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In Whose Backyard? The Wicked Problem of Siting Nuclear Waste Repositories

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This article focuses on the "wicked problem" of siting nuclear waste repositories. It addresses the question of why local communities are not willing to host nuclear waste facilities, and what factors play a decisive role for acceptance and voluntarism. We discuss the extent to which compensations together with trust could be decisive in easing the decision making processes for a site search. Starting from the assumption that voluntary processes have been the preferred path in countries in an advanced stage of planning or constructing a repository, we question whether the factors that allowed for success in siting in Finland, Sweden and France or for failure (United Kingdom) can be of use in other contexts, e.g., in Germany. By analyzing the relationship between government, industry and the communities willing to host repositories, we discuss different forms of voluntarism in combination with various site typologies, i.e., Blowers' "nuclear oases"; "communities with industry awareness"; "nuclear communities", and "Springfield communities."

KEY WORDS: Nuclear waste, NIMBYsm, voluntarism, siting, community benefits, wicked problem

建在谁家后院? 核废料处置库选址面临的棘手问题

本文聚焦于核废料处置库选址的"棘手问题"*(wicked problem)*。处理了为何本地社区不愿意建立核废料设施的问题, 以及哪些因素在"主动接受和自愿主义"(即同意建立核废料设施) 上起决定性作用。本文讨论了赔偿和信任在何种程度上帮助简化选址决策过程。本文假设自愿过程是国家在计划或建造处置库后期阶段的优选道路, 质疑了在选址一事上成功 (例如芬兰, 瑞典和法国) 或失败 (英国) 的因素能否用于其他背景, 例如德国。通过分析政府、工厂和在建立处置库一事上社区意愿之间的关系, 本文讨论了与不同选址类型结合的自愿主义, 即布洛尔斯 *(Blowers)* 的"核绿洲" *(nuclear oases*, 用于核废料处理和再加工*)*; "具备行业意识的社区"; "核社区"和"斯普林菲尔德社区" *(Springfield communities)*。

关键词: 核废料, 邻避效应, 自愿主义, 选址, 社区利益

¿En el patio trasero de quién? El grave problema del emplazamiento de depósitos de desechos nucleares

Este artículo se enfoca en el "grave problema" del emplazamiento de depósitos de desechos nucleares. Aborda el tema de por qué las comunidades locales no están dispuestas a tener sitios de almacenamiento de desechos nucleares, y qué factores juegan un papel decisivo para la aceptación y el voluntariado. Discutimos qué tanto las compensaciones junto con la confianza podrían ser decisivas en

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facilitar el proceso de toma de decisiones para buscar un sitio. Empezando con la suposición que los procesos voluntarios han sido el camino preferido en países en estado avanzado de planeación o construcción de un repositorio, cuestionamos si los factores que permitieron el éxito de encontrar sitios en Finlandia, Suecia y Francia o del fracaso (Reino Unido) pueden ser usados en otros contextos, por ejemplo, en Alemania. Al analizar la relación entre el gobierno, la industria y las comunidades que están dispuestas a tener depósitos, discutimos diferentes formas de voluntariado en combinación con varias tipologías de sitios, por ejemplo: los "oasis nucleares" de Blowers; "comunidades con conocimiento de la industria"; "comunidades nucleares" y "comunidades Springfield."

PALABRAS CLAVES: desechos nucleares, NIMBY (No en mi patio trasero), voluntariado, emplazamiento, beneficios para la comunidad

Introduction

The management of high-level radioactive waste (HLW) and the search process for siting a permanent repository are controversial issues. People perceive the dangers associated with the disposal of HLW to be much greater than those associated with other possibly "noxious" projects (Slovic, 1991).

Deep Geological Disposal (DGD) has been advocated by a large majority of scientists and technical experts as the most adequate way of disposing of HLW. Moreover, this position has been endorsed by national governments as well as by international bodies such as the Nuclear Energy Agency (NEA) of the OECD or commissions of independent experts (the Blue Ribbon Commission on America's Nuclear Future, 2012). It has been claimed that DGD is the only available option to ensure long-term security and not to burden future generations (ENEF, 2009). It is nevertheless recognized that there are diverging views and public concerns about geological repositories (European Nuclear Energy Forum [ENEF], 2009, p. 3). By contrast, for NGOs, the existence in a number of countries of plans for DGD solutions and the rejection of other options is *per se* no evidence that DGD is the best possible solution. Moreover, there are still many technical issues that remain unresolved and have implications for policy development (Wallace, 2010).

Although advocates of the permanent closure of radioactive waste in DGD consider this to be the option with the highest levels of security and safety for the long term, some countries are pursuing other options, essentially buying time to learn more about technological possibilities for addressing nuclear waste (Budelmann, Di Nucci, Isidoro Losasda, Köhnke & Reichardt, 2017).[1] A number of countries have decided to store their HLW in interim facilities before making a decision on whether to pursue DGD. For example, the Netherlands has implemented a policy of long-term storage (Brunnengräber, Di Nucci, Isidoro Losada, Mez & Schreurs, 2015).

Site selection is a common challenge all around the world. In the European Union (EU), only Finland and Sweden are in advanced stages of implementing plans for the direct disposal of spent fuel and HLW. In both countries, sites have been selected and the construction has started. France is in an advanced stage of planning whereas the siting in the United Kingdom is in a stalemate situation.

What needs to be done from a policy perspective to advance the search for nuclear waste disposal sites? These issues "must focus on the conditions for social and political acceptability, within the constraints identified by physical science and engineering" (Rosa et al., 2010, p. 762). Whether the population or the individuals concerned are willing to accept a repository in their immediate vicinity depends on a number of factors, including social, cultural, economic, and political ones. These factors are subjective as well as objective, which means that perceptions also play a role. There are no definitive solutions and we can observe many specific interrelated problem constellations in which the interests and preferences of the most important actors and stakeholders are highly diverse. These are influenced by the local geographic, political, cultural, and socio-economic context. From an ethical point of view, intra and inter-generational questions of justice with regard to the conservation of the ecosystem as well as the burden that we entrust to future generations are of key importance (Ash, 2010; Shrader-Frechette, 2000; Wissenburg, 2006). Blowers (1999, 2016) pointed out that solutions must be scientifically robust and must achieve the highest technical standards, but they must also be acceptable and accepted by the public. Rosa et al. (2010, p. 763) maintain that the social aspects have been often considered "as an obstacle to overcome, not an element of the democratic process." They claim that "planners and officials fear that public involvement may shift an unengaged or uninformed public toward more controversy or opposition, thus reducing their control." Although there may still be resistance to more participatory and open planning structures, new and more democratic modes of governance are recognized even by official nuclear institutions as necessary for moving forward with siting (NEA, 2004, 2015).

This article compares siting procedures in Finland, Sweden, France, and the United Kingdom and contrasts their experiences with the German case, where the site search process has just been re-started and new governance bodies have just recently been set up. The siting procedures in these countries are characterized by voluntary approaches. But individual experiences differ as they have been based on voluntary procedure schemes (Sweden), decisions with strong local community support (Finland) and a rather top-down decision making (France) where the final decision on-site selection is subject to the outcome of a public debate. In the United Kingdom, notably in Cumbria, the unsuccessful site selection procedure was based on the so-called "partnership" approach.

As far as participation and procedural equity are concerned, our article focuses only marginally on procedures of public involvement. There is a large body of scholarly literature and of empirical studies addressing various forms of involvement in the planning process and in decision making.[2] It has been pointed out that participation is an ambiguous notion, which can range from the population's "right to know" to its "right to object" and even to its "right to decide" (Di Nucci, Brunnengräber & Isidoro Losada, 2017). The countries under examination in this article have experienced varying forms of public participation since the 1990s, ranging from passive information to consultation and partnership. Some countries have reached by a stepwise approach a good balance between the

requirements of fair representation and "competent participation." NEA (2009, 2004) considers this to be one of the underlying elements of the partnership approach, which is designed to help achieve a combination of licensable site and management concepts with host community support and a balance between compensation, local control, and development opportunities.

