



Social Science Research 2004–2010
Themes, results and reflections

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This report has been translated from the Swedish version “Samhällsforskningen 2004–2009. Teman, resultat och reflektioner” and extended with materials from the later projects. In spite of extensive quality control it may be that certain concepts and intended nuances could differ from what the original authors would have used within their research field.

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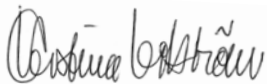
Foreword

The purpose of this report is to give a comprehensive review of the work that has been done to date within the Social Science Research Programme at Svensk Kärnbränslehantering AB (Swedish Nuclear Fuel and Waste Management Company) and make it known to a broad international readership. The report may also be of interest to an international research community in its efforts to identify important nuclear waste management issues that have yet to be investigated.

The report has been prepared by SKB's Social Science Advisory Group which includes professor Boel Berner, Linköping University, Sweden, professor Britt-Marie Drottz Sjöberg, Norwegian University of Science and Technology, Norway, and professor Einar Holm, Umeå University, Sweden. The group serves as a forum for initiation and evaluation of projects concerning a wide range of social and behavioural issues related to nuclear waste and which are funded by the Social Science Research Programme.

I wish to express my sincere appreciation and thanks to the members of the Scientific Advisory Group for their contributions!

Svensk Kärnbränslehantering AB



Kristina Vikström

Project leader of the Social Science Research Programme

SKB's assignment and methods

The nuclear power companies in Sweden joined together in the 1970s to establish the Swedish Nuclear Fuel and Waste Management Company (SKB). SKB's assignment is to manage and dispose of all radioactive waste from Swedish nuclear power plants in such a way as to secure the long and short-term safety of human beings as well as the environment.

SKB's proposal is that the spent nuclear fuel will be disposed of according to the KBS-3-method. This involves encapsulating the fuel in copper canisters with cast iron inserts and depositing the canisters at a depth of 400–700 meters in the bedrocks, where stable mechanical and chemical conditions prevail. The canisters are surrounded by bentonite clay, which constitutes a buffer against minor rock movements and prevents corrosive substances from getting in to the canister. The clay also effectively absorbs radionuclides that are released if the canister is damaged.

The site investigations conducted prior to the suggested localisation of the final repository were concluded in 2007 in Oskarshamn and Östhammar. Since then material has been examined, analyzed and evaluated, and in June of 2009 SKB selected Forsmark (Östhammar municipality) as the site for the final repository for spent nuclear fuel.

Today the spent nuclear fuel is being temporarily stored in Clab (central interim storage facility for spent nuclear fuel) in Oskarshamn Municipality. In November 2006, SKB submitted an application under the Nuclear Activities Act for a permit to build and own an encapsulation plant for spent nuclear fuel and a licence to operate it integrated with Clab. This entails that the permits for Clab are also being reviewed.

In March 2011 the application for the final repository under the Nuclear Activities Act was submitted. At the same time, SKB applied for permits under the Environmental Code for the interim storage facility, the encapsulation plant and the final repository. A joint Environmental Impact Statement (EIS) was appended to the applications.

The Social Science Advisory Group

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Britt-Marie Drottz Sjöberg, Einar Holm and Boel Berner.

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Koppararkapser för förvarning av
radionaktivt avfall i Lurberg



1 Introduction

SKB's Social Science Research Programme was initiated to meet the need for knowledge regarding many major societal issues associated with the management of spent nuclear fuel. Such issues include the impact of a final repository on the economy, difficult and complex decision-making processes, individuals' perception of risks and opportunities, and various changes in the surrounding world that may affect current, as well as future, attitudes and decisions. These issues are among those elucidated within the Social Science Research Programme. Contributions have been made from the specific areas of social and behavioural sciences, law and the humanities.

1.1 The Social Science Research Programme

SKB's Social Science Research Programme has been in place since 2004. The work can be reviewed from a variety of perspectives. In this context we have chosen to highlight three aspects:

1. **Content**, in terms of the scope and themes of the produced research.
2. **Background**, research policy providing the basis to the programme.
3. **Benefits**, based on the effects of the program.

1. Content. The programme has been very productive in terms of content, with 18 completed projects and corresponding final reports, popular scientific articles and a large number of presentations and scientific publications. Research groups throughout the country and in many scientific disciplines have received grants to participate in the programme. The research results provide multi-facetted and complementary answers to many societal issues associated with the complex work of planning a final repository for spent nuclear fuel.

Chapter 2 of this report presents a summary of the most important research results within the four specified areas of the Social Science Research Programme: 1) Socio-economic impact; 2) Decision-making processes – governance; 3) Opinions and attitudes – psychosocial effects; and 4) Societal change in the surrounding world. In Chapter 3 we highlight some important general themes for discussion, and in Chapter 4 we summarize our reflections on the work of the Social Science Research Programme and add possible topics for future research. All projects are listed in Appendix 1 and briefly presented in Appendix 2.

2. Background. Among the circumstances leading up to the programme, we would like to draw particular attention to three: SKB's history, research funding conditions in Sweden, and the respective roles of the Social Science Advisory Group and the researchers.

SKB started the work to locate a site for final disposal of spent nuclear fuel afresh in the beginning of the 1990s by writing to all municipalities of Sweden with an invitation to discuss collaboration. This broad approach partly resulted from the success that local action groups had obtained in resistance to earlier test drilling, but was also a result of new insights at SKB that the planning of a final repository for spent nuclear fuel involves more than just issues of a technological nature. The contacts that followed with those municipalities that invited SKB to discussions again showed the significance of local anchorage for support of large, long-term industrial projects where there are divergent views in the general public on their importance and risks. This lesson was learnt by SKB as well as the leaderships of the relevant municipalities. Following the public referenda in Storuman and Malå, where local residents voted against test drilling, SKB discontinued the investigation of potential sites in these municipalities.

In the next phase, preliminary studies were conducted in Tierp, Älvkarleby, Östhammar, Oskarshamn, Nyköping and Hultsfred. At this point new forms of collaboration were developed with the municipalities that also clearly brought out societal issues. During the more recent site investigations in Östhammar and Oskarshamn, the municipalities have assumed some of the responsibility for promoting the idea of an industrial establishment from a local and regional perspective. It was also in those more recent years that SKB formalized its Social Science Research Programme, in parallel with the continued local investigatory work. The aim and direction of the research programme was developed in dialogue with the larger research community and other interested groups and in conjunction with several preparatory conferences in the early 2000s.

It is neither unusual nor especially controversial for an industrial company to fund research in its sector. For example, both the pharmaceutical and automobile industries have been doing so for years. Thus it is not especially noteworthy that SKB, too, has developed a research programme. What is unique, however, is that the research not only includes technology and the natural sciences, but also the humanities, law, and social and behavioural sciences.

It is possible to claim – as some participants in the debate have asserted – that because the issue of nuclear waste is of national significance, studies of the topic should be funded by bodies independent of the industry. However, this has not been the case during the reviewed time period. It is justifiable to ask why national research councils and authorities have not created their

own major programmes to fund research projects in such an important area as the societal dimensions of nuclear waste issues. Such programmes would have offered a complement to the research that SKB has initiated. Nor has the field been highlighted in current government research propositions as a particularly important field of study. As a consequence, a major portion of current knowledge from the social sciences and humanities arenas pertaining to the nuclear waste issue in Sweden has been obtained through SKB's Social Science Research Programme. We conclude that without SKB's funding most of this research would not have been conducted.

One question that has been posed is whether or not this industrially funded programme has produced a distorted, or possibly even erroneous, knowledge base. We, who have worked in the Social Science Advisory Group to assess applications, progress and final reports from the projects as well as been involved in dialogues with municipalities, organisations, the general public and research community, do not think so. Our work has been based upon the programme's aim, and research areas that a broad group of researchers considered important before the work of the Social Science Advisory Group began. The latter has then been confirmed and further extended in dialogues with the research community, the municipalities involved in the siting process, and various organisations. Calls for proposals have been open, and significant efforts made to reach the largest possible research community. Applications have been assessed on the basis of scientific criteria generally applied within the research community regarding relevance and clarity of the research topics, realistic implementation of work plans, and competency in the field, and in observing the same disqualification rules that are applicable to other research funding organisations. We have also been in dialogue with researchers, for example through the scientific seminars that were arranged each year around the projects funded through the programme. This has helped to create synergy effects across projects and to enhance the quality and relevance of the particular studies.

The implementation of the research always remained the responsibility of the individual project managers. It was the researchers' task to clarify the aim and research question, choice of methods, use of analyses, and the basis for conclusions. The research should reach high international standards of quality and be at the forefront of its field. Researchers who received funding from the programme were all PhD's, and well established in their fields. These prerequisites were demanded to secure independent research of high scientific quality. Thus, the Social Science Research Programme targeted experienced researchers who were capable of conducting independent research of high quality, regardless of funding source.

3. Benefits. We would like to point out several important contributions. Based on a budget of SEK 23 million between the years of 2004 and 2010, the programme has been able to gather and stimulate the involvement of researchers representing a variety of fields, disciplines and methodological approaches to conduct important research that might not otherwise have been realized. This has helped to create specific competencies related to nuclear waste management within various specialties and research environments, as well as new networks of contacts between researchers who were previously unfamiliar with one another. On this basis the research has gained in scope and depth as it has been discussed and evaluated in interdisciplinary settings, e.g. at the annual seminars based on that yearbook's summary of the ongoing projects.

This research effort has hopefully also been beneficial to the municipalities, organisations and general public that have taken part of the results. Researchers have been required to discuss their results, not only with other members of the research community but also with an interested general public. Their results have been presented and made generally accessible via SKB's website and also in popular scientific articles in the programme yearbooks. Research results have also been discussed at the annual Social Science Research Programme seminars arranged by SKB, and seminars initiated by the projects.

Has the Social Science Research Programme managed to produce a relevant and complete picture? The question is partly rhetorical. We encouraged international publication in order to secure high quality, as well as an extended distribution, of the results. A "complete picture" is not achievable in a dynamic society in constant development. However, some important pieces of the larger picture have been highlighted in the various projects, and those will be addressed later in this report. We also suggest that the results of the programme may contribute to an enhanced understanding of other major industrial investments, both within and outside Sweden. We want to differentiate, however, between the available results on the one hand, and how they may be utilized by decision-makers in future choices, investments and decisions on the other. The programme has contributed to the production and dissemination of results. Issues of if or how these will be used by various actors in the society do not lie within the mandate of the programme. It is our understanding, however, that the research generated by the programme can be viewed as a rich source from which specific knowledge, summarized experiences, and inspiration can be mined.

We know that the research production of the Social Science Research Programme has generated a great deal of interest in other countries, especially in England and France. This is also true for the programme's design and direction. We find this to be a positive effect. On this basis we would like to point out the potential universal applicability of several of the results. These may be related to the understanding and management of uncertainties today and in the future; the economic development of regions in relation to industrial establishments; the significance of individuals' perceptions and evaluations of risks in their geographic proximity; and the significance and shaping of broad participation processes in societal decision-making.

1.2 The structure of the report

The structure of this report can be described as follows: After this introductory chapter, Chapter 2 gives a presentation of the most important research results in the areas of: Socio-economic impact; Decision-making processes – governance; Opinions and attitudes – psychosocial impact; and Societal change in the surrounding world. Each project's main contributions are summarized in the chapter. A more comprehensive presentation of each project is given in Appendix 2. For access to original work, e.g. reports and other programme publications, see the references in Appendix 7 or go to SKB's website www.skb.se.

In Chapter 3 we discuss in greater depth selected themes of importance for the understanding of the nuclear waste issue's societal relevance. These are themes brought to the fore by, and investigated in, the various projects. We have chosen to focus on issues of societal change patterns, varying views of benefits and risks of the repository for spent nuclear fuel, both in local municipalities and nationally, on opinions and attitudes on different levels, and on the long-term significance of the repository. We approach these themes as issues of interest for further research and discussion. Finally, Chapter 4 provides a summary evaluation of the work of the Social Science Research Programme and the need for future research.

A picture of situation in the world concerning the issues nuclear power and waste management are given in the Appendices 4 to 6.



2 Four research areas

In the preparatory work for the Social Science Research Programme, four general areas of research emerged as being relevant for the waste issue:

- Socio-economic impact.
- Decision-making processes – governance.
- Opinions and attitudes – psychosocial impact.
- Societal change in the surrounding world.

It is important to note that research projects in several cases spanning several research fields, and that some projects as natural could belong in an area other than where it is entered here.

2.1 Socio-economic impact

Socio-economic impact is one of the four research areas identified as especially relevant to SKB's social research and has served as a framework for calls for applications and completed projects.

The relevance of applied research in this field may seem obvious. Local residents, industry, the state and municipal governments all have an interest in an enhanced understanding of how the local economy, labour market and population would be affected by a repository for spent nuclear fuel, in addition to other types of influences. However, not everyone shares this view. As mentioned in Magnus Frostenson's project, for example, some opponents argue that socio-economic impact and municipal acceptance should not be allowed to have any influence on the choice of method and site. There is therefore a reason to return to the issue later of what benefits and risks that may, or may not, be negotiable.

Two major projects have been completed in this research area: Urban Lindgren's and Magnus Strömgren's "Long-term socio-economic impact of large investments on small and medium-sized municipalities" and Lena Andersson-Skog's "Local development and regional mobilisation of around large-scale technical projects". The projects are presented, along with other projects, in Appendix 2.

2.1.1 Project content and methods

Both projects focus on local effects on the residents and labour markets in the municipalities where site investigations for a final repository were conducted, i.e. Östhammar and Oskarshamn, but they use different methods and data materials. Andersson-Skog conducts a broad economic-historical tour, seeking

parallels that might indicate what outcome could be expected of an investment in a final repository. Lindgren's and Strömgren's point of departure involve the classical macro-level regional economic and economic-geographic multiplier models, developed into a detailed micro level model mirroring the dynamics of the entire population's mobility and adaptation patterns using an agent based simulation. This approach makes it possible to take into account aspects such as that the outcome on the labour market is shaped by the matching of the specific needs that are directly and indirectly generated by the industrial establishment, on the one hand, and the local and regional work forces' special mix of individual skills, on the other. The simulation model also includes that the availability of person related competencies in turn, for example by moving, is affected by the opportunities that other family members have to find a job in the local labour market.

2.1.2 Economic-geographic simulation of effects

All municipalities are different in terms of their situation, including economy, and regarding the already established prerequisites for various needs related to a repository for spent nuclear fuel. This entails, as Lindgren and Strömgren show, that the effect is far from symmetric when comparing Östhammar and Oskarshamn. The socio-economic impact would be rather large in Oskarshamn if the repository for spent nuclear fuel is placed in Östhammar, while the effects in Östhammar would be very limited if it is localized to Oskarshamn.

The project's model development has been used for more concrete impact studies in each of the two candidate municipalities where site investigations were conducted /1, 2/. Overall, the project and the impact studies indicate that the planned nuclear technology facilities and a part of SKB's management functions would supply Östhammar with 240 direct jobs and an average total of approximately 450 jobs, including indirectly generated jobs, during the period 2010–2060. The corresponding results for Oskarshamn, which involves a larger investment that includes the encapsulation facility (and less "leakage", i.e. that a larger portion of the investment can be made with local suppliers), would yield about 640 direct jobs and an average total of about 1,000 jobs per year. The increase in the population would be approximately the same, not more, in both cases, as the total employment. In both cases there would also be a net increase in commuting and moving into the municipality. The simulation suggests that it may be difficult to fulfil the increased demand for labour in both municipalities with local applicants in the short time perspective. This would lead to greater commuting to the municipality and/or that vacancies remain, though not necessarily mainly in the nuclear technology facilities. A number of vacancies could "move" to other local operations, which would thus have greater difficulty in recruiting/keeping competent employees.

The estimated population effect is lower than what could be expected from a conventional multiplier model for which the simplest variety involves multiplying an estimated increase in employment in the region with the average number of individuals in relation to employed persons in the population. The idea is that each new employee is related to an equal number of non-employees, equivalent to the proportion in the entire population. That method usually strongly overestimates the local population effect. Moving in of families is nowadays replaced more than before of commuting or by singles who move in. The difference is mostly due to long-term changes in family-related labour market and migration behaviour reflected by individuals in the simulation model. The old norm of the sole family provider has been replaced by the norm that both the man and the woman shall contribute to work income and have access to self-realization through jobs. If both do not receive suitable jobs and day care for the children at about the same time in the proposed location, then they will not move. A much greater proportion of the regional moves today, as opposed to a generation or two ago, are represented by age groups that have yet to complete their education and start a family. Four fifths of those who have moved say that their move was not related to the labour market.

The redistribution of the population is thus currently more related to housing preferences than to industrial localisation. This has been indicated by a number of studies in this field of research¹. The simulation model reflects these new conditions. An experiment in “shortening” the distance between Östhammar and Uppsala to incorporate Östhammar “closer” to the greater Stockholm area had a much stronger population effect than the establishment of a repository for nuclear fuel there. The equivalent experiment with Oskarshamn-Kalmar produced nearly the opposite effect. The population was hardly affected, although the already high level of commuting to Oskarshamn increased considerably. To continue to live in, or move to, Kalmar is more attractive for many model subjects who have a job in Oskarshamn than both living and working in the industrial community of Oskarshamn. This outcome is in agreement with a common claim in center-periphery research, i.e. that the periphery often loses relatively by an increased interaction with the core. For Östhammar, however, there is a strongly centrifugal effect away from the centre, which is an effect of “leaving” the periphery and becoming a suburb of Sweden’s largest and most diversified regional labour market. There is no equivalent population pressure away from Kalmar to other smaller municipalities. Another experiment elucidated the significance of diversification of the local labour market by establishing operations in a sector that employs a large proportion of women and college-educated persons. The result indicated that in order to develop the municipalities it is important to

¹ A brief summary of this can be found in E Lundholm’s article ”Unga flyttar alltmer” [Young people move more], *Forskning och Framsteg*, no. 4. 2009.

complement nuclear technology operations with other operations that would increase the possibilities for all family members to live and obtain gainful employment in the municipality.

2.1.3 Historical parallels in economic development

Andersson-Skog's project also points to the limited population effect of industrial establishments. A tangible impact on population development can often be observed during the period of construction and initial operation, whereupon this effect diminishes and population development returns to its previous trend. Already in Eli Heckscher's study /3/ of the local economic impact of railways it was shown that it was during the construction period and early stages of operation that the most marked effects were made on population development, and primarily so in the railway station communities. In general, however, an industrial investment had a larger local impact the farther back in time we look. As mobility of goods and people increases within the country, along with more specialisation and an increasingly internationalised economy, the impact of an investment becomes less local over time. The project report describes, for example, how the high technology underground laboratory in Bure in eastern France was partially motivated by its significance for the regional socio-economic development /4/. Seven years after the opening of the laboratory these effects have yet to be seen. In Sweden, Kiruna and Malmberget underwent rapid growth in the decades around the turn of the century 1900, when investments in Malmbanan (the railway system) enabled large-scale investments in mining operations. A century later, decisions were made to invest billions of kronor again in mining operations. The expected effect on population development has been negligible, however, according to assessments by both the company and the political bodies. This is due, in part, to the fact that all the specialists, experts and consultants needed today can live wherever they want, which is not always in the mining district itself.

2.1.4 Conclusions

Taken together, the analyses of these two projects and the applied studies indicate that the various parts of SKB's final repository programme, relative to what can be expected from the new situation today, nonetheless offer a substantial, valuable and quite sustainable contribution to the economy, the employment situation and the population, regardless of where – in Östhammar or Oskarshamn – the repository is located. The effect will not, however, be equally large in both municipalities, and this is true with regard to the scope of employment opportunities in the planned nuclear facilities and the jobs that are generated indirectly via local subcontractors, as well as with regard to the impact on commuting, relocation and population. This also means that potential additional "compensatory" investments would have

dissimilar prerequisites in the two municipalities. In his analysis of the industrial organization of the final repository, Frostenson claims that one of the most unique aspects of the organization is the amount of additional activities SKB and its owners have promoted for the local candidate municipalities. Among several efforts, the “surplus value agreement” stands out. It gives more additional development resources to the municipality that did not get the repository, i.e. Oskarshamn, compared to Östhammar. (The project is presented, along with other projects, in Appendix 2.)

The two first mentioned projects and related applied studies have been strongly focused on local population effects and job opportunities highly relevant to a final repository for spent nuclear fuel. A number of questions are still unanswered and may become significant after SKB’s selection of site. These involve issues with a more narrow and detailed focus regarding other local consequences, and questions other than those concerning the sheer numbers of the population and employment, as well as issues that extend beyond the scope and relevance of the local and the specifically nuclear-related activities. The final chapter of this report provides examples of such issues.

2.2 Decision-making processes – governance

The research area “Decision-making processes – governance” covers several themes and could be summarized on the basis of most of the projects in the Social Science Research Programme. The focus in this review, however, lies on “content aspects” related to decision-making and governance, although such processes are difficult to separate from e.g. legislation, socio-economic conditions, attitudes and processes of change in contemporary society. For example, in their report “Resource or Waste? The politics of handling spent nuclear fuel in Finland, Germany, Russia and Japan”, Arne Kaiser and Per Högselius /5/, elucidate how various factors and societal aspects have interacted in political decision-making processes in different countries. In conformity with Jonas Anshelm’s historical review of the development of public attitudes in Sweden, and the results obtained by Per Cramér’s research group investigating national and international legislation in this field, these results are highly relevant to the theme “Decision-making process – governance”. Also the previously mentioned studies on socio-economic impact in municipalities that establish large-scale industries are certainly relevant to this theme (see section 2.1; the reports by Urban Lindgren and Magnus Strömgren, and by Lena Andersson-Skog /1, 4/).

However, when we review relevant work in this chapter, the focus is on the framework and rules that circumscribe the Swedish decision-making process as well as on descriptions of what took place within the processes that were selected for closer review. Thus it is primarily the projects led by Per Cramér,

Rolf Lidskog and Carina Keskitalo that are of topical interest in this context. In addition, Sven Ove Hansson's project is of central importance, but in a different way, since the ethical and philosophical perspectives, which he presents in project reports, demand a higher level discussion of what bases and principles can possibly be used in decision-making covering very long periods of time, how risks and uncertainties are to be assessed in such a context, and what the precautionary principle signifies.

2.2.1 Framework rules for Swedish decision-making

Cramér, Stendahl and Erhag /6/ write in the summary of their report "National responsibility for spent nuclear fuel in an expanded European Union?" that the issue of assuming responsibility on a multilateral level is regulated primarily through the Nuclear Non-Proliferation Treaty of 1970 and the IAEA Joint Convention on the Safety of Spent Fuel Management and Radioactive Waste Management of 1997.

Responsibility for spent nuclear fuel is not regulated directly through the European Union since the initiative for joint legislation was blocked by Member States. The issue of responsibility is thus of a predominantly national character and the report includes a discussion of the significance of the fact that Member State legislation in this field differs on the basis of nationality, which appears to conflict with "the idea of regional European integration."

The authors further assert that there are two sides to the principle of national responsibility. On the one hand it is about how Sweden takes responsibility for spent nuclear fuel, and on the other about "the rights that Sweden thinks that it has to prevent other countries from disposing or temporarily storing spent nuclear fuel in Sweden." The authors conclude that in the latter case there is a statutory ban against final disposal and temporary storage of foreign nuclear fuel in Sweden, though "the issue of how Sweden is to take responsibility for its own spent nuclear fuel" is not legislated in the same way.

Swedish planning of the decision-making process includes several statutes and stages of development. In brief, this means that the operator, SKB in this case, applies to the government via The Swedish Radiation Safety Authority, SSM, for a permit for a final repository according to the Nuclear Activities Act and submits an application to the Environmental Court for permission in accordance with the Environmental Code for the final repository system, i.e. the interim storage facility (Clab), the encapsulation plant and the final repository. A joint Environmental Impact Assessment accompanies the applications. In parallel, the municipality in question prepares a detailed plan in accordance with the Swedish Planning and Building Act.

The decision to grant permission for a final repository system is taken by the government. For this reason the Environmental Court does not give a ruling, but submits an opinion to the government. This opinion states the Environmental Court's view on the permissibility of the operation in accordance with the Environmental Code. When the opinion of the Environmental Court has been received by the government it forwarded to the municipality in question for a decision by the municipal council, whereby the municipality determines whether or not to approve the operation.

If the municipality approves and the government decides that the operation is permissible, then the Environmental Court must issue a permit and determine the terms and conditions that it deems necessary.

In compliance with the Nuclear Activities Act, an application is prepared by the Swedish Radiation Safety Authority (SSM) prior to the government decision on the permit. The government will probably delegate the permit decision to SSM, i.e. to decide on the terms and conditions for the operation regarding nuclear safety and radiation protection.

If a go-ahead is given for all steps of the process, then SKB can apply for a building permit in the municipality in question.

There is currently no project in the Social Science Research Programme of the magnitude required to elucidate activities on all the above-mentioned levels over a given period of time. The present projects, however, discuss the issue of governance on several levels in general terms, making use of reviews of published studies that are based primarily on theoretical overviews or policy development. In addition, various comments by project participants regarding their own participation are reported. Thus various forms of formal decision-making structures and processes on a national, regional and municipal level, as well as the content of the work that has been done, remain to be elucidated in depth or in a comprehensive manner.

2.2.2 Responsibility at the end of the nuclear fuel cycle – A legal perspective

The recently completed study by Cramér and associates "The responsibility at the end of the nuclear fuel cycle. A legal perspective." consists of three subprojects of relevance for the future decision-making process. The first part analyses the legal structures surrounding the issue of responsibility for safe management and final disposal of spent nuclear fuel. Its purpose is to shed light on the legal aspects to be considered in the future licensing process and thereby to contribute to a better understanding of the importance of the legal structures for the decisions about final disposal that lie ahead. One conclusion from this study is that the Swedish regulation of nuclear activities creates a legal basis for exacting far-reaching industrial responsibility from the reactor owners, but also for an extensive and interventionist state influence over the activities.

The second subproject discusses the fact that responsibility for management and disposal of spent nuclear fuel is regulated in Sweden by several different laws and regulatory complexes. This means that the regulatory frameworks overlap each other and a permit and licence for a final repository have to be applied for under both the Nuclear Activities Act and the Environmental Code. The study shows that due to parallel regulation at a national level, there are certain risks of overlap and contradiction, not least as regards conditions governing environmental responsibility as well as nuclear safety and radiation protection. Conclusions from the parallel reviews that have been conducted in Sweden, for example in connection with permits for power increases in Swedish nuclear power plants, show, however, that the parallel licensing process works satisfactorily in purely practical terms. Nevertheless, there is a potential risk that parallel review and parallel regulation may lead to a lack of clarity that affects the very legitimacy of the licensing decision.

Perhaps the greatest challenge for the development of civilian nuclear energy production is the need to create a regulatory framework that effectively prevents civilian nuclear activities from contributing to an increased proliferation of nuclear weapons. The purpose of the third study is to describe and analyse how responsibility for upholding international commitments regarding non-proliferation of nuclear weapons is concretized in connection with the final disposal of spent nuclear fuel in Sweden. The most obvious problem identified in this study concerns the extent of the responsibility in time after the operating phase is over and closure has taken place. Under the current Swedish regulatory framework, the endpoint for SKB's responsibility will probably not be defined on the basis of an assessment that the obligations under the Nuclear Activities Act have been fulfilled. The endpoint will instead be defined by a political decision on discharge from responsibility, after which the state will assume responsibility. The authors note in conclusion, that there is a need to formulate principles for such a transition of responsibility.

2.2.3 The EIA process

Two studies have especially focused on the consultation process. Keskitalo, Nordlund and Lindgren studied the development of the Environmental Impact Assessment (EIA) process and its related documentation. They write in their introduction (p. 6) that:

In Sweden an EIA report is to be prepared by the one, e.g. a company, that proposes the establishment of a potentially environmentally hazardous operation, and this documentation forms a basis for decisions by relevant regulatory bodies. The process of drafting an EIA report must include the possibility for a concerned public and organisations to express their opinions, and it is possible for the decision-making body on a state or municipal level to reject an EIA report if it is judged that the public did not have a sufficient opportunity to participate in the process.

In the report, “The Creating the basis for decisions in the nuclear waste issue. Experiences of parties and participants of the legislative basis and the EIA process” /7/, Keskitalo, Nordlund and Lindgren discuss three central issues:

1. What is the formal decision-making mandate and what are the decision-making bodies at different levels (municipal, regional or county, national) according to the legislation, and what interpretation problems have these actors experienced with regard to the legislation and the EIA process?
2. What “broader public” and organisations, besides groups within the formal decision-making mandate, have participated in the consultations, and what viewpoints have they expressed regarding the EIA process and consultations?
3. How have judgements and understanding of, and reactions to, risk related to the final repository been handled in the process?

The authors found that various participating parties felt comfortable in their roles and that the distribution of types of participants varied across levels of the decision-making process. Environmental organisations, for example, appeared to have been most active locally or on the municipal level. Results also show different perspectives on the role of consultation with regard to environmental organisations and other established actors. The former were characterized as representing an “environmental paradigm” with a focus on long-term consequences and an emphasis on the precautionary principle. The ongoing process of nuclear waste storage was instead characterized as a communicative planning ideology with a local level focus.

The authors underline that an EIA process also is a social process involving a large number of different interest groups with specific agendas – who therefore easily “talk past” one another – and this in addition to the issues themselves being difficult to address. They also report a perceived ambiguity between sectoral laws and the Environmental Code with regard to nuclear waste.

In their project report “The public, the experts and deliberation. Consultation on the final repository for nuclear waste” /8/ Soneryd and Lidskog focus on public participation. They describe the background, conditions, and opinions to the process among participants. They conclude that public participation in planning, discussing and decision-making regarding environmental issues is supported by various reforms and policies, which is reflected in Agenda 21, The Aarhus Convention 1998 and the European Union’s EIA directive (85/337/EEG). In their contribution to the annual report 2006: “The public,

the experts and deliberation – Consultation on the final repository for nuclear waste” Lidskog and Soneryd described the bases for the EIA report and consultations as follows (page 90):

In order to consider a permit for environmentally disturbing facilities or operations, it is required in the Swedish and in European Union legislation that an EIA report must be submitted. According to the European Commission’s EIA Directive, the public has a right to access information on the environmental impact of a project, within a reasonable amount of time, and shall be given the opportunity to comment on the plans before a project is granted or refused a permit². Member States determine the form of information and consultation as well as what is considered to be a reasonable amount of time.

According to Chapter 6 of the Environmental Code, there must be regulated consultation with authorities, municipalities, individuals, organisations and the public that is assumed to be affected by an issue. What does “the public that is assumed to be affected” actually mean? The definitions of “public affected” in the Aarhus Convention and the EIA Directive involve individuals or organisations that are affected or interested in the decision-processes in the environmental area. Neighbours of the proposed operations as well as organisations that promote environmental protection are regarded to have such an interest. The Directive’s use of the term “public” refers to a larger group than “affected public” and includes in principle everyone who wants to be heard. Swedish legislation has integrated the provisions of the Directive and the Aarhus Convention.

That EIA regulations emphasize participation is clear, although the law makes no clear stipulation regarding the operator’s performance of consultation process. In addition to legislation, EIA is surrounded by a number of ideas regarding the benefits of involving a broader public in the planning process.

Hopes and ideals are expressed in international political documents, guidelines and handbooks. An ideal model, that combines broad participation and environmental concern in plans and decisions, is expressed in terms of good EIA practice. The importance of broad participation is emphasized due to the knowledge that the general public can offer.

² The Council’s directive on the assessment of environmental impact from certain public and private projects (85/337/EEG), amended by the European Parliament’s and Council’s Directive (2003/35/EC) on measures for public participation in the drafting of certain plans and programmes regarding the environment and on changes regarding public participation and access to justice.

Soneryd and Lidskog summarize their results in four points:

1. The consultation process has been organised in such a way as to result in a specific focus on the municipalities, the local population and local environmental issues.
2. The implementation of the consultation process has led to changes in the initial design, introduction of new elements, and new dilemmas to handle and weigh have arisen.
3. The consultation process contains mechanisms that both support and counteract a discussion and renegotiation of the limits of expertise.
4. Issues of responsibility have been discussed in relation to many trans-boundary issues, making deliberation appear to be a key democratic value.

The authors conclude that the EIA tool provides the operator with an opportunity to critically assess existing plans and projects. The authors assert that an open attitude in regard to participation and to the issues discussed supports the idea of deliberation as an important democratic value. It also challenges the boundaries between the public and experts. In addition, the authors point out “limitations to the good dialogue and the good arguments” in relation to the organizational form chosen, the development of participation over time, and power relations.

2.2.4 Overarching principles

Hansson’s project on ethical and philosophical perspectives on the nuclear waste issue is also highly relevant to the discussion on decision-making. He addresses, among other aspects, the relevance of underlying principles of decision-making with regard to very long time perspectives. In a chapter of the 2008 SKB Social Science Research yearbook /9/ he gives an overview of the problems associated with discounting when this method is applied to extreme periods of time. The idea of “discounting” needs to be replaced by other principles, even for comparisons of values and risks across time perspectives covering more than one generation. Hansson compares core issues related to nuclear waste management to assessments of long-term effects of e.g. chemical substances, as well as the work within the international climate panel, IPCC. Hansson notes that the climate panel works with a time perspective of approximately 100 years, and comments that a lot could be learned if the long-term effects of climate change, as well as long-term effects within other decision areas, were to be dealt with in a manner similar to that attached to nuclear waste.

2.2.5 Conclusions

Formal frameworks and comprehensive views of ongoing and future decision-making processes have been elucidated within this theme of the Social Science Research Programme. It has also covered overviews of bases for decisions, and available principles and methods for decision-making. Projects have also discussed the parallel and possibly conflicting legal issues in future decision-making. Results of the various projects point to major complexity already in the everyday and practical work to include, and jointly manage, essential dimensions of decision-making. In addition, there are major challenges with respect to understanding what kind of knowledge and methodology that reasonably could be used to estimate effects over long periods of time.

Some of the problematic issues are of a formal nature and concern a lack of clarity in regulations, roles and processes. Another part is more social and relates to who participates, and what the contributions consist of, and still another, and more fundamental, part of the complex of problems is theoretical and addresses what principles and methods that can be validly used. Some of the available principles are irreconcilable with one another. More research is therefore needed to address fundamental principles considered in relation to the issue of a final repository, as well as research focusing on appropriate methods of evaluating consequences over extremely long periods of time. We will return to the latter aspect in the final discussion in Chapter 4.

The Swedish example involving broad EIA and consultation processes points to the importance of the existence of discussion arenas, as well as it shows how fast both dialogue and social interaction become multi-dimensional. Researchers in the field have emphasized the importance of the fundamental principle in democracies that prerequisites for exchange of ideas and reflections, or “deliberation”, exist, that decision-making processes are important regarding both the content, and not the least the form, and that processes develop and change over time and reflect both the regulatory framework and the participants involved.

The Swedish example of studying decision-making and governance, among other aspects, within SKB's Social Science Research Programme has contributed to better insights into what takes place and is planned in decision-making processes at different organisational levels. It has also laid a foundation for a broader understanding of the significance of in-depth studies of principles and practices of decision-making that are expected to affect generations to come. These are issues that contemporary society encounters in an increasing number of technology and environmental fields.

2.3 Opinions and attitudes – psychosocial effects

In the thematic area of “Opinions and Attitudes – psychosocial effects” several research projects have contributed new information and knowledge. The overall most notable result, from an international perspective, is the predominantly positive attitude toward constructing a final repository for spent nuclear fuel in the site investigation municipalities of Östhammar and Oskarshamn. This has been expressed clearly in Lennart Sjöberg’s attitude studies, in the multi-national data utilized by Thorleif Petterson, and elucidated on the basis of local and national media coverage by Annika Egan Sjölander.

The current opinion is also particularly interesting in light of Jonas Anshelm’s review of historical developments since the 1950s, which for most of that time indicates a major scepticism toward nuclear power in Sweden, as well as a prolonged or compact local resistance in geographic areas where test drilling or preliminary investigations for a final repository for spent nuclear fuel were considered. The positive public opinion in the two site investigation municipalities therefore appears to be special from a national perspective, and it can be noted that the Swedish development differs from that in many other countries.

However, opinions are often transient and attitudes can quickly and strongly be influenced by change. What is the situation “below the surface”? And how stable can the results in this field of research actually be? What explanations are there to the public opinion and attitudes, and how do people reason when it comes to a final repository of spent nuclear fuel? Also these questions have been probed by the researchers.

Per Johansson and Ebba Lisberg Jensen used interviews within and outside the site investigation municipalities to identify “thought patterns” that constitute the underlying basis for understanding what individuals utilize as a foundation for attitudes toward the management and storage of spent nuclear fuel. Magnus Frostenson worked with a large corpus of written material in order to analyze values and ethics argumentation related to the issue of the final repository.

Lennart Sjöberg used broadly covering questionnaires to study the content, as well as structure, of attitudes, and for describing what can be used to construct and explain the attitudes. Annika Egan Sjölander compared the interest in and content of local and national media, primarily the press, and pointed to major differences in interest as well as focus, of the contents. Mikael Sandberg’s part in one of the projects focused on testing whether opinion changes over time foremost could be attributed to specific attributes of different generations or to time trend characteristics.

