humans and the environment from the waste over ten- or hundred-thousands of years (Berkhout 1991). Thus, the political field has to be included in any governance arrangement designed to fulfil active tasks over a long period of time. One instructive example for such a task, which requires political debate and social support, is the decision whether or not to retrieve a certain amount of nuclear waste from an underground repository when monitoring data suggests that “something is going wrong down there”.

As an evaluation of the efficiency of the decision taken cannot be carried through (output-legitimacy), it seems that the quality of the decision-making process gains importance (input-legitimacy).<sup>9</sup> Research in Switzerland suggests that a fair decision-making process is central for acceptance (Krütli 2012). This means that if social control over a repository is deemed important over a long time-span, a robust decision-making structure has to be available as it facilitates robust structures of assessment and action. It would need to be flexible enough to react to changes in the social and natural environment and at the same time fixed so that responsibilities are clear.. The role on public participation in long-term governance also needs to be clear; concepts of citizen science and the knowledge of semi-professionals as important assistance in knowledge creation are stressed in literature (Finke 2013). The empirical test if complex participatory regimes are the best solution is still open. Also, not all actors put trust in this solution to lead to good results. Just as with public participation processes in the present, it is not sufficient to decide on the format (whether it be a citizen conference, a public dialog or other), but it needs to be embedded in the decision-making process (e.g. Langer/Oppermann 2012, Mauch 2014). Further the interfaces between formal and informal decision-making need to be clearly defined.

#### **4. Tasks in Long-term Stewardship**

The first central question, which needs to be answered when thinking about long-term stewardship, is what different types of tasks will need to be fulfilled and what are the corresponding basic institutional requirements needed to be able to fulfil those tasks.

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<sup>9</sup> Scharpf (1999: 6) distinguishes between two types of legitimacy: “Input-oriented democratic thought emphasizes ‘government by the people’. Political choices are legitimate if and because they reflect the ‘will of the people’ – that is, if they can be derived from the authentic preferences of the members of a community. By contrast, the output perspective emphasizes ‘government for the people’. Here, political choices are legitimate if and because they effectively promote the common welfare of the constituency in question.” (Highlights in original)



The tasks to be fulfilled and the time-span over which they will need to be fulfilled differ depending on the disposal option chosen and the concept behind. Above-ground facilities require much more constant institutional control than deep geological repositories with the option for retrievability. Least institutional control is needed for deep geological repositories without the option for retrievability.<sup>10</sup> For both types of deep geological repositories strong control will be needed until closure, which is several decades from now (at least 80 years in Germany). Thus, the challenge of long-term stewardship is there for all three kinds of facilities.

- Above-ground challenges in every option:
  - Maintenance of the building
  - Limiting access to the site and its infrastructure and technology (e.g. fences, alarm system, guards)
  - Maintaining knowledge for handling the waste (conditioning, packing, safety and security during storage, documentation)
  - Maintaining knowledge on the functioning of the building and its technology
  - Robust decision on marking and creating memory
- Additional challenges in the case of underground disposal with retrievability:
  - Maintaining knowledge on monitoring facilities (repairing faulty monitoring devices if accessible)
  - Maintaining knowledge on monitoring data (interpretation of data collected requires knowledge about the waste and what is “normal” and what represents a deviation from the expected development of the repository)
  - Maintenance of technology needed to retrieve the waste (including knowledge about the technology)
  - Maintaining knowledge and technology for finally closing the repository.
- Additional challenges in the case of underground disposal without retrievability
  - Maintaining knowledge and technology up to closure
  - Limited possibilities for reversibility of decisions mean limited time for monitoring and correction, thus high demands on regulating and controlling institutions.

The second central question is about time and possibly about two intervals. What different “types of challenges” are to be expected in the short and in the long-run and how can they be classified? Regarding classification, the long-term stewardship definition of active and passive tasks seems a bit too general in order to derive institutional requirements from it.

The same kind of task can pose very different challenges to long-term stewardship depending on the point of time at which it occurs. In the following we will shortly illustrate this using a dense description of an event in which stewardship would be needed at two different points in time.

The event we use as case is that in a deep geological repository with the option for retrievability, some monitoring data develop in a different way than was suggested by the reference-models steering the monitoring concept. Once this unpredicted development has been reported to the

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<sup>10</sup> Repository with retrievability will be open for longer time-span than repository without (ESK 2011). For the concepts of retrievability see Stahlmann et al. 2014 and NEA 2012.

institution responsible for decision-making, it will have to decide on how to proceed. Either it could decide that the deviation is acceptable and no further action is needed or it could decide that it is not acceptable and some kind of action needs to be taken. A further possibility is that it would need more information in order to be able to decide.