This paper addresses the question of why, in most cases, local communities are not willing to approve sites for nuclear repositories. However, we do not aim to frame our analysis from a NIMBY (Not In My Backyard) angle. A review of the literature shows there are numerous scholarly articles either defining and classifying various forms of NIMBYism or providing a critique of the NIMBY syndrome or even the term NIMBY. Additionally, there are works concentrating the psychological, social, territorial origins of NIMBY reactions as well as articles that use another lens to understand NIMBY behaviors, e.g., "place attachment" and "place identity" (Devine-Wright, 2009).[3] There is also a strand of literature that in the 1990s specifically engaged with NIMBY opposition to nuclear power and the siting of toxic or nuclear waste repositories, especially in the United States and the United Kingdom (Kemp, 1990; Kraft & Clary, 1991). Following the critique of Luloff, Albrecht and Bourke (1998) and Wolsink (2006) who claimed that many authors use the term NIMBY without a clear definition, empirical support or conceptual understanding, we argue that NIMBY has become a label that is used regularly and falsely as a synonym for local opposition, regardless of the reasons for the rejection of a large-scale project (Di Nucci, 2016).

This article focuses on the reverse concept "In My Backyard" (IMBY) and on voluntarism, which could be equated with IMBY attitudes. We analyze the specific question of siting a DGD facility and discuss the extent to which voluntarism, eventually buttressed by compensation packages, can be decisive in easing the decision making process for a successful site search and for acceptability. We try to ascertain whether there might be particular conditions under which the provision of community benefits and incentives can enhance local support for siting a repository, particularly in a context in which the abuse of NIMBY rhetoric on behalf of politics, nuclear industry and the media has been striking. We also take stock of the body of literature on trust, especially on institutions and experts, and consider trust as an additional explanatory variable in easing the siting process.

An essential advantage of voluntary siting approaches *vis-à-vis* D-A-D (Decide-Announce-Defend) strategies relates to distributional justice aspects and to the consent of the affected population. Recognizing this, we explore to what extent voluntarism (connected to a right of withdrawal and to exercise a veto) and possibly in conjunction with compensatory measures, has served to accelerate siting procedures. We start from the assumption that search procedures based on the willingness of the communities to engage voluntarily in the siting process have been the preferred path in countries that are in an advanced stage of planning a repository or are already constructing one. This is the reason for selecting the cases of Sweden, Finland, and France. Although the siting in the United Kingdom is in a stalemate situation, we also briefly discuss the procedures for selecting Cumbria as a hosting

region, because this case offers interesting insights with respect to voluntarism. However, our major concern was to select cases that proved to be successful.

We describe briefly the modes of voluntary siting procedures in Finland, Sweden, France and the United Kingdom, search for common patterns and differences between them and contrast their experiences with the German case. The experiences of these countries are not entirely applicable to other national contexts, especially because of the different modes of governance (Brunnengräber et al., 2015). Nonetheless, it is an enticing task to try to infer whether the preconditions and strategies, which were key for acceptability and allowed for success in siting could be useful to derive some lessons for policy for the German case.

More specifically, by trying to understand and classify community responses to siting nuclear waste repositories, this article addresses following specific questions:

- Is the promise of economic benefits an incentive for an IMBY response by local communities?
- How far can concern about the potential risks connected with repositories be neutralized by the prospect of economic incentives and side benefits including infrastructure or jobs offered to host communities?
- How do potential host communities cope with the "bribe effect"? Is this always an obstacle to successful siting procedures or can compensation be considered legitimate?
- What role is played by trust in institutions and in the nuclear industry?
- What characteristics are displayed by those communities that are willing to accept a repository in their vicinity?

So far, in Germany voluntarism is not included in the criteria for site selection and it is not anchored in the present legislation. In the conclusions, we discuss whether in Germany voluntarism could represent a path of least resistance.

This paper draws on a comparative, qualitative case study based mostly on document analysis and literature review, primarily on nuclear waste governance, socio-technical aspects, local conflicts and on participation in the siting process as well as on topical issues in national case studies. This information has been supplemented by interviews and discussions with national experts on nuclear waste policy in Sweden, Finland, United Kingdom, and France.[4] In the case of Germany, stakeholder interviews were conducted in the period 2013–2017. The document analysis and interviews helped to identify the main issues of acceptability, acceptance and conflicts and the role of compensation. Additionally, we have incorporated evidence from the research conducted in the framework of our five-year interdisciplinary project and participatory observation in the works of the German "Commission for the permanent disposal of high-active Waste" (*Endlager-Kommission*) of the German Parliament (2014–2016). The data set consists of more than 300 minutes of meetings and documents that are available on the internet and in the final report (Endlager-Kommission, 2016).

A Wicked Problem

The management of HLW and the search process siting a repository are subject to considerable conflicts. The million-year time period during which HLW must be stored poses problems for which no "absolute" safety criteria and no definite or objectively "acceptable" solutions are at hand. In the socio-political research on final disposal of nuclear waste, such phenomena are referred to as "wicked problems" or as "tricky" or "nasty" problems (Brunnengräber, 2016; Brunnengräber, Di Nucci, Häfner & Isidoro Losada, 2014).[5] These include specific interrelated problem constellations in which the interests of the most important actors are highly diverse and influenced by the local political, cultural and socio-economic context. Against this background, the process leading to a final repository can only be understood *ex post*, i.e., when the search process is completed and the final repository has been built, as specific problems are unpredictable and can emerge during the search process, construction, and disposal.

As in many other cases concerning the relationship of science and technology to political power (socio-technical and political issues), one can assume that three core dimensions of the problem are closely interrelated. These are: the material nature of the problem and its possible dangers; the high technological requirements regarding controllability and safety risks (technical problems); and the social conflicts, conflict situations, and political practices that are reflected in the individual behavior of actors, institutions, organizations, in the state or in international organizations (Brunnengräber, 2016). In the case of disposal of radioactive waste, there are additional specific problems. Apart from the fact that the period to be taken into consideration extends up to a million years, the risk dimension includes further problems: technical, geological, and social measures must be taken, however their functionality cannot be tested for such a lengthy time scale. Moreover, the fears of local populations, which cannot either be minimized or considered unrealistic or unjustified, must be faced and dealt with.

Thus in spite of all efforts to achieve an ideal solution, only "clumsy" solutions (Verweij & Thompson, 2011) can be expected in which the interests, values, and positions of the different actors have to be balanced. Quite simply, a site cannot be found "outside" of society, and this requires that all involved actors are ready to make compromises. However, new conflicts are unavoidable due to deep differences in the values, interests, and preferences of the actors, who have different views on the procedure as well as of the desired results. This is also because negative feedback loops can occur. To this extent, it is essential to ensure that the social process is as flexible as possible, in order to ensure that new adjustments and a reformulation of the process steps, i.e., a productive handling of conflicts, are possible in the long run. Solutions can never be justified, for example, simply by virtue of technical-material merits. Thus, while one can agree that "geology matters," it is clear that problems are "socially produced" and their (possible) solution depends on how the issues are framed and the definition of the problem also depends on the potential solution being considered or taken.