2.3.1 Public opinion in the site investigation municipalities and in Sweden

Sjöberg’s project responded to questions about the current opinion situation in the site investigation municipalities and in Sweden at large regarding a final repository for spent nuclear fuel. In the report from 2006, which is based on several representative samples, it is evident that the populations in Oskarshamn and Östhammar on average were clearly positive to having a final repository for spent nuclear fuel in their municipality. Their attitudes differed significantly from attitudes in a comparable Swedish municipality (Finspång), where there were no such plans, and from the nation at large. In both latter samples was the overall attitude clearly negative. See Table 2-1.

Analyses of differences between women and men in the various samples indicated that women were consistently less positive than men were, and that the gender difference generally was constant across the four samples. It is common that research on risks indicates major gender differences and thus Sjöberg’s results were not unexpected. What is notable, however, is that the attitude differences between the four samples were four times larger than the differences between the attitudes of men and women. This result indicates that where respondents resided, i.e. in site investigation municipalities or elsewhere in the country, had a larger impact on the explanation of the attitude than if they were men or women.

Table 2-1 Overview of responses to the questions “What is your attitude to having a final repository for spent nuclear fuel in your municipality?”

Scale ¹	Östhammar	Oskarshamn	Finspång	Entire nation
Very strongly positive	14	15	2	1
Strongly positive	17	21	3	2
Rather positive	25	24	12	10
Neither negative nor positive	24	25	29	24
Rather negative	8	9	17	16
Strongly negative	5	2	12	17
Very strongly negative	7	3	25	30

¹ Steps on a 7-step scale and distribution of responses in percentages from respondents in the municipalities of Östhammar, Oskarshamn and Finspång, as well as a national Swedish sample.

Analyses performed in each sample to test which variables that best explained the attitude toward a final repository in one's own municipality showed that the perceived benefit to the municipality was the primary explanatory factor in all samples, although it was a stronger contributor in the site investigation municipalities. In addition, perceived risk to the municipality and perceived personal risk contributed as explanatory factors. See Table 2-2. The table shows that these three factors quite well could explain the attitude to a final repository in the own municipality. The result also shows that the populations in the site investigation municipalities perceived the benefit of a final repository in their municipality as larger than did respondents of other municipalities, and that the former were less likely than others to emphasize risk aspects.

Attitudes toward a repository for spent nuclear fuel may also be related to the age distribution of the population, so that e.g. different age groups report different attitudes. Sjöberg reported, from a study performed in 2005 /10/, that younger people (under the age of 34), men as well as women, had a more positive attitude toward a repository for spent nuclear fuel than older persons, in Oskarshamn and Östhammar. In a later data collection (November 2007 – February 2008), older people were instead more positive than the younger. Sjöberg explained that a decline in attitude had occurred since 2005, especially among younger people, and he also found less interest in the issue among younger people in the later investigation. Results from the later project are shown in Figure 2-1. The results show an interaction between gender and place of residence, revealing a smaller gender difference in Oskarshamn and Östhammar than in the rest of the country.

Table 2-2. Results of regression analyses.

Explanatory variables ¹	Östhammar	Oskarshamn	Finspång	Entire nation
Benefit	0.61	0.57	0.40	0.45
Risk for the municipality	-0.25	-0.21	-0.41	-0.31
Personal risk	-0.09	-0.09	-0.05	-0.13
Explanatory value R^2_{adj}	0.69	0.57	0.56	0.55

¹ Standardized regression coefficients in four samples used to explain attitudes toward a final repository in one's own municipality. This procedure generates values that can be compared.

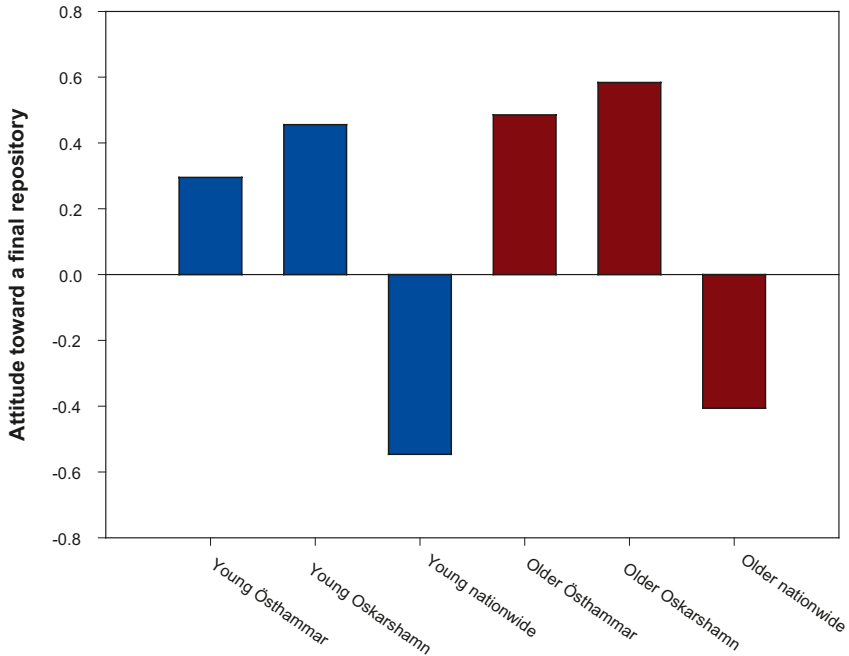


Figure 2-1. Average values of attitude toward a final repository among younger (below the age of 25) and older (25 years of age and older) respondents in site investigation municipalities and the entire country.

A central issue in this context is what factors can explain opinion differences between the site investigation municipalities and the country. Sjöberg (2008) /11/ found that the differences primarily were information, employment within the nuclear technology industry and the attitude toward nuclear energy. Regarding the smaller difference between Oskarshamn and Östhammar, it was instead primarily information, perceived influence and attitudes toward nuclear energy that entered as explanatory factors. See Table 2-3.

Sjöberg also showed that the explanatory variables used in the analyses played quite different roles in explaining the different types of variation. For example, both the gender and age variation were explained by attitudes toward nuclear energy, concern, and interest in the issue. Note that the variable “interest in the issue” was especially important in explaining the age variation.

Table 2-3. Explanatory factors in the model of attitudes toward a final repository, in order of importance based upon the estimated effect sizes.

Order of importance	Gender	Age	Site investigation municipalities compared to the entire country	Only Oskarshamn and Östhammar
1	Attitude to nuclear energy	Attitude to nuclear energy	Information	Information
2	Concern over accidents in nuclear power plants and their waste	Interest	Working in the nuclear technology industry	Influence
3	Interest	Concern over accidents in nuclear power plants and their waste	Attitude to nuclear energy	Attitude to nuclear energy
4	Influence	Influence	Influence	Interest
5	Information	Information	Interest	Working in the nuclear technology industry
6	Working in the nuclear technology industry	Working in the nuclear technology industry	Concern over accidents in nuclear power plants and their waste	Concern over accidents in nuclear power plants and their waste

2.3.2 Views on nuclear energy and democracy among youths

Sjöberg’s data, which shows attitudes toward a final repository for spent nuclear fuel in various groups, can be discussed in relation to Sandberg’s work on views among youths regarding nuclear energy and democracy. The latter work, which is based on longitudinal interview data from the period 1986–2005 obtained from the SOM Institute (University of Gothenburg), presented trends over time of responses from Swedish population samples on the question whether nuclear energy should be used, categorized in terms of gender and age. Both Sjöberg and Sandberg present results that show a strong correlation between attitude toward nuclear energy and attitude toward a final repository for spent nuclear fuel.

We note that the initial year in Sandberg’s figure is 1986 (see Figure 2-2). This is the same year as the Chernobyl accident, which may explain the low initial value. Having said this, the general trend since 1986 shows a steady increase in the proportion of Swedes who holds the opinion that nuclear energy should be used. The increase can be observed among men as well as women, although the proportion of men is higher throughout the period.

The figure presents a rather large variation across the different age groups over time, but overall the trend shows an increase in the percentage that holds the opinion that nuclear energy should be used. The fluctuations in the data material that concern the different age groups in Sandberg’s report (2008) /12/ can perhaps contribute to an explanation of the differences that Sjöberg obtained in relation to age groups in his data collection in 2005 and later, i.e. the long-term trend can be unequivocal in spite of the possibility of variations in the results at measurements at different times.

Sandberg offers an interesting contribution in his attempts to find out whether attitude is affected primarily by current age or primarily by generational identity (cohort). By focusing on attitudes toward technology and democracy, Sandberg worked with data on individuals as well as aggregated data sets in order to answer the question whether a person is “imprinted” during youth by contemporary values and maintains these values over time, or if the youth period “always” differs from older generations’ views and that basic values change with age. Sandberg found that throughout the period 1986–2005, the younger people were among the most critical toward nuclear energy – as well as the most satisfied with democracy – even if gender, risk perception, and preference for a particular political party also contributed to some variation in the group. The positive attitude toward the democratic system was related to the degree of confidence in politicians.

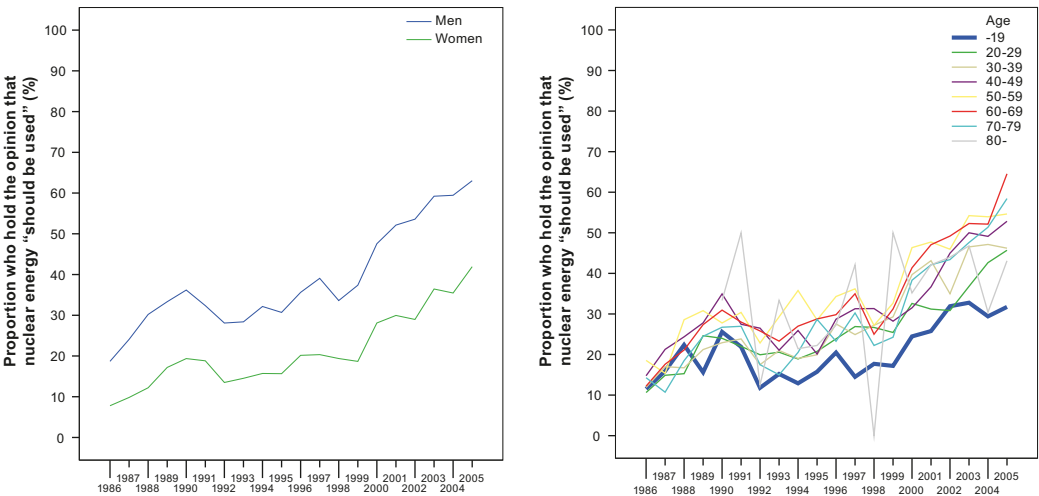


Figure 2-2. Proportion of men and women and different age groups (1986–2005) who hold the opinion that nuclear energy “should be used” (averages in percent).

Sandberg asserts that “attitude epidemics”, i.e. that attitudes spread quickly, especially can be observed in time series analyses where the computer and IT revolution strongly correlates with the growing acceptance of nuclear power. Sandberg summarizes the strongest individual “immunity factors” against accepting the use of nuclear energy to involve being young, a woman, and to worry about nuclear power risks. Thus Sandberg points to the significance of one’s views on risk in not accepting nuclear power, while Sjöberg emphasizes that the perceived benefit to one’s own municipality concurs with the acceptance of a final repository for spent nuclear fuel in the site investigation municipalities.

2.3.3 Local and national media coverage and content

Yet another perspective on public opinion and attitudes, locally in the site investigation regions and nationally, was presented by Egan Sjölander in a project on media coverage and content. The project showed that there had been a greater supply of articles and other materials locally than nationally, rather large variations over time, and that there were major differences in the content of the published materials.

Local media content focused primarily on local events and plans, such as the site investigations and SKB’s other activities, while the national interest to a higher degree reflected general policy issues in relation to the debate on nuclear power or methods of final disposal, as well as it, at times, presented fictive accounts related to risks. Table 2-4 shows that the most frequent contributions on the local level originated from politicians, the environmental movement, citizens and industrial representatives, whereas citizens, newspaper editors, and experts were frequent sources in national coverage.

Table 2-4. Type of debater in the national and local press.

Type of debater	Total no. of contributions	National press		Local press	
		Freq.	Row-%	Freq.	Row-%
Politicians	45	8	17.7	37	82.2
Citizens	41	27	65.8	14	34.1
Newspaper editors	30	17	56.7	13	43.3
Environmental organisations	27	6	22.2	21	77.8
Industry/ company representative	20	8	40.0	12	60.0
Experts/ scientific community	19	1	63.2	7	36.8
Others (e.g. journalists)	7	5	71.4	2	28.6
Authorities	4	3	75.0	1	25.0
Municipal organisations	4	–	–	4	100.0
Sum	197	86	43.6	111	56.3

2.3.4 Existential perspectives on nuclear waste

What then is the substance of various views of on a final repository? Johansson and Lisberg Jensen (2006a) studied this in their project “Identity and security in time and space – cultural theoretical perspectives on the existential dimensions of the nuclear waste issue”. Through interviews and text analyses from a human ecology perspective, they found a predominantly positive local attitude to a final repository in the site investigation municipalities, based on expectations of a positive socio-economic development if a final repository were to be established locally. The authors claim that the mental conceptions related to time and space that appear in the results of the project largely are based on notions of a stable present, which one, on the one hand, believes will function in a similar way in the future but, on the other hand, one fears will end /13/.

Among the topics related to time, the authors bring up time perspectives, the final repository, responsibility, retrievability, and information preservation. They emphasize a common view that a period of 100,000 years is incomprehensible and impossible to grasp from a human perspective. They also observed various intellectual strategies which people used to handle the time perspectives. One such strategy involved to deny that the perspective is necessary, and another used two different types of time perspectives, namely. an existential and a theoretical one. In addition, the authors found some “striking features” in the interviews as well as the texts, which they interpreted in terms of a lack of confidence in the future development of society. They specified three time perspectives for taking responsibility: the current time (up until a maximum of 10 years), disposal time (up until the year 2060) and the final repository period (beyond the year 2060). The boundary between the two first time periods was perceived as fluid by the interviewees, while the cut-off between the latter two seemed more definite.

It was shown that the interviewees primarily utilized two different time categories, i.e. “societal time” and “final repository time”. In this context, societal time was associated with instability, while the repository, sealed in bedrock, was – as a complement and by way of contrast to societal time – strongly associated with stability. These associations were also related to strong value judgments: instability is bad and stability is good. What is stable was associated with the long, geological time perspective, while the instable was associated with the brief, societal perspective.

Uncertainties with regard to stability or change in the future seemed to lead to an increased interest in being responsible now. Similarly, the rhetoric regarding future generations’ “freedom to act” contained the dilemma of both wanting to give them the freedom to act and not wanting to force problems on them that could or should be handled by present generations.

The authors also found that the responsibility shouldered by municipalities is more complex than that of industry. Within the framework of space-related issues, the authors brought up topics related to the localisation of a repository, enthusiasm and scepticism, trust, phenomena of sparsely populated areas, the risk of stigmatisation, and local identity. They summarized their impressions under the heading “two worlds”, and identified a mainstream discourse, where the growth ideal is emphasized, and contrasted it to an alternative and more sceptical approach, which challenged the mainstream discourse. This research has contributed both an analysis of how the interviewed individuals reasoned, as well as added a reminder that too little critical debate or questioning of the current alternatives is not necessarily the best approach in the long-term perspective.

2.3.5 Ethical argumentation on the issue of a final repository

Magnus Frostenson focused his project on ethical argumentation in relation to the issue of a final repository. Thus the research area “Opinions and attitudes” was complemented by an additional perspective, based in this case on an analysis of texts written by active debaters or participants in the consultations. Frostenson categorizes these debaters/participants into groups of “process drivers”, “observers” or “nuclear power opponents”. In addition, he divides the topical discussion into three parts: choice of a location for a final repository, choice of method, and the design of the decision-making process. Frostenson’s results quite naturally show that there are differences of opinion. However, the particularly interesting results point to the case that most participants share fundamental ethical values, such as the principle to do no harm, intergenerational equity, and the principles of producer responsibility and of co-determination.

What separates the participants in the debates instead seems to be views on the relevance of functional values in relation to ethical values. Frostenson (2008) writes (p. 5): “It concerns the existence of different views on the relevancy of process efficiency with respect to time, economy and general socio-economic effects regarding the final repository issue” /14/. Frostenson has thus perhaps come close to the “heart of the matter” in understanding how such intensive discussions can be developed over a long period of time in an area that is regarded to be primarily a natural scientific and technological field of expertise, and in a population that from an international perspective is relatively value homogeneous.

2.3.6 Swedish values in an international perspective

A review of Swedes' fundamental values is presented in Pettersson's 2008 report "Keeping the faith! A comparative analysis of basic values and attitudes toward democracy and politics among young adults from 24 countries /15/. Based on a large international data material collected within the World Values Survey, Pettersson makes use of information from 24 countries, enabling him to show that Sweden differs from other countries in obtaining high scores on both the value dimensions of "willingness to change and secular-rational values" and "emancipative and self-transcendent values". See Figure 2-3.

In comparing the young, or "future adults", and adults, Pettersson found that young people in all 24 countries scored higher on "willingness to change and secular-rational values" (which to a higher extent emphasize openness to change, valuation of creativity, freedom and excitement than preservation of the status quo through high regard of traditional authorities, such as religion and the family). The adults in many countries, on the other hand, scored higher on "emancipative and self-transcendent values" (that stress a positive view on helpfulness, the collective good, horizontal social trust, active participation in civil society, tolerance of minorities, and that individual integrity and autonomy are more important than economic development and law and order).

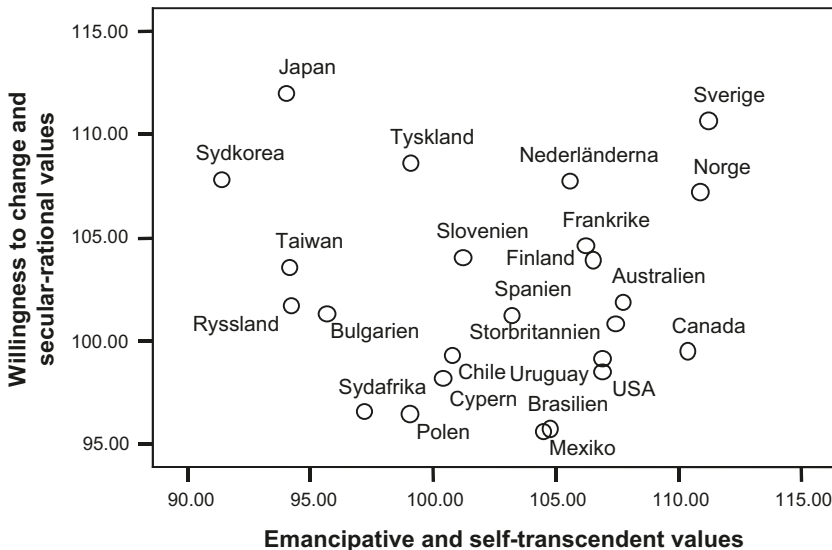


Figure 2-3. Mean values from 24 countries on two fundamental value dimensions.

In the latter instance, however, Sweden appeared to be an exception compared to many other countries, since Pettersson did not find that young future adults in Sweden were less interested in the collective good than the adults. Pettersson writes (p. 79):

The different Swedish value profile can be explained with reference to Sweden's economic development, that economic disparities between different groups are comparatively limited, and that political and societal institutions function comparatively well. It can also be referred to the existence of a long and tenacious cultural tradition of such values in Sweden.

Thus, in the project Pettersson shows that younger and older Swedes are more similar to one another in terms of values than what is the case in many other countries. The result is in line with the idea that Sweden is a relatively homogeneous country in terms of values, and thus it supports Frostenson's conclusion that there is a substantial common value basis also in the most animated debate on a final repository. Obviously the results point to an interesting future research challenge in that the coexistence of both a long, dissentient and heated debate, and a common fundamental value basis, demands an explanation. An approach could be based on Sjöberg's results (2008, /16/) that more extreme attitudes are associated with a greater tendency to act. Thus, for example, heated debate may not be a question of divergent fundamental values, but the extent to which extreme or polarized attitudes are voiced.

2.3.7 Views of the consultation process

Another project in the thematic area of "Opinions and Attitudes" studied the argumentation, as well as the decision-making process, in conjunction with the planning of the Swedish final repository. The project report "The public, the experts and deliberation. Consultation on the final repository for nuclear waste." by Linda Soneryd and Rolf Lidskog /8/ presents results of interviews, observations from meetings and analyses of regulations, as well as accounts of involvement and views on the development and content of the process by different groups. The report focuses primarily on the consultation process in the site investigation municipalities. The authors have contributed new descriptions and interpretations of "broader participation" and "deliberation", and placed local consultations in a larger theoretical framework of power relations, predictability and influence, issues of boundary setting and communicative visions and tools. Similar to Pettersson's and Frostenson's conclusions, the results of this project can be seen as interesting varieties of perspectives that are all firmly based upon the deeply ingrained Swedish value that consultation is fundamentally positive.

2.3.8 Conclusions

The tentative conclusions from projects in the thematic area of “Opinions and Attitudes” point at a solidly positive opinion situation in the two site investigation municipalities regarding the establishment of a final repository. This is particularly the case in comparison to the rest of the country. There are differences between categorized groups, primarily based on background factors such as gender and age, but also due to political preference and perception of risk. These differences are, however, less striking than the trend toward an increasing general acceptance of nuclear energy, and local acceptance of building a final repository, in the candidate municipalities.

The results from the projects also indicate that people’s awareness was directed toward current events in the relevant municipalities, whereas there was not a lot of interest in the local work at the national level. Local media covered the site investigations with a different kind of interest than that shown by the national media, and the local population was more enthusiastic about the socio-economic benefits and development of their home district than inclined to speculate about effects or potential risks related to incomprehensibly long periods of time. In this sense the results point to a primarily pragmatic attitude in the site investigation municipalities.

This pragmatism has encountered opposition in the form of argumentation from the environmental movement, as well as in the form of reflections and comments from researchers involved in the Social Science Research projects. There is a hint of fear in this argumentation that the speed of developments creates tunnel vision so that risks, especially long-term risks, are ignored or obscured by general optimism. The projects also provide alternative views on history and future developments, and they offer various suggestions as to what should be taken into consideration in the course of the process. Taken together, the various projects within this research theme have succeeded in presenting an interesting chronicle that contains a large number of results, as well as thought-provoking hypotheses that can be studied in subsequent projects.

2.4 Societal change in the surrounding world

The theme “Societal change in the surrounding world” is the last of the four topical areas that were initially highlighted for their relevance to SKB’s Social Science Research programme, and which has formed a framework for applications and completed projects.

The siting of a final repository for spent nuclear fuel is a project with unique traits that are clearly associated with changes in the surrounding world. A number of questions can be posed regarding how ongoing and future changes in technology, views, politics and practices in other parts of the

world concerning e.g. energy supply, nuclear power and nuclear waste may affect Swedish decisions regarding a final repository. Certainly do also national trends in politics, economy and opinion influence events and views, locally and nationally.

“Societal change in the surrounding world” can potentially refer to a very large number of factors and processes. In this chapter we highlight four projects, each with a slightly different focus. The projects contribute knowledge in four key research areas: The international regulation framework of nuclear waste, the internationally diverse technological and political backgrounds to different strategic approaches to nuclear waste taken in selected countries, changes in the Swedish public debate over a period of fifty years, and the characteristics of the Swedish public opinion compared to those of other countries. The focus lies on the characteristics and causes of change processes. The projects are presented here in brief, and some conclusions are drawn concerning the significance of the changes on the current Swedish situation. The projects are also presented in Appendix 2.

2.4.1 Legal aspects

The management of spent nuclear fuel is an issue regulated at several levels: nationally, regionally and internationally. There are several definitions of what is considered waste in the nuclear energy sector and they relate to a country's view of spent nuclear fuel, e.g. some countries view spent nuclear fuel as a resource for reprocessing and extraction, whereas in the Swedish case, spent nuclear fuel is waste for which responsibility shall be taken through final disposal. Thus, the issue is what legal framework there exists for a national Swedish nuclear fuel policy, and consequently, for political decisions in this regard on a national level.

In the project “National nuclear fuel policy in a European Union?” (project leader Per Cramér, final report 2007) the principle of national responsibility was analyzed, i.e. that each country takes responsibility for the nationally produced spent nuclear fuel. The principle involves two aspects: One concerns the manner in which Sweden takes responsibility for waste generated within the country when nuclear energy is extracted. The other aspect concerns the rights that Sweden claims to have to hinder that spent nuclear fuel from other countries is permanently deposited or temporarily stored in Sweden. The latter aspect has been confirmed by law in an explicit ban against permanent disposal and temporary storage of spent nuclear fuel from other countries in Sweden. The issue of how Sweden shall take responsibility for the spent nuclear fuel produced within the country is not, however, similarly regulated by law.

The researchers furthermore analyzed international regulations. On the multi-lateral level the issue of responsibility is primarily regulated in the Nuclear Non-Proliferation Treaty of 1970, and the IAEA 1997 Convention on Safety of Spent Nuclear Fuel Management and Radioactive Waste Management. The Nuclear Non-Proliferation Treaty confirms the right of all sovereign states to develop a national civilian nuclear power industry and within the scope of this sovereignty lays also the competency to decide on the design of the final step of the nuclear fuel cycle. However, IAEA has since the beginning of the 1990s initiated a series of studies on legal, political and physical prerequisites for establishing multinational facilities for temporary storage or final disposal of spent nuclear fuel or high-level nuclear waste.

Within the framework of the European Union, the issue of responsibility for spent nuclear fuel is not directly regulated. The Swedish import ban regulation has analogues in several other countries, e.g. Germany and France. Throughout its membership negotiations Sweden had a ban on import, and Sweden conveyed clearly that sovereignty in the matter was a prerequisite for the negotiations. At the same time it should be noted that there is no binding EU legislation wherein the principle of national responsibility is expressed. This principle, however, is expressed in various political documents that state that no nation can be forced to receive spent nuclear fuel or nuclear waste from another country. In summary, there exists a main thread in the EU conduct since 1992 that recognizes national responsibility, and also leaves open possibilities for voluntary joint solutions.

2.4.2 Distinctive international strategies

The international perspective can also be found in the report “Resource or waste? The politics surrounding the management of spent nuclear fuel in Finland, Germany, Russia and Japan”, (project leader Arne Kaijser, final report 2007). The project aimed at clarifying and analyzing decision-making processes associated with nuclear waste from an international and historical perspective, and thus contributes to a better understanding of Sweden’s international cooperation in the nuclear power area, and of the Swedish strategy for nuclear waste management. The project selected four countries, i.e. Finland, Germany, Russia/Soviet Union and Japan.

A clear historical divide can be discerned between countries that decided to reprocess spent nuclear fuel and those that chose final disposal. Three of the mentioned countries have, unlike Sweden, considered spent nuclear fuel as a resource rather than as waste, and for that reason invested in reprocessing. The latter choice concerns Japan and Russia, and in an earlier phase, Germany. The project provides an account of how and why the countries chose different alternatives. The authors explain why these countries, despite a common basic approach, gradually came to aim at completely different strategies and methods for spent nuclear fuel management. Today Germany has totally abandoned its previous reprocessing strategy, Russia has maintained its strat-

egy, but also steered certain operations toward direct disposal, and Japan has recently completed a major industrial reprocessing facility. The issue of final disposal is, however, far from solved in Germany and Japan.

The authors reason in-depth on these different strategies, the conflicts that occurred and the various alternatives that were available, and sometimes rejected. This history has been characterized by sudden changes, uncertainty as well as continuity. In order to understand why different countries have chosen one alternative over another, and how a strategy changed over time, the authors chose to elaborate on eight key dimensions. Five of these relate to nuclear power issues, such as whether or not a country produces nuclear weapons, has an expansive or stagnating nuclear power sector, weak or strong competency in the field of nuclear energy, good or poor prerequisites for a final repository, and whether or not it has domestic uranium resources. Three other dimensions cover political characteristics, i.e. whether or not the country had or has a strong or weak anti-nuclear movement, whether it is a democracy or a dictatorship, and whether or not it is characterized by strong or weak local political power. The latter aspect is seen as essential to issues of local acceptance of a spent nuclear fuel repository.

In summary, the mentioned eight factors were stated as important in shaping the management of spent nuclear fuel, the various conflicts, and the choices made in the four countries. The authors present a picture of exceedingly dynamic processes, where geological and technological prerequisites, as well as availability of domestic uranium resources, clearly were important, but wherein politics, in a broad sense, appears to have been of key importance for choosing alternatives, and for how the choices were made. The reasons behind these different choices seem to be the military use of spent nuclear fuel and the absence of a democratic discussion (Russia), consensual political decision-making (Finland), and situations of strong political opposition and local disputes (Germany and Japan).

2.4.3 A shifting national debate

In altering the focus to the national Swedish arena, a number of uncertainties and sudden changes appear in the historic development of views on nuclear waste also in Sweden.

In the project “Nuclear waste: From an Energy Resource to a Disposal Problem” Jonas Anshelm analyzed the nuclear waste debate since the 1950s, including issues of risk, responsibilities, design of a final repository and safety of the technology. The author points to the importance of elucidating the different kinds of answers that have been given concerning these issues in different time periods. The challenge is to understand how changing technological, political, economic and scientific circumstances have influenced perceptions and debates. Such clarification can broaden the perspective and facilitate an understanding of the complexity of the issue.

The project observes shifts in meaning and public opinion changes regarding central aspects on the nature of nuclear waste – as a resource or as waste, and the characteristics of the waste – as well as of its associated risks. Likewise, issues of who has responsibility for the final repository, what should be considered scientific truths concerning bedrock characteristics, and the sustainability of the technological solutions, have been subjected to controversy throughout the period. It is striking, Anshelm notes, that central actors have been both utterly confident in their opinions and able to assume a totally different point of view in new situations. This characterization applies to both proponents and opponents of nuclear power.

In summary, this contribution illustrates that what is perceived to be true, valid, correct, morally right, and rational with respect to the debated issue recurrently have been subject to renegotiation and change during the past half-century. This has resulted in a number of serious conflicts since the 1970s. The issue has, at the point in time of this report, currently reached a level of stabilization and does not exemplify a strong national or local controversy. It is, however, reasonable to assume that current views on what is true and right regarding the nuclear waste issue – on which there is some consensus today – also in the future will be subjected to renegotiations in light of scientific, technological, economic and political reorientations.

A slightly different picture emerges from the report by Nord and Stúr (“From make-or-break issue to back-burner issue. A study of the political debate about nuclear waste in Sweden from 1976 to 2009”) It investigated how the premises for the political decision processes regarding the issue of final disposal of the Swedish nuclear waste have been affected by changes in the public opinion climate and global events between the 1970s and today. It focused on how the national political debate leading up to decisions interacted with the media debate, and on the public opinion dynamic that arises when the two debates relate to each other. The study shows that the nuclear waste issue was at the centre of the domestic political debate during the 1970s, but then gradually lost ground in political importance during the following decades. What can most accurately be described as a make-or-break political issue at the start of the studied period was by the end of the same period at most a back-burner issue of limited interest and had virtually been removed from the political sphere.

The nuclear waste issue in Sweden differs from most other political issues in the degree to which its importance waxes and wanes, i.e. from being extremely important in the 1970s in the political debate and the formation of governments, to occupying a marginal role as an issue of political debate in the first decade of this century. This situation may, however, as Anshelm’s study has shown, be reversed in a new decision-making situation.

2.4.4 Idiosyncrasies and stability in the Swedish view of democracy and technology

Finally, the reports by Torleif Petterson and Mikael Sandberg, in the project “In activism or disinterest? Swedish young people’s view on democracy and environment, science and technology in a comparative perspective” (final reports 2008), provide important clues to describing the Swedish debate. Their researchers had a specific focus on young people, i.e. future citizens and decision-makers.

One assumption of this project was the idea that present and future attitudes toward a final repository for spent nuclear fuel are part of a composition of attitudes toward other phenomena (such as technology and political governance systems). These attitudes can, in turn, be traced to fundamental value dimensions that concern degree of self-transcendence and willingness to change.

The project consisted of two studies. The Swedish longitudinal study (Sandberg) investigates how views on nuclear power, other technologies, technology and science in general, and democracy, have changed across the past decades in Sweden. The results indicate that criticism of the system has subsided since the 1960s and 1970s, both with regard to the nuclear power based energy system and the functioning of the political system. It is primarily persons born in the 1940s and 1950s who have changed their position and become less critical both to nuclear power and to democracy as such. Thus, the age factor plays a relatively limited role in central issues concerning the experienced functionality of the political system, although the young people were shown to be somewhat more positive. This result differs from the one concerning nuclear power where the tendency was that young people were more critical.

The international study (Petterson) investigated how people’s attitudes toward democracy and politics on the one hand, and science and technology on the other, are related to their fundamental values and to the economic-political structure, in a number of different countries. In addition, the study investigated whether or not young Swedes differ from youths in other countries. In an effort to capture a historical dimension, the analysis also takes into account how views on democracy and civic ideals have changed over the past quarter of a century. The analyses focus on people who are referred to as “future adults”, i.e. persons between the ages of 18 and 27. Their attitudes toward democracy and politics were studied in relation to, for example, the value dimensions: “emancipative and self-transcendent values” and “willingness to change and secular-rational values”. Self-transcendence is characterized by a positive view of helpfulness and the common good, horizontal social trust in others, active participation in the civil society, tolerance of social minorities, and that integrity and autonomy of the individual is more important than economic development, law and order. Willingness to

change is characterized by openness to change, and appreciation of creativity, freedom and excitement rather than preservation of the status quo in terms of traditional authorities, such as religion and the family.

Sweden stands apart from many other countries with its high scores on both value dimensions. In all countries, including Sweden, young future adults score higher on willingness to change and secular-rational values. However, regarding the emancipative and self-transcendent values, adults in many countries score higher than youths. Sweden is an exception in this regard, and the youth or future adults are just as interested in the common good as the adults.

The analyses also show that the view on democracy and citizenship has changed in the direction of a more individually oriented perspective, i.e. from a community-centered view of democracy to one that is oriented toward the individual, and from a civic and solidarity based view of citizenship toward a more activist attitude. These changes are most obvious in Sweden. Thus, the Swedish political culture is specific, with regard to its value dimension profile, its positive view on democracy and politics, as well as its attitude coherence between youth and adults. The conclusion is that future adults in Sweden follow in the footsteps of adults in their views on democracy and politics. And there is no reason to believe that Swedish youths will lead developments away from the Swedish political tradition.

In a final analysis, connecting both the mentioned studies, Petterson discusses whether or not today's Swedish youths differ from young people in other countries in that they share the same perceptions of democracy as their adult compatriots but differ on views of science and technology. The answer is that Swedish future adults are like youths in other countries and share their elder compatriots' restrictive view on science and technology. On the other hand, the Swedish future adults are considerably more pro-democratic than youths in other countries, and thus in this respect more similar to Swedish adults than youths in other countries are similar to their older generation.

2.4.5 Conclusions

The projects presented here provide new and deeper knowledge in several important areas. The international perspective has pointed to certain distinct features in Swedish development, but also highlighted factors that connect the Swedish situation with situations in other countries.

Regarding the legal situation, for example, Sweden has a regulation banning import of spent nuclear fuel, in resemblance to Germany and France. At the same time it should be noted that there is no binding EU legislation wherein the principle of national responsibility is expressed. The principle is available, however, in various political documents that declare that no nation shall be forced to receive spent nuclear fuel or nuclear waste from another country.

Concerning the development of a strategy for managing spent nuclear fuel, Sweden, like Finland and Germany, has arrived at an orientation toward final disposal. Spent nuclear fuel is viewed as waste, not as a resource. This distinguishes Sweden from Japan and Russia, where the reprocessing option remain. In contrast to Germany, but similar to Finland, the Swedish strategy has not been a source of strong political conflict, at least not in more recent times. The historical development in Sweden shows, however, that views on a number of different aspects of the nuclear waste issue – technology, bedrock, scientific results, risk analyses, etc – may be questioned and renegotiated by various public actors, and sometimes in non-predictable ways. The current situation also contains several important differences of views and divergent analyses beneath the consensus surface dominating the overall picture (see Frostenson's study in the thematic area of Opinions and Attitudes above /14/). Although basic ethical principles are shared by many actors, the principles may be interpreted and utilized differently in concrete situations, e.g. in relation to methods for final disposal, choice of a site, and the perceived legitimacy of the decision-making process.

At the same time, an international comparative analysis of attitudes and values shows that both older and younger Swedes have an unusually strong commitment to democratic decision-making processes. This is connected, however, with scepticism toward nuclear power and technology among many youths in Sweden – a scepticism that diverges from the view of older Swedes who have become increasingly more positive to nuclear energy.

In summary, the analyses of some important dimensions of contemporary society and changes over time in Sweden and internationally indicate variability as well as stability, conflict as well as consensus. The future holds a number of uncertainties related to external factors, some of which concern the evaluation of nuclear power and nuclear waste in light of future energy policy, the international judicial situation, and what strategies important countries in the surrounding world will choose for their nuclear waste management. We will return to some of these issues in the discussion in Chapter 3, as well as to other questions raised in the presentation of the projects.