In our *first example* we assume that this situation occurs during the operation phase, in which the repository is still open. At this point of time there are diverse options for action. At such a stage, some waste will already have been placed in drifts and some drifts will already have been closed. Other drifts will still be open and some drifts will still be empty or even still under construction. The technological equipment for handling the waste will still be underground, especially trained staff will be used to working with the different kinds of technology and to handling the waste. Getting further information on the development of the repository will be comparatively easy. Further, the waste problem will still be 'present' on the political agenda and resources will be allocated. In this situation, the institution responsible for stewardship will have a relatively large degree of freedom regarding its decision as it is very likely that it will have the knowledge, man power, technology and resources it needs.

In our *second example* this occurs during post-closure instead. Under this condition the situation will be quite different. The repository will have been closed, which means that the technological task of getting to and handling the waste is much more difficult. Further, depending on the amount of time that has elapsed since closure, the staff at hand might be well trained (if at all), but may not have any experience with handling the waste. Also, it will be much more difficult to get additional information on the development of the repository so that any decision taken will have to rely on less information than in the other case. Resources could also be a problem as the waste will probably not be on the political agenda any longer and the will to allocate additional resources is limited. In such a situation, the degree of freedom will be much smaller and the consequences of a decision to retrieve the waste much bigger. Hence, the decision will be more difficult to take due to limited information, limited resources and possibly larger institutional hurdles.

In both cases, the central question is who should decide. Can it be science alone? Or is it or should it be also a political question? If yes, who should be involved? How should the public take part in decision-making? How to guarantee transparency in the sense of comprehensibility of decisions? Our hypothesis is that the answer differs depending on the point of time (operation phase, closure, post-closure) due to the different challenges that prevail in each of the time-spans.

## **5. Challenges and Institutional Requirements in Long-term Stewardship**

Due to the different challenges that an institution responsible for stewardship is faced with at different points of time in the repository life-time, it was argued above that the institution will have to change over time and with it also the institutional set-up it is embedded in.<sup>11</sup> What this means will be the topic of this section.

In table 1, an overview is given on some hypothetical requirements during three different periods of time (operation, closure and post-closure). This is not a final collection, but rather represents a collection of hypotheses. This table will need to be extended and the argumentation for the

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<sup>11</sup> The above-ground option is excluded in this chapter as the natural environment of such a type of facility is much more complex than for underground repositories and therefore the stewardship is more challenging.

requirements in the different periods will need to be deepened based on future research. Before discussing the table it is necessary to define what we mean by “stewardship”, i.e. to describe the characteristics, the role and the duties of a steward organizing the stewardship for an underground repository over time.

During all three periods of time, certain actors and institutions will be present. Those are an implementer of the repository, a national authority, which is responsible for control, and regional participative institutions, such as for example the Swiss “regional conferences”, which accompany the different phases and which will have to be organized and supported by the national authority. One of main tasks for all of the actors will be to keep informed about the state of safety and security of the repository. Our hypothesis, based on the stewardship debate is that in the long-term this arrangement has to be supplemented by a “stewardship institution”.

The stewardship institution’s main task is being responsible for the monitoring, the robustness of generated monitoring data and the technical infrastructure which is the precondition for measuring and data interpretation. In our logic, the “steward” as the director of this institution is at the same time someone like the chief of an emergency unit and the director of a small research institute. This could for example be an institute integrated in a technical high-professionalized university with basic research and applied sciences for radioactive waste management and training of PhDs and post-docs for generations of experts. Their research field has to be oriented on the state of the art of geological monitoring and data interpretation.

It cannot be assumed that the current academic structures and public institutions will be able to fulfil all required tasks due to the problem’s doubly complex nature (Kuppler 2012, Dryzek 1996). This means that in addition to the technical tasks, the stewardship organization will have to be able to enter into a dialogue with civil society and probably react to a changing political environment as well as be able to react to uncommon and/or extraordinary events in the repository. Those events will mostly be foreseeable by analysing the monitoring data from the repository. Reflecting the state of the art in nuclear and waste science the stewardship institution will have to have access to the infrastructure and knowledge to carry through practical tasks at the repository site within short notice. To guarantee the availability of the required scientific knowledge, the right technology and infrastructure and competent personnel under these conditions and at each point of time is not easy task. In conclusion our hypothesis is that the stewardship organization will have to have the characteristics of a “hybrid organization”.

The table in this section gives an idea, from the specific processes and arrangements in which this stewardship institution will have to act. Long-term activities later than 500 years after closure are not in the focus.<sup>12</sup> The characteristics are developed for the operation of a repository, its closure and the post closure-phase (for a low number of centuries) in the columns. In the rows the different dimensions and their trends over time are listed (see table).