NIMBYsm and Voluntarism in Siting

The major focus of research in the field of nuclear waste disposal is on solving technical problems. In the last decade, greater attention has been devoted also to socio-technical issues as well as to questions of participation and transparency (Bergmans, Kos, Simmons & Sundqvist, 2014). This new focus is reflected by a growing body of literature on technical issues concerning nuclear waste repositories complemented by socio-technical works on risk, acceptance, acceptability, and participation in the siting process (see e.g., publications of the Nuclear Energy Agency (NEA) of the OECD.[6] Today "inclusive" communication and participation in the siting procedures are being recognized as a compelling necessity (Brans, Ferraro & von Estorff, 2015). A broad social dialogue and greater public involvement are regarded as a prerequisite for a promising approach to the problem of disposal (NEA, 2009, 2015).

The discourse about suitable sites is not confined to the scientific and techno-political domains; it engages civil society, social organizations, social movements, and affected communities. Siting processes are affected and shaped by various actors and factors, such as the nature of the political and legal systems, formal and informal rules and procedures, culture, political constraints, geographic conditions, technical skills, the stock of knowledge, and public acceptance. In the case of the siting of nuclear waste repositories, a country's nuclear history also plays a decisive role (Bickerstaff, 2012). Additionally, long-lasting and thorny social conflicts and distrust make siting decisions challenging.

Rosa et al. (2010, p. 763) claim that institutional cultures frame challenges as technical problems rather than societal challenges. By contrast, NGOs (Wallace, 2010) assume that there are many unresolved overarching issues, technical "unknowns", and uncertainties. "Thus, in addition to the tension between the economic benefits being offered to host communities and long-term repository safety, there is a tension between endorsement of deep disposal as a potentially 'least bad' option for existing wastes, if the scientific and technical difficulties can be resolved at some point in the future, and nuclear industry claims that deep repositories provide a safe solution which will allow the 'sustainable' expansion of the industry" (Wallace, 2010, p. 45).

Community attitudes that foster NIMBYism are complex; and any explanation of those attitudes should be based on an analysis of specific factors that should take such diversity and complexity sufficiently into consideration. In the body of literature on NIMBYism, opposition to large or to (perceived) "noxious" facilities is explained as the result of an unequal spatial distribution of the external effects of such technical facilities, e.g., nuclear power plants (NPPs), waste incineration plants, large infrastructures, or even social facilities such as refugee homes. We take stock of the long-standing, but still cogent definition from Freudenburg and Pastor (1992), who regard the reaction of the public as the core of the problem and speak of the "NIMBY syndrome," while those who consider such plants or projects as problematic refer to them as "locally unwanted land use"(LULU).[7]

The number of theoretical and empirical studies dealing with NIMBY phenomena has increased over time. They investigate the reasons for "non-

acceptance" and the various forms of opposition such as demonstrations, civil disobedience, or petitions. Some of these studies have also led to a different understanding of the role of experts (Petts, 1997). A frequent criticism of opposition was that the public cannot make a clear distinction between the real risks or impacts associated with a nuclear waste repository or, in general, new large-scale projects and the subjective or perceived risks. In many cases, citizens' perceptions and assessment of these risks have been presented in the political debate or in the media as exaggerated or unfounded or it has been purported that the public was simply "wrongly" informed about the facts. This has led to the supposedly legitimate approach in which the experts, or the political actors they advise, have made decisions and later defended them. A significant number of national large-scale projects have been inspired by such a D-A-D-strategy. In light of the fact that the attitude to risk-taking has changed and systemic risks are becoming more and more important (Renn, 2011), this approach increasingly shows its limitations. Large projects often do not only lack broad support; they also provoke considerable opposition. Particularly in the case of complex projects, a broad and very diverse actor spectrum can oppose the project and mobilize against it. This applies in the energy sector not only to "critical" and controversial technologies such as nuclear power, but also to renewable energy such as biomass plants and wind farms (Devine-Wright, 2011; Wolsink, 2007). Opposition is not necessarily triggered by potentially risky or harmful plants and projects, but rather by the fact that genuine public participation in the projects is often not envisaged.

Conversely, IMBY reactions can be defined as the willingness to host new facilities or even the desire for housing them. Such an attitude relates to real or perceived tangible or intangible external effects of new facilities that spill over into the community and may bring about benefits for a group of individuals or for a locality. NEA (2009) defines voluntarism as the expression of interest of a community to participate in a search process for a suitable radioactive waste repository in their vicinity. Some voluntary processes include the right of veto and to withdraw from the process within a certain period of time. In some countries, a right of veto is ensured either by law or is based on agreements between communities and the nuclear industry or the respective governments (NEA, 2009). The Swedish and Finnish voluntary approaches have caught on and served as a model for much more advanced approaches to a siting process, e.g., the partnership as tried out in the United Kingdom (Blowers, 2016; CoRWM, 2006) or in Belgium (Laes & Bombaerts, 2006). Partnership can be considered as an empowering approach, which contributes to transparency and enhances accountability in decision making. Cotton (2017) considers voluntarism to be based on ethical egalitarian principles. Citizens enjoy better opportunities to be involved without coercion in decisions that affect them. The CORWM voluntarist model was aimed at reducing the coercive effect and "is egalitarian in the sense that any community of citizens could enter into (first) discussion and (second) agreement with government to concentrate such risks." (Cotton, 2017, p. 200).

The partnership approach is a collaborative working relationship between the host communities and the developers of the nuclear facility. They interact (directly

or indirectly) without feeling excluded by a national process over which they have little control. According to NEA (2009), there are various arrangements to implement a partnership (permanent or temporary working groups, panels, etc.) that reflect a determination to empower communities in decisions that may affect their future. Partnerships can be organized through legally binding agreements or through less formal arrangements. The Committee on Radioactive Waste Management (CoRWM) (2006) underlines that although the framework for a partnership should be established nationally, this should accommodate the requirements of local communities.

However, in both "Scandinavian" models as well as in the partnership approach or in any collaborative governance approach, trust in the institutions and preparedness to delegate negotiation is a critical characteristic (Tait, 2011). Trust is understood as a complex, multidimensional, and context-dependent concept and can be considered as a key factor (Petts, 1997). Empirical studies especially in the fields of contested technologies show that trust in institutions, technology, and procedures is fundamental for enhancing the acceptability of energy infrastructures or even technological paths, and to smooth environmental and social problems.

Major Characteristics of National Siting Experiences

In the countries analyzed below, siting procedures have taken place under different framework conditions and with different outcomes. Finland and Sweden are in an advanced stage of implementing a DGD Repository.[8] Their sites can be described as "nuclearized," as nuclear facilities exist within the municipality or in the neighborhood. In France, the designated site already hosts an underground research laboratory; in the United Kingdom, Sellafield and Cumbria register the highest concentration of nuclear facilities (and radioactivity).

Finland

Finland has already started building a DGD facility; the Onkalo repository at Olkiluoto is scheduled to begin operations by 2020. Onkalo's construction has been proceeding with little public debate and the influence of NGOs has been limited (Lehtonen, 2010). The siting process can be subdivided in two stages. The first one took roughly place in the period 1980–1994 and was characterized by a "technical approach or a geological suitability approach," in which the general geological conditions of different areas were analyzed to verify their suitability as final disposal sites. The major decisions in this period were the Parliament Decision-in-Principle (DiP) in 1983 that set the framework and a timeline for the implementation of a DGD project.[9] The next step was a list of potential repository sites as well as the identification of potential sites that "volunteered" to accept more detailed investigations. These were subsequently carried out at three sites (Auffermann, Suomela, Kaivo-oja, Vehmas & Luukkanen, 2015). In the period 1997–1999, the Environmental Impact Assessment (EIA) was performed. In 2001, Olkiluoto, in the municipality of Eurajoki, already hosting two nuclear reactors, was selected

as a site. It has been reported that an earlier survey of the three potential sites revealed significant public opposition once existed at this location but this opposition decreased over time (Kojo, Kari & Litmanen, 2012; Lehtonen, 2010). The EIA procedure represented a very important step preceding the licensing process and opened up citizen participation in planning processes. Litmanen, Kari, Kojo and Solomon (2017) argue that although the EIA procedure in the late 1990s was a major vehicle for public participation, this proved to be ineffective and was amply criticized by opponents and observers due to its "narrow framing." Cooperation took place between the operator Posiva owned by the nuclear industry and the local councils with whom the negotiations were carried out.[10]