3 Discussion

In this chapter we address some of the major issues that have emerged from the programme projects. These are themes of central importance to the understanding of nuclear waste management today and in the future. How to consider societal change processes, the various short and long-term social consequences of a final repository for spent nuclear fuel, as well as the values, opinions and attitudes that have been and continue to be relevant to decision-making concerning nuclear waste management? We want to emphasize that we are bringing these issues to the fore as questions for further research and discussion.

We begin with a discussion of some of the ways that processes of social change can be understood before addressing various societal aspects of the issue of a final repository. We move on to questions regarding attitudes and opinions in Sweden and internationally, before closing with a discussion of the long-term consequences of a final repository for spent nuclear fuel.

3.1 Societal change processes

The solution to the problem of nuclear waste management is important, not just today but for generations to come. Questions regarding the way changes in society have influenced and may continue to influence have an impact on a planned final repository are therefore of interest.

3.1.1 Different ways of understanding societal development

Several projects within the SKB Social Science Research programme investigate the understanding of societal development. It should be noted, however, that projects investigating futuristic scenarios involving totally different social systems (or no system at all) have not been included in this programme. On the other hand, it has been considered valuable, as Sven Ove Hansson does in his essays on “Risk and uncertainty” and “The time perspective of nuclear waste”, to discuss various ways of understanding risk and theoretical problems related to calculating risks over long time perspectives. We seldom know much about the consequences in one hundred years from now of the decisions we make today. Hansson refers to the issue of nuclear waste as a pioneering issue, in the sense that uncertainty has not been an obstacle preventing us from taking long-term questions seriously. In Chapter 3.4, “Consequences for future generations” we return to methods and approaches

that may be considered useful for such analyses. However, it is not self-evident how to reason and what aspects to include in such long-term perspectives. The same is true to some extent of how to understand societal changes in the short-term perspective.

Researchers in the social sciences and history work with a variety of theories on the significance of unique events as well as on how to understand the course of history. While we can construct various possible explanations for sudden events in retrospect, and even observe patterns in the preceding course of events, it has proven difficult to foresee what actually did happen. It has also proven difficult to grasp what is actually going on while events are still on-going. There are countless examples of this from recent times, such as the fall of the Berlin Wall in 1989, events in the USA on 11 September 2001, and the global financial crisis that began in 2008. Even afterwards it can be difficult to reach a consensus on the long or short-term causal factors resulting in these events, as well as their consequences.

Historic development does not consist solely of these kinds of sudden and sweeping events, but above all of more long-term trends, which of course also may lead to sudden and rapid processes of change. What these trends consist of, what patterns that can be discerned, and what they signify, are all questions related to various theoretical orientations and political interpretations. The periods of time that have been analysed also vary, from several hundred years to short-term cycles or stages of development. Researchers have focused attention on processes such as industrialization, urbanization and secularisation when they have examined the history of the West in the 19th and 20th centuries. Regarding the end of the 20th century, other trends were studied, e.g. trends associated with the growth of the service sector, the spread of information technology, or economic and cultural globalisation. Social scientists and historians have studied such developing processes as well as contrary trends, e.g. it can be discussed to what extent post-industrial countries in the West, such as the US, are secularised not to mention other parts of the world.

Researchers have also examined other patterns in change processes than the linear: cyclical trends, long waves in prices, trade and investments, shorter business cycles, sudden trend breaks, and crises. They have also analysed the way different kinds of change processes occur simultaneously and at different speeds. There are, firstly, very long-term and slow processes, such as the development of capitalism since the 15th century, that are summarized e.g. in the expression “*la longue durée*”. Secondly, within the framework of such sweeping gradual change in economy, politics and culture, etc – as well as in relation to other relatively slow changes, such as the shifting of the centre of the world economy (from Italy, to the Netherlands, England, USA, and perhaps to Asia in the future) – displacements occur. Thirdly, in the course of a generation, it is possible to observe how patterns of alliances, conflicts,

wars and cooperation develop, for example within 20th century Europe. Such short-term shifts ought to be predictable in principle, but the interpretations of what is occurring often differ, and insights do not always lead to wise decisions.

Certain kinds of short-term changes have, however, more stable patterns that enable us to predict with rather high probability what will happen, based on knowledge of previous events. This concerns, for example, demographic changes in birth and death rates, which are relatively stable within the framework of overall trends. It also concerns behaviour that is linked to investments in infrastructure and other material conditions by individuals or the society. People commute if there are roads and railways between two districts; people do not move easily if they have a house and a loan, or friends and relatives nearby. It can take half a life to acquire detailed knowledge about the area in which one lives and such “insider information” is lost when one moves; it is easier to build up a business if there is a network of local contacts, subcontractors and service, etc. The reasoning may also be applicable to certain kinds of values that are relatively stable within a context of national customs, religious and educational traditions, and political systems.

3.1.2 Nuclear waste and societal changes

What can we say about managing nuclear waste on the basis of these thoughts and the projects in the Social Science Research Programme? It should be noted that the projects that discuss societal change do so within the context of current social systems rather than of possible future societies. These studies have focused primarily on opinions, values and attitudes. The analyses that were performed of development over time have shown rather extensive conflicts and changes, as well as stability regarding specific questions related to nuclear waste.

Anshelm’s study of the public debate on the nature of nuclear waste, its risks and its scientific, technical and political management shows significant reassessments and shifts of perspective over the 50 years the issue has been topical. In their international and historical study, Kaijser and Högselius indicate similar types of change and conflict in several other countries concerning the best way to manage nuclear waste. Also currently, as Frostenson’s study has shown, there are considerable differences in how various publicly active actors interpret the methods, choice of site, and decision-making processes in relation to the disposal of nuclear waste.

On the other hand, there is also considerable stability in Sweden in what can be referred to as fundamental values concerning political processes and commitment to a democratic framework. This is applicable, as Sandberg’s study shows, to both older generations and youth, that is, to the generation that will be involved in decisions about nuclear waste in the near future.

Nevertheless do the socio-economic studies assume a relatively unchanging near future with regard to the way people react to economic stimuli and employment opportunities, the way companies act, etc. These assumptions were made so that insights from previous experience would be applicable to investments in the selected municipality. The approach seems realistic.

In general it seems that certain variables – such as confidence in the democratic process and economic deliberation – have a slower and lengthier process of change. They are rooted in people's everyday experiences, in socialization patterns, and in traditional customs and material conditions. In this context, the nuclear waste issue represents only one (if any) dimension of daily life.

Other variables that connect to a political and medial public debate follow a different logic, according to which different points of view should be exposed and debated. This is certainly not characteristic of all social issues, but the issue of nuclear waste is one where, as researchers say “closure” or shutting down, has not been achieved, neither technologically, politically or socially. Views and alternative views on desirable developments are presented by various actors in the media. There exists, as Frostenson has shown, a common value basis among those who express themselves in the media. Most actors appear to share fundamental ethical values, e.g. the principle of doing no harm, intergenerational equity, and the principles of producer responsibility, and the principle of participation. But the actors differ in their views on what Frostenson refers to as “functional values”, which concern the relevance of process efficiency in terms of time, economy, and general socio-economic effects regarding the final repository issue, in relation to ethical values.

Interestingly, however, the nuclear waste issue has been largely absent from Swedish party political debates in recent times. Nord and Stür show in their study of the political and media debates since 1976 that the position of nuclear waste in the Swedish political debate can be explained with reference to an opinion-related interaction between politics and media. The nuclear waste issue was at the centre of the domestic political debate during the 1970s, but then gradually lost ground in political importance during the following decades. What can be described as a make-or-break political issue at the start of the studied period was by the end of the same period at most a back-burner issue of limited interest and had virtually been removed from the political sphere.

Provided that also future decision processes will contain institutional and legal uncertainties, as Keskitalo, Cramér and Frostenson have discussed from various perspectives in their different projects, we can expect more changes in the public debate in the foreseeable future. Also, the international dimension of nuclear waste management may become more important in the future. In this context, Cramér and associates' study of international legislation has highlighted some uncertainties. Similarly has the issue of nuclear power's future standing as an energy source, in Sweden and elsewhere, been brought

to the fore in light of the climate change discussion. This means, as we discuss in another chapter, that entirely new issues might come to affect both the public discourse and the decisions that will be taken, and which are of overall importance to societal development.

3.2 Societal aspects of spent nuclear fuel

Central to the current debate are questions related to the societal significance of how risks associated with nuclear waste are to be managed, as well as questions regarding public expenses and potential benefit of a nuclear waste disposal facility. These issues involve many dimensions, as the projects show. Not the least does the debate comprise questions of who is to define these risks, costs and benefits, and how the views are to be represented, and allowed to influence decisions, regarding the final disposal of nuclear waste.

3.2.1 Waste or resource?

Spent nuclear fuel may be a resource, from a technical perspective. It can be reused after reprocessing and partitioning. Transmutation involves a reduction of the duration when the high-level waste is radioactive, especially by converting transuranic elements into substances with shorter half-lives.

As Kaijser and Högselius have shown in their project, spent nuclear fuel is regarded as a resource in several countries. The reprocessing enables it to be reused as fuel, or used as nuclear weapons material. Internationally, the view of spent nuclear fuel as a resource is found in many countries with nuclear weapons, and possibly also in countries that aspire to become nuclear powers. Two countries, Russia and Japan, selected for comparison purposes in one of the programme's projects, have reprocessing facilities; in Russia these facilities were clearly linked to military use, and in Japan they were associated with the need for fuel in a country with few internal energy resources.

Several countries, including Sweden, have taken a very restrictive stance on recycling spent nuclear fuel, given the technical complexity of the processes and potential risks. In Sweden the idea of reprocessing as a way of reducing the amount of waste and obtaining fuel for nuclear reactors was written off in the 1980s. As Cramér and his colleagues have shown in their first project, the idea of reprocessing has been abandoned politically even if there is no stipulated legal ban against it in the Nuclear Activities Act. The definition of nuclear waste according to Swedish legislation is spent nuclear fuel that has been placed in a final repository. This means that Swedish law does not exclude the reprocessing of spent nuclear fuel from a reactor in Sweden as a resource for fuel.

Nuclear power was also questioned with respect to safety at the beginning of the 1980s. The idea of reprocessing was abandoned due to political, economical as well as technical reasons. Since plutonium is a by-product of reprocessing there is a risk of uses for purposes other than the “peaceful” use of what is often termed “waste” in Sweden. Nor was it possible to defend reprocessing on economic grounds, since it is a costly procedure, even if the price of uranium was still low in the 1980s. Cramér and his colleagues point out that reprocessing does not exclude the need for a final repository. High-level radioactive waste requiring advanced final disposal is still present after reprocessing.

Proposals for transmutation have recurred during the 1990s and first decade of the 21st century. This technology could reduce the amount of waste and also provide new fuel for nuclear reactors. The potential of such technology is much discussed. Interestingly, proposals to this effect have been presented in recent years as an argument against SKB’s KBS-3 method, which involves final disposal without reprocessing. As Anshelm shows in his study, this discussion involves a changed view on the management of spent nuclear fuel by some environmental organisations.

The same train of thought includes notions of retrievability as a reasonable criterion. Frostenson has shown in one study that retrievability is brought up as an important criterion for a repository, even among those who are sceptical toward the KBS-3 method, because it is associated with the development of transmutation technology. Some debaters assert that when the technology is available it will be possible to reuse the spent nuclear fuel. The retrievability aspect involves many diverging views. The dividing issue concerns whether or not retrievability is compatible with long-term safety, and whether it is a prerequisite for, or threat to, future generations’ freedom to act. Some arguments concern security. There is, although to various degrees, an emphasis on the risks associated with future generations’ more or less unrestricted freedom regarding the possibility of retrieving the spent fuel and using it as a resource.

Perhaps the greatest challenge for the development of civilian nuclear energy production is the need to create a regulatory framework that effectively prevents civilian nuclear activities from contributing to an increased proliferation of nuclear weapons. A project by Cramér and associates analyses how responsibility for upholding international commitments regarding non-proliferation of nuclear weapons is concretized in connection with the final disposal of spent nuclear fuel in Sweden. The most obvious problem identified in this study concerns the extent of the responsibility in time after the operating phase is over and closure has taken place. The endpoint for SKB’s responsibility will, the study argues, probably be defined by a political decision on discharge from responsibility, after which the state will assume responsibility. There is therefore a need to formulate principles for such a transition of responsibility.

This reasoning raises the question of who should be regarded as stakeholders, in the short and long-term, in the issue of a final repository. Who is affected by decisions concerning a final repository – now and in the future? The answer to the question determines whose interests the decisions should take into consideration, and who is responsible for a good solution to the problems associated with a final repository. This normative issue, the answer to which is expressed in political decisions and legislation, is often answered differently in the on-going debate depending upon the adopted perspective and whether the impact is judged to be negative or positive. Positive effects are less problematic with respect to responsibility, but may involve difficult weighing of the interests of different groups. For example, who is to benefit from positive effects on the local economy? And how is the benefit to the entire current population to be evaluated in relation to the benefits and harm that may impact future generations? In Chapter 3.4, “Consequences for future generations’ interest in nuclear waste as a risk or a resource.

3.2.2 Selection of a site

Although the local socio-economic benefit of a final repository for spent nuclear fuel was not a criterion for the selection of a site for a final repository, knowledge of the socio-economic effects was considered of interest for a municipality, and also for the nation from a regional policy perspective. For the municipality that is selected as the site for a final repository for spent nuclear fuel, the potential costs and possible benefits of a major facility are of importance. It is a matter of consequences affecting employment opportunities, the local economy and population development. A couple of the projects included in the programme studied these issue using different methods.

Andersson-Skog unveiled the limited local population effect related to new industrial developments. A substantial effect can often be observed during the construction phase and initial operational period, whereupon the effect diminishes and the population development returns to the previous trend. Population redistribution is today more related to residence preferences than to employment opportunities created by industrial establishments.

It is emphasized in Lindgren’s and Strömgren’s project that municipalities are different in terms of their overall situation, economy, conditions and already established prerequisites for a repository for spent nuclear fuel. This means that the economic effects are hardly symmetrical in a comparison between Östhammar and Oskarshamn, which Lindgren pointed out in his study of the possibility for local contractors to supply goods and services to the construction of a nuclear waste facility. The socio-economic impact was expected to be sizeable in Oskarshamn, if Östhammar was chosen as the site for the final repository (as became the case), whereas the effects in Östhammar would be very limited if the repository were to be located in Oskarshamn. All in all, the

analyses indicated that the various parts of SKB's final repository programme could provide a substantial, valuable and rather lasting contribution – though different in size – to the economy, employment and population of both Östhammar and Oskarshamn.

It must be added, however, that the major part of the economic effects of the final repository and its annex facilities will end up outside of the municipality where they are located. Thus, it is primarily the smaller local effect that is adjustable. Other relevant national and international contractors, specialists, consultants and suppliers will remain where they already are. They have an obvious interest in the realization of the construction of the facility, but it is of relatively less importance to them, as well as to the national economy and employment situation, if the localization is Östhammar or Oskarshamn.

Beyond the question of “conventional” local impacts of the now settled location issue is the societal, industrial and local effects of how the project of establishing a final repository is organized in detail. That is the target area for a second study by Frostenson. He emphasizes the importance of one novel feature in the siting process chosen by SKB and its owners, i.e. the “surplus value agreement” that was negotiated with both the municipalities of Östhammar and Oskarshamn before the location was decided. The main points of the agreement were that both municipalities should receive additional funds for local developments but more so to the municipality that did not get the repository, 1.5 billion SEK compared to 0.5 billion SEK. Frostenson claims that this is one example in a set of “contextual organization” efforts that puts the case apart from the mainstream industrial project. He concludes that this is observed in terms of a deepened actor relationship between SKB's owners and SKB on the one side and the municipalities Östhammar and Oskarshamn on the other. He claims that in spite of active organizing, the final repository arena “narrows down” and the final repository issue turns into a local issue in many respects, and furthermore that there is a clear tendency that SKB's roles are multiplied in order to handle the demands that central stakeholders – in particular the municipalities – place on the organization in relation to the final repository project.

Several studies have discussed views of the residents of the municipalities in question regarding the costs and benefits of a final repository. On the basis of several questionnaires, Sjöberg has pointed to a major difference between Oskarshamn and Östhammar on the one hand, and the country at large on the other. In the first project, Sjöberg showed that benefit was judged to be much larger by people in the site investigation municipalities compared to the rest of the country, but that the difference was smaller regarding risk assessments. The benefit was viewed as somewhat greater by older persons than by youths in both municipalities. In addition, it is conceivable that residents of a nuclear power municipality that also already has the interim

storage facility (Clab) would view a final repository as an improvement over a continuing interim storage. The argument that Clab is a temporary step, not a final repository, has been voiced in discussions and served as one of the explanations for local acceptance in Oskarshamn.

The second project led by Sjöberg, which compared attitudes toward a final repository for spent nuclear fuel of youths to those of older persons, again showed that residents of Östhammar and Oskarshamn perceived the benefits to be greater and the risks as smaller than did respondents in a national sample. The results also showed that different explanatory factors emerged from the analyses that shed light on differences between men and women, between age categories, and between the two site investigation municipalities. Differences between the combined sample of the two site investigation municipalities and the national sample were primarily related to information, employment in nuclear industry, and attitude toward nuclear power. The minor difference of attitude toward a final repository between Oskarshamn and Östhammar was explained foremost by information, perceived influence and attitude to nuclear power. The latter result seems, according to Sjöberg, be related to a higher penetration of SKB's information in Oskarshamn than in Östhammar, and that residents in the former municipality perceived that they had a greater possibility to influence the municipality's way of handling the issue.

Johansson and Lisberg Jensen interviewed residents of Östhammar and Oskarshamn regarding their image of their local community with or without a final repository. The majority of the interviewees expressed a very positive attitude toward receiving a final repository to their home municipality. Socio-economic opportunities for the municipality played a major role in this attitude. They expressed the importance of bringing people with high qualifications and education into the municipality, people who would share their experiences and who could contribute to the development of the community in various ways – professionally, politically and socially. An establishment might also be accompanied by a rejuvenation of the age structure in the municipality.

Improved infrastructure and the increased international significance of the municipalities, including the potential for advanced level research, were also brought up. Others referred to the economic “hey-day” when the construction of the nuclear energy plant vitalized the municipality, its cultural and social life, and generated new ideas and competencies. This was associated with a construction boom and an expansion of related industry.

On the other hand, many sceptics expressed doubts about this enthusiasm regarding the effects of a final repository, arguing that it was based on far too short-sighted notions about the benefits to the community. Several suggested that the enthusiasts had not considered the matter thoroughly enough, or that they were overly optimistic about the ability of a final repository to

bring about the same economic boom as the establishment of the nuclear power plant. The important peripheral economic effects of the project were expected only as part of the construction and operation phase, but not as long-term effects. They also believed that the effects would not be so strong, since the municipality did not have the required competencies, and thus people would have to commute in from other municipalities.

A cost that was brought up in Johansson's and Lisberg Jensen's study was that in the future, when the nuclear facilities were closed, these could no longer be seen as tourist attractions, and the municipality would stand out as just a huge atomic waste site. Such a development would ruin the image of the municipality. It would be stigmatized, and for example find it difficult to sell products grown in the area and that people with negative attitudes would want to spread rumours to this effect.

The images of socio-economic advantages that were brought up by residents of the municipalities were thus not unlike those shown by the socio-economic studies performed within the research programme referred to above. Vitalizing effects, possibly short-term, were envisioned along with the prospect that the municipality did not have all relevant competences; neither would be able to attract the moving in of such resources.

These studies have taken into account the local situation and the residents, organisations, authorities and companies of the municipalities involved. However grossly simplified, it is possible to assert that they provide an overview of interested parties who may have a specific stake in the selection of a site for the final repository. This leads, in turn, to a discussion of the nature of the decision-making process as elucidated by some projects.

3.2.3 The character of the decision-making process

There is commitment and knowledge concerning nuclear waste issues in the municipalities that are directly involved. There is less interest nationally, especially in recent years when, as Nord and Stúr have documented, the issue has changed from being extremely important in the 1970s in the political debate and the formation of governments, to having a marginal role in the first decade of this century as an issue of political debate. They attribute this development to the mutual reinforcing influences between media and parliamentary debates. Current lack of national interest has also been shown in Egan Sjölander's study of media coverage of the nuclear waste issue. During the period of the study (2001–2005) there was greater local than national coverage, as well as strong variations over time. The material also varied widely in terms of content. Local media focused on local events and plans, such as the site investigations and SKB's other activities, while the national media covered mostly policy issues related to the debate on nuclear power or method of final disposal, as well as an occasional fictive account associated with risks.

Egan Sjölander's material also revealed differences between local and national media with respect to who was actively contributing regarding the nuclear waste issue. Local contributions originated mostly from politicians, environmentalists, citizens and industrial representatives, while the national media contents were dominated by lead editors, active individuals and experts. The result raises questions as to how different opinions are expressed and where they are expressed, and how much leverage is given to different kinds of actors to form an opinion and influence decision-making.

The consultation process that had dominated the nuclear waste issue until SKB chose the site for the repository had involved primarily local and regional stakeholders in relation to the site investigation municipalities. Since the beginning of the 1990s SKB has worked on the basis of a model that includes extensive information and with a focus on the need for the municipalities themselves to determine whether or not they want to be considered as candidates for site investigations. The process that followed if municipalities expressed an interest involved a number of consultations. The consultation process can be viewed as an opportunity for extensive learning, and is regulated by Swedish and European legislation. It is a process that enables the local population, politicians and organisations to obtain considerable knowledge and influence through participation in the consultations and other sorts of involvements prior to a decision on a complex and controversial issue. A couple of projects in the Social Science Research Programme have focused on specific lessons from these processes, as well as on what can be learnt in general about how to obtain the intended participation and transparency of an Environmental Impact Assessment (EIA) process.

These research projects show, on the one hand, that many useful lessons have been learned along the way that can be disseminated to similar sorts of decision-making processes. On the other hand, there are those who believe that the process has been and continues to be fraught with deficiencies, and that the process is defined and altered depending upon the participants. Several projects discuss these issues. Frostenson has analysed various opinions about the consultation process expressed by those directly involved. Their views are related to current laws and ordinances, and comments by participants either express openness and sensitivity to the critical views that have surfaced (according to SKB) or point to a democratic deficit (according to critics). The latter criticize deficiencies in current rules, e.g. that SKB is the organiser of the consultations, the design of the consultations, and the perceived passivity of several instances. Lidskog and colleagues, as well as Keskitalo and her team have also discussed these issues in their respective projects on the basis of analyses of how the consultations were performed, by observations, documentation and interviews, and they too present the afore-mentioned multi-faceted picture.

Taken together, however, the projects show that – despite different opinions in factual matters, at times strongly divergent opinions regarding how the process actually evolved, as well as how it should be – there was significant local dialogue between various interest groups, organisations and citizens, as well as an extensive build-up of knowledge on the content and significance of the issue. This can be considered an important benefit to society that has been developed in the course of a long process and with significant contributions from many stakeholders.

The consultation process, as well as the subsequent decision-making process, raises questions of a more general nature regarding decision-making in projects that involve major costs and perception of major uncertainty, and that are of major significance to society in the short and long-term. In addition, the nuclear waste issue is complicated by the fact that future generations also have an interest in the safe handling of waste. Hansson's project has broadened the perspective, from the specific and current matter of nuclear waste management to decision-making that concerns long-term risk management in general. Various kinds of environmental problems, destruction of cultural heritage and changes to the infrastructure may lead to the loss of value for future generations. Hansson highlights two traditions of thought that are used to evaluate possible results or outcomes in the future, namely discounting and the sustainable development principle. We seldom know much about the consequences in one hundred years of the decisions we make today. Hansson views the issue of nuclear waste as a pioneering issue in the sense that this uncertainty has not prevented us from taking long-term issues seriously.

When the issue is transferred from the municipalities to national authorities and the Environmental Court for review of SKB's applications, other players will dominate the scene and discuss both short and long-term issues. At this point, questions of a possible lack of clarity, and potential contradictions in governance, will become especially interesting, which has been brought up in Keskitalo's project, as well as in projects by Cramér and associates.

Cramér's study, "Responsibility at the end of the nuclear fuel cycle – A legal perspective", shows that due to parallel regulation – both the Nuclear Activities Act and the Environmental Code – at a national level, there are certain risks of overlap and contradiction, not least as regards conditions governing environmental responsibility as well as nuclear safety and radiation protection. There is thus a potential risk that parallel review and parallel regulation may lead to a lack of clarity that affects the very legitimacy of the licensing decision. Likewise, the international aspects of nuclear waste management can become more critical in the future.

Whether the repository for spent nuclear fuel is discussed on the basis of the narrower focus of site selection or from a broader perspective, the question remains of how the real and potential influence of various groups on future decisions to be made shall be understood and organised. It is of interest and relevance, both with regard to the nuclear waste issue and in light of decisions on other important political issues, how the relationship between parliamentary rules of democracy and other forms of influencing decisions will evolve. In a functioning democracy there should be a discussion about, and a clear procedure for, how “deliberative” forms of influence can be reconciled with the rules and functioning of representative democracy. These are issues that are important in all political life and not only in relation to the nuclear waste issue.

3.3 National and international opinions and attitudes

How people perceive risks associated with nuclear waste, their attitudes to various alternatives and to the design of the decision-making process are central to the management of nuclear waste. Several studies within this programme have investigated these topics, using various methodologies.

The concept “attitude survey” refers to many different kinds of studies. In ordinary language it means the kind of studies where people’s opinions and views are expressed. For example, when an evening paper asks five persons on the street what they think about the selection of programs on Swedish Television the approach falls within the common understanding of the concept, although the approach does not at all correspond to the demands placed on scientific research using the same concept. Scientific work with attitudes embraces several different perspectives, depending upon exactly what is being studied. It involves for example, opinion surveys, studies of specific consumer groups, and studies of how attitudes develop, how they are influenced, and what constitutes an attitude.

The ordinary aim of opinion surveys is to describe the distribution of different views or preferences, e.g. regarding political parties, within a well-defined group of people, e.g. people who are living in Sweden. This kind of study seeks to generalize the results to the entire population that was targeted. For this reason, the way respondents are selected is highly important. Respondents must be randomly selected from the entire group in question in such a way that each person in the group has the same probability of being selected. In countries that have personal identity numbers or similar registers of citizens this requirement is not a problem, since a randomly selected group of the desired size, and for example within a certain age interval, can be obtained

together with address labels. In countries that do not have a comprehensive or available database of the entire population it is, of course, impossible to fulfil the requirement of a random selection of the entire population. In such cases other techniques are applied, such as a “stratified” selection or “panels”, whereby the composition of the respondents or participants is made up on the basis of known population data or of people who have consented to participate in the study. The selection process and the extent to which those who were contacted actually participated in the study have a bearing on whether the results can be generalized to the larger group in question. If there are major weaknesses in the methodology then the results will not be reliable and cannot be used for prognoses, for example. Without going into the technical details of these different methods, we would like to make it clear in this context that the primary purpose of opinion surveys is usually to map the distribution of different views and preferences. Thus results from such studies can simply be presented in percentages in various tables that also present the specific questions asked.

Those who work with preferences among various customer segments, for example, can obtain information in a similar way about the kinds of products or goods that consumers want to purchase, what they are prepared to pay and the best way of making the product or service available. In the field of marketing studies are often made of well-defined consumer groups, defined e.g. on the basis of income, age, gender and profession. The purpose of such studies is to compare or calibrate the relationship between product and consumer. On this basis can targeted advertising or information be developed.

The examples above illustrate surveys or research where the purpose is to map existing opinions and their distribution in the selected group. In attitude research, however, the focus lies on understanding how attitudes are developed, influenced and changed, as well as how the attitudes are related to behaviour. It is possible to map the distribution of people’s attitudes and preferences without any understanding of the origin of the attitudes, the way they change or what impact they have. Furthermore, to have an opinion does not necessarily mean that behaviour or actions are congruent with the opinion. It is far from impossible to say one thing and do another. For this very reason, a major field of research has developed over decades aiming at a better understanding, and measurement, of how attitudes are formed and how the relationship between attitudes and behaviour can be reliably analysed. The main practical interest usually lies in what people do, e.g. which political party we actually vote for or what choices we make when we shop, than in what we express verbally about these matters.

The available theories of how attitudes are formed, etcetera, are used by researchers as the bases for collecting data and testing the validity of theories. The purpose of this type of study may be to examine the relationships between various factors. Today there is broad agreement among researchers that attitudes consist of values as well as beliefs. In the context of nuclear waste management, for example, if we believe/think that spent nuclear fuel will actually seriously harm people to a great extent, then it is probable that we also evaluate spent nuclear fuel in an extremely negative way (assuming, of course, that the importance of not harming people is a fundamental value we hold). This type of studies focuses on intra-individual mental processes and investigates relationships between thoughts, experiences and feelings within the individual (and a study includes a large number of individuals). They aim at investigating the relationships, as well as cause-effect relations, between various psychological and behavioural processes that can be conducted in laboratory experiments or through different kinds of qualitative (e.g. interviews and diaries) and quantitative studies (e.g. questionnaires).

Within the Social Science Research Programme, Annika Egan Sjölander attempted to shed light on both frequencies of various types of contents, and to classify the contents, of the media output related to the work with the Swedish final repository, and among other results presented the views that were voiced, locally as well as nationally. The projects led by Thorleif Petersson, Magnus Frostenson and Per Johansson did primarily attempt in-depth studies of what people value and hold true. Pettersson, who made use of data from the World Values Survey that included information collected from 24 countries, showed that the views of Swedes appeared to differ systematically from those of people in other parts of the world, in that Swedes' show high scores on the dimension referred to as "willingness to change and secular-rational values" and on the dimension "emancipative and self-transcendent values". Frostenson reported on the interesting phenomenon that those who were more active in the discussion about the planned final repository appeared to have common fundamental values in the exchanges that could be studied, but that they differ when it comes to assessing the relevance or consequences of these values. The principle of not causing harm is an example of such a shared fundamental value. Differences can be demonstrated, however, when this principle is "translated" into actual choices or practical action, e.g. regarding the design of a final repository or its long-term maintenance. Johansson and Lisberg Jensen studied people's conceptualisation of their local community, the present and the future by focusing on "meaningful mental images". In the results, the researchers emphasized the significance of the time dimension and pointed to an immediate and more "concrete" time and reality experience compared to the inconceivably long periods of time that are brought to the fore in the planning of a final repository for spent nuclear fuel.

Other research has shown that our attitudes are strongly influenced by our own experiences and knowledge, and that it does not require especially long periods of time or major changes before our experience of uncertainty and alienation make us careful and even afraid. Uncertainty and fear create an unwillingness to make decisions and reinforce wishes or active attempts to rid ourselves of unpleasant experiences. Ways of overcoming such experiences include distancing ourselves (physically or psychologically), and ignoring or trying to forget what is conducive to the negative experience.

The afore-mentioned projects have thus contributed to a better understanding of attitudes and their concrete content relative to the current planning of a final repository for nuclear fuel. Pettersson described Sweden, and the young and adults, in relation to value dimensions and 24 other countries. Johansson and Lisberg Jensen in their project the experienced content in the opinions and attitudes conveyed by respondents in the site investigation municipalities. Frostenson used argumentation analysis in order to penetrate beneath the surface of general attitudes and was able to show that many different and important considerations take place on the levels between fundamental values and general outlook.

Lennart Sjöberg's two projects have encompassed several areas of attitude research. Separate data collections in two projects have provided the distributions of perceptions regarding a Swedish final repository for spent nuclear fuel based on random, representative samples from the two respective site investigation municipalities, as well as the nation. This has made it possible to compare the two municipalities with one another as well as with the country at large, and provided a possibility to investigate attitude change across time (although over few years). In his studies, Sjöberg has also included analyses enabling the study of what factors have formed the expressed attitudes. In addition, he has studied what underlying factors that can explain, as well as be used to foresee or predict, the attitudes that were expressed in various groups. Of special interest are, perhaps, the results that show the importance of information for the (positive) attitude in the site investigation municipalities. The significance of information and knowledge was also clearly evident in the same project's interview study with youths in the municipalities, and in the country at large.

Together these projects have contributed results and information on different phenomena of relevance for a better understanding of our time. We want to emphasize that this kind of research is largely applied research, which means that it gives a current picture rather than lasting truths. Unlike much of basic research, applied social and behavioural research have a "best before date", which is that the most correct picture is obtained from current research in a changing world. This does not mean that the results that are presented here are not reliable, but it means that e.g. attitudes can change relatively quickly.

3.4 Long-term consequences and social context of a repository for spent nuclear fuel

The final issue that we would like to discuss in this context concerns what significance should be attributed to the situation of unborn generations as compared to that of the current population. This question has been addressed in several contributions to the Social Science Research Programme. Hansson discusses possible approaches to the difficult problem of comparing utility and risk for different individuals separated by long time spans. Frostenson discusses the value premises that motivate the principle of responsibility for future generations. Johansson and Lisberg Jensen examine the way people relate to different time spans classified as present time, disposal time and final repository time.

There are several reasons for drawing attention to consequences for future generations of the repository for spent nuclear fuel, especially on the bases of the long duration of radioactivity and the principle of responsibility for coming generations. These reasons are here discussed briefly, followed by a text discussing possibilities and difficulties, regarding the principle of responsibility for coming generations, whether it is at all possible to say anything about consequences in the excessive time perspective that is motivated by the duration of ionizing radiation.

The duration of radioactivity is more or less the only aspect of the future impact of the final repository that is posited as a problem when it comes to taking responsibility for future generations. It is often asserted that it is the very long-term effect that is unique for nuclear waste. What is unique, however, is not the scope and significance of the long-term cumulative effects, but that we in this specific case happen to be knowledgeable of the content of the long-term effect. The radioactivity and its specific risks are incontrovertible and uniquely long-term with respect to predicting future levels. "The danger will have been reduced by approximately a factor of ten at the time of the disposal compared to the situation one month after its use in reactor operation is terminated. It will continue to decrease by approximately a factor of ten for every tenfold passage of time. After approximately 100,000 years the danger of spent nuclear fuel will be comparable to that of the natural uranium ore that is used to produce the fuel" /18/.

3.4.1 Responsibility for future generations

One condition for regarding coming generations as stakeholders in a final repository for spent nuclear fuel is that someone who is alive today cares about it. This means that "after us, the deluge" is not the predominant planning principle, but instead that "we" are prepared to take the well-being of the future population into clear consideration in today's investment decisions.

The important moral issue is presumably not if present generations are responsible to coming generations for solving the issue of nuclear waste, since most people probably would answer that question with a normative yes. The important question is rather how far this responsibility should be extended in terms of resources, compared to investing the same resources in other issues that may mean more to present and future generations.

The sacrifices made today for future generations can be seen as an extension of the responsibility we take for the first of these future generations, our own children. Most societies and families are prepared to take a far-reaching responsibility in this manner, both in terms of time and other resources. The overall scope of the population's total "investment" in its children (in the home, schools, infrastructure, higher education, etc) may provide an indication of the maximum level of the additional responsibility we are prepared to take for the welfare of all generations to come.

In his project Frostenson brings up some fundamental principles applicable to the issue of the repository for spent nuclear fuel: The principle of fairness, which can be understood to mean that unjust burdens must not be placed on one who has not been able to benefit from a specific activity; and the principle of autonomy, which concerns self-determination and the freedom to act (e.g. between generations). The principle of utility, which states that an act is right if it produces at least as much well-being as an alternative action, stands a bit apart.

Of these principles, the principle of autonomy is the one that most directly deals with the responsibility between generations and provides a sort of framework for the possible meaning of responsibility. Maintaining freedom of action between generations can be interpreted to mean that the present generation must not perform actions that limit the freedom of action for subsequent generations. Similarly, one can argue that present generations should not fail to carry out acts necessary for preserving the freedom of action of future generations. Like all other general principles, the principle of autonomy does not mean much until its significance is put to the test in concrete terms, i.e. beyond the demonstration of goodwill and correct core values.

The significance of the autonomy principle has no clear implications on acts until the question is answered: What freedom to act should not be restricted, in relationship to what and for whom? Is it a question of natural resources as they were before the human being appeared on the scene or about economic and social resources relative to the previous generation? Such comparisons with a frozen cross section in time are nearly always absurd. Everything changes over time, positively and negatively in different proportions for different people. By virtue of its own power, nature too can undergo negative

change without human intervention. A more reasonable basis for assessing a possible restriction of the freedom to act would be to simultaneously make a comparison with an alternative scenario, indicating the change that would have taken place if some previous potentially restricting activities had not been carried out, i.e. a contra factual scenario. An example is the act of replacing olive groves along the Mediterranean with citrus groves that require irrigation and such deep wells that groundwater becomes mixed with salt water.

