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Decommissioning Cost Assessment

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Abstract

The future costs for dismantling, decommissioning and handling of associated radioactive waste of nuclear installations represents substantial liabilities. It is the generations that benefits from the use of nuclear installations that shall carry the financial burden. Nuclear waste programmes have occasionally encountered set-backs related to the trust from society. This has resulted in delayed, redirected or halted activities, which has the common denominator of costs increases.

In modern democratic countries, information sharing, knowledge transfer and open communication about costs for the management of radioactive waste are prerequisites for the task to develop modern methods for public participation and thus to develop well-founded and justified confidence for further development of nuclear energy. Nuclear and radiation safety Authorities have a clear role to provide unbiased information on any health, safety, financial and environmental related issues. This task requires a good understanding of the values and opinion of the public, and especially those of the younger generation.

Background

It is perceived that prolonged decision making processes about policies on nuclear energy, as well as on the associated nuclear waste management, are influenced by the requirement of not to passing on any financial burden to future generations. The fulfilment of this aim is a crucial task for the present generations. This mission includes not only the development of sustainable systems for safe keeping of financial assets in segregated funds, but also includes the task of developing modern dialogues with the general public. Hence, it is a crucial to build justified mutual confidence and trust for the actions needed in order to design, construct, and operate geological repositories for radiological waste from dismantling of nuclear power plants and other nuclear installations needed.

Objectives of the project

It is recognised that younger citizens constitute a stakeholder group that is often excluded in decision-making processes. It should be remembered that the existence of substantial gaps between the involvement of older and younger stakeholders decision processes needs to be properly addressed. The reason for this is that imbalances might lead to inter-generational inequalities in allocation of opportunities which may limit the future wealth and consumption level of the next and coming generations.

In the current survey, authentic field data has been collected, analysed and compiled. This empirical data gives knowledge about the values and opinions of younger citizens that - properly used - can mitigate cost raiser within the field of public participation and planning for dismantling of nuclear power plants and other nuclear installations.

Results

The survey constitutes stratified samples from four locations in Poland and once area in Slovakia. A total of 1 445 students in the age group 14-19 years of age have participated in the study. A database has been compiled. It contains valuable information about younger people's values and opinions regarding handling of nuclear waste and associated topics.

Conclusions

If the resources accumulated for Nuclear Waste management are to become used efficiently, it is recommended that the views of younger stakeholders be included at early phases in planning for decommissioning of nuclear installations.

Furthermore, it is prudent to use modern channels for communication in order to achieve participation from young people and hence avoid delays in environmental assessments.

Project information

The project leader Bea Labor has written the report and performed the co-ordination with determination and outmost skill.
SSM reference: SSM

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This report concerns a study which has been conducted for the Swedish Radiation Safety Authority, SSM. The conclusions and viewpoints presented in the report are those of the author/authors and do not necessarily coincide with those of the SSM.

Content

1. Preamble

It is a widely shared scenario that a waste number of permanent shut-down research reactors, commercial nuclear power plants and other kinds of nuclear facilities utilizing radioactive materials will enter into the status as decommissioning projects to before long. Some of these nuclear facilities are coming to the end of their financial as well as physical operating lives and will soon enter into the de-commissioning phase. Common feature for these kinds of nuclear facilities is that they all were built, constructed and operated in many countries simultaneously in the early days of the nuclear era. Hence, the range and dimension of local nuclear experiences varies widely. The dismantling and decommissioning of nuclear power plants, as well as other types of nuclear installations, are to a significant degree a linear function of the radiological risks due to ageing and other related issues, such as political considerations or environmental constraints.

This report focuses on questions that need to be addressed from an open and accessible political process in order to achieve a full democratic potential in decommissioning projects. One major part of the process is communication between all involved stakeholders. For younger citizens in particular there seems to be an interest for dialogues in environmental questions.