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<sup>12</sup> For the operational and the post-closure phases see also IAEA (2014: 26-29).

**Table:** Stewardship in the Governmental Context

<b>Structural element</b>	<b>Operation</b>	<b>Closure</b>	<b>Post-closure</b>
<b>Monitoring</b>	underground monitoring at test repository or at drifts / chambers etc.	underground monitoring near disposal chambers / drifts	monitoring close to the underground repository
<b>Government</b> <i>(leading institution in the process, organizer of public participation)</i>	one leading and responsible ministry with access to resources and the waste producer	one leading and responsible ministry in cooperation with control agencies, funds for unexpected activities and stewards	national agencies with a strong link to regional sites, nuclear science and independent access to resources
<b>Institutional Setting</b> <i>(in which the stewardship institution is embedded)</i>	site specific regional conference with a link to science, national politics and waste producers	site specific regional conference with a strong link to national waste politics, stewards and controllers	stewards organizing monitoring programs and data interpretation together with the affected regions and stakeholders
<b>Participation</b> <i>(option for local actors to be involved in monitoring an stewardship)</i>	independent experts accompanying the local government and stakeholders	pluralistic expert committee for long-term stewardship and control	reliable and trustworthy cooperation and coordination of maintenance, monitoring and deliberating unexpected results in a professional and science-based way
<b>Checks and Balances</b> <i>(challenges in establishing modes of governance)</i>	new governance within independent institutions, governmental organizations and stewards for control, maintenance, problem-oriented research and preparations for decision-makers	Flexibility and experience to make routine governance structures work with monitoring professionals and access to independent research and decision-makers, established procedure for alarm and action in consequence	professional and powerful governance structures including regional actors, stewards, authorities, national waste politics and long-term training and knowledge documentation, established procedure for alarm and action in consequence

Source: Kuppler / Hocke / ENTRIA

For each structural element mentioned in the table we identify a development over time.

- On the level of “monitoring” the possibilities of nearfield monitoring decrease over time. Ensuring professional “monitoring” is – so our hypothesis – beside maintenance the central task for a stewardship institution.<sup>13</sup>
- The attention of official politics and “governmental organisations” decreases too. The reason is that radioactive waste management moves from being a highly-politicized problem to a classical problem of waste management and control.
- The stewardship institution needs to be prepared during the operation phase. In the phase of closure and post-closure its importance is generally high and constantly increasing. So the “institutional setting” changes over time.
- At least the residents at a local site of the repository need to be involved in stewardship and so “participation” can be organized also in this field. In the beginning their interest possibly will be represented by experts they trust. In closure and post-closure they will probably be involved more directly.
- In an ambitious stewardship model a robust system of “checks and balances”<sup>14</sup> plays a central role. We expect an increase of complexity in decision-making for the stewardship organization, but also for the interactive process between all involved actors. The importance of functioning checks and balances increases as the political and societal attention decreases over time.

In addition to the institutional requirements described above and the hypothetical developments of the long-term governance arrangements, further requirements for a functioning governance arrangement can be described. First, regarding the knowledge needed for decision-making, the responsible public institutions will need to have the scientific expertise at hand which is needed for taking the decision. The source of information should not only be the stewardship organization. Rather, a diverse, functioning research community would be favourable, which is able to provide different kinds of knowledge from basic to applied and stands in a critical dialogue with dissenting scientific positions. Second, the question needs to be answered how the public and stakeholders will be involved. Public and stakeholder involvement can have different functions in the process, from critical observation to the provision of knowledge and the involvement in decision-making. The possible tasks for participation are described in the table. The responsible authority needs to ensure that the participative elements are embedded in the decision-making process and that they have sufficient resources to be able to fulfil their task.

## 6. Governance Theory and National Contexts

In general, the theoretical framework for long-term governance needs to be strengthened. Several questions are still open, such as how to keep the public interested over such a long time and how to induce organizational change in a constructive way of governmental coordination and dialogue with

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<sup>13</sup> We do not take into consideration intrusion in this paper, independent from it being intended or unintended. As Buser strengthens, the debate on marking a repository has special relevance for this debate (Buser 2013).

<sup>14</sup> The term “checks and balances” refers to the need for some kind of institutional balance in democracies, which ensures that governments cannot abuse their power (Dry 2015).

the public.<sup>15</sup> The question in how far the theoretical answers to those questions can be translated into empirical experiences remains open and is a matter for empirical research.