The discussion of possible constraints imposed on future generations should be linked to specific concrete actions of today. Furthermore, the partial effect of such actions/measures on future freedom of action should be assessed. Otherwise, it's hard to know whether a perceived restriction on freedom of action in the future could have been prevented with the help of acts that the present generation has the power to do, or if the restriction is determined by inaccessible drivers and would have occurred anyway. In addition, there is the impact of all the system dependencies that enable the essential effect to occur in another area than where one believed that there would be a restriction of the freedom to act. The limitations imposed on one person can be a prerequisite for the freedom of another and vice versa. The penetration of salt water after citrus cultivation may have destroyed far more cultivated agricultural areas than those occupied by the original olive groves.

3.4.2 Consequences for future generations

In a chapter in the 2008 yearbook /9/, Sven Ove Hansson effectively demonstrates that conventional methods of comparing values at different points in time, e.g. interest on interest, only work on a very short-term basis. Given time horizons beyond a generation, the consequences of all discount rates above zero per cent becomes absurd. But zero per cent does not work well in the long term either – over the many generations that correspond to the duration of radioactivity in the final repository – which covers thousands of generations. For every human being who is alive today there will be at least 1,000 people who have lived on earth over the next 100,000 years, even if the total population were to remain unchanged. If we have the same responsibility for each and every one of these future human beings (zero per cent discount on “human value”) as we have for our living children and ourselves, then 99.9 per cent of the results of our work would have to be set aside on account of future stakeholders. Inversely, a maximum of a thousandth of the resources we put into safety and risk reduction, for example, would be left to reduce the risk to ourselves and our children; the rest would have to be reserved for our 1,000 future descendants in order for them to receive equally as much risk reduction per person – from us.

This problem is often “solved” with the help of an implicit, not outspoken prerequisite for the principle that “the current generation must not act in such a way that it limits the freedom of action of subsequent generation”. That prerequisite is to say that what is “preserved” (water, air, land, forest, species, knowledge, fixed capital etc) for the next generation is then automatically preserved unchanged also for all subsequent generations.

Another sometimes-implicit assumption is that all depletion of resources is irreversible – that resources cannot be regenerated. This is applicable in some cases: it is not within human power to regenerate lost species, depleted biotopes, minerals or uranium ore from radioactive waste, for example. The value that is currently attributed to the preservation of species diversity is thus a value that inevitably is assigned also to all future generations without consulting them.

The problem is that this notion of preservation sometimes also is applied to all resources/investments for the future that both can and must be regenerated in each generation. Land use and ground cover can often be returned to a state that is very similar to a previous state. The wish to preserve is in practice often not about a return to some sort of natural state, but about the preservation of the use of land or resources that was prevalent two generations ago, and which is currently considered especially valuable. The major portion of the resources that can be considered valuable in order to secure the freedom of action of future generations not only can, but must, be regenerated, otherwise they will disappear.

Buildings, infrastructure, machines and facilities for water supply that are not maintained or rebuilt are soon useless. The accumulated knowledge gained from research must be recaptured and reproduced by every generation through investments in education, both in order to be expanded by new research and to continue to effect the development of society – otherwise it will be lost, in practice it would be almost as if the knowledge had never been created.

Regarding the latter resources it is not reasonable to burden the present generation any responsibility that extends further than to the next (children’s) generation. After that there are no others than those living in the future who can do what is necessary to maintain, reproduce and make new investments. The scope and focus of these endeavours is something the current generation ought to leave for them to determine. This they will do in any case regardless of our ambitions to influence their life and environment.

Thus it is only with regard to resources that are irretrievably lost (e.g. species, minerals) or which inevitably and unwontedly remain (e.g. radioactive waste, global warming) that it is meaningful to discuss responsibility that extends so far into the future. As Hansson demonstrates, each devaluation of current responsibility now per capita for increasingly distant future generations is

totally arbitrary. Why should the importance of the risk that a grandchild is exposed to dangerous radiation be assessed as a hundred times greater than the importance of an equivalent risk to his/her descendants one hundred generations later?

As discussed above, the principle of equality (i.e. zero discounting) for each future generation is more ethically acceptable, even if it can easily create an unreasonable burden for the present generation. In the unequivocal case – where the problem and all the benefits of the project are created within a single generation, though inevitable and negative consequences extend over thousands of generations – it is difficult to circumvent this absolute principle of responsibility.

Substituting risks with utility is not just expedient, but necessary for most human activity even if it is seldom done explicitly. Instead, the choice is often simplified to a rule of thumb whereby a certain level of risk is considered acceptable regardless of the level of benefit. Two circumstances make the exchange of risks for benefits particularly dubious in the case of a repository for spent nuclear fuel.

Firstly, it is possible to consider that an informed person who is alive today can be responsible for choosing between one act associated with high risk and high benefit and another act associated with less benefit and risk, if other people are affected as little or as much by the choice. It is inevitable however, that 99.9 per cent of all stakeholders in a final repository over a period of a thousand generations are neither informed nor consulted. Thus it is simpler not to ascribe a benefit to them that nobody knows if they will apprehend, but instead to choose a level of risk that is so low that it can be applied even if there is no benefit.

Secondly, the benefits in terms of employment opportunities, income, lower energy prices and less global warming diminish over time considerably faster than the radioactivity. Such values are discounted to zero long before the risk for future generations who have not been consulted is over.

This reasoning points toward a conclusion similar to the one that has guided the final repository programme, i.e. that a level of risk close to zero for at least a thousand generations should be attempted attained. In the next section, we discuss yet another societal aspect of the risk of exposure to ionised radiation from a Swedish final repository in the distant future. How many people may be exposed to such radiation and when? It may be significant in the assessment of the risk to future society and people if none, a few, or approximately as many people as today may be exposed in every generation. Another factor of relevance to the assessment is the extent to which these future individuals can be expected to have the resources to discover and to protect themselves from the radiation.

3.4.3 The distant future

Several contributions to the Social Science Research Programme state that it is impossible to assert anything at all about a society that may exist in a hundred thousand years from now, apart from the level of residual radiation in the final repository. Claiming responsibility for the radioactivity that people may be exposed to in 50,000 years, presupposes implicitly the existence of a concomitant society in which someone can be harmed by ionised radiation from the final repository. Can anything be said about such an assumption that is more than a pure guess? The various scenarios produced in conjunction with the safety analyses for the repository indicate that it is possible to say quite a bit about climate, geology and nuclear physics. Since the laws of nature do not change quickly it is also possible to draw conclusions about faster biological, chemical and physical processes, such as radiation and water penetration etc, well into the future.

It seems preposterous to say anything about human societies in hundreds, thousands, tens of thousands or hundreds of thousands of years into the future, given the enormous change in the prerequisites for human life, organisational forms and artefacts that have come about in the last hundred years alone. In Chapter 3.1, “Societal change processes”, several examples of dramatic social change were presented – changes that few were able to foresee even ten years prior, but that were viewed in retrospect by all the more people as nearly fated occurrences in the course of history. Other relevant societal changes are more continuous and gradual over the centuries, but are still difficult to predict for a future extending beyond a generation.

As discussed in the chapter “Societal change processes” above, all human organisational change is not so transient. The basic demographics follow life expectancy and thus it is possible to say quite a bit about age distribution in 50 to 100 years. The large-scale structure of human settlements changes very slowly since most people wish to continue to live where they are, often in the vicinity of parents and children. Most “insider advantages” related to place knowledge, work, and social relations are lost if moving far away. The relative geographical population distribution changes mostly by local/regional urbanization and suburbanization (population growth in the hinterland within commuting range and relative decline in the urban core). Cities grow in places where they were established as trading sites a thousand years ago or so.

What is most difficult to foresee is exactly where and when major or lesser events will occur, e.g. which towns will grow and where. It is much easier to predict that an event will occur within a given period of time and within a major region (towns/cities usually grow) on the basis of structural trends. Important aspects of the climate can be predicted years ahead, but not the weather on a certain day. Nonetheless, in ten thousand years all organised societal life can change dramatically if basic conditions for human needs change

radically. The fragments of the future that could possibly be foreseen in a thousand years still cover only a small fraction of the time that is relevant in terms of the duration of radioactivity in the final repository for spent nuclear fuel.

It may be possible to make some progress by heeding the statement that the prerequisites for human life are affected by more than the desires, culture, knowledge and experiences that have been generated over the last thousand years. The human being is also a biological, chemical and physical being. *Homo sapiens* is a relatively recent species, not older than a glacial cycle. The most recent, the Weichselian glaciation has lasted approximately 120,000 years. During that period the selection process has made some changes, but we have essentially the same genome as the first human being. We cannot possibly know if there will be people at all e.g. in the Swedish municipality of Östhammar in 50,000 years given the likelihood of a considerably colder climate and glaciation during an interim period. Nor can we foresee exactly what the social organisation, infrastructure, technology and consumer patterns will look like, yet it is not unreasonable to assume that the needs and wishes that drive these distant relatives are approximately the same needs and wishes that drive us today.



4 Final comments

In this publication we have highlighted some of the societal issues that are relevant in conjunction with a planned repository for spent nuclear fuel and upon which SKB's Social Science Research Programme is intended to shed light. We have also indicated some important results of the research supported by the programme between 2004 and 2010. In conclusion, we want to return to some themes brought up in the introductory chapter. How can the programme be assessed and what remains to be done? We address three aspects of the programme: its character, quality and content. We then wind up with some reflections on the need for further research.

4.1 Programme character – applied research with both breadth and depth

A central aim of SKB's Social Science Research Programme is to generate a broader knowledge basis for decisions concerning the possible impact and societal problems associated with nuclear waste. A sector oriented research programme of this kind nevertheless has a more limited focus than what a programme within, for example, the Swedish Research Council or the Bank of Sweden Tercentenary Foundation would have. Such sectorial research implies a clearer focus than most research council funded research.

One can ask, as we did in the introductory chapter, why state research councils and agencies have not created their own major programmes to fund projects in such an important area as the societal dimensions of nuclear waste. Such programmes would have offered a complement to the research initiated by SKB. This has not, however, been the case. Nor has the field been singled out as a particularly important area for study in current government research propositions. As a consequence, a major portion of our knowledge pertaining to the nuclear waste issue in Sweden from social science and humanities perspectives has been obtained through SKB's Social Science Research Programme, even though there are a few research projects funded also by other sources. Thus, it is fair to claim that without SKB's funding there would have been much less research conducted in this important area. It is also reasonable to assume that a financial contribution of the same magnitude as the SKB programme, if it had been included in the budgets of the state research councils, would not necessarily and continuously have gone into social science research related to the final disposal of nuclear waste. For these reasons we believe that the Social Science Research Programme meets an essential need for research targeted on this specific issue.

Accordingly, SKB's programme involves applied research of relevance for the work to dispose of Sweden's spent nuclear fuel in a final repository. Broad issues concerning Swedish national nuclear power, energy, safety or environmental problems may be included in the projects, but are not their primary focus. Instead, the research funded by SKB must have a clearly stated relevance for the nuclear waste issue. The requirement that the relevance of the research should be clearly expressed does not mean, however, that the perspectives, methods and results involved in the projects are steered from the outside.

Applied research is not uncritical research. Several projects and contributions to the programme yearbooks contain argumentation and results that can be considered clearly critical to phenomena, decisions, actions and central players in the field, not the least to SKB. Other contributions can be seen as more in line with the current Swedish policy for developing a final repository. Within the Social Science Research Programme and the Social Science Advisory Group our task has not been to assess or weigh arguments for or against the choice of a specific site, method or political decision. Nor has our assignment been to govern researchers' choice of approach to their projects or their interpretations of results.

A central task of the Social Science Research Programme is, however, to secure that relevant research is actually conducted and presented publicly. That includes the broader public as well as decision-makers – and involves the programme's yearbooks, project reports and publications, that are also available via SKB's website – and the research community, in the form of international scientific journals. Publication and dialogue are not ends in themselves, but necessary tools for the development of broad perspectives, new insights and good solutions. For this reason we are pleased to note the interest with which the programme has been received by the research community, and not least by public authorities, municipalities and various organisations. The meeting arenas that have been arranged within the framework of the programme have served as quality control as well as sources of inspiration.

4.2 Programme quality and the work of the Scientific Advisory Group

The work of the Social Science Advisory Group has been conducted according to criteria of scientific quality and subject matter relevance. We have strived for an open dialogue with researchers and for including projects within a broad area of research.

Calls for proposals have been announced annually and been widely disseminated to all universities and research institutes in the country in order to reach as many interested researchers as possible. Based on short research suggestions, a number of project ideas were selected each year to prepare

a more thorough proposal and the possibility obtain a grant for 1 to 2 year projects. There has been no lack of good applications; however, the overall prerequisites have been such that it has been possible to award grants only to the very best studies in the most central fields of research.

The Social Science Advisory Group has specified a number of criteria for the assessment of the applications:

- The research projects should focus on questions that relate to SKB's mandate to manage and dispose of Sweden's spent nuclear fuel. They should contribute to the knowledge base for future decisions by SKB and by the municipalities involved in conjunction with a final repository for spent nuclear fuel. The research projects should also broaden perspectives and enhance knowledge regarding the nuclear waste issue in general.
- The aim, problem area, work plan, method and expected results of the projects must be clearly described. The expected results should be relevant both to the field of research and to SKB. The project budget should be reasonable and realistic. Applied research has priority. The research must be of high quality and based upon the scientific "state-of-the-art" in the respective research areas.
- Participants in the Social Science Research Programme must be highly scientifically qualified, have a good knowledge of SKB's work, be familiar with the background and content of the process of establishing a repository for spent nuclear waste in Sweden and be updated on the current situation in SKB's final repository programme. Unlike research conducted with funds from public research councils and foundations, the projects funded by SKB are more clearly applied research. They must, of course, also be of high scientific quality in order to be relevant for funding from SKB.

Apart from the assessment of the scientific quality and relevance of the applications, the Social Science Advisory Group has also been responsible for a regular follow-up of on-going work. This has included comments on the projects' progress reports submitted every six months. These reviews concerned matters of a practical and financial nature, not scientific assessments.

The Social Science Advisory Group has also entered into a dialogue with the researchers funded by the programme in conjunction with the yearbooks and the final reporting; this has been done in order to facilitate the clear and effective communication of the results. It has been assumed that the project results would lead to scientific journal articles, subject to peer review according to the usual academic procedure. In addition, SKB's Social Science Research Programme is also reviewed, by the Swedish public authorities in conjunction with their review of SKB's Research, development and demonstration (RD&D) programmes. The quality and relevance of the projects has also been subjected to scrutiny during various open seminars, organized by SKB or the universities involved.

The researchers who have been awarded grants were expected to convey preliminary results to target groups during the project work. The contract also included participation in seminars and meetings where decision-makers and other interested parties took part and reviewed the findings of on-going research. Presentation seminars of this sort – with representatives from public authorities, SKB, municipalities, environmental organisations and the research community – have been held each year since 2004. Information about the projects is also published routinely on SKB's website, as well as the final reports.

We believe that the Social Science Advisory Group's work methods have functioned in a satisfactory manner, though work has been intensive periodically. The dialogue with the researchers has generally been perceived as stimulating by both parties. Through the internal and external seminars it has been possible to build up a network of contacts that included all the researchers who were involved; this has enabled an accumulation of knowledge within the Swedish research community and facilitated future research efforts in the area. In consequence, there exists today substantial specialisation knowledge related to SKB's work in various research groups throughout Swedish universities and colleges.

It should be noted that initially the Swedish research community with competence in the field was relatively small. The SKB programme and the researchers work may have contributed to make the nuclear waste issue more visible and thus stimulated the interest of more researchers who have realised how their competencies could contribute to new knowledge in this field. Each call for proposals has brought in new groups of researchers, who in many cases had not worked previously with nuclear waste issues. A perceived limitation in the Social Science Research Programme is that it has not provided support for PhD students. We are aware that much research within the Swedish universities and colleges is produced as part of doctoral dissertations, but due to time and financial constraints, such educational projects have been excluded in this programme.

We have been careful about involving many different perspectives, disciplines and theoretical angles in the projects in order to understand the complex issues at stake. The resulting eighteen projects testify to the considerable breadth of SKB's research programme. The programme covers a number of research fields, e.g. in behavioural and social sciences as well as studies with economic, legal and historical focus. We have also noted that the Social Science Research Programme has attracted some of the most outstanding researchers in the country, who have a large international network of contacts and substantial international publications. The results have been widely disseminated in various journals³.

³ Appendix 3 provides an overview of the scope of the Social Science Research Programme in terms of content and geographical distribution. Appendix 7 lists the publications generated by the project.

An important consequence of the consistently high quality of the projects is that they have been able to inspire research in related areas and receive funding also from other sources. The results from the research projects have also shown an impressive success rate in scientific journals. The project's methods and results related societal processes, attitudes and decision-making ought to be applicable also in other work areas as well as of interest to other areas of research. Thus, we hope that the projects reviewed here, their work methodology and results will inspire future research efforts in other industrial settings, as well as in environmental and energy research.

4.3 Focus and content of the programme

We would like to conclude by discussing the focus of current and future research. The focus of the programme was developed at seminars held in 2002 and 2003 with researchers, as well as with representatives of the two site investigation municipalities, Oskarshamn and Östhammar. Four broad topics of interest were singled out as most important: Socio-economic impact; Decision-making processes – governance; Opinions and attitudes – psychosocial impact; and Societal change in the surrounding world. These areas were central to SKB and the municipalities, and were also considered to be scientifically relevant by the research community. They have served as a framework for the calls for proposals in the period the program has existed, and been further elaborated in dialogue with researchers and other interested groups in society.

This report has shown that there have been projects ongoing over the years in all four of these areas. At the same time, there has been a significant overlap: many of the projects are relevant in more than one area. We maintain that these projects have significantly enhanced knowledge, broadened perspectives and provided a deeper understanding of work in the municipalities and within SKB, and also contributed useful knowledge to other major industrial or infrastructure projects. These aspects are reflected in the objectives that SKB delineated for the Social Research Programme.

We wish, however, to make a distinction between the specific results themselves and how these may be used in the future decision-making. The programme has contributed to the dissemination of results, whereas the use of these results by society does not fall within the scientific scope of the programme. It is, however, our hope that the results will contribute to more solid grounds for choices and decision-making. We also hope that the various perspectives, which complement as well as contrast with one another, do not create confusion but help to stimulate an interest in and understanding of the inherent complexity of the issues involved. It is also our hope that the uncharted territory and questions or uncertainties that have been identified by the projects can be explored in future research efforts. For this reason we would like to conclude with some reflections and questions of possible interest in future research.

4.3.1 Need for further research

One essential reflection concerns whether or not the Social Science Research Programme lacked any critical dimension or theme already at its inception. In relation to the evaluations of SKB's RD&D-programmes – where the Social Science Research Programme also was reviewed – it has been suggested that also broader energy and environmental issues, as well as future outlooks, should be included. These are comments that ought to be considered having SKB's specific mandate in mind as well as considering the point of view of the society's expectations on SKB's mandate.

Have any new fields of research or research issues emerged during the time of the programme? Without offering a clear answer to this question, we can confirm that a lot has happened in the municipalities, within various fields of research, in society and in the work of SKB during the time period. Studies of changes and trends, possibilities and prerequisites for good, long-term planning and information exchange, as well as the impact of technological development and changes in societal values emerge as attractive candidates for further studies in this context. We also wish point to some issues within the themes that have been studied during the period that could be interesting to further elucidate.

Regarding the theme of **socio-economic impact** there have been two major projects, and some concrete application studies outside of the framework of the programme. These studies have been strongly focused on the local impact of a nuclear fuel repository on population and employment developments. This focus, which has been justifiable in light of the need for knowledge in both of the site investigation municipalities, nevertheless leaves several questions unanswered, which may be of importance when the first phase of the site selection has been completed. The recently concluded project by Frostenson provides valuable insights into the organizational choices made by SKB and the municipalities to further future economic and social development.

In this context, there are other questions than those of population and employment development that also may be important on a local level. Planning for a relatively long period of construction of a technically well-defined facility such as a final repository could be extended into several areas: a) to ensure that education is better able to meet coming needs, b) to reinforce local competence to supply the requisite products, c) to take advantage of the possibility to establish complementary business, d) to better cater to the housing demand of the local population (so that they will remain in the municipality) and e) to enhance the attraction of the local culture. These more detailed issues could be of interest in future research.

Other issues are of a wider significance. As several projects have shown, the primary socio-economic effect of a repository for spent nuclear fuel falls outside of the municipality concerned. What does this imply, under different circumstances, to the region and the nation? How can the development be influenced? Finally, and as an even broader issue, the final repository can be related to the energy supply of the entire country. A potentially relevant question is then: if one applies the same criteria to risks, benefits, costs and environmental impacts to all parts of the energy supply system, what scenarios would then appear to be nationally and globally suitable?

With regard to the thematic area of **decision-making** in the Social Research Programme there is a current lack of projects that include and elucidate activities on all governance levels over a given period of time, i.e. the main focus has so far been directed at the municipal level. Projects have discussed the general issue of governance on several levels, however, making use of reviews of published studies that are based primarily on theoretical overviews or policy development. In addition, various comments from participants regarding their own experiences of participation have been reported.

Despite the recent work by Cramér et al. on the legal framework for current and future decisions at a national level, much remains to be done. Various structures and processes for formal decision-making by authorities and other agencies on national, regional and municipal levels, as well as the content and principles behind the work being done, have yet to be adequately elucidated. This more comprehensive approach could also include the regulation and function of the relationship between national and international decision-making. There is also reason to take a closer look at how opinions and attitudes are formed – in the individual and in group processes – and how they are presented and negotiated in relation to decision-making.

Results of the various projects point to major complexity already in the imminent and practical work at hand to include and jointly manage essential dimensions of decision-making. In addition, there are major challenges when it comes to understanding the required knowledge basis, including the methodology, which can be validly used to estimate effects over long periods of time.

The challenges are in part of a formal nature: about understanding ambiguities in regulations, roles and processes; another part is social and concerns who participates and their contributions; and a third part is theoretical and deals with what principles and methods that can be utilized. Some of these principles are irreconcilable with one another. More research is therefore needed that deals with fundamental principles in relation to the issue of a final repository, as well as investigate different ways of evaluating consequences over extremely long periods of time.

Concerning **opinions and attitudes**, research to date has covered cross-sectional studies that investigated and compared opinions and attitudes in the site investigation municipalities and other groups in comparison to the country at large, as well as research based on comprehensive, long-term and international data available to the researchers. The results have provided a current overview of opinions and attitudes as well as placed Sweden in an international context. There are additional issues to be investigated in the area, apart from monitoring opinion development over time (thus far some data covered a relatively short period time). One of these additional issues concerns gaining a better understanding of the kind of information and knowledge that people think they need or want, another the identification of obstacles to efficient communication, and thirdly what generates interest and personal involvement in e.g. industrial projects.

Thus, this part of the research programme has not, for example, been able to follow longitudinal developments of the chosen primary issue of the various included projects. All of the projects present results from specific points in time, where the previous course of history or forecasts for the future are based on other sources. An exception with respect to the access to longitudinal data is Pettersson's analysis of international data from the World Values Survey and Sandberg's use of data from the SOM Institute (Gothenburg University), which are based upon interviews conducted over a long period of time. Data from each year are not, however, linked on the individual level, nor specifically related to the site investigation municipalities, and thus the results are useful for describing general trends on the group level, they cannot be used to describe changes on the individual level over time. Data collections over a longer period of time, based on information from the same individuals, are necessary in order to study causal relations.

The gathering of such longitudinal information from individuals necessitates considerable long-term planning. If one begins today, it will take up to ten years or a generation to be able to draw reliable conclusions regarding cohort and time effects on the basis of the material.

The field also lacks studies that make use of "before and after" designs with various data collection instruments, whereby it would be possible to systematically study reactions to events or decisions. This methodology requires, of course, more strategic efforts and larger investments than what have been possible to date.

One concrete study that would provide an interesting relief to the Swedish results would be an international study (in collaboration with one or several international research organisations) of attitudes toward final disposal, nuclear waste and nuclear power in several other nuclear power municipalities throughout the world. The results could be compared to the attitudes in otherwise similar "twin municipalities" (or nationwide on a random basis) in each country. The Eurobarometer, for example, supplies interesting data, but does not

provide enough information to enable the specific study of especially nuclear power municipalities in different countries, or the comparison of smaller segments in available national datasets.

Among the theoretical topical areas that have not been proposed as projects in this context are, for example, more detailed studies of how people (e.g. experts, the public, young, old etc) go about making various kinds of decisions. For example how they scrutinize a particular risk, the line of thought in considering participating in a consultation process, or becoming acquainted with advanced technical material. There is also very interesting research problems associated with “the silent majority”: who they are, how they reason, and what it implies not to show interest and involvement. The significance of new or different styles of life and communication means could have been elucidated in the programme, but there were no such proposals. It might also be interesting to investigate the way attitudes change in the course of a process that develops from a newly awakened interest to personal involvement in discussions or in decision-making processes. The field could also include studies of the way different peripheral processes are propagated, e.g. why various situations and decisions create a “contagious” optimism or pessimism, or varying degrees of interest or activity in local communities and groups.

Finally, **societal change in the surrounding world** is a very large topical area that can be developed in many different ways. In the preliminary work preceding the Social Science Research Programme, there was a call for research on global change, nuclear waste issues in Europe, international developments in legislation, and the significance of new threats and risks, as well as new technology. Several projects in the programme have attended to some of these issues and, for example, studied different definitions of nuclear waste and management options in the world, as well as national legislation, and that in force in the EU and internationally. These matters are, however, variable, which could be appreciated in relation to the global economic crisis and climate change issues. Such factors seem to affect people’s views of nuclear energy, energy supply and the importance of good management of different types of radioactive material, and therefore the issues remain topical.

Likewise changing perceptions and realities, connected to threats and risks, as well as new ownership conditions, technological breakthroughs etc, may mean that there will be new conditions for the decisions that can or will be made on the nuclear waste issue. We believe that research on conceivable and real long-term changes in the way societies are governed, including the regulations and forums for “participation”, is also as relevant to people’s perceptions as it is for decision making on the management of nuclear waste.

The past time period – the time during which the Social Science Research Programme has existed – concurred with a shift in political power in Sweden, a larger and more integrated EU, increasingly grim reports on future environmental threats and, not the least, an unwieldy international economic crisis.

In retrospect, we can summarize that the programme has remained within the initially given framework while the external coordinates of that framework have changed. Increasing use of new forms of media, information and communication technology, changing life-style ideals and sources of identification, views on economic security, internationalisation of finance and industry, as well as in many professions and educations, are examples of some of the societal changes in the surrounding world that directly or indirectly produce repercussions on experiences and decisions. Long series of data and continuous research efforts are required in order to capture and comprehend these kinds of processes. Such efforts have not been available within the scope of this research programme. Neither has the ambition to catch, and study in a comprehensive manner, the contributions to decision-making made at different societal levels, and by various groups, yet been possible to pursue in greater depth.

It is our hope that the work and results presented here will lead to intensified research efforts in the future, by SKB or other research financiers. That would imply that the long-term and multi-dimensional nature characterizing work related to the final repository would be reflected in perspectives from the social sciences and humanities also in the future, thus contributing to the generation of important new knowledge on the vital issue of nuclear waste management.

List of projects

Completed projects

Local development and regional mobilisation of large-scale technical projects.

Lena Andersson-Skog (research manager), Department of Economic History, Umeå University.

Long-term socioeconomic effects of large investments on small and medium-sized communities.

Urban Lindgren (research manager), Department of Cultural Geography, University of Umeå.

Magnus Strömngren, Department of Cultural Geography, University of Umeå.

The public, the experts and deliberation.

Rolf Lidskog (research manager), Humanity/Technology/Environment Research Centre, Örebro University.

Linda Soneryd, Score.

Resource or waste? International decision processes relating to spent nuclear fuel.

Arne Kaijser (research manager), Department of History of Science and Technology, Royal Institute of Technology, Stockholm.

Per Högselius, Department of History of Science and Technology, Royal Institute of Technology, Stockholm.

Identity and security in time and space: cultural-theoretical perspectives on the existential dimensions of the nuclear waste issue.

Per Johansson (research manager), Department of Human Ecology, Lund University.

Ebba Lisberg Jensen, Department of Human Ecology, Lund University.

Nuclear waste: From energy resource to disposal problem.

Jonas Anshelm (research manager), Department of Technology and Social Change, Linköping University.

Attitudes to final disposal for spent nuclear fuel.

Lennart Sjöberg, (research manager), Centre for Risk Research, Stockholm School of Economics.

National nuclear fuel policy in a European Union?

Per Cramér, (research manager), Department of Law, School of Economics, University of Gothenburg.

Thomas Erhag, Department of Law, School of Economics, University of Gothenburg.

Sara Stendahl, Department of Law, School of Economics, University of Gothenburg.

Like night and day despite the same nuclear origin? Concerning (dis)similarities and opinions in the treatment of the nuclear waste issue in national and local/regional media.

Annika Sjölander (research manager), Department of Culture and Media, Umeå University.

In activism or disinterest? Swedish young people's view on democracy and environment, science and technology in a comparative perspective.

Thorleif Pettersson (research manager), Department of Theology, Uppsala University.

Mikael Sandberg, School of Health and Society, Halmstad University.

Ethical argumentation in the final repository issue.

Magnus Frostenson (research manager), Center for Ethics and Economics, Stockholm School of Economics.

How young people view democracy and technology issues.

Lennart Sjöberg (research manager), Centre for Risk Research, Stockholm School of Economics.

Responsibility at the end of the nuclear fuel cycle – A legal perspective.

Per Cramér, (research manager), Department of Law, School of Economics, University of Gothenburg.

Thomas Erhag, Department of Law, School of Economics, University of Gothenburg.

Sara Stendahl, Department of Law, School of Economics, University of Gothenburg.

Ethical and philosophical perspectives on nuclear waste.

Sven Ove Hansson (research manager), Royal Institute of Technology, Stockholm.

Participatory democracy and the decision's legitimacy in multi-level governance.

Carina Keskitalo (research manager), Department of Social and Economic Geography, Umeå University.

Annika Nordlund, Department of Psychology, Umeå university.

Urban Lindgren, Department of Cultural Geography, University of Umeå.

The industrial organization of the final repository – Pitfall or consistency?

Magnus Frostenson (research manager), Department of Business Studies, Uppsala University.

Democratic core issues – A study of opinion and external changes affecting the political decision about the final disposal of nuclear waste.

Lars Nord (research manager), DEMICOM, Mid Sweden University.

Elisabeth Stúr, Department of Information Technology and Media, Mid Sweden University.

Project not completed at this report's printing (april 2011)

The time frame of nuclear waste in comparison.

Sven Ove Hansson (research manager), Royal Institute of Technology, Stockholm.

Project presentations

Local development and regional mobilisation for technical and large-scale projects

Lena Andersson Skog

Umeå University

This project was carried out by Fredrik Andersson and Lena Andersson Skog, economic historians at Umeå University. The issues addressed touch on those in Lindgren's and Strömngren's project on the long-term socio-economic impact of large investments in small and medium-sized districts, but are analysed here using entirely different methods and data.

The project aims to show the impacts on the municipal population and the development of commercial and industrial life that can be expected if a final repository is established in Oskarshamn or Östhammar.

Materials and methods

The analysis is based on a historical method that compares population development in municipalities as a whole from the "outside", and investigates possible traces of impact from industrial investments. Official statistics and historical source material were used.

The project's introductory study traces the effects of the nuclear power plant's construction on population development in Oskarshamn and Östhammar. Total municipal population development is used as an indicator of the effect of the industrial establishment. For the sake of comparison, the time scale was adjusted so that the start of operations in the municipalities forms the point of departure for a common "model time" period. Each of the municipalities' population development is compared to a "twin municipality" in the same county (Västervik and Tierp).

Results

The introductory study implies that one obvious effect on population development can be observed during construction and initial operations. The effect decreases after that point, and population development appears to return to the municipality's previous development trend.

In the next step, the comparison is extended to include hydroelectric power and mining municipalities and medium-sized industrial municipalities. The population in the two nuclear power plant municipalities grew heavily during the years of construction and the early period of the plant's operation. The effect of the early stages of the investment was somewhat more distinct in Oskarshamn. However, the positive effects diminished more quickly in Oskarshamn than in Östhammar. Population development in Västervik and Tierp, the reference municipalities, was much lower during the corresponding period even though the nuclear power plant municipalities and reference municipalities had similar population trends prior to the nuclear power investment.

In a similar manner, it appears that the hydroelectric power expansion in Älvkarleby and mining development in Skellefteå resulted in a population upturn during the construction and investment phase. Initially, Oskarshamn and Östhammar also had a more positive population development than the average medium-sized industrial municipality. The analysis is complicated by the fact that there are other factors that can impact development in the various municipalities during corresponding periods. The nuclear power municipalities had a relatively positive development from the beginning of the nuclear power period, even if it was not spectacular. Given the historical development and other differences, however, the authors believe it is less likely that a final repository investment will lead to considerable and steady local population growth. This corresponds well to what has previously been observed after railway investments, such as that described in Eli Heckscher's classic study of the railway's economic effects on a local level /3/. Heckscher notes that the period of construction and the first few years of operation produced the most notable effects on population development, primarily in the communities that had a railway station.

On the other hand, population growth stabilised in Oskarshamn and Östhammar at higher levels than would have been the case without the nuclear power industry. The nuclear power municipalities also developed differently in terms of population composition than did the reference municipalities. This indicates that nuclear power had an impact on the local economy that may well have caused a structural change that altered the socio-economic structure of the district in the long term. The nuclear power municipalities fared better than the reference municipalities and other industrial municipalities in the 1970s and 1980s.

Several general development trends indicate that industrial investments had relatively minor effects on the local population. In general, however, an industrial investment had a larger local effect the further back in time we look. As mobility of goods and people increased in the country, along with more specialisation and an increasingly international economy, the effects of an investment become gradually less local over time. This is especially true in an area that is as specialised and technically advanced as the nuclear power sector, where market players work on a national or international level. In one empirical example investments were made in a high-tech underground laboratory in Bure in eastern France; these investments were motivated by their significance for regional socio-economic development since this area was lagging economically. Almost seven years after the inauguration, the effects were still not manifest.

Taken as a whole, increasing productivity in industry, increased levels of quality and reduced costs for the transportation sector, the development of information technology and increased internationalisation of the economy, have led to a diminishing effect on local employment and local development of industrial investments. This movement is exemplified by the Malmfälten (mining area) case. Both Kiruna and Malmberget experienced a quick growth phase during the decades around the turn of the century, when investments in the Malmbanan mining railway enabled large-scale investments in mining operations in these districts. In order to supply the labour needed for these investments, it was necessary to relocalize and build entirely new communities in both districts. A century later, in 2005, major investment decisions worth billions were made in the mining operations in both districts. The company and political bodies, however, expected a negligible effect on population development in both municipalities. One reason is that individuals with specialist expertise and consultants can live anywhere they choose today, and can choose to work only temporarily in a specific location.

The analysis based on economic historical comparisons concludes that an investment in a final repository for spent nuclear fuel will have a local impact, but that it ultimately will not suffice to propel socio-economic development. Even if the local socio-economic effect is the issue being studied, the national importance of nuclear power cannot be ignored. Factors related to the political decision-making process and public debate on nuclear power may well have influenced the local economic outcome. One example is the Forsmark plant, which went through a long and drawn-out period of construction as a result of the complicated political situation related to nuclear power during that period.

Long-term socio-economic impact of major investments in small and medium-sized districts

Urban Lindgren

Umeå University

This project was carried out by Urban Lindgren and Magnus Strömberg, human geographers at Umeå University. Their point of departure is in classic effect analysis methods, which they then include in an agent-based simulation model.

The project aims to elucidate what local population, employment and income effects can be expected in Oskarshamn or Östhammar if a final repository is established. A secondary aim is to further develop a suitable methodology for these types of local effect studies based on earlier research in the field.

Materials and methods

The selected methodology – empirical analyses and multiplier models that calculate direct local income effects and microsimulation/agent-based simulation to calculate local employment and population effects – is not typical of the methodology prevalent in earlier effect studies. This choice entails significant method development based, for example, on Swedish researchers' unique access to longitudinal, localized microdata for each individual in the population. In addition, local companies responded to a questionnaire regarding how their current sales were allocated to the 25 different areas that needed investment.

The project was introduced with an overview of the methodology and results from earlier effect studies. A multiplier model is generally used, whereby a direct initial income from the planned investment is multiplied by the calculated factors that should reflect the size of the indirectly generated local effect on income, employment and population. The three most utilized techniques are the export-base model, input-output model and the Keynesian multiplier model. The input-output model can be seen as a further development of the export-base model, but with a more detailed division of the local economy than merely into a domestic market and export market.

These types of multiplier models are formulated on macro level; all of the parameters in the model are population averages for the region (or nation). It is often difficult to find data to calibrate some of the parameter values. Another problem is that it is difficult to differentiate the analysis on the basis of the population's heterogeneity in terms of characteristics and behaviour. A third problem is that the majority of the mutually dynamic dependencies between different companies, partial labour markets and individuals are excluded from the analysis. These disadvantages justify calculating the effect

on employment and population development, that the various multipliers are meant to reflect, alternatively with a microsimulation model. This type of model is based on a set of individuals that reflects the observed population in the municipality and surrounding municipalities within 80 kilometres in terms of numbers, characteristics and behaviour. Individuals live their own artificial lives here, interact with one another and respond to changes in the local labour market in a manner that corresponds to the dynamics found in the observed population.