Hence, in this subject it is vital to find didactic techniques and methods to stimulate younger citizens to participate and be included in the process to plan for safely and efficiently decommission of reactors and other nuclear installations.

2. Modes of Dismantling

At current there exist no absolute definitions of decommissioning and dismantling neither of nuclear power plants nor other nuclear installations. Hence, a stringent and workable definition is a task that would be welcomed by professional as well as nonprofessional participants in the nuclear field.

There exist in principle two common strategic options for the decommissioning and dismantling of older nuclear facilities.
These are;

- Prompt dismantling, which sometimes is referred to as direct dismantling,
- Deferred dismantling, and occasionally
- Entombment (in situ dismantling).

Each of these three options may be found in different kind of steering documents, e.g. IAEA guidelines on decommissioning strategies. It is also possible to use strategies that are intermediate between these fundamental options, e.g. periodic dismantling on longitudinal basis - that is over longer time periods as 30 to 50 years. Occasional, in some cases even time frames as long as 120 years has been used for planning. Such concepts may from time to time be suited to given situations: e.g. on a multi-facility site or in a country with unpredictable availability of resources.

Notwithstanding, regardless of which strategy is chosen in an authentic situation, for one or another reason, it is a prerequisite that characteristics from the local environment are used as a crucial and vital input to decide the optimum strategy.

Immediate dismantling

The immediate dismantling, or direct decommissioning and dismantling, strategy covers the situation where a nuclear facility is completely dismantled and decommissioned in the near future, e.g. between 2 to 15 years after the permanent shutdown on the specific nuclear site. It ought to be noted that this option is chosen when only limited benefits will be achieved from radioactive decay (normally decay of C 60 for one to two periods). This strategy imposes requirement for prompt and immediately available funds, well developed planning and other needed financial resources.

Deferred dismantling

In this case the decommissioning - and the direct dismantling activities - are deferred to a future date with an intervening period, a so-called transition period. An attempt to give a definition of the concept of transition period can be found in reference [1].

During the transition period surveillance and maintenance in order to guarantee a safe and risk-free mothball period is needed. In some extreme cases the transition period can consume all available funds, and thus become the “standard” state since the financial resources for dismantling and decommissioning has been fully depleted by paying for the costs during this stage. In this situation the deferred dismantling

strategy is unsafe or risky. For older research reactors, as well as for nuclear installations of smaller scale, this is usually equivalent to direct or prompt dismantling of accessible peripheral parts of the plant while leaving the activated parts, i.e. the reactor core, as a safe enclosure.

The deferral period is given either to allow the decay of shorter lived isotopes and/or until waste disposal storage facilities are in operation. It must be noted that extended periods of maintenance during the transition period may consume a lot, if not all, of segregated financial resources. The cost-drivers during the transition period can have different reasons, e.g. increased participation from the local community in the planning phase.

Inadequate financial funding may give rise to an automatic deferred dismantling by making all other opportunities financially void. Regardless of the length of the transition period, i.e. from the end of the operation to the beginning of the dismantling of the nuclear power plant, the requirements for safe conditions often demand immediately available financial assets as well as other more intangible actions. One example of such intangibles is the support and cooperation with the local society and dialogue with municipal organisation.

It may be appropriate to raise the question, already on this introductory level, that systematic surveillance and maintenance require continuous flows of funds during the transition period. The total cost of deferred dismantling can be on a higher level that the alternative of direct decommissioning and dismantling, even if the cash flow from time to time gives requirements that can boost incitements to faster than planned dismantling. However, it is normally expected that the majority of the costs can be deferred to a distant, and sometimes non-defined, future day. In this situation it is more or less crucial to stress that international accounting standards will have an impact on the pace of the process if and how future cash requirements are discounted. The positive benefit in this context that the financial assets may have grown over time must be weighed against the other limited resources, such as municipal inclusion, knowledge transfer of the plant and its condition, that normally degenerate over time. Hence, to fix a comprehensive setup of data for the alternative with deferred decommissioning and dismantling where inter alia the length of the mothball period have to be integrated into a full SWOT-analysis that addresses the strengths, weaknesses, opportunities and treats on a site-specific basis for deferral.