Sweden

Sweden is also in an advanced stage of implementing its DGD facility. This is the outcome of a long process which started with nationwide test drillings in the 1980s and resulted in widespread local protests (Kåberger & Swahn, 2015). Subsequently, the site selection strategy gave priority to local involvement (Sundqvist & Elam, 2010). After local referenda excluded the two potential sites in the sparsely populated inland area of northern Sweden, the Nuclear Fuel and Waste Management Company SKB, decided to focus its efforts on the communities already housing nuclear waste facilities and/or nuclear power plants. A decisive success factor was the process of social negotiations, by which SKB adapted its plans and programs to the demands of the different stakeholders (Lidskog & Sundqvist, 2004). Two municipalities, Oskarshamn and Östhammar, expressed interest and competed with each other for the right to host a repository. In 2009, SKB announced Östhammar to be the host community, whereas the encapsulation plant would be sited in Oskarshamn. However, it appears that measures addressing trust and SKB's strategy to de-emphazise the issues related to geology, i.e., geological barriers, also helped improving the possibility of local acceptance (Lidskog & Sundqvist, 2004). On the other hand, these authors also argue that the SKB strategy is characterized by a top-down approach concerning technical issues. In this strategy, "the public and other stakeholders are reduced to saying yes or no to the proposals presented by SKB, and when they say yes all is set and a site is found" (Lidskog & Sundqvist, 2004, p. 266).

France

In France, the search for a site to host a nuclear waste repository started in the late 1970s. Site investigations conducted in the late 1980s generated intense local opposition, prompting the government to declare a one-year moratorium on the search for a site in 1990. After extensive consultation, parliament adopted the country's first nuclear law in 1991 (Bataille Law), which reopened the search for a solution. In 1994, site investigations were resumed with the selection of four voluntary candidate areas (departments), which expressed their interest in further investigations. Whereas local politicians supported the idea of further studies, local communities mostly opposed it. In 1998, after the exclusion of Gard and

Vienne due to technical reasons and ongoing protest by local opponents, the village of Bure (82 inhabitants) in Meuse/Haute-Marne remained the only candidate to host the planned underground research laboratory (URL) for DGD. In 2005, the National Radioactive Waste Management Agency, Andra (Agence nationale pour la gestion des déchets radioactifs), confirmed that the already operating URL site in Bure was also appropriate to host a final disposal facility, the Cigéo (Centre Industriel de Stockage Géologique). The Cigéo repository at Bure remains a controversial project and a subject of bitter dispute. It is also a political symbol, which on the one hand captivates a region in economic decline with its promise of socio-economic benefits, but on the other hand also generates many doubts and concerns, including possible negative impacts on local image and long-term economic development (Blowers, 2016; Lehtonen, 2015). Pending approval from the government and the nuclear safety authority ASN, the waste management operator Andra plans to start the construction of Cigéo in 2020. The pilot phase of disposal could start in 2025 (WNN, 2017).

United Kingdom

In the United Kingdom, nuclear waste is provisionally stored at 36 sites. However, Sellafield in Cumbria houses the largest concentration in terms of radioactivity deriving from reprocessing products and spent fuel (MacKerron, 2015). The advisory non-departmental public body, the Committee on Radioactive Waste Management (CoRWM) recommended 100 years interim storage and geological disposal as the end-point for HLW and spent fuel disposal. The government pursued a DGD solution, with a site selection process based on community voluntarism.[11] In 2010, it was foreseen that a DGD would be available in 2075 (MacKerron, 2015). Siting procedures have witnessed harsh protests and public opposition. In 1981, the government decided to postpone a decision on the disposal of HLW by fifty years. In 1991, Sellafield was selected for detailed studies for low- and medium-level radioactive waste (MacKerron, 2015; NEA/OECD, 2011). On the basis of the CoRWM recommendations on participation processes (Committee on Radioactive Waste Managemen (CoRWM), 2006) and of the White Paper of 2008, a search process was started to find communities which manifested their "expression of interest" to host a repository (NEA, 2011; Richardson, 2010). Only local authorities around Sellafield (the communities of Copeland and Allerdale) manifested their initial interest, but after a partnership-based negotiation process, in 2013 the Cumbria County Council voted against moving to the next stage of the process and decided to halt the project and withdrew its candidature (WNN, 2014). Up to now, no further community has declared to be interested in a voluntary process and the government is still seeking a candidate site.

Germany

Differently from the other countries reviewed here, Germany has decided to phase out its NPPs between 2020 and 2025. Spent fuel is stored in 12 on-site

interim storage facilities at NPP sites; vitrified reprocessed waste and spent fuel is stored at Gorleben in Lower Saxony (IAEA, 2007). In the past, all nuclear waste sites (Gorleben, Asse, Konrad and Morsleben) were designated top-down by government decision. Even the International Atomic Energy Agency (IAEA) (2007) considered that the approaches to siting nuclear waste facilities taken by the implementer did not meet the current requirements for openness and transparency. In 1977, the government of Lower Saxony designated the Gorleben salt dome as a site and the Federal Government accepted this decision. Since then, the search for a long-term disposal site for HLW nuclear waste has been characterized by 40 years of controversy over the suitability of the Gorleben site and by fierce public opposition. Over the decades, a strong movement against nuclear energy and the transport and storage of nuclear waste at Gorleben has grown up and continues to be a forceful political actor in the present siting process.

A milestone in the siting search process has been the establishment of an interdisciplinary expert commission known as AK-End in 1999. One of the AK-End merits has been to bring to the fore the importance of socio-political criteria for the siting process. Moreover, the AK-End report pointed out the importance of the concept of voluntary candidature for participation in selection procedures in municipalities and discussed the concept of "Beteiligungs bereitschaft" (willingness to participate) (AK-End, 2002, p. 191).

In April 2013, the Ministry for the Environment and Reactor Safety announced a new site selection process for a repository. The federal "Repository Site Selection Act" (Standortauswahlgesetz) which entered into force in 2013, and its amendment of 2017 represent a compromise between political parties and major stakeholders about a stepwise approach for selecting a site for a DGD repository for HLW. It also proposes principles for developing site selection criteria.[12] In spite of widespread critique, the act "fills the gap in the German legislative system that did not include regulations for the siting process before" (Hocke & Kallenbach-Herbert, 2015, p. 190). Voluntary candidatures for participation in selection procedures as in Sweden and Finland and as recommended by AK-End are not considered in the law.[13] A "Commission for the Disposal of High-Level- Waste" (henceforth EK; Endlager-Kommission) was established to define a new site selection procedure, to develop the criteria and decision bases to evaluate the "Repository Site Selection Act" and to make proposals for public participation. The EK, which brought together 32 representatives of the political, social and scientific communities and the nuclear industry, was set up in April 2014 and concluded its work in 2016. The shadow of Gorleben continued to divide the EK members and past conflicts were reproduced also in this new body.[14] In compliance with section 8 of the "Repository Site Selection Act" and following the recommendations of the EK, a so-called National Advisory Body (*Nationales Begleitgremium*) was kick-started at the end of 2016 as an independent, pluralistic body to accompany the implementation of public participation in the site selection process. The site selection procedure should start in 2017. In principle, every federal state is open to consideration for a HLW waste repository, except for the city-states of Berlin, Bremen, and Hamburg.

Is Compensation Key for Voluntary Siting Processes?