Results

Calculation of direct local subcontractor effects, i.e. how large a proportion of investments and operations can be absorbed by local subcontractors and thus generate local income and employment, is a central, inevitable and dominant part of this project's analysis (as has been the case in earlier effect studies). This calculation precedes and provides input for the more detailed consequence experiments enabled by the simulation model.

In nine Swedish studies of the direct local effect of various types of new and major investments (army units, pulp and paper mills, bridge building, final repositories for nuclear waste in Storuman and Malå and the interim storage facility in Oskarshamn), the estimated proportion of an investment that could be procured locally varied between 11 and 60 percent. The proportion for Storuman is 29 percent, for Malå 27 percent and Oskarshamn 42 percent. These percentages drop significantly if "leakage" arising at later stages of the procurement chain (some of the third tier subcontractors are located outside the municipality) is taken into consideration. For example, the effect of the interim storage facility in Oskarshamn decreases from 42 percent to around 25 percent; this lower amount corresponds to an additional income of SEK 200 million or around 600 fulltime employees per year.

Variation between projects and municipalities in terms of the proportion that can be procured locally and have local effects is related to the technological level of the investment (negative), the size of the municipality (positive), the investment's connection to specific local economics (positive) and in particular to previous positive experiences with a specific supplier (positive). The local effects will be negligible for a high-tech investment in a small municipality that does not have industry that is linked to the investment's content and without previously established contact networks between the investor and local contractors. The investment becomes an isolated enclave that lacks contact with and impact on the local community. An investment that is based on a more common technology and that is made in a larger municipality with several companies that can supply what is needed and that have previously cooperated with the investor can be almost entirely absorbed by and have an impact on the municipality.

Oskarshamn's and Östhammar's capacity to supply the needed goods and services for the final repository has been investigated within the framework of this project. Company turnover in 25 commodity areas was compared to corresponding investment needs for detailed planning, construction and equipment installations for the final repository. In most of the smaller categories of purchasing requirements, local delivery capacity vastly exceeds procurement demand. Both municipalities also have capacity to supply the required construction work, ground work, vehicles and machinery. However, local capacity for the largest investment posts, i.e. rock work and process systems/specialist equipment, is currently small.

The estimate indicates that local procurement can reach a maximum of 34 percent in Oskarshamn and 17 percent in Östhammar. Thus, the comparison between supplier capacity and procurement need yields different results for Oskarshamn and Östhammar. It is estimated that over four-fifths of the investment amount would leak out of Östhammar because local businesses would not have the capacity or expertise to run the requisite delivery projects. The corresponding figure in Oskarshamn is just over two-thirds, which means that a larger proportion of the investment would be filtered through the local economy in Oskarshamn compared to Östhammar. An estimated effect of operating the facilities can be added to these local effects. In total, the number of jobs per year could reach 460 in Oskarshamn and 320 in Östhammar.

The final repository programme consists of different investments with different localisation prerequisites. In addition to the final repository for spent nuclear fuel, the programme includes an expansion of the Final Repository for Short-lived Radioactive Waste (SFR) and an encapsulation facility and a factory for assembling canisters. The SFR expansion must take place in Östhammar since SFR is already located there. SKB believes the encapsulation facility should be built next to the central interim storage facility for spent nuclear fuel (Clab), which is located in Oskarshamn. This means that portions of the total investment for the final repository (approximately SEK 15 billion) are already tied to specific locations.

The repository for spent nuclear fuel including peripheral investments would have effects in both Östhammar and Oskarshamn, regardless of its location. The socio-economic effects would be fairly large in Oskarshamn if the repository goes to Östhammar, while the effects in Östhammar would be very limited if it is placed in Oskarshamn. From a municipal perspective, it appears that local effects would be greater in Oskarshamn; from a broader regional perspective that includes each of the municipalities' functional trading areas, however, the effects of Östhammar's proximity to Stockholm must be taken into consideration. Östhammar is part of a metropolitan region that has a considerable delivery capacity, while Oskarshamn constitutes a smaller regional centre.

The public, expertise and deliberation

Rolf Lidskog

Örebro University

This project was carried out by Rolf Lidskog, Professor in sociology at Örebro University, and Linda Soneryd, PhD in sociology at Score, Stockholm University.

The project investigated the relationship between expertise and a broader general public in participatory processes that deal with scientific and technical issues. The Swedish consultation process associated with a final repository for spent nuclear fuel is used as a specific example. The researchers were interested in approaching four questions: 1) How is the general public defined and which methods are used? 2) Which arenas are created for dialogue with citizens and what are the institutional prerequisites for participation in these? 3) Are there mechanisms that support or counteract negotiation on the limits of expertise? 4) How do participants in consultation activities approach expertise? How is local and cross-border environmental impact discussed in the consultation process?

Materials and methods

The operator, SKB in this case, is responsible for initiating consultation. The consultation process takes place within the framework for drafting the Environmental Impact Assessment (EIA), which must be attached to applications for a permit to build a final repository. Legislation stipulates that consultation must take place with the authorities, municipalities, general public and other organisations that may be affected. The overall aim is to involve and inform a broader general public in planning and policy work. The researchers emphasize that legislation does not stipulate in detail how the consultation process should proceed, which is why the operator has a certain amount of freedom in terms of organising consultation.

The researchers adopted organisational theory to approach the complexity involved in designing a consultation process that includes dialogue among experts, decision makers and the general public. The study is based on a qualitative case study methodology and material was collected via participatory observation (at consultation meetings and in other contexts where the final repository project was presented), formal and informal interviews (with SKB, EIA experts and representatives of environmental organisations) and documentation studies (primarily consultation minutes). Material for the observations was collected in 2005 and the first half of 2006 at open meetings within the framework of the Forsmark Consultation and EIA Group and the Oskarshamn EIA Forum, seminars with the Swedish National Council for Nuclear Waste and the Oskarshamn and Östhammar municipalities, as well

as during a study trip organised by SKB. Interviews were held with representatives of environmental organisations, with SKB personnel in charge of the EIA and public information, as well as with individuals at the EIA centre at SLU (Swedish University of Agricultural Sciences). The data is also based on informal contacts with SKB's staff and official minutes from consultation meetings.

Results

One of the key concepts of the project is the public, and the researchers emphasize that there is no given or obvious "general public" to which SKB can turn for the consultation process. Instead, the group with which SKB consults is determined by how external rules, demands and expectations are understood as well as the operator's history, culture and internal organisation. The latter has overall responsibility, but researchers emphasize that the consultation process is formed by many players. As regards the key concept of expertise, the researchers write:

"The consultation process involves different types of expertise. In addition to experts who assess expected environmental impact and perform safety analyses, there are legal experts, application specialists for good EIA practice and experts on related activities such as communications projects. Expertise can also be used by all of the consultation participants as references to different expert areas, and potentially to legitimate their own positions" /8/.

An additional central key concept in the project is deliberation. The researchers understand deliberation "in relation to democratic decision-making processes and open, communicative planning processes. On the basis of these traditions, deliberation is related to several democratic qualities such as broad participation, critical questioning, the ability to understand the other participants' perspective and a relatively open and fair discussion that is characterized by both argumentation and good arguments" /8/.

The researchers find that those who are involved in the consultation process (local population, municipalities, authorities and local and national environmental organisations), and are defined as consultation partners, meet SKB in different types of arenas. This affects the way knowledge is exchanged. Furthermore, SKB differentiates between formal consultation according to the rules stipulated by the Swedish Environmental Code and other types of local information and communication activities within the site investigation municipalities. However, the researchers point out that the boundary is not completely clear "since SKB also considers more informal meetings with the local population to be an important basis for a positive process" /8/. In addition to distributing information material, local work in Oskarshamn and Östhammar includes, for example, "organised study visits, lunch seminars, neighbourhood meetings, Christmas markets and school meetings", as well as other types of informal and personal contacts.

On the basis of previous research, they attempt to clarify different ways of approaching the EIA process, e.g. the objectives, values and qualities that should characterize the process. The following are their examples of some of the criteria for good EIA or consultation quality:

1. **Those affected by the project need to be involved early on.** It is not possible to determine in advance who will be affected by a project, but potential stakeholders should be given the chance to define themselves.
2. **Consultation is an ongoing and variable process.** It does not consist of a number of pre-determined activities. In principle, all of the opinions that are forwarded to the applicant until the application has been submitted can be assigned to the consultation process.
3. **Aim for balance of power in relationships.** The applicant has a dominant position that should be balanced in various ways. Introducing independent moderators or secretaries can help counterbalance the applicant's dominance.
4. **Clear rules and predictability.** The applicant must be clear regarding the consultation procedure: which activities will be included and during which period of time, which questions will be followed up and lead to new activities, etc.
5. **Clear information on environmental effects.** The EIA tool offers the applicant the chance to critically consider its own plans and projects. This approach to the EIA tool is also clearly stated in legal texts, as stipulated requirements for alternative accounting.

The results of the project are summarized as four key points:

- The consultation process is organised so that it leads to a specific focus on the municipalities, the local population and local environmental issues.
- Implementation of the consultation process has led to changes in the initial design; new elements have been introduced and new dilemmas related to management and balancing have emerged.
- The consultation process contains mechanisms that both support and counteract a discussion and renegotiation of the limits of expertise.
- Issues of responsibility have been discussed in relationship to many trans-boundary issues, making deliberation appear to be a key democratic value.

As a result of its local information and communication activities in the site selection municipalities, SKB has provided the local population with a wide range of information. A great deal of interest has focused on local environmental impact and change. Consultations in the municipality and on the regional level have afforded the local population opportunities to take part in and enrich the discussions.

The researchers note in their study that SKB is sometimes faced with conflicting demands or wishes from different parties in the consultation process. Hence demands for process change must be weighed against the wishes of the involved entities (SKB and other consultation parties) to retain established working methods. They write: “During consultation meetings, legal expertise is one element that is used both to uphold and question the design. The role played by legal expertise in the process can in part be explained by the fact that the EIA is not merely a work process, but also a legal tool. The environmental organisations attempt in various ways to reinforce their role as consultation partners in order to achieve greater focus on the long-term environmental issues in the process. SKB regards the measures it has taken as major changes to the process, the public consultation meetings in particular. The new organisation that was introduced, however, means that the institutional prerequisites of the different consultation arenas are upheld or at least not dramatically changed” /8/.

Regarding the third point, the researchers assert that consultation meetings and other gatherings have offered participants opportunities to express scepticism in relation to an “expert-focused” or technocratic attitude to the final repository. SKB has viewed the local population as experts on their own quality of life, while the authorities have taken on the role as experts on safety issues, for example. The discussions have also included demands from all participants for additional and more reliable know-how. The researchers point out, however, that a renegotiation of expert boundaries does not arise from citizens being attributed as “experts”. They also provide examples of opinions from the local population that have resulted in SKB performing new investigations.

As regards accountability and transboundary issues, the researchers state, for example, that “during consultation on a final repository, there is an opportunity to clarify the values that are associated with methods, conceptions about the future and expected consequences. This potential has not been utilized in the current consultation process. As a consequence, the role of citizens in the consultation process is limited to contributing substantial viewpoints on local environmental impact, and issues related to more long-term aspects will never be the primary object of the consultation process.” They also state that in situations where there are many uncertainties, it is important to uphold “responsiveness” – one aspect of responsibility – so that awareness of and openness to ideas, opinions and interests help improve decision-making processes. In light of this, the researchers conclude that deliberation is an important democratic value, and emphasize the particular importance of mature deliberation in conjunction with issues that include uncertainty and long-term consequences.

Resource or waste? International decision-making regarding spent nuclear fuel

Arne Kaijser

KTH, Royal Institute of Technology, Stockholm

This project was conducted by Arne Kaijser and Per Högselius, technology historians at KTH Royal Institute of Technology in Stockholm.

Storing high-level nuclear waste in bedrock is not the only alternative being discussed internationally. Different countries have had very different opinions and proposals for a solution. Two other alternatives being discussed are reprocessing the spent nuclear fuel and disposal through export.

The project aims to clarify and analyse the decision-making processes related to nuclear waste from an international and historical perspective. Focus is on four important countries: Finland, Germany, Russia/Soviet Union and Japan. Understanding the forces and considerations that have determined which strategies have been chosen in a few important countries can result in better understanding of the international cooperation on nuclear power that Sweden has taken part in, as well of the Swedish strategy for how nuclear waste should be handled.

Materials and methods

The project was introduced with a survey study of a larger number of countries, based on literature and other secondary material on the international history of nuclear waste management. Around ten countries were discussed in the survey study, which provided perspectives on the subsequent focus of the project. In the main phase of the project, four countries were selected for more in-depth case study: Finland, Germany, Russia and Japan. Three main types of material were collected during visits:

- Documentary material – reports, investigations, debate articles, etc. The original language was used for Russia and Germany, and translations for Finland and Japan.
- Interviews with key individuals. Around ten interviews were performed in each of the countries, primarily with policy decision makers and representatives of relevant organisations.
- Descriptive statistics from nuclear waste and nuclear power organisations on national and international levels.

Results

A clear historical dividing line can be seen between countries that have decided to reprocess and those that have chosen final disposal. Unlike Sweden, three of the examined countries have regarded spent nuclear fuel primarily as a resource rather than as waste and have therefore invested in reprocessing. This is the case in Germany, Japan and Russia. The project offers a picture of how and why countries have chosen this alternative. The authors want to explain why these countries, despite a common basic outlook, have gradually come to focus on completely different approaches and methods for the management of spent nuclear fuel. Today Germany has totally abandoned its previous reprocessing strategy; Russia has maintained its strategy, but also focused some activity on direct deposits; and Japan has recently completed construction of a major industrial reprocessing facility. The issue of final disposal is, however, far from being resolved in Germany and Japan.

The authors reason in-depth on the different strategies, on conflicts that have arisen and the various alternatives that have been offered and sometimes rejected. History has been characterized by sudden changes, uncertainty and continuity. In order to analyse why different countries have chosen one alternative over another and also how strategies have changed over time, the authors chose to work with eight key factors:

- Does the country produce nuclear weapons?
- Does the country have an expansive or stagnating nuclear power sector?
- Does the country have strong or weak technical competence in the field of nuclear energy?
- Does the country have a strong or weak anti-nuclear power movement?
- Is the country a democracy or a dictatorship?
- Are the politics in the country characterized by strong or weak local political power?
- Does the country have good geological prerequisites for a final repository?
- What is the extent of the country's access to domestic uranium assets?

Nuclear power's connection to military objectives has influenced the options. The Soviet Union had a very close connection between nuclear military ambitions and the management of civilian nuclear fuel, which is embodied by the Russian reprocessing plants. The same connection to the military has not existed in other countries, but the issue has been very politically controversial. As regards the status of nuclear power, Germany's nuclear power sector is presently the one that is most obviously stagnating since it has been decided that all nuclear power in the country should be phased out; there is no indication that the sector will be revived. Finland is building a fifth reactor in Olkiluoto. Japan and Russia can also be described as expansive countries

since they have put new reactors into operation the past few years and have plans for future expansion. There is a clear distinction between Russia, Germany and Japan, all of which have substantial nuclear technology know-how, and Finland, which is not a nuclear technology super power. On the other hand, Finland has made a conscious effort to cooperate with and share know-how with larger nuclear power countries such as Sweden.

As regards geological prerequisites for final repository, tectonic instability in Japan and the country's high population density create a great deal of uncertainty. Concern has hardly diminished after the major earthquake in July 2007 that damaged the country's largest nuclear power plant. Finding suitable areas has been difficult, and none of the country's municipalities have signed up to be a candidate for preliminary investigations. This has been an argument for investing in a closed nuclear fuel cycle since such a cycle leads to smaller volumes of waste and somewhat shorter half-lives. Compared to most of the players, Finland is believed to be the country with the least problematic geological prerequisites for final disposal. The Russian situation shares certain similarities with the Finnish one. Focus has been on the geological formations in direct proximity to the primary nuclear technology sites, even if this entails long transport routes due to the large size of the country. In Germany, consensus was reached early on in nuclear energy circles that the country's abundant salt formations were excellently suited for final disposal of nuclear waste. However, the anti-nuclear movement has subsequently questioned the suitability of the salt formations that have figured into the decision-making processes and demanded that several alternatives be investigated. As a result, geology has played an inhibitory role in German decision making.

Domestic access to uranium has historically played a very large role in national strategic reasoning around spent nuclear fuel. Japan lacks significant domestic access to uranium. Concern for potential problems due to lack of uranium access has shaped the political decision-making processes in Japan and been an important reason – or argument – for investments in reprocessing technology and breeder reactors. Similar reasoning can be discerned in the Soviet Union's early nuclear power history, even if it has become clear over time that there is a reassuring level of available uranium. Current investments in direct deposition as the only allowed solution for managing spent nuclear fuel in both Finland and Germany indicate an implicit belief that uranium access will remain unproblematic in the future.

Scandals, political disputes, antagonism and strong anti-nuclear movements have had a decisive impact, especially in Germany and Japan where the current situation appears to be uncertain or at a dead end. In Russia – and the former Soviet Union – the absence of substantial questioning has resulted in a continued focus on reprocessing even if there are doubts in terms of financial and technical considerations, while the democratic consensus that has developed in Finland has resulted in a decision on a final repository.

In conclusion, Kaijser and Högselius assert that these eight factors have been important in shaping the way spent nuclear fuel issues have been handled, the conflicts that have arisen and the choices made in the four countries that were investigated. They have communicated a picture of extremely dynamic processes in which geological and technical prerequisites and access to domestic uranium resources have naturally been important, but where it appears that politics in a broad sense have been critical from a military point of view and in terms of the absence of a democratic debate (Russia), as political consensus (Finland) and as political dispute and local questioning (Germany and Japan).

Identity and Security in Time and Space – cultural theoretical perspectives on the existential dimensions of the nuclear waste issue

Per Johansson

Lund University

This project was implemented by Per Johansson (research manager) and Ebba Lisberg, then human ecologists at Lund University.

The project's point of departure is that the complex of problems related to nuclear waste management calls the modern individual's attention to existential themes such as personal security, identity and self esteem. In times of perceived social insecurity and a high rate of change, the current generation must make decisions on an issue with consequences very far into the future. This issue is of particular importance for the people living in the site investigation municipalities. The study focuses on how these people view the current situation and the future as well as the significance of a future final repository for the district. These are issues of responsibility and influence, but also belong to more existential themes concerning the way people think about the character of social and natural reality.

On the basis of relevant cultural studies theory, the original aim was to investigate the implicit symbols and experience-related aspects of the debate on nuclear waste management and final disposal. The aim of the project was subsequently specified to include how people in Oskarshamn and Östhammar perceive long periods of time and how a final repository for spent nuclear fuel impacts the perception of where one lives.

Materials and methods

Interviews, observations and documentation form the basis of the study material. A total of 61 people were interviewed, the majority in Oskarshamn and Östhammar. Of these, 33 people were interviewed primarily on spatial, location-related issues while 28 were interviewed on time-related issues. The interviews were qualitative and semi-structured. Interviewees consisted of politicians, civil servants, SKB employees, specialists, non-profit stakeholders and local residents. Furthermore, consultation meetings and seminars were observed in 2005–2006, and a large amount of written material was analysed from various stakeholders. Ideas that have characterized debates, texts and formulations have been studied in detail, primarily through critical discourse analysis and analysis of metaphors and argumentation. How people perceive time – especially long time spans – is key to the presentation, as is “space” – the location or district.

Results

This project offers a cultural perspective on the existential dimensions of the nuclear waste issue. It studies individuals’ perceptions of threats or opportunities in conjunction with a nuclear fuel repository, and links these to their view of nature, trust and different types of identification with their home district. Thus, the analysis focuses on the cultural aspects of the relationship between humans and nature.

One somewhat surprising result is the large amount of uniformity in the material, even if there are clear dividing lines as well. The period of time up until a decision was reached about a nuclear fuel repository and the time to construct the facility itself were perceived as easy to grasp, but the long final repository period was perceived as indefinite. There seem to be two different concepts of time at work: a societal time and a final repository time. Reasoning related to responsibility for future generations and the issue of final repository depends on which concept of time dominates thinking.

The authors want their analysis to achieve an “estrangement of the familiar”, where increased distance to the current phenomena and events can offer deeper understanding from new perspectives. They point out that the long time horizon is experienced as “dizzying” and incomprehensible for most people, and that this perception greatly contributes to the issue of responsibility being so closely linked to the current discussion of a final repository. However, the respondents’ opinions differ in terms of the time spans for which responsibility is pertinent and how responsibility should best be taken. The results also indicate, though, that the situation is characterized by perceived haste, which is more or less clearly linked to notions of future and stability.

As regards the spatial dimension, there is a predominantly optimistic attitude to placing a nuclear fuel repository in both Östhammar and Oskarshamn due to the belief that it would give the districts an important socio-economic stimulus. There are a few sceptics, however, who questioned this belief and the entire process. In Oskarshamn, where the local competence building process has influenced the local debate, existing opposition was lacking. In conclusion, projections related to a time-space homology are largely based on notions of a stable present, which one believes will function similarly in the future but likewise fears will end.

One key issue is whether the degree of positive public sentiment (in the field investigation municipalities) suppresses other opinions or critical points of view. The authors point out this risk, stating that the lack of clear alternative viewpoints may pose a problem in the long term.

Nuclear waste: From an Energy Resource to a Disposal Problem

Jonas Anshelm

Linköping University

This project was carried out by professor Jonas Anshelm, an expert on the history of ideas at Linköping University, Department of Thematic Studies – Technology and Social Change.

Ever since plans for a Swedish nuclear power programme gained a hearing in the Swedish Parliament in the 1950s, a number of issues have been debated, intensively at times, regarding the character and risks of nuclear waste and issues of responsibility, nuclear fuel storage and the safety of the technology. The basic assumption of this project is that it is important to elucidate the various responses to the issues over time, addressing the way changing technological, political, economic and scientific circumstances have influenced perceptions and debate. Such elucidation can broaden our perspective and provide a better understanding of the complexity of the main issue.

The aim of this research project was to study how the media's formation of public opinion on nuclear waste disposal has changed between the 1950s and today on a national level.

Materials and methods

This study has involved a discourse analytical reading of extensive public material for the period spanning 1950 until 2000 (8,000–10,000 newspaper and journal articles, polemical books, brochures, investigations, publications from the Swedish Parliament, industry material and research reports).

Results

Anshelm reviews a number of areas where perceptions differ and have greatly changed over time, i.e. perception of risks, responsibility, knowledge, technology, science and nature. He shows that many of the involved players – politicians, researchers, representatives from the power industry and the environmental movement – have changed their attitudes and view of the truth over the course of the examined period. Previously indisputable notions have been abandoned, and a number of the key aspects of the nuclear waste issue have been renegotiated.

An initial renegotiation concerned the actual definition of nuclear waste – from an important energy resource in the breeder reactors of the 1950s to waste that must be processed in the 1970s. Thus the perception of how much waste was involved multiplied. Another assumption that drastically changed was the storage period needed for nuclear waste – from less than 100 years to hundreds of thousands of years. In the early 1990s the definition of nuclear waste was once again subject to renegotiation due to ideas on transmutation technology.

In the 1950s and 1960s the debate concerning the risks of nuclear waste was very limited. A notable reassessment took place in the 1970s that had a great impact on politics, primarily via the Swedish Centre Party. A moratorium on nuclear power was introduced in 1973 until a convincing plan for managing nuclear waste could be presented. The risks of nuclear waste were addressed much more seriously and defined in an entirely different manner than previously. The conflict with the anti-nuclear movement was not about whether or not radioactive waste was associated with considerable risk, but whether or not the risks could be overcome by the methods that the nuclear sector had begun to develop through SKB. Over the past few years, the environmental movement has asserted that a final repository for nuclear waste should be postponed, since less risky methods for final disposal than those recommended by SKB might be developed within a foreseeable future. SKB has made an entirely different risk assessment.

The issue of responsibility has also been an object of controversy and defined in different ways since the 1970s – with tension between local and national definitions. Consensus has been achieved to some extent as a result of the site investigations in Oskarshamn and Östhammar. There is greater disagreement about the character of nature, in particular of the bedrock. Sweden's abundant access to stable primary rock was previously presented as a guarantee for safe final disposal, and the search for the most geographically suitable rock has been a priority. At the end of the 1980s, SKB declared on the contrary that most locations in Sweden were suitable for a final repository, and that it was not the rock that constituted the most important barrier to the surroundings, but rather the canister that enclosed the spent nuclear fuel. The issue of nature's stability was replaced by the issue of stability of the technical design.

The organisations that had previously opposed rock cavity storage introduced geohydrological criteria in order to emphasize more suitable geological formations – inland with slow groundwater flows – and not as was previously the case solely to prove the general unsuitability of rock cavity storage. The aim was to compromise SKB's choice of municipalities for site investigations, Oskarshamn and Östhammar.

The scientific truths that had been promoted by reactor engineers, nuclear and radiation physicists and geologists began to be called into question in the 1970s by scientists such as Hannes Alfvén, Björn Gillberg and Sten Lindeberg. Different sides of the debate joined forces with different scientific experts, and the nuclear power industry lost its monopoly on knowledge. It was no longer obvious what was true in terms of nuclear waste, or whose truth could be trusted. Both critics and promoters of the Swedish final repository programme have been able to assert that their own position is scientifically-based and that their opponents' position is based on politically distorted scientific claims to the truth.

The technical solutions presented have been controversial. The political debate in the 1970s questioned early technology, resulting in intense work and the introduction of the KBS-3 method in 1984. Factions of the environmental movement have subsequently problematized the assumptions – e.g. regarding hydrological conditions, rock fissuring, material durability and corrosion – upon which SKB's technical design of rock cavern storage and storage canisters is based. In the 2000s, some groups within the environmental movement have demonstrated strong optimism for technical solutions other than SKB's, namely final deposition in deep drill holes. However, SKB has not been supportive of this alternative. Thus not even in terms of confidence in technical development and progress does the history of ideas depicted here follow a simple, linear logic. The optimism concerning new technology that existed in the energy sector and SKB in the 1970s and 1980s was no longer applicable in the 2000s. During a period in the 1990s, the anti-nuclear movement's strong doubts about large-scale technical solutions were transformed into what could be perceived as a radical, however tactical, technical optimism, and which in the early 2000s could be perceived as confidence in new large-scale technology.

Anshelm's conclusion is that what is perceived to be true, valid, correct, morally right and rational in the current situation has been subject to recurrent negotiation and change throughout the last half century. The fact that differences of opinion have resulted in recurrent and trying conflicts for over three decades emphasizes the gravity of the problem. It is, however, reasonable to assume that the stabilization of what is true and right that has been achieved may also be renegotiated in the future in light of new scientific, technological, economic and political reorientation.

Attitudes to a final repository for spent nuclear fuel

Lennart Sjöberg

Stockholm School of Economics

This project was carried out by Professor Lennart Sjöberg from the Center for Risk Research at the Stockholm School of Economics.

The project's overall aim was to generate in-depth understanding of risk perception and attitudes toward risk associated with a final repository for spent nuclear fuel. More specifically, the project aimed to study relationships between perception of risk and the phenomena that have been linked to this in earlier research and that might be used to explain variation in risk perception. In this context, it was interesting to compare a selection of respondents from Oskarshamn and Östhammar with respondents from a similar Swedish municipality and a representative selection of residents from the rest of Sweden. The project's extended aim was to achieve a better understanding of attitudes to risk and policy, which can contribute to improved communication on risk and management of policy issues.

Materials and methods

The empirical survey was based on a questionnaire that focused on risk perception in relation to factors such as benefit, attitude, confidence, emotional reactions and moral aspects, all of which were linked to work during the site investigation phase and a planned final repository for spent nuclear fuel. The study also examined people's perceptions of future prospects and different time perspectives, and compared the results from the survey, which was performed in 2005, with data and conclusions from earlier studies. The significance of the choice of methodology for research work, e.g. the effects of how questions and response options are formulated and the words that are used were also discussed. This summary focuses on attitudes toward a final repository for spent nuclear fuel.

The questionnaire contained 267 questions or assessment tasks. It was produced on the basis of contact with Östhammar and Oskarshamn as well as with public opinion firm Temo. It took an average of 30 minutes to complete the questionnaire. The entire background data and results are not presented here, but can be found in the project report /10/. The survey was mailed to four separate groups of 1,000 randomly sampled persons each, aged 18 years and older, who were asked to respond to the questionnaire. Finspång was selected as the control municipality since it corresponds well to the site investigation municipalities in terms of size and economic structure and because it has a nuclear technology industry. The groups (samples) and frequency of responses were as follows:

Östhammar: 468 responded (50.5 percent)

Oskarshamn: 420 responded (48.4 percent)

Finspång: 540 responded (54.1 percent)

Sweden as a whole: 508 responded (52.6 percent)

A control question in the survey showed that 65–74 percent of the people in the groups perceived the survey as meaningful and 65 percent or more believed that it addressed “what is important in the context”.

In order to analyse attitudes to a final repository for spent nuclear fuel, and in particular variation in attitudes between municipalities, age and gender groups, Sjöberg used four main explanatory variables: 1) Attitude to nuclear power, 2) Employment in an industry with ties to nuclear technology, 3) Understanding of final repository’s benefit, and 4) Feeling of being able to influence the municipality’s actions on the issue.

Results

The point of departure for this project was an examination of attitudes to a final repository in the respondents’ own municipality. An attitude was defined as an assessment of an attitude object rated on a positive to negative response scale. Earlier research shows that this type of global assessment is very informative and useful. In the survey, attitude was measured with the following question: *What is your attitude toward locating a final repository for spent nuclear fuel in your municipality?* The possible responses were given a number value from 1 (Extremely positive) to 7 (Extremely negative). As shown in Figure B-1, there were great differences between Oskarshamn and Östhammar on the one hand and Finspång and the nation as a whole on the other. Attitudes toward a final repository were more positive in Oskarshamn and Östhammar than in the other two samples. The results are not unique. Similar results, where the people who are most positive live close to a nuclear facility, have also been demonstrated earlier in American and Swedish studies.

The data collected in 2005 were compared with responses from a survey in Oskarshamn and Östhammar conducted in 2001. The results showed that attitudes had grown more positive for all subgroups during the period. Men in particular were more positive than women in 2005; gender differences had increased by 2005, see Figure B-2.

In earlier research, attitudes to a final repository have been correlated with gender and age. There is relatively little research on age development of risk perception and related attitudes. As regards different age groups, attitudes can deviate for two different reasons: attitudes change over the course of a lifetime and differences can depend on cohort effects. In order to track attitude development over time, longitudinal data is needed from the same individuals. In this project, age variation is presented on the basis

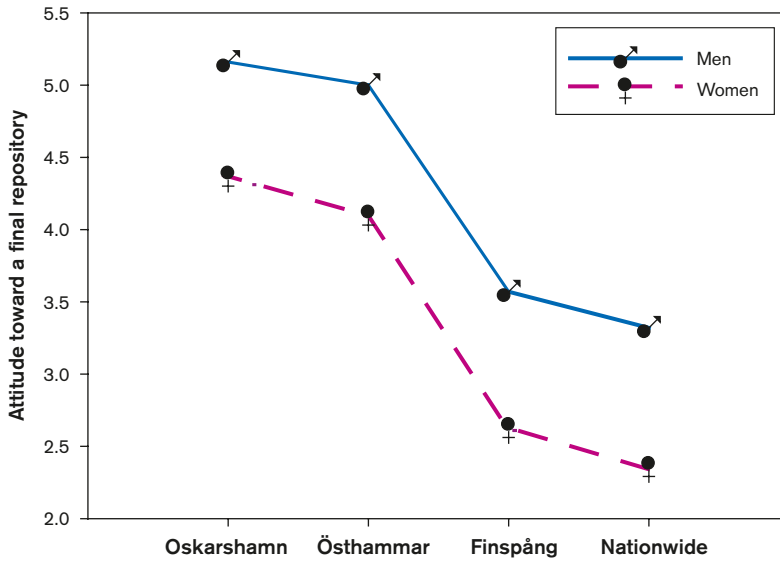


Figure B-1. Attitude toward a final repository in one's own municipality.

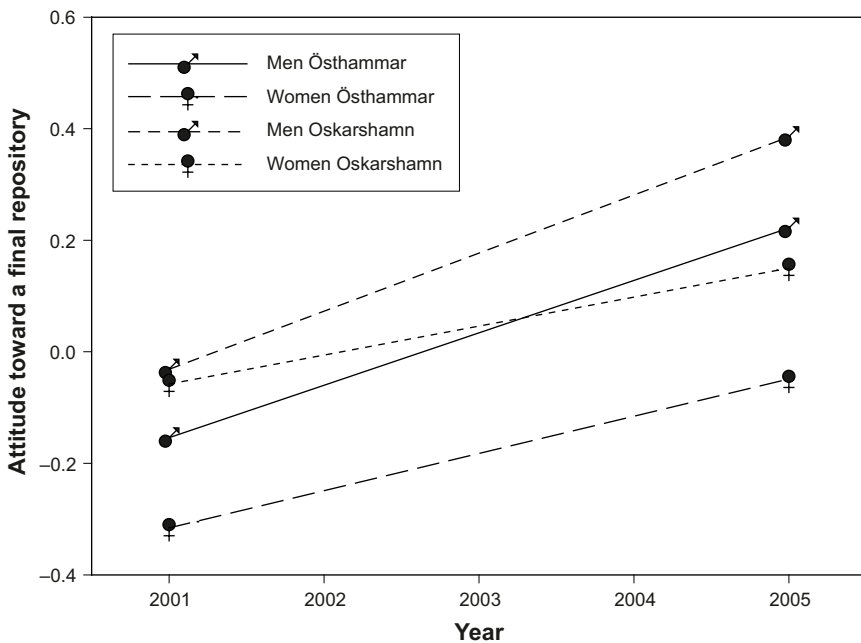


Figure B-2. Attitude toward final repository 2001–2005. Standardized scale⁴.

⁴ Negative values arose as a result of the scale being standardized to an average value = 0 and standard deviation = 1. The negative values do not mean that the attitude itself is negative, just that it falls below the average for the aggregated data.

of data that was collected on one single occasion. Results from the entire nation (Finspång's data were very similar to data from the entire nation) are shown in Figure B-3, and from the aggregated data from Oskarshamn and Östhammar (the two municipalities that showed very similar trends) in Figure B-4. The results showed that the greatest difference between genders was in the 40–60 years of age category. The individuals in these groups were young in 1975–1980, a period that was characterized by intense debate on nuclear power and associated risk. That fierce controversy may have resulted in gender polarization.

One plausible explanation for the gender differences might be a difference in the perception of power and influence. The questionnaire contained four questions that examined how much the respondents believed that people in the municipality could influence education, health care, taxes and the localisation of a final repository for spent nuclear fuel in the municipality. Relatively strong relationships between the responses to the questions demonstrate a general tendency to experience power or powerlessness. Thus, the first three questions were used to create an index that measured a general feeling of power-powerlessness. The data was then related to the feeling of being able to influence the localisation decision. The results show that men experienced a greater sense of being able to influence the localisation decision than women, and that the difference was particularly great in Oskarshamn and Östhammar. However, differences in attitude between men and women

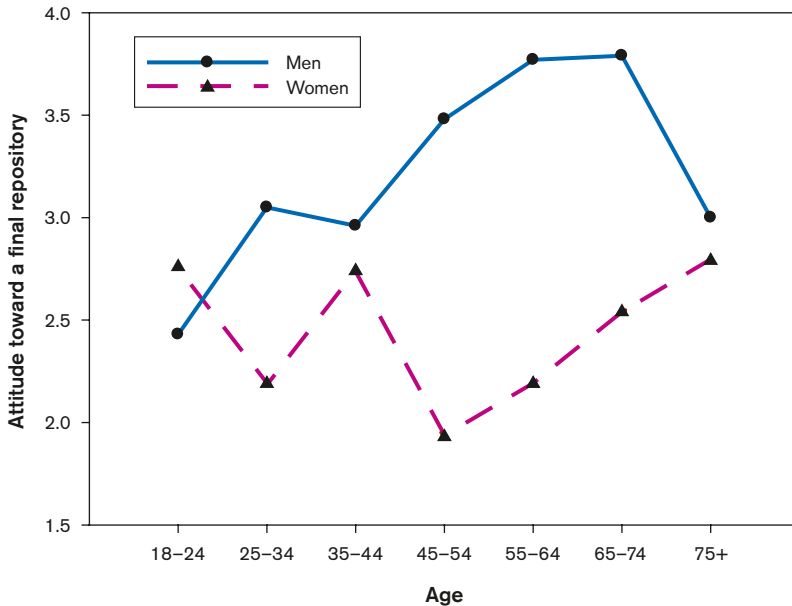


Figure B-3. Attitude as a function of age; data from the entire country.