If the local municipal and its citizens are included in the process on an early stage it is possible to enhance the pace of the future process and give room for new, and maybe, today yet un-seen opportunities. Early inclusion of all the stakeholders in principal, and the local community and its citizens in particular, is probably a prerequisite for a success public involvement in the process for dismantling nuclear power plants and nuclear installations. Since deferred decommissioning and dismantling may consume time for between one half to over one generation it is crucial to incorporate the younger citizens at an early stage in the process.

Entombment – in situ dismantling

The particular case when a nuclear power plant or nuclear facility is taken care of on the site is in most cases generally referred to as entombment.

This option is not appropriate to normal commercial power plants but may be attractive for some odd smaller nuclear installations on grounds of simplicity and low

costs. It ought to be said that this alternative not have been broadly used as a decommissioning strategy. It may be stated that the strategy of entombment was a viable decommissioning strategy in the early years of the nuclear era being practised in a few countries. But in reality the entombment approach often means that the problems is passed over to future generation and thereby violates the polluters' pays principle.

Entombment is perhaps suited where the older nuclear facility is situated in areas with low population density far from populated localities and with an inferior infrastructure that hamper appropriate logistic solutions. This approach may be applicable in an area where the geological and hydrological characteristics are suitable for building of a near surface repository and/or surface storage (land-fill). In general, entombment may be a "forced-upon" decommissioning strategy for countries that have the task to decommission a single facility and at the same time lacks financial assets, or are refused international aid and contributions, to develop the appropriate infrastructure needed to apply to international rules for transportation, as well as logistic constraints, for transportation of waste, definition of waste routes, waste handling and disposal of waste.

Likewise, as is the case in the previous situation with deferred decommissioning, the case of entombment calls for an early inclusion of the younger citizens in the process. This is due to the fact that this strategy might take a long time to implement and consequently is likely to have effects on the younger generation's future consumption of energy, goods and services.

3. Dismantling Strategies

Decommissioning strategies will vary according to a number of considerations. Hence, it is anticipated that the accessibility and availability of waste disposal routes, the quality of radiological mapping, the radiation protection policy, cost and funding considerations and local site factors are of most central importance to the process of defining opportunities for efficient decommissioning strategies in general.

In this context some pros and cons of key influences on the choice of decommissioning strategy needs to be revealed and presented as a first step. In this process of work it is essential to define the various resources required to achieve decommissioning. It ought to be stressed that there exist a close relationship between potential strategy options and availability and accessibility to financial funds and other kind of opened resources. Furthermore, it may be stressed that it is customary to draw a clear distinction between short term resource requirements on one hand - occurring soon after facility shutdown after the date when the last load of fuel has been reloaded- and other long term requirements relating to effects many years later, on the other side. The latter types of requirements need special attention, since they are crucial for the quality of the planning in the early phases of a decommissioning project. Likewise, short -term resources need to be available as well. However, since these resources normally are budgeted for in close interdependence to the shutdown of the specific nuclear facilities this question tends to have a less critical impact in the longer perspective in practice.

It is a rather well-known fact that public inclusion and stakeholder relations are a potential factor for deviant project plans that may jeopardise the timely delivery of a decommissioning project. There are many different stakeholders involved in this kind of project and some of the more crucial ones are local municipalities, planning authorities, regulatory bodies, the public, 'pressure groups', environmental groups, anti-nuclear activists and other interested parties. One classic lesson learned from earlier decommissioning projects is that early involvement of local stakeholders in the project creates good working relationships. If stakeholders are given access to the process and are able to participate in planning sessions with the project team a positive atmosphere of mutual trust and understanding may be created. By this step the working process will stimulate good and open communication to the public, which may give support for the chosen project approach. For a discussion of this process se for example references [2-4].