Can compensation be considered a legitimate and successful means for promoting acceptability and increasing social consensus for a repository? The provision of community benefits or compensation can take several forms, depending on the development stage of the project. The potential of compensation measures for easing the siting of controversial facilities has been recognized for over two decades, but to date there have been hardly any empirical comparative studies systematically investigating the effectiveness of "nuclear compensation." An exception is the work of Richardson (2010), which provides a comparative overview of a number of community benefits and incentives in countries involved in the planning process for siting nuclear waste repositories. The different forms of compensation, classified as "cash incentives," "social benefit measures" and "community empowerment" measures are considered to offer "some form of 'mitigation' measures to offset perceived fears among the host community and any potential financial impacts, should they occur, in addition to other measures designed to compensate for real impacts" (Richardson, 2010, p. 4).

If one follows the thesis that NIMBY reactions are mostly motivated by the protection of self-interests (Dear, 1992), then it would be expected that acceptable solutions can be achieved by (financial) compensation to host communities. If there is an imbalance between collective benefits and regional or local costs or burdens, then compensations could aid offsetting this real or perceived discrepancy. Compensations could help mitigating possible consequences of the construction or operation of a facility (for example, real estate value guarantees); actual or assumed costs in the event of an accident (e.g., an emergency fund); or to compensate the local community for risks and burdens caused by the construction and operation of the repository (see also Carnes et al., 1983). Compensation does not need to be purely financial (Claro, 2007). Designated sites and their surrounding municipalities can also be offered improved or new infrastructure (i.e., construction of roads, swimming pools or cultural centers), fiscal incentives and the provision of public goods or labor market policies for the development of the region (Di Nucci, 2016). How can such monetary and non-monetary measures be justified?

Economic approaches emphasize divergences between the costs and burdens at both the local and regional level vis-a-vis the benefit to society at large. The burdens caused by the facilities (possible effects on human health, environmental quality, changing property values) are often spatially distributed in the vicinity of the facility while the benefits accrue to people in non-affected areas, or to society in general (Kraft & Clary, 1991; Sorensen, Sodersrom & Carnes, 1984). The gain for the community is based, on the one hand, just on the cheaper electricity tariffs that nuclear power is supposed to enable or on economic spillover in terms of jobs. On the other hand, this community has to bear the greatest risk in the event of an accident. Thus, the advantages for people who are directly confronted with the construction and operation of a repository are small. Economic compensation approaches are based on the assumption that a "market" exists even for

potentially risky undertakings. Accordingly, all parties involved would conform to an individualist competitive worldview. Individuals and groups would compete for the maximization of their own benefit (as in the case of the two sites in Sweden). If the monetary compensations are higher than the estimated risk or burdens, according to the economic theory, it is rational to agree to host a repository.

From the standard economic theory angle, compensation would be a useful tool for solving the problem of acceptance; costs and benefits are distributed in an appropriate way (see Frey & Oberholzer-Gee, 1997, p. 747; Wolsink, 2007; Wolsink & Devilee, 2009). This approach can also be applied to municipalities: communities in the vicinity of the place where a nuclear facility is to be sited are rewarded for possible disadvantages by the rest of society that benefits from possible advantages of these facilities (or for not having to host them in their vicinity). From this perspective, the aim would be to provide the communities with "tangible benefits" or monetary compensations, so that their risks and burdens can be compensated to a certain extent. Following a standard economic approach, the optimal level of compensation would be at the intersecting point between a buyer's "willingness to pay" (WTP) and a seller's "willingness to accept" (WTA). The municipalities that voluntarily offer themselves as a site show a WTA (measured through the minimum sum that a community is willing to accept to "tolerate" something negative) which will be matched by a compensation reflecting the so-called WTP (measured as the maximum amount that society/nuclear industry is willing to make available in order to avoid a "nuisance" or—in other words—to recognize that the community is volunteering an essential "service" to the nation) (Di Nucci, 2016). Where alternative sites are possible, potential siting candidates are asked to list their desired compensation payments to "offset" burdens. The candidate that provides the most economical offer wins.

Other approaches call for incorporating broader social justice concerns in decision making (Jones, Sovacool & Sidortsov, 2015) and examine how concepts from justice and ethics can inform energy decision making by reframing energy problems as "pressing justice concerns" (Sovacol, Heffron, McCauley & Goldthau, 2016) and by taking into consideration also distributional equity. In this case, the beneficiaries of nuclear plants (i.e., in terms of jobs and business revenues) should also bear the highest responsibility for the construction of a repository. Consequently, a repository site would have to be built in the communities where NPPs are located. However, in the case of a DGD repository, the site should in principle be selected with regard to the most secure barrier functions, depending on the selection of the host rock (salt, clay, or granite). Against this background, it is rather unlikely that an NPP site and favorable location conditions for a repository will match. From an environmental justice point of view (Ash, 2010; Wissenburg, 2006), however, it could also be argued that in the past, communities hosting nuclear facilities have borne an increased (environmental and health) risk for the benefit of society as a whole and now other subjects have to take over this responsibility and host a repository. In both cases, compensatory payments may be justified for reasons of fairness.

The body of scholarly and empirical literature assesses the effect of compensations differently and there are contradictory conclusions on whether or not compensation can reduce resistance to an unwanted facility such as a repository. Some studies show that direct monetary compensations for individuals or communities can help increase acceptance (Bacot, Bowen & Fitzgerald, 1994). Others argue that such direct financial transfers can also provoke the opposite response (Gallagher, Ferreira & Convery, 2008). Some studies have also disclosed that non-monetary compensation (e.g., infrastructure development) is generally more likely to be accepted and is perceived as more appropriate than monetary compensation (Claro, 2007; Jenkins-Smith & Kunreuther, 2001; Kunreuther & Easterling, 1996; Kunreuther, Easterling, Desvousges & Slovic, 1990). Why, however, are non-monetary compensations likely to be more attractive? Two arguments appear rather compelling: the bribe effect and the "crowding out of public spirit."

The first argument relates to the situation in which individuals are offered money to accept "undesirable" facilities in their communities. This "bribe" is unappealing as people are made to feel that they can be bought. In addition, they would have to make (morally) inadequate compromises between health risks and money (Claro, 2007, p. 91). The second argument is based on an empirical analysis of the Swiss search for a repository for radioactive waste, which shows a reduced acceptance due to the stigmatization, the bribe effect and a "crowding out of public spirit" (Frey, Oberholzer-Gee & Eichenberger, 1996, p. 1311). Accordingly, the individual's inherent motivation to act out of common interest and to accept a nuclear facility in their own environment is diminished by financial compensation. To put it the other way round: acceptance is not necessarily increased by financial compensation for local "nuisance." Frey et al. (1996) have shown that the positive impact of the two proposed indicators ("support for nuclear energy" and "acceptance of the procedure") decreases as soon as financial compensation is introduced.[15]

The failure of compensations can also be explained according to Jenkins-Smith and Kunreuther (2001, p. 373) by the fact that the burdens of a repository were not presented in detail to the general public and the possible compensation was not negotiated in a transparent way. They assume that a "compensation package" would be much more attractive if combined with a package of safety measures. They propose that safety measures and compensation should be brought together in a "negotiated" package. This approach is said to be more promising than one in which the mitigation of risks and compensations are viewed separately. In this way, legitimate decisions are possible. The host community as a whole would benefit from the compensation, and this collective benefit would counter the bribe effect.

"Pure" or "Bought" Voluntarism? A Taxonomy of the Host Communities

As we have seen above, incentives, compensation packages and community benefits have been frequently used in connection with large infrastructure projects or facilities that are perceived as potentially noxious in order to enhance the acceptability of these projects. But what are the specific characteristics of the host communities prone to accept such incentives?