In addition to the general institutional requirements summarized in the table above, it needs to be asked how these could be implemented in different countries. The openness or closure of administrative action and national political cultures regarding their interest to integrate contradictory positions seems to be an important factor shaping the national long-term governance arrangements. In each country, the current institutions and their structural setting would need to be analysed regarding their ability to fulfil the identified requirements including their ability to change. As Probst & McGovern (1998) have shown for the U.S. DOE, a historical analysis of the institutions involved helps in understanding their current role and their ability to fulfil future tasks.

Many of the basic requirements suggested above, such as checks-and-balances, the involvement of stakeholders and the distribution of roles need to be considered for each country separately. This means that an analysis is necessary how this could be translated into working institutions within the democratic traditions in a country. The Swiss case has shown that a major innovation, such as the Sectoral Plan and the connected policy of transparency, is more easily accepted by administrative staff if they are based on existing and known procedures (Hocke/Kuppler 2015). If administrative staff opposed innovations, they will be even harder to implement.

Questions of responsibility and of conduct will need to be identified and answered. Examples for such questions are “what is transparency?”, “who decides whether to retrieve the waste or not?”, or “who is responsible for collecting the monitoring data?” The questions are universal in nature, but the answer will differ for each country and for each period of time.

## **7. Conclusion**

Flexibility to react to the future! This is one of the major challenges in radioactive waste management – also in Germany. First, there needs to be flexibility in order to be able to react to natural underground processes that occur due to bringing the high-radioactive waste in geological formations – a human action which has “intended” and with a certain probability “unintended consequences” on the geology and also on long-term isolation. Second, flexibility is needed in order to guarantee transparency, professionalism and historical awareness. Those are three “social challenges”, which are not easy to transform into consensual action. Transparency is necessary as neighbours of nuclear underground repositories want to know how and by whom decisions are taken and about the risk and inherent safety of such a nuclear installation. Professionalism is necessary as underground repositories are “advanced technologies” of waste management and historical awareness helps to learn from experiences with nuclear research disposals regarding technical aspects and from experiences in conflict resolution and nuclear waste governance regarding governance and social aspects. But the question is whether this will happen in a professional way and under conditions of substantial participation.

On a general level it seems to be a matter of course that quality control is needed in this context. But which institution will care for the repository over decades or eventually longer periods like some centuries? Long-term aspects of ionizing radiation are discussed now, but also have to be reflected

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<sup>15</sup> See Grande 2012, who highlights the necessity of coordination and cooperation as central aspects of governance.

by competent institutions, which are prepared for long-term monitoring, data interpretation and action. For this reason society is asking for solid planning of the operation phase of an underground repository, but also of the closure and the post-closure phase. This means that there has to be a system of checks and balances for monitoring and data interpretation for several decades or even for centuries. The long-term planning of technological, governance and social aspects is one central prerequisite for a widely supported solution of the nuclear waste problem in Germany and possibly also elsewhere. Long-term planning is a possibility for the current responsible institutions to create hope that the problem of high-radioactive waste management is managed in a solid and intellectually reflected manner. Planning “on the paper” is though not sufficient to create this hope. Rather, a substantive preparation of the needed institutions is necessary. If “high-quality decisions” with robust public support in modern civil societies are expected, the responsible authorities should have a “plan”. Transparency and long-term stewardship are the keywords mentioned in this debate. But can there be solid planning for those long periods of time?

The expectations of civil society in the German context are obvious. German civil society wants more than formal correct licenses and administrative correctness. It requests solid planning for monitoring of long-term developments and scientific assessments of security in different phases of an underground repository. As German nuclear waste governance is still in development, a sophisticated debate under experts about high responsibility of governmental agencies, platforms for regional participation and an ambitious plan for professional stewards has the chance to give orientation. For example, public participation needs to become an essential part of German decision-making and decision-making processes and not only as a temporal “add-on” – an add-on that can be neglected by government agencies and waste producers.

In this way processes of social reforming and societal learning have to be integrated in nuclear waste governance in Germany. This learning has to be rooted in the past (historical development), enabling in the present (focus on conflict resolution in Germany) and preparing the future (institution building) if it is to function in the long-run. One future research question will be, in which way the conceptual work of OECD-NEA and their “Forum of Stakeholder Confidence” can be integrated in the German site selection and planning procedure (NEA 2014). Without integrating local civil society at potential repository sites, an important chance is lost for gaining tolerance or at least some kind of support for the ongoing planning for a multi-generational project like an underground or a long-term surface disposal. Konrad Ott, a German philosopher, classifies the waste as “evil” (Ott 2014). A win-win situation will not be possible for any region. In this situation, gaining tolerance for and acceptability of the planning procedure is the only possibility to succeed.

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