The public may have had no awareness of the existence of a longstanding facility until decommissioning is announced. Hence, public concern may suddenly be aroused if it is realised that the site may be used for storage of spent nuclear fuel or other forms of radioactive waste disposal.

4. The Framework

The prime objective of the project is to provide information so that it will be possible to describe and present authentic data about younger citizens values towards decommissioning and dismantling older nuclear installations. By adopting this approach it will be possible to retrieve knowledge about different values of the younger population in this crucial question.

Hence, based upon the retrieved survey data it will be possible to derive value functions in this topic. This knowledge can be used to establish and implement more comprehensive and contemporary systems for inclusion of younger citizens in a question that will be valid for many generations and centuries to come. In a longer perspective cooperation and mutual understanding, as well as potential support, from the younger generation may contribute to a more efficient process of constructing and building underground repositories and on ground storages and landfills for nuclear waste, hazardous waste and waste from dismantling of older nuclear power plants. This is not a question that is isolated to specific local areas within the European Union, but it will be a European concern.

In this study data has been gathered by reproducing one survey made in Kalmar in year 2006. The questionnaire has in a first step been translated into Polish. In this process some of the questions have been adopted to Polish and European conditions. After in depth interviews with groups of students some questions were modified and some new questions were added to the questionnaire. As an examples questions about the use of different energy sources and the view on the polluter pays principle was added to the questionnaire.

5. Model for Transparency

The task to inform the public about present as well as future risks of nuclear waste management is of strategic importance if the general public shall be able to develop a general trust for the nuclear energy as a long term viable energy source. In information activities concerning the risks linked to the use of nuclear technology there tends to be a biased to inform older prior to younger citizens. In order to support this statement we will refer to the risk and communication project (RISCOM) [5-8].The RISCOM project has been financed within the European Commission fifth frame program. Within this project a simple model for transparency was developed in a smaller explorative study, a Pilot Project, funded by Swedish Nuclear Inspectorate and Swedish Radiation Protecting Agency. The aim of this project was to enhance transparency in the decision-making process in nuclear waste programmes. The aim was not only to increase the transparency in the process in the involved member countries but also within the European Union as a whole. The aim was to find ways and structures by which the level and degree of inclusion of public participation can be stimulated and enhanced.

In the RISCOM model different types of processes for public participation can be analysed. This approach enables in turn the development of more modern, coherent and clearer procedures for public participation and communication.

From day to day we confronts as individuals with values and meanings produced and given to us by the operations of governmental institutions, commercial enterprises, multinational companies, pressure groups, support groups etc. As citizens we are evaluating all these values and information in on going and interactive processes by which we all create and develop considerations and alternative views. The failure to establish fully opened democratic processes and thereby create a situation with non-optimal interaction between different stakeholders can be described as a “democratic deficit”. By drawing attention to the development of more appropriate communication channels, the society will be able to bridge the gaps between the silent majority vis-à-vis official appointed experts, official officers and politicians.

In this study on aims is to describe the values and views of younger citizens and their opinions about dismantling of nuclear installations. On major reason for this is that this is a group that often experience barriers to entry the regular stakeholder processes. The effect is that their opinions may not be taken into account in the public opinion.

6. Levels of Inclusion

For structuring of the different types of influences to the creating of values it might be beneficial to define sources of influence. According to the taxonomy developed by Dimmick et alia (1982) [9] the following levels of influences are at present[1];

- Supra-national, e.g. international regulation agencies or multinational firms.
- Society, e.g. government or national social institutions like political parties.
- Media industry, e.g. competing media firms, advertisers, etc.
- Supra-organizational, like chains and conglomerates.
- Community, e.g. city, local business.
- Intra-organizational, e.g. groups or departments within an organisations.
- Individual, this is depending on role, social background, personal attitude, gender and ethnic origin.