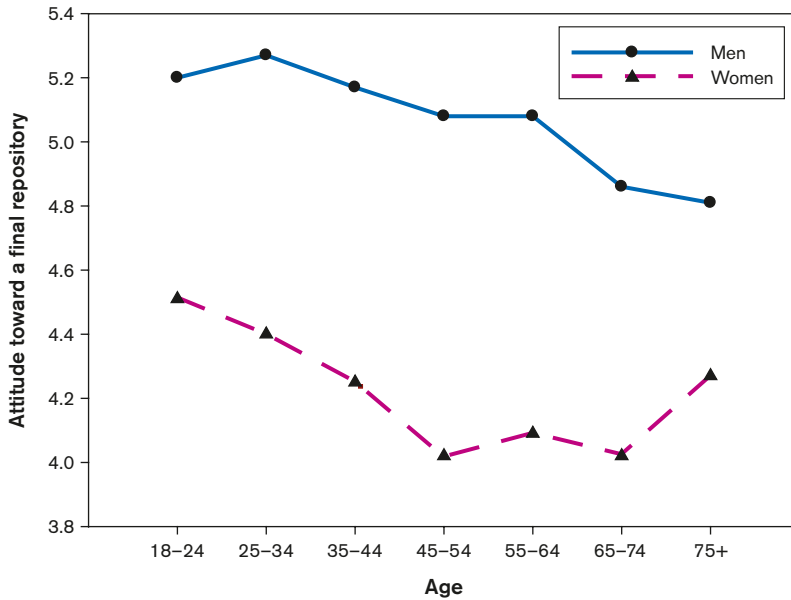


Figure B-4. Attitude as a function of age; aggregated data from Oskarshamn and Östhammar.

could be explained only marginally by the difference in the extent to which an individual feels he or she can influence the decision. When the attitude to a final repository was adjusted for perceived opportunity to influence, the difference was only reduced by 20 percent, which means there is a great deal that remains to be explained.

Attitudes to nuclear power was investigated in the four samples in 2005, compared to the results based on data from 2001 in Östhammar and Oskarshamn. As expected, attitudes to nuclear power had become more positive, and the biggest change was in Oskarshamn and Östhammar.

Can positive attitudes to a final repository be explained by the fact that Oskarshamn and Östhammar have many residents who are directly or indirectly employed by the nuclear technology industry? In order to investigate this, a job-related question was added to the questionnaire: *Do you or does anyone in your family work at a company that supplies products or services to the nuclear technology industry (nuclear power plant, management of nuclear power waste)?* The results showed that attitudes in Oskarshamn and Östhammar could only partially be explained by working for the nuclear technology industry (maximum of 25–30 percent of the effect). The benefit or risk of a final repository to the municipality were then used to explain some of the differences between the four sample categories. The dimension risk and benefit was responsible for no less than 66 percent of the variation in attitude

and benefit weighed much more than risk. When taken together with the effect of working for nuclear technology industry, over half of the differences between the samples in terms of attitude to a final repository could be explained by the perceived benefit of a final repository to the municipality and the relatively low risk that residents of Oskarshamn and Östhammar associated with such a facility. The benefit was more important than the risk.

In conclusion, attitudes to a final repository were much more positive in Oskarshamn and Östhammar than in the rest of Sweden in 2005. Attitudes in these municipalities had also developed in a positive direction since 2001. Attitudes to nuclear power could only explain a part of the difference of opinion in terms of a final repository. Working in the nuclear technology industry (directly or as a subcontractor) explained about a third of the differences. However, the perceived direct benefit or risk of a final repository could explain over half of the variation between the samples. It was primarily perceived benefit to the municipality that had an impact.

Attitude differences between the two site investigation municipalities could well stem from the information that was presented in the two municipalities. If this is the case, then information may also have had an indirect effect on attitudes by altering views on benefit and risk. The large gender differences in attitude toward a final repository were probably due to several underlying factors. The power aspect explained about 20 percent of the gender differences in attitudes toward final repository. There are obviously more factors to take into consideration when seeking a more complete explanation for the gender differences.

National nuclear fuel policy in a European Union?

Per Cramér

University of Gothenburg

This project was carried out by Per Cramér, Thomas Erhag and Sara Stendahl from the Department of Law at the School of Business, Economics and Law, University of Gothenburg.

The principle of national responsibility is analysed in the project “National nuclear fuel policy in a European Union?”, i.e. the principle that each country takes responsibility for its own spent nuclear fuel. The management of spent nuclear fuel has become subject to regulation on several different levels: national, regional and international. Because some countries view spent nuclear fuel as a resource for reprocessing and extraction, while others, e.g. Sweden, view it

as an issue of responsibility for its final disposal, there are uncertainties and doubts. What then is the legal scope of a national Swedish policy on nuclear fuel and thus for rational political decisions on a national level?

The aim of this project was to examine the potential legal scope of a national nuclear fuel policy by analysing relevant aspects of EU legislation, and thereby predict how rules and regulations might be interpreted. The Swedish policy – based on the principle that every country take responsibility for its own nuclear waste and spent nuclear fuel – is related to historical background, EU membership, international work and applicable conventions.

The task also included a forward-looking perspective to investigate what trends in European legal development are likely and how they might impact the design of a national Swedish nuclear fuel policy.

Materials and methods

The researchers reviewed the current legal situation and elucidated legal strategies that are important for future development of the principle of national responsibility. They used a legal dogmatic method, which meant that laws, preparatory work, treaty regulations, relevant policy documents and court rulings were systematised and analysed. It was important to identify the areas where conflicts between different levels of governance might arise, i.e. between Swedish law, EU law and international law.

Results

The amount of high-level radioactive waste from the European nuclear power sector is constantly increasing, but most EU Member States still lack set plans for final disposal. The increasing societal relevance and international character of the nuclear waste issue is reflected in an increase of activity over the past ten years in terms of regulations – both within the framework of the IAEA and the European Union.

There are two aspects of the principle of national responsibility. One concerns the way in which Sweden takes responsibility for waste that is generated within the country when nuclear energy is extracted. The other concerns the rights that Sweden claims to have to prevent other countries from permanently depositing or temporarily storing their spent nuclear fuel in Sweden. The latter aspect of the principle has been upheld in a legal ban in Sweden on the permanent disposal and temporary storage of spent nuclear fuel from other countries. How Sweden will take responsibility for its own spent nuclear fuel is not, however, regulated by law. These two aspects of the principle have been handled differently. Division of responsibility for Sweden's own waste is regulated by law, which safeguards a dynamic attitude to developments in the area, but there is a

statutory ban on waste from other countries. There is tension in the relationship between the obligations associated with EU membership and a Member State's upholding the principle of national responsibility for disposal of nuclear waste and spent nuclear fuel. It might be argued that such a discrepancy in the interpretation of the principle does not serve its legal power.

The issue is regulated on a multinational level primarily through the Nuclear Non-Proliferation Treaty of 1970 and the IAEA Joint Convention on the Safety of Spent Fuel Management and Radioactive Waste Management of 1997. The Nuclear Non-Proliferation Treaty reaffirms the sovereign right of all States to develop a national civilian nuclear power industry, and the competence to decide on the design of the final step of the nuclear fuel cycle falls within the framework of that sovereignty. Accordingly, governments are free to apply a principle of exclusive national responsibility for disposing of spent nuclear fuel and radioactive waste. This sovereignty is also expressly confirmed in the Joint Convention. Since the beginning of the 1990s, however, the IAEA has initiated a series of studies on the legal, political and physical prerequisites for establishing multinational facilities for interim storage or final disposal of spent nuclear fuel or high-level nuclear waste. Several arguments in favour of this type of development have been presented in reports from these studies. A twofold interest is at the core of these arguments: partly an interest in financial gain and technological economies of scale, and partly in security policy to prevent the spread of fissionable material that can be used for military purposes. The political decision to take part in this type of international collaboration, however, is clearly within the framework of sovereign national competence.

The issue of responsibility for spent nuclear fuel is not directly regulated within the framework of the European Union. Common legislative initiatives from the Commission for final disposal and temporary storage methods for spent nuclear fuel have been blocked by Member States. The issue of responsibility has a national character, which is expressed in the legislation of some Member States; since this is discriminatory on the basis of nationality, the issue appears at first to be in contradiction with regional European integration. Ideas on integration are expressed within the system for fuel supply and right of option in the Euratom Treaty and in the rules on free mobility in the Euratom and EC Treaties. This regulation by treaty has the potential to cover national regulation for nuclear waste and spent nuclear fuel management. There are equivalents to the Swedish import ban in several other countries, e.g. Germany and France. Sweden had a ban on import throughout its membership negotiations and made it clear that it considered sovereignty to be a prerequisite for those negotiations. At the same time, it should be noted that there is no binding EU legislation wherein the principle of national responsibility is expressed. Various political documents declare, however, that no State shall be forced to accept spent nuclear fuel or nuclear waste from another country.

Thus, there is a hypothetical possibility that the Member States' right to uphold a principle of national responsibility may be subject to review by the European Court of Justice. In summary, there has also been a consistent thread in the conduct of the Union since 1992, recognizing national responsibility and leaving the door open for voluntary joint solutions. Opportunities are very limited in terms of adopting legislation that binds Member States and that impacts their current national regulations.

Like night and day despite the same nuclear origin? Concerning (dis)similarities and opinions in the treatment of the nuclear waste issue in national and local/regional media

Annika Egan Sjölander

Umeå University

This project was carried out by Annika Egan Sjölander, Senior Lecturer in Media and Communication Studies at the Department of Culture and Media Studies, Umeå University.

The aim of the project was to analyse mass media coverage and the formation of public opinion in the press and in television news in relation to the nuclear waste issue during the first four years of the site investigations. The empirical material was analysed quantitatively and qualitatively and obtained from national and regional media, as well as from the local media in Östhammar and Oskarshamn, the two site investigation municipalities.

Materials and methods

The data is collected from the beginning of the site investigations in December 2001 until December 2005. The material includes a total of 1,118 articles from fifteen different mass media channels and 77 television reports; see Table B-1. Analyses of the material are partly based on quantitative content analysis. This is a method well suited for investigating *what* is addressed in the media, *who* the players are and to illustrate how journalist coverage and the media debate are distributed over *time*. A qualitative text analysis is also undertaken to analyse the dominant themes in the media coverage more in detail.

The collected material includes all of the text types that explicitly address Swedish nuclear waste and its management, with the exception of advertising, campaign material and articles about radioactivity in general, for example, on ionizing radiation, medical treatment, nuclear power, transmutation and nuclear weapons.

Results

The quantitative analysis shows that newspaper texts constituted the overwhelming majority of the material (over 90 percent), but that television news was also responsible for a fair share (77 reports over the period). A review of the whole material shows that the media coverage was in general most intense in 2002 and 2005. One exception was *Östhammars Nyheter*, which steadily increased its coverage over the period; in 2005 it had over twice as many articles as its local competitor *Oskarshamns-Tidningen*. As outlined in Figures B-5 and B-6, the greatest amount of material was found in the local media. A total of 297 texts were produced in 2002. This was when Östhammar, Oskarshamn and Tierp took a stand on continued participation in the localisation programme. In 2005 (with 331 published texts), SKB presented its preferred welding method for copper canisters, Greenpeace and other environmental organisations criticized the decision to transport older Swedish nuclear waste to Sellafield, and there was a debate on how the Swedish Prime Minister and the Government viewed the process in the site investigation municipalities. All these events generated considerable media attention.

Table B-1. Overview of the newspapers included in the study.

Selected newspapers	Published/ broadcast	Political orientation	Circulation 2005 (weekdays)	Number of articles
NATIONAL PRESS (207)				
Morning papers				
Dagens Nyheter (founded 1864)	Daily	Independent liberal	363,100	68
Svenska Dagbladet (founded 1884)	Daily	Independent liberal conservative	187,100	69
Evening papers				
Aftonbladet (founded 1830)	Daily	Independent social democratic	429,000	41
Expressen (founded 1944)	Daily	Independent	321,800 (2002)	29
LOCAL PRESS (911)				
Upsala Nya tidning (founded 1890)	Daily	Liberal	58,500	177
Östhammars nyheter (founded 1996)	Weekly	Independent	2,600	148
Nyheterna (founded 1860)	6 days/ week	Social democratic	6,000	365
Oskarshamns-Tidningen (founded 1880)	6 days/ week	Liberal conservative	10,000 ¹	221

¹ Information obtained from OT/Barometern's customer service. OT's and Barometern's circulation is normally aggregated jointly, which came to a total of 43,900 printed copies in 2005 (Tidningsutgivarna, 2005).

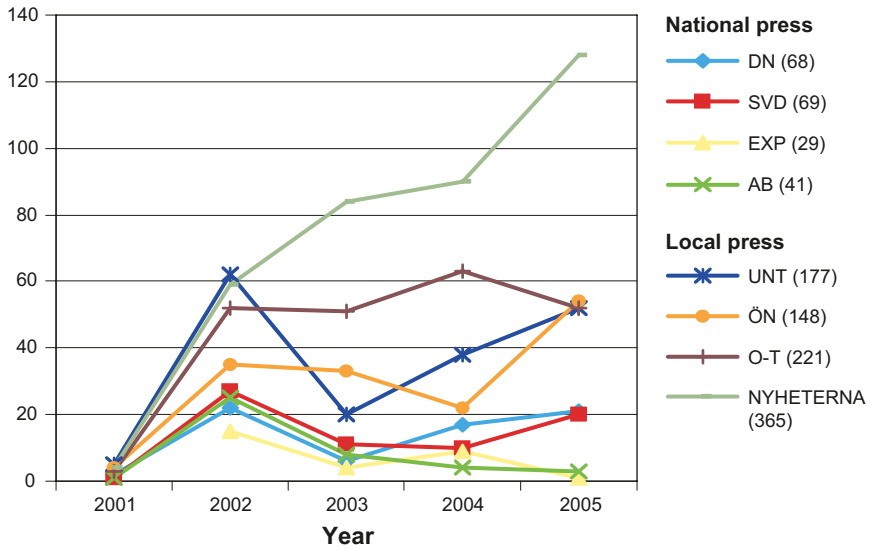


Figure B-5. Media coverage by year and newspaper.

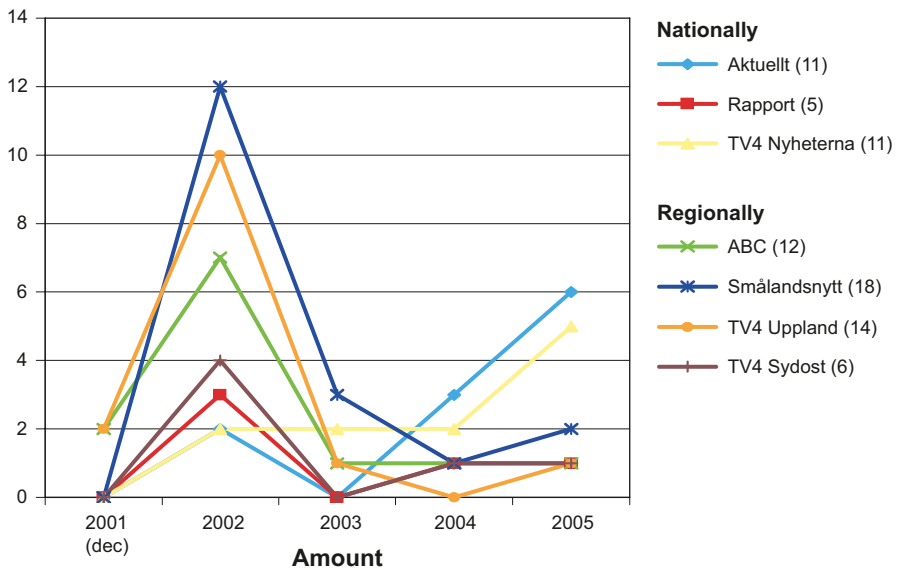


Figure B-6. TV news over time.

The newspaper material, both editorial and non-editorial, was analysed in terms of type and content. See Table B-2. In the editorial category, texts written or edited by editorial staff are included. The editorial category contains material that commonly aims to shape public opinion, such as letters to the editor, debate articles and editorials. The non-editorial, journalist material dominated all of the newspapers. Out of a total of 1,188 texts, only a share of 197 were editorial texts aimed to explicitly shape public opinion. The rest were newsroom produced. There was, however, a great deal of variation in the shares of editorial versus non-editorial material in the various newspapers.

Two dominant subjects in the press material were the site investigations (decision to initiate a site investigation, results from testing specimens, etc.), and SKB and its different activities. Other frequent themes included the final repository, acceptance, information and study visits, resistance and negative opinions on nuclear waste. As much as 84 percent of the reviewed text material was produced by journalists, and local reporters produced four out of five of these texts. It is pointed out that all of the studied newspapers had a remarkably low degree of investigative journalism. Egan Sjölander writes: “The task of journalism is not just to keep citizens informed, but also to scrutinize people in positions of power in the community and to give the individual a voice in the public arena. How the newsrooms worked and the nature of the discussion between journalists remains to be investigated. It is interesting to note, on the basis of the content analysis, that specialist know-how regarding nuclear waste issues in the journalist profession is more commonly found among local reporters than in the larger newsrooms with greater resources.”

Table B-2. Type of text in the press. Percent and number of different types of texts for the selected newspapers. Number is in parentheses.

Type of text press	DN	SvD	AB	EXP	UNT	ÖN	OT	NYH
Editorial								
News items (187)	28 (19)	19 (13)	3 (1)	45 (13)	12 (22)	15 (22)	19 (42)	15 (55)
Articles/ Interviews/ Reports (646)	28 (19)	21 (15)	54 (22)	21 (6)	69 (122)	57 (85)	52 (116)	72 (261)
Other (such as short notices on the first few pages) (88)	19 (13)	9 (6)	14 (6)	–	3 (5)	5 (7)	11 (25)	7 (26)
Non-editorial								
Lead editorials (30)	7 (5)	3 (2)	17 (7)	7 (2)	1 (2)	4 (6)	2 (4)	0.5 (2)
Letters to the editor/ Debate articles (167)	18 (12)	48 (33)	12 (5)	27 (8)	15 (26)	19 (28)	15 (34)	5.5 (21)
Total (n=1,118)	100 (68)	100 (69)	100 (41)	100 (29)	100 (177)	100 (148)	100 (221)	100 (365)

Egan Sjölander identifies both similarities and differences between national and regional/local media. Some of the similarities include the use of images and increased coverage when a new phase commenced. Some of the differences identified concerned what was focused upon and which angles were used. As opposed to the local press, the national media debated the issue of waste and nuclear power more often at the same time, and in relation to alternatives to the KBS-3 method. The local press, on the other hand, monitored the site investigations and SKB's other activities much more closely, and these issues also dominated their news coverage. The national evening papers also included reviews of fictitious stories about dangerous nuclear waste, in contrast with the local press. Their reported more that SKB had located rock that was free of fractures and thus suitable for disposal of spent nuclear fuel, or that SKB had developed a new welding method. Consequently, Egan Sjölander states that the mass media coverage varied a great deal during the first four years of the site investigations. The greatest and potentially most significant differences between the regional/local and national media concerned the coverage of all the local efforts related to the issue of a final repository, the interest in the ongoing test drilling activity and the municipal processes in Östhammar and Oskarshamn. These areas were generally ignored by the national press and television. Egan Sjölander questions whether the absence of conflicts due to the widespread acceptance on a local level might be a reason for the low level of national interest in these processes. She asserts that both quantitative and qualitative differences in reporting exist in the analysed material, and raises the question what the impact of these discrepancies might have on the future decision-making process.

In activism or disinterest? Swedish young people's view on democracy and environment, science and technology in a comparative perspective

Thorleif Pettersson

Uppsala University

Mikael Sandberg

Halmstad University

This project was carried out by Torleif Pettersson, a sociologist of religion at Uppsala University, and Mikael Sandberg, a political scientist at Halmstad University. Petterson was responsible for the international study /15/ and Sandberg for the Swedish longitudinal study /12/.

One point of departure for this project was the idea that current and future attitude toward a final repository for spent nuclear fuel, decisions regarding its inception and placement and its long-term legitimacy cannot be viewed

solely as a separate and isolated attitude here and now. An individual's perception of this type of specific issue is part of a complex of attitudes toward other phenomena, which are also shaped by more fundamental ideas related to values, risks and decision-making systems. For example, an individual's attitude toward a final repository might be connected to a related attitude to nuclear power, which might be linked in turn to an attitude to other energy supply systems, new technology in general, other specific technical systems, political perceptions and the decision-making system (democracy) to which the person belongs locally, nationally and internationally. These relationships can, in turn, be traced in different proportions for different people to the fundamental value dimension attributed to self-transcendence and willingness to change. All such components of and driving forces behind attitudes toward a final repository change relatively quickly and influence one another – in individuals, between individuals and between different groups and countries. This project focuses on young people, who must live a long time with the results and who take some of their early attitudes with them throughout life. The authors analyse how some of the elements of this fabric of attitudes and driving forces are related and develop.

The longitudinal study investigates changing views among young people during the past decade regarding nuclear power and other technologies, technology and science in general and democracy. What role has age played compared to year of birth in terms of changes in attitudes toward technology, primarily the use of nuclear power, and democracy since the 1980s? What processes have changed views on technology and democracy among young people over the past few decades?

The international study investigates the way attitudes toward democracy and politics on the one hand, and science and technology on the other, are related to both fundamental values and as well as to the economic and political structures in a number of different countries. The issue of whether Swedish youth deviate from young people in other countries in terms of having the same ideas about democracy as their adult compatriots, but different ideas about science and technology is also investigated.

Materials and methods

The longitudinal study is empirically based on data for Sweden during the period 1986–2005 from the SOM Institute and supplementary election survey data from 1979. Factors that may be used to explain attitudes toward nuclear power are extracted from the SOM Institute and election data, e.g. “phase out” or “use”, “being for a socialist society”, how “satisfied one is with democracy in Sweden” and a few individual qualities. The material is analysed mainly using diffusion theory and regression analysis.

The international study uses cross-sectional data (World Values Survey 2006 and International Social Survey Programme 2004) from 24 selected countries. From this data, factors are used to shed light on attitudes to democracy and science and technology, as well to indicate each country's basic value dimensions, such as "degree of self-transcendence", "willingness to change" and individual qualities such as gender, age and education. The analysis is primarily based on factor and regression analysis. The cross-sectional material does not contain any questions that directly concern nuclear power. None of the material contains questions about nuclear waste.

Results

The longitudinal study (Sandberg) indicates that criticism of the system by young people has abated since the 1960s and 1970s, both with regard to energy systems based on nuclear power and the way the political system works. The analysis indicates that it is primarily people born in the 1940s and 1950s who have changed their position and become less critical both to nuclear power and to democracy as such. Attitudes to nuclear power seem to be better explained by age than year of birth, while the opposite applies to attitudes to democracy.

Diffusion theory generates a hypothesis on the process, which is primarily investigated in terms of how views on technology and democracy among young people have changed over the past few decades. This means that some attitudes seem to propagate rapidly over a relatively long period of time. This type of attitude diffusion is established as "path dependence" where the extent of a specific attitude at a given point in time changes slowly and thus greatly depends on its scope during earlier periods of time.

Technology-related attitudes in particular seem to spread more as an effect of time passing (i.e. as a diffusion course of events with a successive, cumulative increase of an already achieved level) than as an effect of other background factors, e.g. that individuals age, that they belong to different generations, that they are male or female or that they have specific values for other characteristics. The analysis was performed with a developed diffusion-based model to determine the impact of different factors on the distribution phenomenon that is related to attitudes. The summarized analysis shows that about 65 percent of the attitudes toward nuclear power in a specific year can be related to the previous year's value. Other factors at the same time point have a more limited impact. It is more difficult to determine this type of diffusion process for attitudes to democracy. It may exist, but the available time series are too short to ascertain such a process.

Everyone ages over time. Over a lifetime, young people accept new technology easiest and quickest, but it is middle-aged people who have the greatest access to technical artefacts and have the most positive attitude to nuclear power. A significantly higher proportion of the people who have access to a personal

computer are positive to nuclear power. Access to personal computers greatly increased during the period 1986–2005. If these connections are interpreted causally, the result is a continuously positive effect on the acceptance of nuclear power. Similar patterns emerge when comparing mobile phone users to non users: the latter group is more critical to nuclear power than the former group. One interpretation of this is that personal computer use and other new technology usage results in a positive attitude to other types of technology, and thus also leads to greater acceptance of nuclear power. Another interpretation that cannot be excluded is that these connections indicate that some of the same people (positive to technology and nuclear power) are self-selected into both groups and that there is another factor that explains the expansion.

As regards attitudes to democracy and the way it works, the youngest are most positive while older people are more critical. Acceptance has already been achieved among most people.

Despite the dominance of the distribution hypothesis as the explanation for attitudes toward technology, nuclear power and democracy, and the way democracy works in Sweden at different points in time, the impact of other factors is not entirely negligible. A relatively constant 10–20 percent fewer women than men are positive to the use of nuclear power. Individuals who place themselves to the right on a left-right political preference scale are more positive to nuclear power. Support for anti-nuclear power parties such as the Left Party of Sweden, the Swedish Green Party and the Swedish Centre Party probably did not have an impact on increased acceptance for this type of energy, since the parties had a combined total of 20 percent of party sympathies over the period, with no specific increases or decreases. The same applies to the proportion of women in the population, which may explain some of the observed cross-sectional differences but not as much of the change since the population's gender ratio is fairly constant over time.

Perceptions of risk play a role: the less the perceived risk of a major accident at a nuclear power plant, the more inclined one is to the use of nuclear power. Regardless of one's risk perception, everyone became more positive to nuclear power from 2000 to 2001, including those who perceived a great risk. Attitude to final repository of high-level radioactive waste in one's own municipality also plays a lessening role in terms of nuclear power acceptance. Acceptance of nuclear power is also growing among opponents to a final repository in their own municipality. On an individual level, some of the factors that most substantially obstruct a more positive attitude to nuclear power include: 1) being a maximum of 19 years of age, 2) being a woman, 3) being in the age group of 20–29 year olds, and 4) believing that there is a great risk of a nuclear power accident in Sweden. Young women who are aware of the risks involved with nuclear power are most immune to the epidemic growth of nuclear power acceptance.

In order to identify factors on a community level that might have impacted how attitudes to nuclear power changed from year to year between 1986 and 2005, it is important to look at what both changed in the same way as nuclear power acceptance and was significant on an individual level. Thus narrowing down the search, we find that only one of the individual factors remains: those who have access to a personal computer. This proportion has grown quickly, and has begun to reach its saturation level with an increasingly lower rate of growth. This may mean that the new communication technologies are also important in terms of attitudes to other technologies such as nuclear power.

The material shows a clear, high and relatively constant connection between having confidence in politicians and being satisfied with democracy in Sweden. Supporters of all political parties are also largely satisfied with democracy. The people who consider themselves “clearly to the right” on the left-right scale are most dissatisfied with democracy. However, there is no support for the thesis that young people are more dissatisfied than older people. The age factor plays a relatively limited role in central issues concerning the way our political systems are perceived to work, even if young people are somewhat more positive. Thus, this tendency is contrary to the attitudes toward nuclear power where young people are most critical.

The conclusion of the longitudinal study is thus that young people do not deviate much from older people in terms of their view of democracy. The international cross-sectional study shows the same results. However, the Swedish material indicates that young people play a role since they tend to accept new technologies. These new technologies, which have led to drastically changed behaviour and systems for communication over the past few decades, seem even in the long term to have contributed to increased acceptance of new technologies for energy production such as nuclear power. As for all claims of causality, this is still an interpretation/hypothesis and, despite support from data, it is applicable only until other factors are found that better explain the observed increase in nuclear power acceptance.

The international cross-sectional study (Pettersson) combines four perspectives on how young people relate to democracy and politics by 1) putting them in a dynamic change perspective; 2) regarding them as being shaped by the Swedish political culture; 3) comparing them to their elder compatriots; and 4) analysing their view of democracy and politics as an expression of their fundamental values. Young people’s views on democracy and politics do not exist in a cultural and values vacuum. Thus, their views on democracy and politics should be seen against the background of their fundamental values. These values have been partially shaped by the political culture of their community. To better understand the values of modern Swedish youth and how they regard democracy and politics, they were compared to young people from other countries. A comparison is also needed from other age categories in order to understand any distinctive characteristics in the outlook of young

people. In an effort to capture a historical dimension, this analysis also takes into consideration the way perceptions of democracy and civic ideals have changed over the past quarter of a century.

The analyses aim primarily to yield results for individuals in the project who are defined as “future adults”. These are people between the ages of 18 and 27 who do not fulfil more than one of the following criteria: married, have child(ren) or a full-time job. This is a relatively new category of young people that falls between teenage/youth and adulthood.

Young people’s attitudes to democracy and politics are studied in light of their fundamental values. The latter are assumed to connect different people’s opinions and outlooks on specific issues into somewhat coherent wholes. The analysis produces value dimensions as a synthesis of individual questions/personal variables against a background of what is to be explained. This results in two value dimensions: “emancipative and self-transcendent values” and “willingness to change and secular-rational values”. Self-transcendence is characterized by a positive view of helpfulness and the common good, horizontal social trust in others, active civil service, tolerance of social minorities, and the view that the integrity and autonomy of the individual is more important than economic development and law and order. Willingness to change is characterized by openness to change and by attributing greater value to creativity, freedom and excitement than to preservation of the status quo in terms of traditional authorities, such as religion and the family.

Sweden appears to be a special case with high scores on both of these dimensions. In all of the countries, including Sweden, young future adults score higher on willingness to change and on secular-rational values. With regard to emancipative and self-transcendent values, adults in many countries score higher than future adults. Sweden, however, is an exception in this respect, and it is not possible to say that future adults in Sweden are less interested in the common good than other Swedes. Thus, the attitude of Swedish youth to democracy and politics is fairly unique compared to most other countries and the world as a whole.

The project analyses how involved future adults are in politics, how pro-democracy they are, what they expect from a democratic form of government, how they evaluate democracy in their own country, how optimistic they are in terms of democracy’s development and how they look upon democratic citizenship. One common result for the 24 countries is that the differences between future adults and current adults are smaller than the differences between countries. Swedes have a more positive view of democracy and politics and the distance between Swedish future adults and current adults is smaller than in other countries. Young people follow in the footsteps of adults regarding perceptions of democracy and politics. Thus there is no cause for pessimism based on the belief that Swedish youth will lead developments away from traditional Swedish political views.

The analysis also indicates that perspectives on democracy and citizenship have changed and become more oriented toward the individual, i.e. from a view of democracy that is community-centred to one that is oriented toward the individual, and from a concept of citizenship based on allegiance and/or solidarity to a more activist attitude. This change is most obvious in Sweden. This change is analysed on the basis of a centre-periphery model, whereby changed views are propagated from the centre of society, where resources are plentiful, to the periphery where resources are scarce. The similarity between future adults and current adults is greater in Sweden than in many other countries. The Swedish political culture is unique compared to other countries with regard to its valuation profile, its positive views on democracy and politics, as well as the fact that views are shared by future and current adults.

A comparison of the results thus far from the two studies within the project justifies an investigation of whether Swedish youth deviate from young people in other countries in terms of having the same ideas about democracy as their adult compatriots, but different ideas about science and technology. Thus in one of the final segments of the project (in a contribution to the yearbook 2008 /17/), Pettersson analyses the issue of whether the difference between the attitude of Swedish youth to democracy respective science/technology is specifically Swedish. Does this attitude deviate from that of young people in other countries? International data on attitudes to democracy and technology/science are needed in order to obtain a basis for such an analysis. Attitude to democracy was determined on the basis of responses to the following questions: 1) To what extent do they believe a democratic political system is positive or negative in terms of governing their country? 2) How important or unimportant do they believe it is to live in a democratic country? and 3) How positive or negative is it to have a strong leader who does not need to consider parliamentary or political elections? Attitude to science and technology was determined based on responses to the following questions: 1) Do they believe scientific progress in the long run will benefit or harm mankind? 2) To what extent do they agree or disagree with the idea that science and technology make life healthier, easier and more comfortable? and 3) To what extent do they agree or disagree with the idea that science and technology afford better opportunities for future generations?

An analysis based on such an empirical point of departure, shows that Sweden has the highest scores on pro-democratic attitude among all the investigated countries (for both future and current adults) after Norway and Germany, which is consistent with previous analyses. Bulgaria and Brazil have the lowest scores. However, when considering a positive view on science and technology, Bulgaria, Poland and South Africa have the highest scores while Japan, Slovenia and Uruguay have the lowest; Sweden has average scores, placing the country in 7th place – after the U.S. but before Canada. The positive view on science and technology has a weak negative correlation with the UN's Human Development Index. Hope associated with science and technology seems to be the greatest in those countries where science and technology are least extensive.

In countries where the adult segment of the population has low scores in terms of pro-democratic attitude, the same attitude is found among future adults. In countries where adults demonstrate high scores, the same is true of future adults; the older segment of the population explains about 70 percent of the young segment's attitude. The corresponding figure for science and technology is 60 percent.

Adults are more pro-democratic than young people, but about three-fourths of the variation in adult precedence can be traced to how long the countries have had a democratic form of government. The longer the tradition, the greater the adults' lead and the more disinterested young people seem to show. Sweden is an exception in this respect. Swedish youth are as interested in a democratic form of government as their elder compatriots. As regards attitude to science and technology, however, both younger and older Swedes demonstrate average and expected values.

The answer to the main question in this concluding analysis shows that future adults in Sweden are similar to today's adults in other countries in that they have a similarly restrictive view of science and technology as their elder compatriots. On the other hand, they are considerably more pro-democracy, and in this respect more like the adults in their own country, which differs from youth in other countries.

Ethical arguments in final repository issue

Magnus Frostenson

The Stockholm School of Economics

Magnus Frostenson, business ethicist at Uppsala University, analyses differences in ethical values concerning a final repository for spent nuclear fuel in this project. His assumption is that ethical values are expressed in argumentation and can be identified by studying the debate and discourse. These values may, in turn, be significant in decision-making. Conflicting values can be the underlying cause of some ethical differences that are difficult to handle. On the other hand, when debaters share similar ethical values there is a risk that important issues are not brought up.

The aim of this project is to contribute to a better understanding of the differences in ethical values concerning the final repository. The analysis aims to answer a number of questions: Who are the public speakers on the issue of a final repository, what are the topics of discussion, what are their arguments and on what ethical values do they base their arguments?

Materials and methods

The project takes an analytical approach, which means that the ambition is empirical, not normative. By studying the argumentation and ethical values of relevant spokespersons, it is possible to obtain some insight into the practical significance of the arguments and values in relation to the specific issue of a final repository. The argumentation of relevant persons is studied on the basis of ethics theory and argumentation analysis in an effort to delineate the ethical values upon which their arguments are based.

The empirical study of public debaters on the issue of a final repository is based upon a review of those who participated in the consultation during the period 2002–2006 and those who have discussed the issue in the media. The criteria used to select argumentative texts and thus be included in the study were that a written article expressed opinions and perspectives on the disposal issue in a factual polemic in opposition to another view.

The project highlights some ethical principles that are applicable to the nuclear waste issue: The principle of fairness, which can be understood to mean that unjust burdens must not be placed on one who has not been able to benefit from a specific activity; and the principle of autonomy, which concerns self-determination and the freedom to act (e.g. between generations). The principle of utility, which states that an act is right if it produces at least as much happiness as an alternative action, is also applicable here to some extent.

An analysis of the initial question – who is debating the issue of final disposal? – is based upon an interesting theoretical, descriptive view from the outside. The issue is not studied from SKB's perspective as an interested party, but more generally from the perspective of those who are actively involved in the issue and the grounds for their position. A possible criterion is that public speakers who have the power to influence, who have morally acceptable intentions and are eager to have an influence on a particular issue are viewed as the most important stakeholders. This might offer a clue: An individual from the general public – even if he or she has strong views on the issue – can hardly be viewed as a stakeholder who has the power to act on an issue. A group of terrorists who can truly have an impact on an operation may be viewed as illegitimate stakeholders, for example, while a political party with both power and legitimacy may be uninterested in prioritizing the issue at stake and thus not qualify as an active stakeholder. In the environmental-ethical debate, future generations are often considered legitimate stakeholders, though they have no power to affect what has already happened. Their legitimacy is morally founded, and often expressed in terms of fairness between generations or a benefit principle. The field is wide open for many to claim to represent future generations.

Results

Who is publicly debating the issue of final disposal? The material and selection criteria applied in this project point to a number of environmental organisations, mainly MKG (Swedish NGO Office for Nuclear Waste Review), Milkas (the Swedish Environmental Movement's Nuclear Waste Secretariat) and Oss (Public Opinion Group for Safe Final Storage of Radioactive Waste). Other participants include MFK (Environmental Friends for Nuclear Power), Swedish National Council for Nuclear Waste (Kärnavfallsrådet) and SKB. Counties, Regional federations of county councils, county administrative boards, as well as authorities such as the Swedish Radiation Protection Authority (SSI) and Nuclear Power Inspectorate (SKI), (today's Swedish Radiation Safety Authority, SSM) have less argumentative texts.

The topics that are discussed fall into three categories: the choice of a site, a safe method and the decision-making process.