Among the framework conditions that may have led to decisions based on voluntarism, the following appear particularly significant: economic marginalization and geographic isolation of the region, economic interests and dependencies from the nuclear industry and the resulting value chain, a strong identification with nuclear power. These factors correspond to classifications of host communities found in the literature, i.e., "nuclear oases," "nuclear communities," "communities with industry awareness", and "Springfield communities."

"Nuclear communities" are municipalities in which nuclear facilities are already located. Nuclear activities have become an integral part of community identity, and this has led to a strong identification with nuclear energy (Litmanen, Kojo & Kari, 2010, p. 92; NDA, 2007, p. 89). To describe similar phenomena, Andrew Blowers (1999) speaks of "nuclear oases." Blowers notes that the local willingness to accept a repository is linked to factors such as increased familiarity with industry, jobs, and regional growth. Additionally, aspects like dependency on the nuclear industry, unequal power relations and processes of "peripheralization" are emphasized (Blowers, 2016; Blowers & Leroy, 1994).[16] Municipalities that correspond to the description of "nuclear oases" are "secluded" or backward and are economically and politically marginalized places which show social, spatial, and environmental inequalities. While the Finnish and Swedish cases do not appear to fit in this framework (Kari, 2009), the designated location for Cigéo, the secluded, rural French village of Bure, is a good example of the Blowers' concept. This "oasis" which extends to the departments that share the URL, receives about 30 million euros annually for each department (Lehtonen, 2015, p. 131).

The nuclear industry prefers to describe these sites as "communities with industry awareness" and does not consider the willingness to host a repository as a sign of dependency (Kari, 2009, NEA, 2004, 2015). The analysis of voluntary participation by the "Forum Stakeholder Confidence" of the NEA-OECD comes to the following conclusions: "there exist cases where municipalities themselves initiate discussions with the implementer or government on hosting radioactive waste facilities. This is more likely to happen in communities that are *de facto* hosts of the waste" (NEA, 2009, p. 4). Additionally, the NEA points out that a site search is more promising when "nuclear communities" are involved because they trigger a long-term, sustainable relationship and local growth. However, this does not mean that these developments are always harmonious (Kojo et al., 2012). It is therefore legitimate to raise the question of whether taking up the burdens of the nuclear industry in the form of radioactive waste can be really explained as a sign of "cultural integration" and of familiarity with nuclear activities.

Nuclear communities also tend to develop a pragmatic acceptance for the final disposal of wastes, especially as a "cultural adaptation" to the nuclear industry, characterized by a sort of shared understanding has gradually evolved over decades. From this perspective, a repository might even be something the nuclear community could be proud of. Following the popular US series "The Simpsons," this case could be named "Springfield Syndrome" (Di Nucci, 2016).[17] The fictional community of Springfield is almost exclusively economically dependent on the nuclear activities of Mr Burns, the owner of the local NPP. Residents have developed a close

relationship with nuclear power, understand and support it as an integral source of local development. This support is a prerequisite for their social (and cultural) integration. The municipalities of Eurajoki in Finland and Östhammar (Forsmark) and Oskarshamn in Sweden derive strong economic advantages from the nuclear industry connected with the value chain of the nuclear facilities on their territory and could be considered as archetypical "Springfield" communities.

Swedish nuclear communities are prosperous. In the past they competed against each other as a location for a final disposal. Solomon et al. (2010) discuss findings by Sjöberg that highlighted the apparent support of local citizens in four municipalities for an HLW repository in Sweden, which according to Sjöberg reflected in part their attitudes toward nuclear power and trust in the authorities and experts. This opinion has been cemented over time and has become a mainstream argument. Representatives of municipalities thus claim that the general position of a Swedish municipality in nationwide policy-making is strong, since municipalities can veto siting of national facilities such as a final repository (Åhagen, Wretlund, Andersson, Hallberg & Nilsson, 2006).

Östhammar and Oskarshamn together host six nuclear reactors. While only 40% of the Swedish population was willing to accept a repository in their surroundings (Eurobarometer, 2008), about 80% of the inhabitants of Östhammar and Oskarshamn agreed to do so. The regional economy of these sites is strongly influenced by the nuclear industry, as the NPP and the future operator of the storage facilities are the main employers of the region. The following statement of a local best epitomizes this position: "*I grew up not far from the Forsmark nuclear power plant. In school they took us on tours of the facility and many friends' parents worked at the plant. The region also has a long history of mining and ironworks, so having the nuclear industry as neighbor was nothing strange. My parents still live there, and recently my mother got a call from a researcher asking her what she thought of the planned repository*" (Nyberg, 2011). This statement reveals that acceptance is also generated via the creation of the feeling of being a "local community" around the nuclear facility and by suggesting that the construction of such a facility is a joint project between the nuclear industry and the community.

A similar case is reported by Hänninen and Yli-Kauhaluoma (2014, p. 134) for Eurajoki. Supported by a "framing" analysis of the newsletters published in the period 2000–2014 by the constructor of the Onkalo facility, they argue that the nuclear industry had developed an understanding of the social and communal aspects of public resistance and counteracted this. They show that the industry built trust in DGD by framing "the waste repository as a shared project that brings the community together, advancing common interests in the community." In this way, the industry promoted "what potentially could be seen as "we" the industry and "they," the lay people, within the frame of seeing both partners as "us," the nuclear community."

In the case of Finland and Sweden, one could talk of "internally grown, progressively built up" voluntarism based on the characteristics of the "Nuclear Communities" or "Springfield Communities," as well as on trust in science and technology, institutions and even in the local nuclear industry. In the case of Bure in France, and West Cumbria in the United Kingdom, one might speak of

"backmailed voluntarism," since the characteristics of Blowers' nuclear oases are more appropriate. These areas are economically depressed and represent paramount cases of environmental injustice and economic blackmail. According to Bickerstaff (2012, p. 2621), West Cumbria bears a stigma for its dependence on the nuclear industry and "political alienation is intensified by the reprocessing of not only United Kingdom but also foreign spent nuclear fuel at Sellafield." Bickerstaff points out that in many interviews, people expressed doubts about the voluntary nature of the siting process, and tends to support a view that the responses of the West Cumbrian authorities (and public) reflect the area's physical and political–economic peripherality.

A similar case is that of the Konrad pit in Germany, a former iron ore mine proposed as a deep geological repository for medium- and low-level radioactive waste located near the town of Salzgitter. In the context of the compensation provided and with the promise of jobs and regional investments, one could speak in this case of "bought voluntarism."

On the other hand, as the case of Cumbria in the United Kingdom shows, despite strong participatory elements and a partnership approach, a voluntary approach can also fail (Bickerstaff, 2012; MacKerron, 2015; Richardson, 2010). Above all, a lack of trust appears to have played an important role. Apparently, the prospect of the so-called "Engagement Packages" and the promise of resources available to local communities, e.g., for the participation in the negotiations process, together with benefit packages for example public services, healthcare provisions, and infrastructure investments have not been persuasive enough to convince the Cumbria County Council and the local population to host a DGD facility.

Voluntarism Bought by Compensations?

Has compensation proved to be a form of "mitigation" to alleviate or neutralize fears in the population of possible negative effects and gain acceptance? This is not always the case, as the experiences with the search for a repository site in the analyzed countries have shown (Bergmans, 2010; Kojo & Richardson, 2014; Richardson, 2010).