If this schematic classification is applied to analyse the stakeholder´s activity level in the process it is often recognised that the possibility to participate in the process depends on the individual´s relations to the actual environment where unwritten social and cultural guidelines, habitué, has to be obeyed.

The scheme also pinpoints the fact that a unique individual's access to the process via stakeholders groups is not easy since there are many other more dominant levels. When the question of access to the transparent process is scrutinized in detail it will become evident that younger citizens[2], as well as citizens to come, have no natural base for participation in the process. In this perspective the younger citizens not only represent their own generations but also indirectly future generations. Due to this it is even more essential to include the values of younger citizens in present processes of decommissioning of nuclear facilities. To exclude the values of younger citizens in a process for evaluation and selection of different decommissioning modes and strategies may give a biased decision process. This biased may ultimately result in that the decision makers of today that are working with models for stakeholders inclusions will not still have a clear and neutral planning assumptions for such a model.

One great leap forward is to develop new decision procedures that will enable us to include younger citizens' values and value structures towards decommissioning of nuclear facilities in modelling

[1] McQuail, Dennis, Mass Communication Theory, 4th edition, SAGE Publications, 2000, page 246-249 [9].
[2] The values of younger citizens might be the best guesstimate for the values of coming, yet unborn, generations. From this perspective the younger citizens not only represent their own generations but also indirectly the future generations. Due to this fact it is even more essential to include the values of younger citizens in present processes of decommissioning of nuclear facilities.

7. The Aim of the Survey

The prime objective of the present research project is to find a knowledge transfer that enables us to describe authentic data about younger citizen's values towards decommissioning and dismantling of nuclear installations. The application of this approach will enable us to retrieve knowledge of the different values of the younger population in a central and vital question that may have substantial impact on democratic processes. Thus, the task to develop a better understanding for value functions of younger citizens may enable the society to develop more efficient strategies for communication and public inclusion in the nuclear waste downstream.

It is evident that mutual interdependence and trustworthiness will be crucial for a successful dismantling process. The younger generation may contribute to develop more transparent and open processes for decision-making in questions concerning handling of nuclear waste. The process to construct and build storage facilities for nuclear waste, like low and medium level wastes from dismantling, and decontamination and dismantling of older nuclear power plants is not only are questions for specific local areas within the European Union. Therefor is it essential that a pan-European perspective is applied already at the start of the process.

8. Previous Survey Sample

The Regional Council in the County of Kalmar conducted in the fall of year 2006 a profound survey with a well-developed questionnaire in four parts of the County. The study covered four municipals; they are Borgholm (on the islet Öland), Kalmar, Oskarshamn and Västervik. In the study a total of 235 youngsters in the age group 15 to 19 years participated [9]. The main raison d'être for this study was to compile increased knowledge how younger citizens can be more included in the activities to build an underground storage (geological repository) for used nuclear fuel in Sweden. The study was not done with particular focus on statistical accuracy as choice of sample techniques, questionnaire formulation and analysis. This study was a typical explorative study, and it is stated in the report that it is a miniature study from which is not possible to make any statistical inference. However, it is said in the short "methodological part" that the reliability as well as the validity of the study can be benchmarked by other similar replicative studies[3]. The main goal of the questionnaire was to find out how younger people can be stimulated to increase their propensity to participate and contribute in an active learning process with linked knowledge transfer about decommissioning of nuclear facilities[4].

[3] One example of a non-experimental study is work done by L. Sjöberg for the Swedish Nuclear Fuel Waste and Management Company SKB [11].
[4] In this document the study made by the Regional Council in the County of Kalmar in year 2006 will be referred to as the *Kalmar sample*.

9. The Survey Design

The field survey data has been collected on the following dates and at the following geographical places.