The focus on Östhammar and Oskarshamn as the main alternative sites for a Swedish repository has been subject to criticism, primarily from a number of environmental organisations, on the grounds that localisation of a nuclear fuel repository should be investigated more. Milkas, for example, is of the opinion that SKB "is not choosing a municipality on the basis of where it would work best technically, but on the basis of where nuclear waste storage can be accepted politically by the municipal government and public." For SKB and the Swedish National Council for Nuclear Waste, the issue is viewed as multi-dimensional and the expression "best possible site" does not mean anything without a specification, i.e. best in what regard and the prerequisites for the application of the term. Use of political acceptance and positive public opinion as criteria for site selection is another source of conflict. SKB asserts that political support and public opinion are fundamental prerequisites for constructing a final repository, though some environmental organisations believe that these should in no way be criteria for site selection.

There are also divergent opinions regarding the choice of method, in light of a statement in 2001 by the government whereby the KBS method was given a unique position as a prerequisite for the planning of SKB's site investigations. There is scepticism, especially among environmental organisations, to the method and to the fact that alternatives to deposition in deep drilling holes do not play a more prominent role. There is also great disparity of opinion on the issue of retrievability. The questions that divide the spokespersons are whether or not retrievability is compatible with long-term safety and whether or not it is a prerequisite future generations' freedom to act. Environmental organisations are critical toward the decision-making process associated with the final repository for spent nuclear fuel, including the allocation of responsibilities of the participants in the process. They believe that the decision-making process has major shortcomings from a democratic point of view.

On the basis of their arguments, the project has grouped public debaters into four categories: process drivers (SKB), observers (authorities, municipalities, county administrative boards, Swedish National Council for Nuclear Waste), process critics (MKG, Oss, Avfallskedjan) and opponents of nuclear power (Milkas, Greenpeace). There is a great deal of disagreement among those who are actively involved in the issue of a final repository. The project notes that though the various debaters have divergent views, they share several important ethical values, above all the principle to do no harm, of fairness between generations, of the responsibility of the producer and co-determination. The project has found that a major underlying controversy concerns the relevance of functional values in relationship to ethical values. The issue of a final repository involves different views on the relevance of process efficiency in terms of time, economy and general socio-economic impact.

Finally, the project discusses the possible risk that the debate on the final repository and nuclear power creates a framework that is too narrow and symbolically charged for public debate. Nuclear waste is a topic of lively and occasionally infected discussion that is relatively isolated from other important environmental-ethical issues. This can be claimed by both the nuclear power industry, which focuses on waste as a problem that can be solved, and the strongly critical environmental organisations for whom waste is a primary issue. Can nuclear power and associated waste problems be discussed without considering the advantages and disadvantages of other sources of energy and environmental problems, resource consumption and the priorities of welfare in general?

How young people view democracy and technology issues

Lennart Sjöberg

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This project was carried out by Professor Lennart Sjöberg, Center for Risk Research at the Stockholm School of Economics.

The overall objective of the project was to examine the structure and reasons for attitudes toward a final repository for spent nuclear fuel. Attitudes were expected to vary among groups since previous research has shown differences between youths (below the age of 25) and older people, between men and women and between the two municipalities where site investigations were conducted, Oskarshamn and Östhammar, as well as between these towns and the rest of the country. The project was thus focused on explaining the differences in attitude between age and gender groups, but also to analyse location-dependent differences. A secondary objective was to carry out a closer investigation of attitudes toward nuclear power, since they contributed so significantly to the understanding of attitudes toward a final repository in a previous study.

Materials and methods

A comprehensive questionnaire (29 pages in A5 format), which had been discussed previously in focus groups, was used to collect data between November 2007 and February 2008. Answers to or assessments of 350 questions and variables were requested. It took approximately 35 minutes for respondents to answer the questionnaire, on the average. The questionnaire focused on attitudes toward a final repository for spent nuclear fuel, though it also contained questions about nuclear energy. To enable the study of fundamental value dimensions, there were also questions formulated by researchers in the field. The information that people receive via the media or other sources, such as SKB, the municipality and opinion groups is an important underlying factor for attitudes and risk assessments. The impact of information was studied by investigating how many people in various groups received information, how they assessed it, and by comparing the attitudes of those who had received information and those who had not.

The questionnaire was sent to a total of 3,000 persons, divided into six groups: young people in Oskarshamn and Östhammar and Sweden at large (three groups); older people in Oskarshamn and Östhammar, and Sweden at large (three groups). The response rate for the entire material was 51 percent. Responses were received from 1,495 persons, of whom 654 were youths.

A distinction between causal and structural reasons for attitudes toward a final repository was made. Information and work experience in the nuclear sector were regarded to be causal factors behind attitudes, while benefit and trust were considered to be structural factors. See Figure B-7.

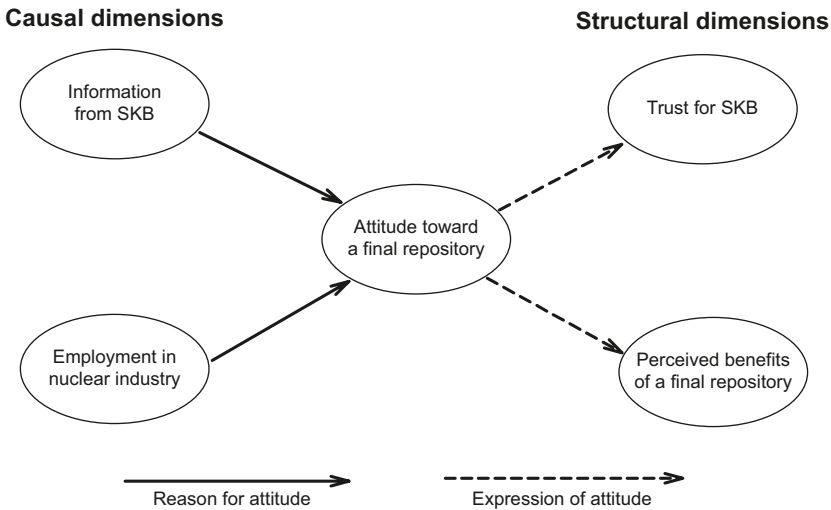


Figure B-7. Examples of causal and structural dimensions in relation to attitudes toward a final repository.

Results

In a previous SKB project conducted in the period 2004–2006, the primary interest was in a comparison between Oskarshamn and Östhammar and between these municipalities and the rest of the country. There was a more positive attitude toward a final repository in the candidate municipalities where risk associated with nuclear waste was considered small. In Oskarshamn and Östhammar, a clear majority of the men were for a final repository, while results indicated some doubtfulness among the women. The attitude toward a final repository in Oskarshamn and Östhammar had become more positive in the period 2001 to 2005. These differences could only partially be explained by the fact that people in these communities worked in the nuclear sector. In an analysis of attitudes toward a final repository in the site investigation municipalities as well as the nation at large, the most important explanation for the differences was the perceived benefit to the municipality. Other important explanatory factors were trust in science (epistemic trust), emotional reactions, attitudes toward nuclear power, and risk assessment.

Results from the survey conducted in 2007–2008 show that attitudes in Oskarshamn and Östhammar remained much more positive than in the rest of the country. Figure B-8 indicates major difference between Oskarshamn and Östhammar on the one hand, and the country at large on the other. Furthermore, the differences between Oskarshamn and Östhammar were small, with

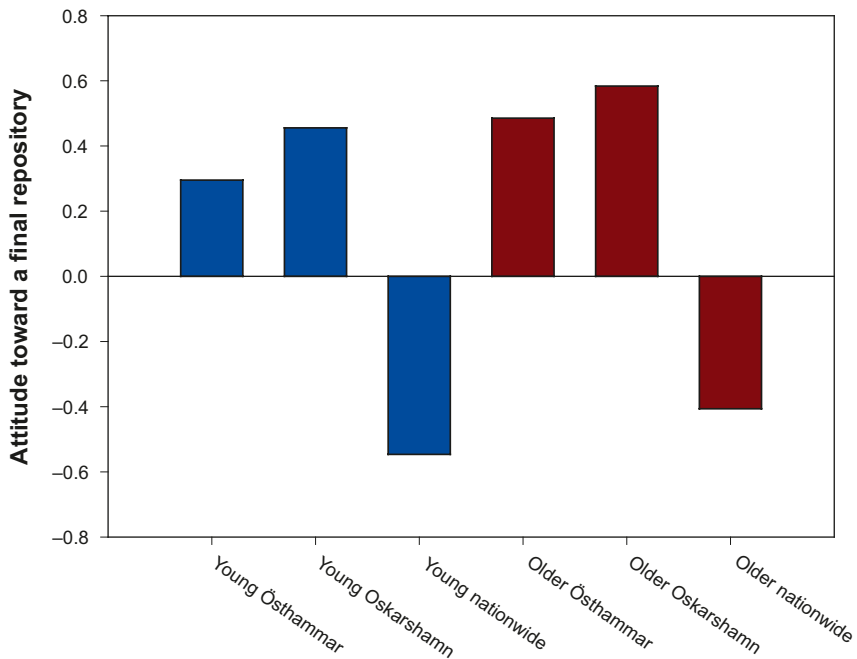


Figure B-8. Mean values of attitudes in six groups toward a final repository.

somewhat more positive values in Oskarshamn and an age-dependent difference, i.e. that older persons were more positive than younger both in the candidate municipalities and in the country as a whole. The age-dependent effect was greater among women than men, and men were generally more positive than women to a final repository, though the gender difference was smaller in Oskarshamn and Östhammar than in the rest of the country.

Respondents from Oskarshamn and Östhammar were the most satisfied with the proposed method, KBS-3, while respondents in the rest of the country wanted to see a development of other methods. Youths in Oskarshamn were more positive toward SKB's method than youths in Östhammar. Women were more positive to the method than men. It was found that values measured in terms of the dimensions Performance and excitement, Prosocial behaviour, Discipline, Individualism, Egalitarian and Hierarchical attitudes did not have any appreciable explanatory value with regard to the attitude toward a final repository for spent nuclear fuel. Thus, these value dimensions could not be used to explain the differences in attitude between districts, gender and age groups. The situation was different when it came to political values, there being a connection between political party preferences and attitudes toward a final repository. Hence, values appear to play a significant role in the formation of an attitude toward a final repository, but not if they are measured on the basis of a general scale of values, such as the kind that have been developed in cultural theory or within the Schwartz tradition.

Results concerning nuclear power showed generally rather positive attitudes toward the Swedish nuclear power programme. Perceived benefit was the most important component of this attitude. There was, however, a certain uneasiness about nuclear power, and attitudes had become less positive in Oskarshamn and Östhammar since 2005. Men were more positive than women and older respondents more positive than younger. Risk played less of a role, but was of major significance when it came to the policy attitude concerning whether or not nuclear power could be replaced by another technology. Emotional attitudes were important, unlike general values, which played a lesser role in attitudes toward nuclear power.

The questions about attitudes were complemented with a measure of intention, i.e. expected behaviour in the future, and how people would vote if there were a public referendum on a final repository in their own municipality. Results showed that younger people in Östhammar (66 percent) and Oskarshamn (77 percent) would vote in favour of a final repository in such a referendum (compared to approximately 34 percent of youths in the country at large). In the group of older persons, 79 percent (Östhammar) and 82 percent (Oskarshamn) indicated that they would vote for a final repository in their own municipality compared to 45 percent in the same age group in the entire country.

Twenty kinds of activities were listed for assessment in the survey and respondents were asked to indicate the degree to which they had, for example, “participated in information meetings arranged by SKB” and “spoken with relatives, friends or acquaintances about this issue”. Responses were compiled to generate an index used to measure an inclination to act. It was found that most respondents had not been particularly active and that those who reported attitudes that were more extreme also showed a greater inclination to act. This means that those who had the strongest positive or negative attitudes had also been those who were most active and engaged in more activities related to the final repository issue. It was concluded that if you turn to people who are particularly committed to an issue, such as that of the final repository, you will encounter people who have unusually distinct attitudes.

Results from the survey that were especially interesting are based on two series of questions about information: a) the source of the information, and b) whether or not the information included what was important (quality aspect). The questions concerned information from SKB, authorities (SSI, SKI), opinion groups such as Greenpeace and information from the municipality in which one resided. The results indicate that information from SKB in particular seemed to have a major effect, generating positive attitudes in all groups (Oskarshamn, Östhammar and the country at large), and that it was primarily those who lived in the candidate municipalities that had received, or obtained, such information. Similar effects, though weaker, were seen in information from authorities and in the municipalities. Information from public opinion groups, such as Greenpeace, seemed to have reached rather few and had some effect on the attitude toward a final repository, primarily in Östhammar. The quality of the information, i.e. whether or not the information brought up important issues, was considered to be high when it came from SKB (80 and 84 percent, in the two candidate municipalities, and 60 percent in the country at large) and somewhat lower when it came from authorities and one’s own municipality. There was less positive assessment of the quality of information from opinion groups such as Greenpeace in Oskarshamn (21 percent) and Östhammar (20 percent), but more in the rest of the country (46 percent).

It was found that information had reached the older to a somewhat greater extent than the younger, and men somewhat more than women. Young and old alike had similar assessments of the quality of the information, but women found it somewhat less complete than did the men. Furthermore, the information had had a greater impact in Oskarshamn than in Östhammar. Those who had a more positive attitude were also generally those who had received more information from SKB. There was a weak trend indicating that those who were most negative were also the ones who had to a somewhat greater extent received or obtained information; this is in line with the previously reported finding that people with more extreme attitudes were also associated with greater activity.

The results show that attitudes toward a final repository for spent nuclear fuel can be explained by the perceived risk and benefit, epistemic and social trust, and by what respondents believed were the perceptions of others. In a model where these variables were considered to be structural factors, i.e. consequences of an attitude rather than a cause, there was also a greater degree of explanatory power (these variables explained 86 percent of the variation in attitude). Perceived benefit was by far the most important explanatory factor. Separate adaptations of the model for men and women, young and old, as well as for residents of different districts all gave similar results.

Six causal factors behind the attitudes were tested:

1. SKB as source of information.
2. Work experience within the nuclear sector.
3. Experience that it is possible to influence municipal politics.
4. Interest in the issue.
5. Attitudes toward nuclear power.
6. Worry about nuclear accidents and waste.

Results indicated that these factors, together with gender, age and place of residence explained 64 percent of all variance in attitudes toward a final repository. All causal factors had a statistically significant effect.

In further analyses, it was investigated whether or not control with the help of the causal factors could reduce the effect of the variables location, gender and age. In all cases, strong reductions were obtained⁵. Given these results, it was concluded that there is support for the supposition that the proposed factors can actually be viewed as causes of the attitudes. The causal factors proved to play quite different roles, however, in explaining individual types of variation. Gender and age variation could be explained best in terms of attitudes toward nuclear power, worry and interest in the issue. Interest appeared to be particularly significant as an explanation for age-related variation. The difference between the candidate municipalities and the country at large was explained primarily in relation to information; work in nuclear technology industry and attitudes toward nuclear power. The difference between Oskarshamn and Östhammar seemed to depend primarily on information, perceived influence and attitude toward nuclear power.

In summary, a tendency among the older people to be more positive than the younger to a final repository for spent nuclear fuel was documented. This tendency could be explained by the fact that the younger respondents were more negative toward nuclear power and less interested in the final

⁵ Six causal factors explained 87% of the variation between locations, 94% of the variation between genders, 74% of the age-related variation, and 87% of the variation between Oskarshamn and Östhammar.

repository issue. It was noted that attitudes toward nuclear power deviated from attitudes to technology in general and that younger people were generally more positive to technology, with the exception of nuclear technology.

Men and women differed considerably with regard to attitudes toward a final repository. This difference can also be explained primarily in terms of attitudes toward nuclear power, and secondarily in terms of worry rather than interest, as with age-related differences. Women were more worried in most respects, but this difference was particularly great with regard to nuclear technology. Younger women in particular had a negative (or only slightly positive) attitude to nuclear power. This may have contributed to the fact that younger people, as a group, were generally less positive to a final repository than the group of older people.

There was a major difference between Oskarshamn and Östhammar and the country at large. Three factors appeared to have a significant effect and explained a large part of the difference between locations: information, perceived possibility to have some influence and work experience in the nuclear sector. These factors might be more directly related to information policies in the municipalities and at SKB. The fact that both of the candidate municipalities differed strongly from the rest of the country can also be explained by these factors. The smaller, albeit clear, difference between Oskarshamn and Östhammar seemed to be based on the greater impact of SKB's information in Oskarshamn and that respondents from Oskarshamn experienced greater potential to influence the way the municipality handled the issue of a final repository for spent nuclear fuel.

Responsibility at the end of the nuclear fuel cycle – A legal perspective

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The study has been conducted by Per Cramer, Sara Stendahl and Thomas Erhag, all at the School of Business, Economics and Law, University of Gothenburg.

It consists of three sub studies focussing on the regulation of responsibility for the final disposal of spent nuclear fuel:

1. Responsibility for safe management of spent nuclear fuel.
2. Responsibility and parallel regulation.
3. Responsibility for non-proliferation of nuclear weapons.

The content of the three studies is presented in brief below.

1. Responsibility for safe management of spent nuclear fuel

This study analyses, based on Section 10 of the Swedish Nuclear Activities Act, the legal structures surrounding the issue of responsibility for safe management and final disposal of spent nuclear fuel. Its purpose is to shed light on the legal aspects to be considered in the future licensing process and thereby to contribute to a better understanding of the importance of the legal structures for the decisions about final disposal that lie ahead of us. The overall question is thus future-oriented: What interpretation is it reasonable to assume will be given to the requirements of the Nuclear Activities Act on “safe management and final disposal” of the spent nuclear fuel in the coming licensing process?

The approach taken in this study is in part traditionally jurisprudential and based on an investigation of the *travaux préparatoires* (drafting history) of the Act and other legal sources. In addition, a study of legal practice is included where previous licensing processes are studied.

One conclusion from this study is that the Swedish regulation of nuclear activities creates a legal basis for exacting far-reaching industrial responsibility from the reactor owners, but also for an extensive and interventionist state influence over the activities. Of central importance in the model for division of responsibility that was established via the Nuclear Activities Act in 1984 is the RD&D programme (Research, Development and Demonstration). The RD&D programme reflects the political will that the requirement of “safe management” should be met through research. The statutory forms for how the programme is to be organized reflect an ambition to place great responsibility for execution and financing on the industry, but also, and not least, an ambition to retain instruments of control and influence in the hands of the state.

It is difficult to judge whether the hopes of the 1980s regarding the influence of the public over this process have been fulfilled. However, this regulatory framework gives the Government great leeway in imposing requirements on the industry with regard to different alternatives for managing the spent nuclear fuel. Based on the general formulation of the regulations, the answer to the question regarding the interpretation of the requirements in Section 10 of the Nuclear Activities Act is that this interpretation is in the hands of the political majority at the time of the licensing process. In other words, the question of what is safe according to the Nuclear Activities Act is a political one, and the legal interpretation is ultimately made by the Government and not by a court. If at the time of the decision there is a political majority that opposes granting a licence, legal argumentation may be offered, but hardly otherwise. This is a conclusion that is confirmed by the review of previous licensing decisions made within the framework of this study.

2. Responsibility and parallel regulation

Responsibility for management and disposal of spent nuclear fuel is regulated in Sweden by several different laws and regulatory complexes. This means that the regulatory frameworks overlap each other. Several recent reports⁶ have noted that a permit and licence for a final repository have to be applied for under both the Nuclear Activities Act and the Environmental Code.

This study describes in general terms the parallel regulation of environmental, nuclear safety and radiation protection matters on the national and European levels. The Swedish regulation of environmental responsibility for ionizing radiation is dealt with initially, where the Environmental Code is generally applicable today. Then the parallel regulation of nuclear safety and radiation protection matters is treated. This part also discusses the regulation of environmental responsibility at the European level. It shows that the division of responsibility and logic embodied in the relationship between the Swedish regulations is only partially reflected at the European level. The international regulatory framework is to a great extent based on an established international regulation tradition, where the issue of ionizing radiation is considered to be of such a special and dangerous nature that it should be separately regulated. The study discusses, first, the relationship between the EU Treaty and Euratom. Then examples are given of regulatory responsibility for waste management and for provision of information in connection with licence applications for final disposal within the framework of Euratom and the EU Treaty. Finally, the consequences of this type of parallel regulation for the Swedish licensing process are discussed.

The study shows that due to parallel regulation at a national level, there are certain risks of overlap and contradiction, not least as regards conditions governing environmental responsibility as well as nuclear safety and radiation protection. For example, there still seems to be a lack of clarity regarding the extent to which the environmental courts can or should issue conditions on the basis of nuclear safety and radiation protection considerations. This lack of clarity stems from the introduction of the Environmental Code. Conclusions from the parallel reviews that have been conducted in Sweden, for example in connection with permits for power increases in Swedish nuclear power plants, show, however, that the parallel licensing process works satisfactorily in purely practical terms. We would, nevertheless, like to note that while any lack of clarity might be regrettable from the viewpoint of environmental responsibility, there is also a potential risk that parallel review and parallel regulation may lead to a lack of clarity that affects the very legitimacy of the licensing decision.

⁶ Kasam Rapport 2007:1 (English version Report 2007:1e), SKI/SSI Rapport 2007:01, SSM Översyn av lagstifningen på strålsäkerhetsområdet, januari 2009, SOU 2009:88.

3. Responsibility for non-proliferation of nuclear weapons

Perhaps the greatest challenge for the development of civilian nuclear energy production is the need to create a regulatory framework that effectively prevents civilian nuclear activities from contributing to an increased proliferation of nuclear weapons. The purpose of this study is to describe and analyse how responsibility for upholding international commitments regarding non-proliferation of nuclear weapons is concretized in connection with the final disposal of spent nuclear fuel in Sweden.

The study begins with an account of the development of the multilateral regulatory framework to prevent the proliferation of nuclear weapons. This is followed by an analysis of how this regulatory framework has been implemented at the regional European and national Swedish levels. The analysis of the implementation of the rules in Sweden focuses on the responsibility that is imposed on the holder of a licence for final disposal of spent nuclear fuel. This analysis tries above all to problematize the scope of this responsibility and its extent in time. In conclusion, we try to identify potential problems in connection with the application of the current regulations.

One conclusion that can be drawn from this study is that the complex regulatory system that governs the implementation of international commitments to prevent the proliferation of nuclear weapons has so far had an effective administrative application in Sweden. At the same time there are obvious risks that the parallelism between national Swedish regulations and directly applicable rules that have arisen within Euratom could give rise to difficulties in identifying commitments and lines for exacting responsibility. These problems could grow larger if Sweden tries to defend a national regulatory autonomy concerning commitments regarding non-proliferation at the same time as the community's regulatory framework in the area becomes increasingly fine-meshed.

The most obvious problem identified in this study concerning regulation of the responsibility for implementing Sweden's international commitments regarding non-proliferation in connection with final disposal concerns the extent of the responsibility in time after the first operating phase is over and closure has taken place. Under the current Swedish regulatory framework, the endpoint for SKB's responsibility will probably not be defined on the basis of an assessment that the obligations under the Nuclear Activities Act have been fulfilled. The endpoint will instead be defined by a political decision on discharge from responsibility, after which the state will assume responsibility. In conclusion, the need to formulate principles for such a transition of responsibility is discussed.

Ethical and philosophical perspectives on nuclear waste

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Sven Ove Hansson has contributed to the Social Science Research programme by the project “Ethical and philosophical perspectives on nuclear waste”. The project and the resulting eight essays /19/, their main themes and results are shortly described below. Hansson has also contributed two chapters to the SKB Social Science Research Yearbook, in 2008⁷ and 2009⁸, that summarize selected parts the project that are also described below.

The project aimed at widening the framework for discussions on nuclear waste management. The central themes were “Risk and uncertainty”, “Radiation as an ethical problem”, “The time perspective of nuclear waste”, “Science and its limitations”, “What does the precautionary principle tell us?”, “How much may it cost?”, “Engineering safety”, and “The politics of risk management”. The texts argue for a rational approach and they also emphasize the usefulness of science and technology. No standpoints are taken on the practical issues of nuclear waste management or energy policies in general. Instead these essays are intended to provide a background for further discussions and policy decisions in these areas.

Risk and uncertainty

The word “risk” is commonly used in discussions on nuclear waste as well as in other discussions on the dangers that we are exposed to. It turns out that “risk” has different meanings in different contexts. In technical contexts a distinction is often made between risk and uncertainty. The difficulties that different interests groups have in understanding each other often depend in part on a lack of understanding (or respect) for how others use these concepts. In order to make a well-structured discussion possible it is important to be clear about how the words are used. The essay is an attempt to contribute to such clarity.

A common ground is that “risk” denotes something unwanted. “Risk” also indicates non-availability of knowledge of an outcome. To have knowledge of a risk thus means to have knowledge of what we do not know, which is a difficult type of knowledge to analyse and evaluate. Hansson notes that the complicated relationship between risk and knowledge is one basis for the confusion in this area.

⁷ The translated title of the chapter is “The time perspective of nuclear waste”. Available only in Swedish.

⁸ The translated title of the chapter is: ”Radiation as an ethical dilemma”. Available only in Swedish.

In the essay he furthermore exemplifies various uses of the risk concept, e.g. in non-quantitative contexts, by ranking and comparisons, the probability of a negative event, and the expected value of the severity of the risk. Hansson tutors the reader in a pedagogical way through the theoretical distinctions of different definitions. He states, for example, that the definition of risk as an expected value differs from the definition of risk as a probability in that the former accounts for the severity of the outcome. Hansson notes that the choice of risk definition has effects on the perception of reality. If the single term “risk” is used to cover various definitions in the same context, e.g. referring to non-quantitative problems in general as well as expected value, the subtle shift of meaning can easily obscure the fact that risks with low expected values may be viewed of greater importance than those with high expected values, depending on other attached qualities.

The uncertainty concept applies to hazards that defy a probability estimate or where such an estimate is meaningless. Hansson gives examples of the use of the terms in everyday language, and in technical analyses. For example, in an everyday situation, not knowing if a certain snake is poisonous results in uncertainty, whereas the risk of being poisoned by a bite by the snake is related to a risk, or no risk, depending on what kind of snake it is. However, in technical language the difference between risk and uncertainty lies in the availability of meaningful probabilities, i.e. the term risk is often used when such probabilities are available, and uncertainty is used when this is not the case. Hansson especially underlines that remaining uncertainties attached to very low probabilities often are neglected. For example, in a decision situation where the basis for decisions involves expert judgements that a particular outcome is extremely low, the main concern should maybe not be if this is acceptable or not, but rather the degree to which one can be sure that the expert judgement is reliable.

An additional twist in this context concerns how to relate to unknown hazards, e.g. potentially negative outcomes of a not yet introduced technology or a genetically modified life form. This type of uncertainties could be denoted “unknown possibilities”, since the potential outcomes are not known, and therefore there is no way to estimate their probabilities.

Yet another type of uncertainty relates to future behaviour and actions of humans. Predictions of future human actions or human influenced events become increasingly unforeseeable with interactions. The work aimed at constructing a final repository for spent nuclear fuel contains all the mentioned types of risks and uncertainties. Certain areas build on well established knowledge and accessible probabilities, whereas other areas involve various degrees of uncertainties. The largest uncertainties can be discerned in the societal area. For example, can we attach probabilities to various future human attempts of accessing the final repository? Have we been able to conceive of all possible reasons to do so?

Radiation as an ethical problem

Radiation often gives rise to strong emotional reactions. Are radiation risks special or should they be treated in the same way as the risks we encounter in our everyday lives? This essay introduces the new area of radiation ethics and shows the interconnections between foundational issues in radiation protection and moral philosophy. The following are among the questions discussed: Can the fact that a radiation exposure is smaller than the natural background be a reason to accept that exposure? Do we need to take (probable) radiation effects into account even if they cannot be detected due to weak statistical connections? Should radiation protection be based primarily on individual exposure or on the total exposure of the whole population?

Hansson describes the initial social fascination with Röntgen's scientific discovery (1895), and for example how photographers bought x-ray machines to take pictures of customers, the availability of toothpaste and mineral water with allegedly health promoting radioactive content, and contemporary claims by mystics that there are connections between radiation and the supernatural. The positive attitude to radiation prevailed into the 1950s but the use of nuclear weapons in Hiroshima and Nagasaki, and not the least the fear of such use during the cold war, changed the perception of radiation.

Today radiation is often described as extremely dangerous, almost more dangerous than anything else. Hansson questions this description and suggests that although it is a fact that radiation can be lethal and that certain radioactive substances, e.g. Plutonium, are extremely poisonous, there are unfortunately a number of other substances and threats in the same category, e.g. certain chemicals and micro-organisms. Hansson asserts that it is true that high level radioactive wastes stay dangerous across hundreds of thousands of years. However, dangers from certain chemicals can last even longer, e.g. lead and mercury are never broken down in contrast to the decaying radioactive substances.

Another common argument highlighting radiation is the quality of being undetectable by human senses, e.g. radiation cannot be smelled or seen. But again this is a characteristic that radiation shares with certain dangerous chemicals and e.g. bacteria and viruses. What specifically distinguishes radiation, however, is the ease with which it can be detected and measured with proper measuring instruments – measuring instruments that are not currently available for all chemicals or infectious agents. Hansson concludes that it is difficult to provide solid reasons to radiation being uniquely dangerous. Nevertheless, radiation risks are sufficiently serious to motivate very harsh protective measures. Thus, the essay goes into depth of discussing ethical and philosophical problems related to radiation protection, and Hansson suggests that a specific reason for moral philosophers to study radiation protection can be noted in the surprisingly extensive structural similarity between radiation protection and theories of ethics.

The essay compares the two areas on the basis of three characteristics, i.e. *weighing* (pro and con comparisons for each alternative, illustrated by a weight), *limit demarcation* (e.g. prohibition or deontological ethics, illustrated by a fence), and *orientation* (virtue ethics, illustrated by a compass). Hansson suggests that radiation protection to a high degree is built upon principles that correspond to these three basic moral philosophical components. He notes that ICRP (1991) summarized the basic principles of radiation protection as justification (cf. right reasons to act, virtue), optimization (cf. weighing, utilitarianism), and individual dose limits (cf. limit demarcation, plight).

In this essay Hansson focuses especially on scrutinizing how to combine weighing and limit demarcation, how to consider non-detectable effects, as well as how to consider natural risks, e.g. natural background radiation. One general conclusion is that there does not seem to be any solid reason to give natural risks a lower priority in risk analysis, whereas there is a reason to include e.g. what is inevitable and well-known. However, in doing so one should address these characteristics *directly* and not via the diffuse and ambiguous concept “natural”. Hansson also asserts that there is sufficient ground to encourage further research in moral philosophy focusing on how to combine weighing and limit demarcation principles, and that radiation provides a good example.

The time perspective of nuclear waste

The most discussed aspect of nuclear waste is its longevity. Previously nuclear waste was the only issue for social decision-making that was widely discussed in very long time perspectives. Today climate change is also discussed in such long time perspectives, and we have a general discussion on sustainable development that does not have any time limits. The two dominant approaches to long-term effects of our present-day decisions are economic discounting and sustainability. The problems of both these approaches are discussed, and alternative approaches are introduced. The nuclear waste issue turns out to be one of many issues that should preferably be discussed in long time perspectives.

Issues involving long time perspectives include the potential extinction of animal and plant species, and especially global warming. In addition to environmental problems there are today also societal issues that take on long time perspectives. When we have drained a natural resource it will not be available to future generations. The same is true about cultural artefacts, e.g. the melting of gold artefacts from the Inca culture meant that those were lost forever. On a smaller scale, the demolishing and creating of new infrastructure change social conditions over time.

These examples do not serve to diminish or obscure the nuclear waste problem, but they aim at emphasizing that lessons learnt from the discussion on nuclear waste may be of relevance and use also with respect to other issues where decision-making covers long time horizons.

Discussions on decisions related to very long time perspectives include the issue of *how* to evaluate outcomes in the far future. For example, is the value of a human life similar or dissimilar if it relates to accessing a final repository in e.g. 10,000 years or in our time? And how should uncertain outcomes be evaluated? We seldom know about the consequences in a hundred year perspective of the decisions taken today. This uncertainty has often resulted in not caring for the long-term consequences of the actions. The nuclear waste issue has become a pioneering case in the sense that uncertainties have not hindered us to consider long-term consequences seriously.

In the essay, Hansson then discusses the two well-known suggestions of how to evaluate future outcomes, i.e. discounting and the sustainable development principle. On the basis of numerous examples Hansson concludes that there are problems with applying discounting in risk analysis. The main arguments point out that interest is only relevant in relation to money, and that discounting results in absurd results if applied to very long time perspectives. In his examples Hansson furthermore shows that “retroactive discounting”, i.e. to use discounting backwards in time, results in pure absurdities. For example, genocides appear as less serious the later in history they occur. Hansson notes that it is difficult to see any reason to adhere to such a standpoint.

Discounting is, however, seriously considered in discussions on future environmental damage. In his analysis Hansson nevertheless concludes that discounting is not applicable to long time perspectives, and that such a conclusion is relevant not only to nuclear waste issues but also to the climate change area.

Another well-known suggestion of how to evaluate future outcomes, e.g. related to environmental damage, is the principle of sustainable development. This principle is less explicit than the discounting approach, and allows several interpretations – which may contribute to its popularity. Hansson distinguishes mainly between weak and strong sustainability. The former relates to the Brundtland report suggesting that sustainable development shall satisfy the needs of the current generation without threatening future generations’ needs. The approach allows for substituting a depleted resource with a similar one. The strong sustainability interpretation, on the other hand, views each resource as unique, and demands sustainability for each resource. The interpretation of “resource” can vary, however, and e.g. involve a specific species or a wider view, such as an ecosystem or biological diversity.

Especially two differences between these views are highlighted by Hansson. Firstly, the idea of substituting, and secondly that the weak view solely considers sustainability from the perspective of human well-being, whereas the strong view opens up also for the sustainability of animals and plants irrespective of their utility to human beings.

The strong view has been criticized for being too impractical and the weak view for being so weak that it becomes irrelevant. Hansson concludes that the latter view could risk becoming equivalent to maximizing economic well-being, and in such a case, the whole discussion on sustainability would be reduced to a rhetorical adornment.

Hansson suggests that many of the difficulties in the discussion on sustainable development are due to the non-specific definition of “natural resources”. He separates three definitions: a) something we consume or use in a technical process, b) an artefact appreciated by humans, and c) something that has an intrinsic value irrespective of human evaluation or use. By exemplifying and analysing the difficulties on this basis Hansson arrives at the conclusion that for natural resources of the first type (a) the weak sustainability interpretation is applicable. However, for the second and third types the strong interpretation should be applied.

Applied on nuclear waste, the sustainable development argumentation leads Hansson to conclude that one often discussed issue can be referred to the first category (a), i.e. the issue of future generations’ abilities to retrieve the spent nuclear fuel. Thus, if it is perceived as an advantage to keep spent nuclear fuel so it can be retrieved, then it can be seen as an economic resource which can be discounted in the same way as other economic resources.

However, the most commonly discussed issues related to nuclear waste are of a different kind, i.e. damage to future humans and the environment. For such outcomes or damages the strong sustainability interpretation should be applied because there is no way to substitute loss of health or environmental damage. This means, according to Hansson, that future generations should not be affected by our final disposal of nuclear waste.

In the essay, Hansson furthermore develops views on discounting principles in the perspective of moral philosophy, and outlines a compromise between traditional economic discounting and zero-discounting, i.e. the latter related to human life, health and environmental values. He analyses the possible usefulness of uncertainty discounting and contrasts it to time discounting. In the context of this summary we only include Hansson’s observation that it is not the uncertainty *per se* that has resulted in the high attention and controversy regarding future effects of a nuclear waste repository, but rather the combination of certainty in specific areas (e.g. radioactive decay over time, etc.) and uncertainty in other areas (e.g. future generations’ knowledge, intentions, etc.). Finally Hansson notes that the International Climate Panel

(IPCC) focuses on a time perspective of around 100 years and utilizes a kind of “trimmed discounting” in the work. He concludes that this is a rather unprincipled reasoning, and suggests that much would be achieved by approaching the climate change issues in a way similar to that of nuclear waste.

Science and its limitations

The controversies on nuclear waste have to a large extent concerned whether we can at all know what will happen in the future. Expert judgements have often been mistrusted, and sometimes the capacity of science to answer the critical questions has been put to doubt. The critics are right in pointing out that science is fallible. It is often rational for a decision-maker to take into account that scientific experts may be wrong. But it is also an important insight that in practice we have to act and decide in spite of uncertainties. The best we can do is to use the currently best available science, while at the same time doing our best to assess its degree of uncertainty and trying to reduce our dependence on the most uncertain information.

In this essay, Hansson starts by asking “What is Science?” He is interested in the normative aspect of what role science ought to have in decisions and estimations of risk. To understand this, Hansson asserts, we must penetrate the nature of science, characterize scientific knowledge, and understand how scientific knowledge differs from other types of knowledge.

He starts by paying attention to the Swedish concept “vetenskap” and its comparable interpretations in the Scandinavian languages and in German (“Wissenschaft”) and compares it to the English concept “Science” which holds comparable meanings in Roman languages. The concept “Science” had initially a very broad interpretation but was specified in the 17–18th centuries to denote “systematic knowledge”, and in the 19th century it came to represent especially knowledge in the natural sciences. The concept “vetenskap”, or “Wissenschaft”, had originally an interpretation as “knowledge” and has developed in current academic use to include all academic specialities.