In the Nordic countries, compensations were negotiated at local levels between the host communities and the nuclear industry. In Sweden, financial resources are linked to specific projects, which are agreed upon jointly between municipalities and the nuclear industry and whose use is strictly controlled and—especially in Sweden—monitored. A fund provides financial backing to the affected communities for capacity building and to support public participation in the siting process. These compensatory packages (the so-called value-added programs) are negotiated locally and reward the municipalities for their "citizenship," in other words for their willingness to help to solve a national problem (Kojo & Richardson, 2014). The provision of resources, such as local capacity building, also includes support for NGOs. However, such community benefits can also hide forms of bribery and, in a way, serve as a subtle manipulation. For this reason, it is important that compensation is settled only after important aspects,

such as safety and security issues, have been sufficiently discussed, and not sooner. In the case of Oskarshamn and Östhammar, compensations were made at the beginning of the siting search process. In this way, public confidence has been gained and has helped to improve the quality of decision making (Di Nucci, Isidoro Losada & Brunnengräber, 2015). Overall, money could have well been a decisive argument for Östhammar and Oskarshamn to volunteer.

In Finland, the municipalities hosting sites for nuclear plants benefit from tax revenues on the basis of parameters which are linked to the operation and duration of the NPP (Bergmans, 2010). For example, the Municipal Council in Olkiluoto saw an opportunity to offset declining revenues from an aging NPP with the repository (Richardson, 2010). They negotiated an agreement in 1999 (the so-called Vuojoki agreement) with the developer Posiva, which led to the site's selection (Kojo, 2009). The community benefits for hosting nuclear facilities derive mostly from the property taxes paid by the waste management company. This benefit is all the more significant, given that a higher tax rate is applied to nuclear facilities than to other business (up to 2.5%, as compared to the 0.5% national average). However, the municipality of Eurajoki is only entitled to a portion of this tax revenue, since the total compensations for the host municipalities are dependent on the number of inhabitants and total budget available to the municipality (Bergmans, 2010).

In France, support in the form of "Groupement d'intérêt" (GIP) has been enshrined in legislation since 1991 and represents a legally binding compensation. Similar to Sweden's approach, GIPs *de facto* benefit host communities for their help in solving the national problem of disposal. In France, 90% of the funding is earmarked for investments in public infrastructure, while decisions and control over the use of the fund lay with the GIP (Lehtonen, 2015). The remaining 10% of GIP funding is allocated in the form of non-dedicated resources, and municipalities can use this sum as they wish.

The procedure in Finland is said to be less transparent and effective than that in Sweden (Litmanen et al., 2017). The Vuojoki agreement was negotiated behind closed doors between the Eurajoki community leaders and the waste management company RU and before the completion of the EIA procedure (Lehtonen, 2010). Project opponents, but also independent observers interpreted this as a maneuver to facilitate community acceptance. In particular, they argued that such behind-the-scenes negotiations undermine the legitimacy of the entire process, including the significance of the EIA procedure as an important forum for citizen participation and deliberation.

The German experience offers a good example of a negative reaction to financial compensation. There is consensus that material advantages cannot offset health and safety risks or the potential stigma of a nuclear disposal site. This attitude derives from a decade-long collective experience of the anti-nuclear movement and the German "nuclear state," which has made decisions according to the D-A-D principle and without broad social participation (Radkau, 2011). Financial compensations, referred to as "Gorleben funds" and "structural aid" (*Strukturmittelhilfe*), have been criticized especially by the anti-nuclear movement. The county (*Landkreis*) and the municipalities concerned have received direct compensation

payments and/or financial means to expanding their local hospital and sports facilities. Direct payments by the Gesellschaft für Nuklear-Service (GNS) to the county (EUR 210,000 per year), the municipality of Gorleben (around EUR 600,000 per year) and the municipality of Gartow (EUR 830,000 per year) will last until 2034 (Di Nucci, 2016). These compensation efforts were not able to prevent or soften the Gorleben protests. On the contrary, they may have aggravated social opposition against the top-down decision for the Gorleben site.

The decommissioning of the Asse II mine also provides interesting insights to attitudes toward compensation. Because of water infiltration jeopardizing the integrity of containers and the site, nuclear waste stored there needs to be retrieved. The Lower Saxony Parliament passed the Act on the "Asse Fund" which entered into force on 20.11.2015. The holding company administering the fund is owned by the Federal Government; the fund is endowed with three million Euros per year. According to Weisensee (2017), this Act is not a law for compensating environmental damage, but allows for special payments "on top" and can be seen as the outcome of a broad political consensus and as a sort of "peace-making instrument." Compensation tries to balance not only the (immediate) environmental impact of the recovery, but also the indirect economic disadvantages for the region. In accordance with the intention of the Act, the fund is to contribute to the promotion of regional development in the area around the Asse II mine.

A study of the Institute for Economic Research of Lower Saxony (Schasse, Schiller & Thiel, 2016) has analyzed the regional effects associated with the activities of Asse-GmbH and estimated the direct and indirect regional economic effects of Asse-GmbH's activities. According to the report, "effects from the Asse funds will depend on the use of the funds in the areas of economic dynamics around the issue of recovery" and "preserving and increasing attractiveness as a place of residence" (Schasse et al., 2016, p. 6). From a regional economic point of view, the study claims that the high costs for the recovery of the radioactive waste and the closure of the mine are offset by the elimination of the risk to the health and livelihood of the current and future inhabitants of the region.

The economic incentives to make the recovery of radioactive waste acceptable have caused various reactions over the past few years. The local and regional press reported on the "indulgence trade" and criticized that money does not flow into the areas that need it. There have been demands to restrict the area into which the money is to flow to a radius of ten kilometers around the Asse mine. Local opposition groups emphasized that economic incentives should not be regarded as a compensation and called for a continuous monitoring of the risks, of the development of the Asse region takes and of how negative developments can be countered, and how unavoidable disadvantages can be compensated—even beyond the end of the decommissioning (Di Nucci, 2016).

Concluding Remarks

What can be learnt from a comparative perspective? Are voluntary (IMBY) approaches, which appear to have been successful in two Nordic countries, a

feasible way to influence positively the siting process? Could they help—also in other contexts—bypass blockages or accelerate the siting process? Is compensation key to smoothing conflicts?

In voluntary approaches, negotiated mechanisms to compensate the affected communities have played an important role. However, this process is positioned at the end of a complex siting procedure. Proper provision of resources for local capacity building, including support for NGOs, long before this compensation stage is a factor that enhanced engagement, increased public confidence, and possibly helped the quality of decision making. This was an important factor in Sweden, where the majority of the NGO groups emphasized that NGOs in order to influence the process must participate in the EIA process from the beginning, before the framing of the debate is set up (Holmstrand, 2006). Conversely, the French and the German civil society and NGOs have been very critical of the implemented or planned siting procedures. In Germany, the whole process leading to the siting act and participation in the activities of the Endlager-Kommission have been questioned and challenged and the position of the anti-nuclear movement as a whole has been somehow weekend by part of the "movement" cooperating with the Commission and part of it opposing it (Kalmbach, 2016).

In conclusion, the cases analyzed seem to suggest that to consider compensation alone as a factor for triggering the acceptability of a siting may lead up a blind alley. Compensation should be considered as part of a wider "community package" in which the rights of citizens (framed as voluntary approaches) and the possibility to veto are coupled with participatory approaches which increase the range of participants and enhance the quality of understanding. However, an indispensable factor to expand the lenses through which problems are solved and to improve final decisions, is trust.

Compensation in siting of controversial projects does not always increase the level of acceptance. It has been argued that more legitimate decision making through voluntary siting is possible in cases where the amount and type of compensation can be negotiated in advance. This could help reduce the perceived "bribe effect" (Kunreuther & Easterling, 1996, p. 615). But the admonition expressed more than 15 ago by Jenkins-Smith and Kunreuther (2001, p. 373) is still valid. The past failures of compensation could be interpreted as evidence that the "expected-utility models provide inaccurate or incomplete descriptions of public responses to facility siting." As discussed in this article, Germany's experience presents an example of a negative response to monetary compensation from the local community. Material benefits cannot alleviate real or perceived health and safety hazards or the potential stigma of the municipality being considered as a "nuclear dump" or a "radioactive cemetery." For the population in the region of a proposed repository site, there are potential hazards associated with radiation, health, falling property prices, pollution of groundwater, and stigma. The promise of potential economic benefits does not play a significant role in reducing opposition to the siting of such a facility.