However, it is not the terminology that decides what is science or systematic knowledge, it is determined by what methodology and approach is used. Furthermore, what we call science is what is currently considered the best available knowledge. This formulation certainly points at a normative quality attached to the concept. Hansson’s essay lays the basis for a better understanding of why scientific knowledge is essential in decision-making by explaining the basic prerequisites and assumptions generating scientific knowledge.

He also explains how it is possible that the most advanced scientific knowledge a hundred years ago not necessarily is true today, i.e. that there is a continuous knowledge development that includes critically scrutinizing available truths and assumptions so that essential facts become more specifically known, or so that non-valid assumptions or statements are corrected or altogether dismissed.

In his pedagogic manner, Hansson provides a scholarly overview of historic developments, theory of science bases for developments in the field of knowledge, as well as stresses the importance and effectiveness of doubt. He points out that there are many worldviews that offer absolute and certain knowledge, and that science is *not* one of these. Science does not make claims of offering absolute truths; instead science takes on the role of producing the best available knowledge, on the one hand, and the task of improving the methods needed to enhance knowledge, on the other.

Hansson furthermore points out that errors and uncertainties are not especially characteristic of science, but that such problems are present in all human knowledge, and that therefore all types of knowledge may be in need of review. However, the fallibility of knowledge does not imply that knowledge can be replaced by any kind of statements. Neither does the fallibility of knowledge provide a reason not to use the best available knowledge – there is actually nothing better available.

What does the precautionary principle tell us?

It is important to distinguish between cautiousness (caution) and the precautionary principle. Cautiousness, as a general concept, refers to the avoidance of acts that could potentially have very negative consequences, even if the probabilities of those consequences are low. The precautionary principle is a principle for how to deal with scientific uncertainty. This essay discusses how the precautionary principle should be interpreted and how it fits into our ways of building and applying scientific knowledge. It is concluded that the precautionary principle is in fact not a special principle in its own right but only an application of the general decision rule for practical decision-making that all available information should be taken into account.

The collective scientific knowledge is the comprehensive collection of knowledge which the large majority of researchers within their respective fields utilize until new data are available. It emanates from experiments and other observations. Through the process of critical evaluation these data create the scientific knowledge which is constantly changing and increasing.

A severe and thorough evaluation takes place before new data are accepted as scientific knowledge. The burden of proof befalls entirely on the one suggesting the change. Hansson explains in this context the process of evaluating new data and results, for example how to avoid the risk of accepting an erroneous hypothesis and the risk of disregarding a correct one. He also describes the respective processes of the internal scientific evaluation of proof (scientific knowledge) and the external process of decisions in practice, and how they differ in the level of required evidence.

Hansson uses an example of baby food and a scientifically based decision to limit the use of a certain ingredient, which has shown indications of a possible influence on growth hormone. Available scientific knowledge must be used to decide whether or not a restriction of the substance in question shall be introduced in practice. The same information is used to evaluate if the presence of such an effect of the substance can be scientifically shown. These two decisions utilize different decision criteria and may result in different outcomes. Thus, although the scientific evidence related to the impact of the substance on the growth hormone is not sufficient to conclude that the negative effects are scientifically proven, the same evidence may be sufficient for a decision to exclude the substance from baby food.

In this manner does Hansson introduce the Precautionary Principle, as well as the argumentation favouring either the “sound science” view, i.e. that only scientifically proven evidence shall be used as bases for decisions, or the Precautionary Principle, i.e. allowing decisions to be based on scientific information lacking full scientific proof.

The “sound science” concept originates from ‘The Advancement of Sound Science Coalition’ founded by the Phillip Morris company in 1993, with the task of enhancing the view that there is insufficient scientific evidence to conclude that passive smoking constitutes a hazard. Thus, proponents of this view advocate the use of the same decision criteria for the internal evaluation of scientific proofs and the external decisions in practice.

Hansson notes that attempts to apply the view suggested by “sound science” have not been made in all decision domains. It has almost always been applied in environmental policies, but not, however, in e.g. areas related to national security. Hansson concludes that the idea to make decisions without considering their practical consequences is too divorced from reality to be taken seriously.

How much may it cost?

Cost-benefit analysis is the traditional economic method for analysing risk management decisions. But the method is controversial, not least due to scepticism against the “prices” on human lives that are used in the analyses. In this essay the pros and cons of cost-benefit analysis are discussed. It is concluded that the method can be useful, but it has limitations that must be taken carefully into account whenever it is used. Cost-benefit analysis can be used to support policy decisions, but it has to be combined with additional information and alone it cannot be the last word on what decision to make.

The method to compare various aspects to each other through attaching monetary values to them is usually advocated by economists, i.e. cost-benefit analysis or risk-benefit analysis. A typical cost-benefit analysis compares two

or more alternatives in a social decision context thorough calculations of the values of the respective consequences. The consequences may be of very different kinds, e.g. economic costs, health or environmental risks, etc. In the final analysis all those aspects are given monetary values, and the decision recommendation forwards the alternative with the highest value of benefits minus costs.

Critics of this type of analyses have focused on especially two aspects: the monetary value attached to human life and the “contingent valuation” method, i.e. to attach monetary values to an alternative based on asking people what they are willing to pay for it.

Hansson notes that not all cost-benefit analyses use these methods, and that it is quite common to perform the analyses without these methods. However, the analyses are very interesting from a moral philosophical perspective and could be seen as a kind of laboratory for consequentialism, i.e. the idea that the moral value of actions shall be judged entirely on the basis of their consequences.

The most common form of consequentialism is utilitarianism. Pros and cons are added, just like in cost-benefit analysis, and measured on a moral metrics, e.g. happiness or need satisfaction, instead of money. Hansson notes that although the metric of the cost-benefit analysis, i.e. money, is not the same as those of utilitarian, the cost-benefit analysis is the only practically applied method of analysis that uses the basic structure of consequentialism.

In the essay, Hansson goes into three basic issues related to cost-benefit analysis: the delimitation of decisions and decision alternatives, the characterization of the decision alternatives, and the evaluation of the consequences. The contents of the essay will not be reviewed here, but we recommend Hansson’s related texts available in English⁹.

Engineering safety

Safety engineering has a long tradition in the engineering profession. It includes traditions for risk management that are valuable not least because of their capacity to deal with some of the problems that are difficult to cover in a probabilistic risk analysis. In this essay three of the most important principles in safety engineering are introduced, namely inherent safety, safety factors, and multiple safety barriers. In discussions of nuclear waste management it can be useful to make comparisons with the application of safety engineering principles in other areas of technologies.

⁹ Hansson, S. O. (2004). Weighing risks and benefits. *Topoi*, 23, 145–152.

Hansson, S. O. (2008). The entry Waste Management, in the *Encyclopedia of Environmental Ethics and Philosophy*. Gale/Cengage learning.

In this essay, Hansson explains the available methods for e.g. estimating probabilities of rare and novel types of negative events (e.g. by using event trees, etc), and the concerns that need to be attend to in drawing conclusions on this basis, including remaining uncertainties. The mentioned three principles of inherent safety, safety factors, and multiple safety barriers have vital importance in engineering safety work to manage various types of uncertainties.

Inherent safety means to eliminate dangers rather than try to manage them. It is also sometimes referred to as primary prevention. The principle has foremost been developed in the process, or chemical, industry, but is widely used today, including in the nuclear sector and its development of new types of reactors.

The replacement of dangerous chemicals with less dangerous ones is consistent with this principle, although such alterations are usually denoted as applying the principle of substitution or the principle of product choice. In the nuclear area it is difficult to imagine how the inherent safety principle could play a major role. The nuclear wastes have their given characteristics and must be managed as presented. Reprocessing and transmutation would be means to approach the principle of inherent safety on the basis of the method's ability to shorten the time of danger. However, these methods introduce other types of risks, including risks in the work environment.

The concept "safety factors", e.g. safety margins, has lately been replaced with the terminology "uncertainty factors". The use of a safety factor implies that a considerable margin is built into a construction so that it will sustain much more than what is estimated as necessary. The principle aims at counter-acting various types of uncertainties.

The use of multiple barriers is an old form of protection, e.g. in defence against hostile attacks. The suggested repository for spent nuclear fuel is one example of the utilization of this principle. An important characteristic of effective barriers is that they are independent of each other.

All three principles are used to manage uncertainties, and not only risks that can be expressed in the form of probabilities. Thus, the utilization of those principles can help manage safety problems that are difficult or impossible to cover in a risk analysis. Examples are human errors, and various intentional threats. In practice there is no choosing between these methods and principles. On the contrary, the risk analysis, together with the three principles, provides the overall optimal tool in engineering safety work.

The politics of risk management

Like many other risk management issues nuclear waste is politically highly controversial. This essay focuses on the political aspects of risk management. What distribution of tasks is appropriate between experts and political

decision-makers? Should we take seriously the criticism against local participation that is commonly expressed with the acronym NIMBY (“Not in my backyard”)? Why has the concept of “acceptance” become so important in discussions of risk? What can be demanded of a democratic procedure in a complex risk management issue? This essay, like the others, aims at showing how nuclear waste management is connected to more general policy issues. It is left to the reader to judge what standpoints should be made in these issues.

In this final essay of the booklet “Ethical and philosophical perspectives on the nuclear waste issue – eight essays by Sven Ove Hansson” he addresses the issues of expert power, acceptance, voluntary risks, and the steps of a decision process. Regarding experts’ contributions to decisions, Hansson underlines that decisions not only concern risk estimates but also human relations, and not the least ethical considerations. Decisions on risk management involve e.g. who subjects whom to risk, and with what intentions. Thus, expert judgements are only one essential part of the bases for decisions, and decision-makers also have to consider other aspects outside the experts’ domains of expertise.

It can be added that “risk decisions” cannot meaningfully be distinguished from other kinds of societal decisions. Almost all kinds of decisions in a society are to some extent “risk decisions”. It is therefore of importance to find optimal ways to manage risk issues in the decision-making process.

In the discussion on overall political decision-making, the central concept is *democracy*, and the aim that the decision shall be in line with the view of the majority. In discussions on risk and risk decisions, on the other hand, the central concept is *acceptance*. It focuses on what risks the general public, or those directly affected, can be made to accept.

The difference between acceptance and a fully developed participation in decision-making is of importance. To accept a decision means not to go against it. This is different from actively supporting a suggestion, e.g. by voting for it. In ordinary political situations (outside the risk area) we take for granted that the requirement for taking a decision is that it has a majority support, not only acceptance. For example, to introduce the Euro in Sweden it is required that a majority votes for it, not only that they refrain from voting against it.

Thus, Hansson distinguishes between three views one can adopt relative a suggestion: to support it, neither support nor go against it, and to oppose it. Majority decisions are based on the first alternative, i.e. a suggestion shall be carried out if the majority supports it. The acceptance criterion instead involves that a majority holds the view of either of the first two alternatives.

Regarding voluntary risks, Hansson highlights that risks are not isolated phenomena but that there are “packages” of risks and benefits involved in certain actions or choices. For example, if a surgical operation only implies risks, and no health benefits, a patient would not accept the procedure. Similarly would

a person probably not work in a mine without pay. The choices made are based on a variety of risks and benefits that come together in the available “packages”.

Therefore, Hansson states, a decision to accept a risk is related to accepting a choice alternative, or package, which contains risks, as well as benefits that one cannot obtain without the risks attached. For this reason, Hansson adds, voluntariness is not necessarily a guarantee for a correctly carried out decision process. Neither does the fact that people make a choice among restricted, and to them unsatisfactory, alternatives imply that they can be held responsible; it is only the consequence of the restricted choice.

Regarding the steps in the decision process, Hansson makes use of the French philosopher Condorcet who in 1793 developed a suggestion to the French constitution. He outlined three steps in democratic decision processes: 1) Discussions of the general principles that will constitute the basis of the decision, investigation of the various aspects of the issues, and the consequences of different ways to take the decisions. 2) A second discussion where views are developed and combined in the purpose of generating a smaller number of general views. 3) The voting when the decision is taken.

In relation to risk decisions Hansson notes that the discussion is often focused solely on the third step. The general public is presented as a group whose acceptance or agreement shall be obtained, and a lot of energy has been invested in achieving trust in this context. Hansson underlines that the reduction of the public's influence to the third decision step regarding risk issues is inconsistent with the principles that generally apply in a democratic society.

Finally a few words on Hansson's ongoing project (“The time frame of nuclear waste in comparison”) within the Social Science Research Programme, its contents and results so far. The new project has its focus on the time perspective of nuclear waste decisions. Comparisons are being made with other areas of social decision making in order to clarify the (often substantial) differences in the time perspectives used in different areas, their causes and consequences. Furthermore a decision-theoretical analysis will be made of how to deal with the asymmetries in terms of uncertainty that increase with time. There are several possible strategies for this: the time perspective can be shortened (in practice done in many long-term issues, for instance climate change), the most uncertain issues (usually social and behavioural aspects) can be disregarded or the latter can be included although the information used about them may not be much better than guesses. Pros and cons of the different strategies will be discussed. Furthermore, this will be related to the notion of sustainable development. Uncertainty discounting will be discussed as an alternative to time discounting. Several ways to combine discounting with sustainability will be investigated and compared.

Participatory Democracy and Decision Making in Multi-level Governance

Carina Keskitalo

Department of Social and Economic Geography, Umeå University

The project has been conducted by Carina Keskitalo (research manager), Department of Social and Economic Geography, Annika Nordlund, Department of Psychology and Urban Lindgren, Department of Social and Economic Geography, all from Umeå University.

The purpose of the project was to analyse the multi-level governance process in conjunction with the siting and design of a final repository for spent nuclear fuel. The Environmental Impact Assessment (EIA) process is of special interest with regard to decision-making, since it brings in both formal decision-making bodies and participation by broader groups. In addition, since no similar activity has ever been implemented in Sweden, there is no available practice for how different laws should be coordinated and interpreted. The study sheds light on three general questions:

1. How have the formal decision-making bodies at different levels (municipal level, regional or county level, and national level) perceived participation in the process and interpretation of legislative and EIA requirements?
2. What “broader public” and which organizations – besides groups within the formal decision-making mandate – have participated in the consultations, and what viewpoints have they expressed regarding the EIA process and consultations?
3. How have judgements and understanding of, and reactions to, risk related to the final repository been handled in the process?

Materials and methods

The study is mainly based on literature study and semi-structured interviews. A literature review with a focus on nuclear fuel management was carried out within the social sciences field. Special interest was devoted to discussing the content of legislation in relation to the EIA process and licensing, and the background and design of the EIA process. Furthermore, the literature review deals with theoretical perspectives regarding perceptions and communication of risk assessments. Protocols from EIA consultations during the period 2001 to 2007 have also been analysed.

Two interview studies with somewhat different orientation were conducted. The first aimed at investigating how different representatives of formal bodies perceive the legal basis and the EIA and licensing processes. Fourteen interviews were conducted with representatives of municipalities (politicians

and civil servants with legal expertise and expertise in the nuclear waste issue), county administrative boards, SKB, at the time the main governmental regulatory agencies SSI and SKI, regional environmental courts, and the Ministry of the Environment. Interviews were also undertaken with regard to consultations during the EIA process. A total of 20 interviews were conducted with representatives of organizations that had participated in such consultations. The interviewed persons represent both government authorities and non-governmental organizations at national, regional and local level.

Results

The results of the studies indicate that there are differences in participation between actors at different levels. The interviews show that municipal level actors and local environmental organizations have played an active role in the process, while at the regional level, the participation by county administrative boards has been more limited. On the national level, of particular interest is the state's impact on the EIA process in the form of recommendations for research as well as financial support for the participation of different groups via the Nuclear Waste Fund. As concerns the perception of the legislation in the field, most of the actors interviewed felt secure in their own role within their particular profession, however, the interaction between sectoral laws and the Environmental Code that came into force in 1999 is perceived as unclear in some respects when it comes to the complex issue of nuclear waste.

The interview subjects expressed a view that the process for EIA and consultations has been based on practices established by the parties participating in the site selection process since the early 1990s. The forms for consultation were thus worked out before the beginning of the formal consultation process in 2001. Several of the environmental organizations perceive that they have entered this process after the consultation form had already been developed, which has somewhat curtailed their chances to influence it. The broadening of participation that took place largely through the institutionalisation of the Environmental Code has, however, given the environmental organizations access in another way than they have had via their traditional oppositional role as nongovernmental organizations outside the establishment.

The environmental organizations and established parties hold largely different perspectives on the EIA and of the role of the consultations. The established parties, including the regulatory authorities, can to some extent be seen as representing a planning paradigm (where the project itself and political decisions about it are in focus), while many environmental organizations traditionally represent an environmental paradigm that focuses on the precautionary principle for potentially environmentally hazardous processes. These differences have characterized much of the consultation process, and can also be seen as characterizing the inclusion of parts of an environmental paradigm within legislation such as the Environmental Code.

The interviews also show that non-profit organizations and private citizens have difficulties participating in the process on the same terms as governmental authorities and representatives of SKB, and that the resources of the company cannot be matched by any other party when it comes to information, participation and expertise. Some of those interviewed believe that the County Administrative Board should play a more central role, given its overall responsibility for coordination under the law. With the exception of environmental organizations, however, there is wide agreement that the developer should be responsible for the EIA process (as is the case under Swedish law but not under European Community law).

When it comes to differences in risk perception between different actors, the study shows that actors with an expert role within, for example, regulatory authorities tend to speak of the low probabilities of the risks and the good opportunities for risk control, while laymen often apply a wider definition of the risks of the final repository. Laymen also appear to underline the consequences for people and society of accidents and disasters to a greater extent than people with an expert role. Furthermore, the study points to potential problems of regarding laymen as a homogeneous group. The interviews shed light on clear differences between, for example, nearby residents and environmental organizations. Nearby residents often speak of risks associated with short-term consequences for their immediate environment, while the environmental organizations are more inclined to focus on long-term risks and on far-reaching consequences for the environment.

The industrial organization of the final repository – Pitfall or consistency?

Magnus Frostenson

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The main purpose of the project is to investigate the industrial organization of the Swedish final repository project for nuclear waste. A systems perspective is chosen for the study since decisions and actions regarding different parts of the project are intimately intertwined and mutually dependent. The organization process is studied from a geographical, operative, structural, responsibility and from a contextual perspective. Special attention is given to circumstances and implications of the closing of a novel kind of “surplus value agreement” between SKB’s owners and SKB on the one side and the municipalities Östhammar and Oskarshamn on the other. One aim of the study is to clarify the motives for the emerging organization and its significance for core stakeholders.

The following three research questions are at the forefront of the study:

- How will the final repository project be organized operatively and structurally over time?
- Why is the final repository project organized in this way by SKB?
- What kind of contextual organization takes place in the final repository project and what are the consequences of the chosen set of activities?

Materials and methods

The study is based on qualitative analysis of written documents, interviews and discussions with representatives for SKB and other core stakeholders of the final repository project. The utilized written documentation includes SKB's public communication concerning the repository in RD&D-Programmes and in published investigation in addition to information given in laws and instructions from responsible authorities. The main empirical source for the study is however semi-structured interviews with respondents representing organizations judged to possess a strong influence on the organizing of the final repository system.

Results

The author claims that SKB itself is an unusual organizational solution. It's an intermediary firm working on behalf of its owners, the energy production industry. The Swedish national state owns a substantial part of one of the member industries. So, the Swedish government is not only a stakeholder in the sense that it has the ultimate responsibility for the nuclear waste but it is also a stakeholder as owner of a part of the private industry managing energy production producing nuclear waste. So, different actors in the final repository project including the Swedish government, has quite intertwined roles.

The geographical aspect of the industrial organization is now settled, at least so far as it's determined by SKB's intentions. SKB's choice of location of the different units of the final repository system narrows down the frame for forthcoming choices. It increases the momentum of path dependency and moves issues concerning operative, structural and contextual organization to the forefront.

How the different industrial units of the final repository project should be run and within which structure, for example concerning ownership and integration of units, is established in the project. SKB's reasons for selecting the chosen kind of organization are also highlighted. In addition, an eventual increase in the duration of the Swedish nuclear power production programme will not influence the current organization of the final repository project in the view of SKB. SKB regards this as a new process separated entirely from the current one.

SKB decided a few years ago to take over the ownership of all parts of the nuclear waste system (except m/s Sigyn). Legal and safety-related demands must be met as well as demands from the owners. Apart from that, SKB's strategic preference for running many operations by itself, "insourcing" in connection with its traditional task centred operative and structural organization is reflected in the organizational choices for the present and future units of the final depository system.

The project report emphasizes the importance of one novel feature of the organization chosen by SKB and its owners, the "surplus value agreement" closed with both the municipalities of Östhammar and Oscarshamn before the location was decided. The main points of the agreement is that both municipalities receives additional funds for local developments, but more so to the municipality that didn't get the repository, 1.5 mdr SEK compared to 0.5 mdr SEK. The author claims that this is one example in a set of "contextual organization" efforts that puts the case apart from the mainstream industrial project.

Contextual organization is observed as deepened actor relationships between SKB's owners and SKB on the one side and the municipalities Östhammar and Oskarshamn on the other. Through active organizing, the final repository arena "narrows down" and the final repository issue turns into an in many respects local issue. There is a clear tendency that the roles of SKB are multiplied in order to handle the demands that central stakeholders – in particular the municipalities – place on the organization of the final repository project.

In the view of the author, an apparent lack of interest in organizational issues has created a space for SKB, its owners and the two involved municipalities Östhammar and Oskarshamn to define the organizational arena for the final repository project. He also claims that the most unique feature of the final repository project is its organization.

Democratic core issues – A study of opinions and external changes affecting the political decision about the final disposal of nuclear waste

Lars Nord

DEMICOM, Mid Sweden University

The project has been carried out by Lars Nord and Elisabeth Stúr, both media researchers at the Mid Sweden University, Sundsvall.

The overall purpose of the project is to investigate how the premises for the political decision processes in the issue of final disposal of the Swedish nuclear waste have been affected by changes in the public opinion climate and global events. It focuses on questions concerning how the national political

debate leading up to decisions interacts with the media debate, and on the public opinion dynamic that arises when the two debates relate to each other. The aim is to provide valuable knowledge regarding how the political agenda has been formed at different points in time to through an analysis of the arguments, arenas and actors involved in the debates.

The following questions are of central interest to the study:

- What characterizes the parliamentary and the party political debates in the nuclear waste issue and how have actors, standpoints and arguments changed over time?
- What characterizes opinion formation and news reporting in the media in the nuclear waste issue and how have actors, standpoints and arguments changed over time?

Materials and methods

The course of the debate at four different times and in connection with four parliamentary elections during the period 1976–2009 is analysed in the study. The analysis includes four parliamentary parties: the Centre Party, the Liberal Party, the Moderates and the Social Democrats, chosen because they have been represented in the Swedish Parliament during the entire period studied and are therefore reasonable to compare. The study has mainly been conducted as a qualitative textual analysis of public print, party documents and media content. The qualitative text analysis is complemented by written documentation such as political memoirs and debate books.

Results

The study shows that the nuclear waste issue was at the centre of the domestic political debate during the 1970s, but then gradually lost ground in political importance during the following decades. What can most accurately be described as a make-or-break political issue at the start of the studied period was by the end of the same period at most a back-burner issue of limited interest and had virtually been removed from the political sphere.

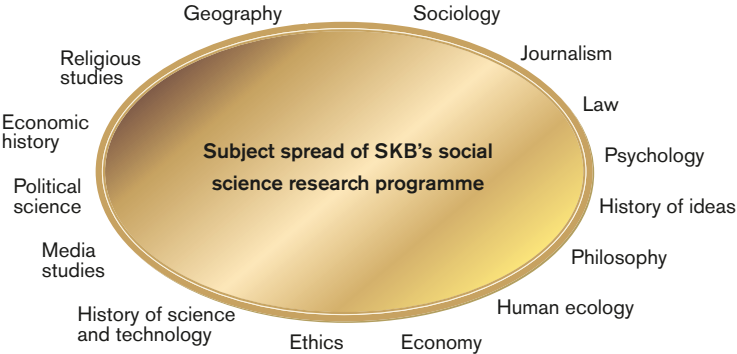
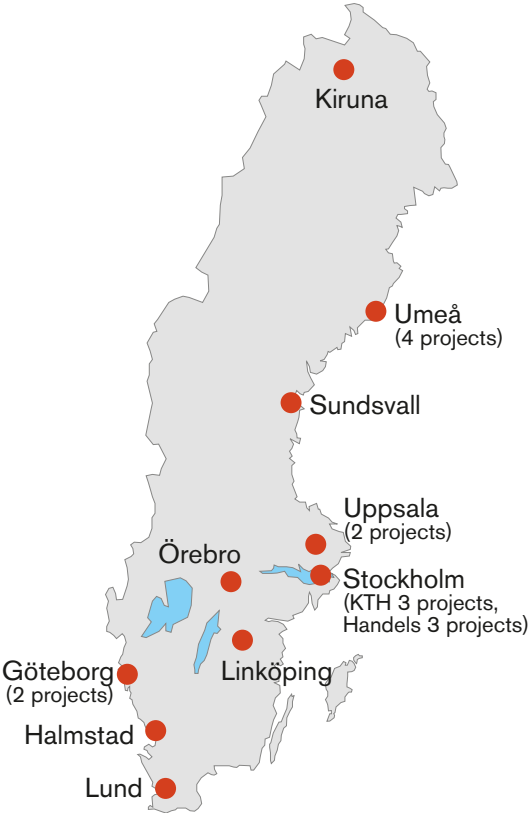
The nuclear waste debate serves as a good illustration of the life cycle of a political issue and illustrates the circumstances under which an issue can be politicized at one stage, only to be marginalized and struck from the political agenda at a later stage. This reversal in importance is seldom as clear-cut as in the case of the nuclear waste issue in the Swedish public debate. For example, six times as much was written on this subject in the four leading daily newspapers during the last three weeks of the 1976 election campaign as during the 1998 election campaign. When it comes to the number of parliamentary motions pertaining to nuclear power and nuclear waste, there were less than half as many during the parliamentary year 2009/10 compared with ten years earlier. In other words, this is an issue that is gradually declining in opinion-related importance, both in politics and in media coverage.

The position of nuclear waste in the Swedish political debate can be explained with reference to an opinion-related interaction between politics and media. Political actors generally make rational judgements and take standpoints to maximize their own influence and to win voters, keep their party together, or promote cooperation with other parties. Such judgements can explain why nuclear power and its environmental consequences were such a big issue in the 1976 election (when the Centre Party wanted to politicize the issue), as well as why it was such a small issue in the 1998 election (when all political actors contributed to depoliticizing the issue).

The nuclear waste issue is characterized not only by the willingness of the parties to politicize or depoliticize it during different periods, but also by the existence of other environment-related issues that compete for the attention of the parties, the media and the voters. The 1980s debate about algal blooms and mass seal deaths as well as the last decade's debate about the global climate threat are issues that probably have influenced the stand taken by public opinion-makers on the waste issue.

The nuclear waste issue in Sweden is also unlike most other political issues in the degree to which its importance waxes and wanes, from being extremely important in the 1970s in the political debate and the formation of governments, to having a marginal role in the first decade of this century as an issue of political debate. The first period's favourable circumstances and mutually reinforcing stances between politics and media could hardly pose a more striking contrast than to the latter period's mutual silence and waning importance. The upward spiral of public opinion that once carried the nuclear waste issue to the pinnacle of domestic political debate eventually turned into a downward spiral that ultimately relegated the issue to the outermost periphery of the Swedish political debate.

Geographical and subject spread of the Social Science Research Programme



Nuclear power in the world

Reactors under construction

	Number of units	Total MW(e)
Argentina	1	692
Brazil	1	1,245
Bulgaria	2	1,906
China	27	26,230
Finland	1	1,600
France	1	1,600
India	6	3,786
Iran, Islamic republic of	1	915
Japan	2	2,650
Korea, Republic of	5	5,560
Pakistan	1	300
Russian federation	11	9,153
Slovak republic	2	782
Taiwan, China	2	2,600
Ukraine	2	1,900
USA	1	1,165
Total	66	62,084

Source: IAEA home page PRIS data base 2011-01-17
(<http://www.iaea.org/programmes/a2/>).

Reactors in operation

	Number of units	Total MW(e)
Argentina	2	935
Armenia	1	375
Belgium	7	5,926
Brazil	2	1,884
Bulgaria	2	1,906
Canada	18	12,569
China	13	10,048
Czech republic	6	3,678
Finland	4	2,716
France	58	63,130
Germany	17	20,490
Hungary	4	1,889
India	19	4,189
Japan	54	46,823
Korea, Republic of	21	18,665
Mexico	2	1,300
Netherlands	1	487
Pakistan	2	425
Romania	2	1,300
Russian federation	32	22,693
Slovak republic	4	1,762
Slovenia	1	666
South Africa	2	1,800
Spain	8	7,514
Sweden	10	9,303
Switzerland	5	3,238
Taiwan	6	4,980
Ukraine	15	13,107
United Kingdom	19	10,137
USA	104	100,747
Total	441	374,682

Source: IAEA home page PRIS data base 2011-01-17
(<http://www.iaea.org/programmes/a2/>)

Shutdown reactors

	Number of units	MW(e)
Armenia	1	376
Belgium	1	10
Bulgaria	4	1,632
Canada	3	478
France	12	3,789
Germany	19	5,879
Italy	4	1,423
Japan	5	1,618
Kazakhstan	1	52
Lithuania, Republic of	2	2,370
Netherlands	1	55
Russian federation	5	786
Slovak republic	3	909
Spain	2	621
Sweden	3	1,210
Switzerland	1	6
Ukraine	4	3,515
United Kingdom	26	3,301
USA	28	9,764
Total	125	37,794

Source: IAEA home page PRIS data base 2011-01-17
(<http://www.iaea.org/programmes/a2/>)

Global production of high level nuclear waste

Estimated amount of high level waste or spent nuclear fuel from nuclear electricity generation

Year	Alternative 1 No nuclear power expansion Today's reactors are modernized	Alternative 2 Strong expansion of nuclear power
2010	250,000	270,000
2020	350,000	370,000
2030	470,000	510,000
2040	610,000	660,000
2050	780,000	820,000

Source: Nuclear Energy Outlook 2008. OECD 2008. ISBN 978-92-64-05410-3

For comparison, the Swedish production of spent fuel is estimated to 12,000 ton if the reactors are operated in 50–60 years (<http://www.skb.se>).

Waste management in selected countries

France

France has 58 nuclear reactors that produce 80 percent of the nation's electricity.

According to French law spent fuel is not considered as waste. Spent fuel is cooled in pools and thereafter reprocessed in La Hague. Vitrified waste and long-lived, intermediate-level waste from reprocessing is temporarily stored at the reprocessing facility. The high level radioactive waste is planned to be disposed of in geological clay formations at about 500 meters depth. The work with a final repository is still in the planning phase but the intention is that the repository will be operating in 2025. There is an underground research laboratory, Meuse-Haute/Marne Centre, in Bure.

There are repositories for short-lived, low- and intermediate-level waste disposal in the Aube area and in the Manche area.

Since 1991, the authority Andra, Agence Nationale pour la Gestion des Déchets, is responsible for the nuclear waste management. The activities are financed partly by waste producers and government subsidies. The producers of nuclear waste are obliged to set aside money for future waste management.

Germany

Germany obtains 25 percent of its electricity from 17 nuclear reactors. In 2002 it was decided to phase out nuclear power, partly because of public opinion.

The spent nuclear fuel was reprocessed in France and Great Britain until 2005 when reprocessing was prohibited. Now, spent fuel is temporarily stored at the nuclear power plants. The main option for high-level waste disposal was previously salt formations in Gorleben. The activities in Gorleben were stopped in 2000 and followed by discussions on a restart where other geological environments are studied. The intention is to have a repository in operation 2035.

Low- and intermediate-level waste was deposited at Asse until 1978 and at Morsleben until 1998. A former iron mine in Konrad is now being prepared to receive low- and intermediate-level waste for disposal. In April 2007, all appeals were rejected and the plans are now to take the repository in operational by 2013.

The nuclear power industry is responsible for handling and intermediate storage of spent nuclear fuel while the government, through "das Bundesamt für Strahlenschutz" (radiation protection authority), is responsible for the final disposal. Funding will come from nuclear power companies' own funds.

Great Britain

In Great Britain there are 19 nuclear reactors in operation, which produce 20 percent of the electricity in the country.

There are interim storages for spent fuel at the nuclear power plants. After reprocessing of the spent fuel in Sellafield the high-level waste is temporarily stored at the Sellafield site pending disposal. During the 1970s, site investigations for a repository were started, but the project was suspended in 1989. Now the process has restarted and according to the government's recommendations the work will be focused on geological disposal.

Since 1959 there is a repository for low-level waste at Drigg, close to Sellafield. The intermediate level waste is usually temporarily stored where it is produced. Neither method nor site for final disposal is determined.

The nuclear power companies take the costs for handling and disposal of radioactive waste. NDA, the Nuclear Decommissioning Authority, is responsible for handling and disposal of radioactive waste.

China

China has thirteen nuclear power reactors in operation, 25 under construction and another 30 planned. The year 2020 it is estimated that nuclear power will provide four percent of China's electricity.

There are interim storages of radioactive waste in each region. For low- and intermediate-level waste there are two ground repositories, one close to the nuclear plant at Daya Bay and one in north western China.

In the 1980s it was decided that the spent fuel will be reprocessed. A pilot plant is built in Lanzhou. The siting process for a final repository began in 1986. Several sites are examined and the Beishan area in the Gansu Province is considered to have the best prerequisites. Future work is focused on building an underground laboratory completed by 2020 and a final repository that could start operating at 2050.

CNNC, China National Nuclear Corporation, is responsible for the entire nuclear fuel cycle, including disposal of radioactive waste. The work in BRIUG, Beijing Research Institute of Uranium Geology, includes site surveys. BRIUG is one of several institutes under CNNC.

Canada

The 18 nuclear reactors in Canada produce 15 percent of the electricity in the country.

Low- and intermediate-level waste is temporarily stored at the nuclear power plants. The municipality of Kincardine has accepted a final repository for this waste. The high-level waste is temporarily stored in pools at the nuclear power plants for about seven years, followed by interim storage in concrete containers in a dry repository.

Since 1995, the final repository is planned to be built at a depth of 500 to 1,000 meters in crystalline rock. In 2002, the time table and the approach had to be changed due to lack of public support. The strategy is now a stepwise process towards completion of a final repository, with retrievability, in about 60 years.

The power companies and Atomic Energy of Canada Ltd. are responsible for funding waste management. The waste producers have established the organization NWMO, Nuclear Waste Management Organization, to find a long-term solution for managing and storing spent nuclear fuel.

USA

In the U.S. there are over 100 nuclear reactors producing 20 percent of its electricity. Since 2007, applications have been submitted to build about 30 new reactors.

Spent nuclear fuel is currently stored at the nuclear power plants. The final disposal is planned for Yucca Mountain, 300 meters below surface and 300 meters above the water. After about 20 years of site investigations, it was approved in 2002 by the president and in 2008 an application was submitted to the authorities. The process has been punctuated, however, by protests and appeals from the citizens of Nevada.

Transuranics from military operations is disposed of outside Carlsbad, New Mexico, low-level radioactive waste from civilian activities is permanently stored in several sites in the country.

The producers are paying for the waste management through a nuclear waste fund which was established in 1982. The U.S. Department of Energy (DOE) is responsible for implementing the final disposal of spent fuel and other high-level (civilian) waste.

Finland

Finland's four reactors, two at Olkiluoto and two in Loviisa, deliver 27 percent of the country's electricity. The construction of a fifth reactor in Olkiluoto is ongoing and will be operational in 2012. Additional reactors are planned.

After a period of interim storage at the nuclear power plants, the spent fuel is encapsulated in copper and permanently stored in the bedrock. Close to Olkiluoto there is a construction of a underground research laboratory going on. The research tunnel is planned to be the final repository for spent nuclear fuel in Finland. Other radioactive waste is disposed of in bedrock repositories at each nuclear power plant.

The producers are responsible for the management of radioactive waste and the costs. In 1995 the nuclear power companies formed Posiva Oy which currently manages research as well as construction and operation of the facilities needed for final disposal of radioactive waste.

Sweden

Sweden has ten nuclear power reactors which together produce about 50 percent of its electricity. After a referendum in 1980 it was decided that nuclear power should be phased out. Two reactors have been shut down. Now public opinion has turned and the continuation of nuclear power is now discussed politically.

Since 1985 a central interim storage for spent nuclear fuel, at the Oskarshamn nuclear power plant, is operating. A final repository, geological disposal at about 500 meters depth, is planned. Between 2002 and 2008, two site investigations were performed in Oskarshamn and Östhammar municipalities. In 2009 Forsmark (in Östhammar) was proposed by SKB as the site for the final repository, the applications will be submitted in 2011. The low- and intermediate-level waste is disposed of at Forsmark in Östhammar.

The producers of radioactive waste are responsible for all waste management and associated costs. SKB, Swedish Nuclear Fuel and Waste Management Co., founded in 1980 and owned by nuclear power companies, have the assignment to manage and dispose of all radioactive waste from Swedish nuclear power plants.

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