In a recent work Litmanen et al. (2017) argue that there is not a Nordic model for SNF disposal. Nonetheless, the experience of the Nordic countries reveals

common patterns and shows that a key element for the successful siting procedures was the fact that compensation and community benefits went hand in hand with trust. The communities trusted governmental institutions, the nuclear industry, and the private waste management companies. This resulted into preparedness to delegate negotiation agreements to the industry and the relevant local authorities, as this was perceived to be in the community's interest. Trust directly influences risk perception, which, in turn, has a direct effect on attitudes toward the repository and an indirect consequence through lessening perceived stigma effects. However, this also requires that local authorities are capable of negotiation, which partly depends on the capacity building support that they received in the process, eventually as part of the community benefits (Di Nucci et al., 2017). Of course, the size, resources, and legal/statutory competences of a community, prior to any support, are key factors. Additionally, trust is a not only a political factor, but also an especially influential cultural factor, or "something that emerges from an individual's or institution's position within a wider matrix of social, economic, political, and cultural ideas" (Tait, 2011, p. 161). In building trust, the project developers and institutions also need to consider the history associated with siting experiences and learn from previous mistakes. The negative impact of social distrust in the siting debate supports the conclusion of Kunreuther and Easterling (1996) that compensation plays less of a role in the siting of high-risk facilities. The burden of Gorleben and the long history of mistrust has represented in the German case a severe, critical legacy.

Concluding, the empirical evidence for compensation remains contradictory and there are differences of opinion as to whether compensation-based site selection reduces resistance to unwanted, problematic developments. In our analysis, we have discussed various forms of voluntarism, also in combination with trust. The experience of the Scandinavian countries can be categorized as "long-standing optimized/internally grown voluntarism" or as "confident voluntarism." In other countries, for example in France, we can speak of "bought-up voluntarism." In the case of Schacht Konrad and Asse in Germany, one could paradoxically even talk of "blackmailed" voluntarism based on the perspective that areas hosting disposal facilities could benefit from substantial investment and skilled jobs for decades. Our discussion of the voluntary approaches in combination with community benefits in some selected countries suggests that voluntary processes ultimately also do not provide the silver bullet.

On the one hand, the fundamental rejection of the principle of voluntarism is as unjustified as a fundamental rejection of compensation. On the other hand, the consent of potential local communities will never be based on "pure" voluntary action, nor can they be "bought-up" or "bribed" exclusively by direct compensation, even in cases in which this is in a "reasonable" relationship to the potential disadvantages. Nevertheless, the question of whether the engagement of candidate communities in the process of site selection should be included in the list of criteria for the search of a DGD site in Germany remains a legitimate question and should be discussed at a wide societal and political level. From our analysis, it can be concluded that the public and the host communities can be quite open to a

siting decision if the preparatory procedures and negotiation processes for a "prima facie" unwanted facility are transparent and open from the very outset and policy-related documents are made available and are also made understandable for a lay audience. In this way, the perception of compensations as a modern indulgence trade, bribery or immoral offer can be avoided. In Germany, the long-lasting controversies surrounding the Gorleben site have shown that "the classical transmission mechanisms between politics and civil society are not enough." Citizens want to influence political decisions and are not willing to accept forms of participation that resemble a window-dressing ritual (Di Nucci et al., 2017, p. 324). Progress in a site selection process for nuclear waste can only be accomplished if more deliberative elements are introduced into the policy framework and by procedural and distributional equity. If appropriate, also by compensation packages.

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Notes

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1. Solomon, Andrén and Strandberg (2010) posit that the DGD paradigm started eroding in the early 1990s and point to seminal publications of Flynn, Kasperson, Kunreuther and Slovic (1992) and of Shrader-Frechette (1993) that argued for both scientific risk assessment and ethical grounds against near-term deployment of deep geologic disposal.
2. For reasons of space, it is not possible to treat the various forms of participations in the various countries analyzed in this article. For a comparative overview of various participation procedures and approaches, see Bergmans et al. (2014); Di Nucci, Brunnengräber and Isidoro Losada (2017); Lehtonen (2010); Ash (2010), Sundqvist and Elam (2010).
3. For a comprehensive literature review, see Schively (2007).
4. Discussions and interviews with Tapio Litmanen, Burkhard Auffermann (on Finland); Markku Lehtonen (on Finland, Sweden, France, and United Kingdom); Johan Swann and Tomas Käberger (on Sweden); Gordon MacKerron (on U.K.); Andrew Blowers (on UK and nuclear oases) have taken place in the period 2013–2016 mostly during four workshops on nuclear waste governance organized within the Project ENTRIA in Salzburg and Berlin.
5. The term "wicked problem" as coined by Rittel and Webber (1973) describes policy problems that are impossible to solve as there is no objective definition of equity. The policies addressing these problems cannot be meaningfully correct or false and it makes no sense to talk about "optimal

solutions." This status describes well the situation of HLW disposal well as the interdependency of actors, interests, conflicts, and policies on different levels and the complexity and challenges of nuclear waste management.

6. However, comparative studies in the field of nuclear waste governance are still limited in number and there is room for further investigation. For a literature review on nuclear waste disposal from the socio-technical perspective, see Solomon et al. (2010).
7. The term LULU describes a general resistance to the use of certain areas for a particular installation, independent of whether individuals or other persons, groups or communities are affected.
8. A comparative perspective on participation and acceptance in siting procedures for HLW repositories can be found in Di Nucci et al. (2017).
9. According to the Finnish legislation, a DiP, approved by Parliament, is a prerequisite for the construction of a nuclear installation and must be preceded by an approval from the host municipality. After a positive DiP, the municipality no longer has a veto right against a government decision on construction and operation licenses (NEA 2009).
10. Litmanen et al. (2017) provide an analysis of the waste management frameworks and emphasize the role of civil society organizations. They argue that due to differences in civil regulation there is not a Nordic model for nuclear waste disposal. Civil regulation of nuclear waste in Sweden follows a more liberal approach, whereas in Finnish case is characterized by a technocratic approach.
11. Nuclear waste management in Scotland is devolved from the UK government and pursues a different policy.
12. These two acts are complemented by a draft bill on financing the decommissioning of the NPPs and management of its radioactive waste, which came into force in December 2016.
13. For reasons of space, it is not possible to discuss the legal and socio-political changes in Germany in the last ten years and analyze the concluded work of the *ad hoc* expert Commission. For details on the German nuclear waste management and governance, see Hocke and Kallenbach-Herbert (2015) and Di Nucci et al. (2017). Important details especially on the technical option and site procedures can be found in the final report of the Endlager-Kommission (EK, 2016).
14. An analysis of the work of Endlager kommission is provided by Kalmbach (2016).
15. Support for a repository of radioactive waste in Switzerland fell from 50.8% to 24.6% when the residents were offered a substantial financial compensation in return for the construction of the plant (Frey et al., 1996).
16. Blowers and Leroy (1994, p. 198) claim that such activities are mostly located in backward areas and that for this reason their location reproduces and reinforces processes of "peripheralization." They argue that peripheral communities are on the one hand "victims of the process, unable to resist and dependent on the jobs and wealth that nuclear industries bring, incidentally extending for decades into clean-up. But, the very fact that they host unwanted activities gives them some economic and political leverage."
17. In the fictitious U.S. city of Springfield, lives the family of Homer Simpson, who works as a safety inspector in the local NPP. See: http://simpsons.wikia.com/wiki/Springfield_Nuclear_Power_Plant. Accessed August 18, 2017.

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