- January and February 2008 in Gdansk, Poland
- September 2008 in Lublin, Poland
- November 20008 in Elblag, Poland
- February 2010 in Trnava, Slovakia
- Mars 2010 in Jaworzno, Poland

In the first part of the Study in depth interviews were conducted with the purpose to clarify if the questionnaire needed to be altered before the collection of survey-data started. In this process the questionnaire was used to retrieve information from the above mentioned stratified samples. In total the samples include a number of 1445 students. After the Survey the sampled data was coded, analysed and presented at working sessions in held in Gdansk and Katowice during November and December 2010. In these working sessions ways to make the findings comparable to the findings from the Kalmar study were presented and discussed.

Date of survey	Country	Place	Number of classes	Number of surveys
2008-01/03	Poland	Gdansk	21	368
2008-11-10	Poland	Lublin	10	285
2008-11-11	Poland	Elblag	5	127
2010-02-15	Slovakia	Trnava	19	471
2010-03-11	Poland	Jaworzno	8	193

10. The Field Study Data

In this section some of the major results and findings from the present survey study will be presented. To support the understanding comparisons are occasionally made between the data retrieved from the survey in Poland vis-à-vis previous retrieved sampling data from the survey in Kalmar. It might be appropriate to be pin-point that the results are presented in the form of *question by question*. Notwithstanding, for the state of clarity it has to be stated that this section only contains the questions that has been given in the surveys done in Sweden, Poland and Slovakia. In May 2010 a scientific article was published that presented results from the Polish field data collected in 2008 [12]. Detailed data corresponding to each question are presented in Appendix A.

Question 1 - Which form of energy do you prefer?

On this question 1443 students ticked in 1 979 answers on the alternatives given in this question. The base for this data is based on the samples from Poland and Slovakia.

According to these answers the most popular mode of energy is windmills, which was seen as a preferred energy source in 33.2% of the cases. Hydro power was preferred by 31.8%, followed by nuclear power that was seen as a preferable energy source by 24.7%. Energy produced by coal (coal condense power plants) was seen as an acceptable alternative for 4.4% of the respondents.

When these data are compared to the Kalmar sample it is possible to detect that the preference order given in the answers are identical. Hence, the priority ranking is for both samples given as follows: *windmills, hydro energy, nuclear power and coal*.

Some answers can be explained by fundamental differences in the energy balance in the two countries. In Sweden there are no priorities for coal, whilst 4.4 % in the Polish sample had ticked this energy mode. This reflects a local difference which has to be considered. Hence, in Poland coal energy plants that are producing electricity are normally supplied with domestically produced coal. This has historically been a prime resource for energy that in the past has had a substantial contribution to the total energy balance on the country. This has, on the other hand, never been the situation in Sweden since a half century. It shall be noticed that if the Katowice sample is excluded the figure drop from 4. 4% to 2.8%.

Question 2 - Are you aware of that nuclear power produces not only electricity but also gives radioactive waste?

In the Polish sample a vast majority of 78.7 % claimed that they know that nuclear power give rise to both long lived and short lived nuclear waste as a negative side-effect. There is a small difference in the answers between the sexes, where the girls answers lies under the average at 75.9% compared the boys that consequently lies above with 82.3%. However, this difference is not large enough to be statistical significant.

On the other hand only a 4.6 %, which is less than 1 out of 20, said that they are unaware about this crucial fact, while the rest or 16.7% said that they were unsure.

In the Kalmar sample, on the other hand, nearly 69% said that they had this knowledge. Furthermore, another 15.9 % of the respondents said that they did not know that nuclear power producer nuclear waste, while the rest, or 15.1 %, did not articulate any direct opinion in this question. Hence, the awareness is somewhat higher in Sweden, which also is what might be expected due to more available information the Kalmar region.

Question 3 - Do you know that nuclear power plants need to be dismantled after it has stopped producing electricity?

This question is linked to the previous question and since the linkages are strong it is appropriate to study the results from the two questions simultaneously.

In the Polish sample more than half of the respondents, or more precisely 52.5%, claims that they knew that the nuclear power plants need to be dismantled after they have stopped operation and no longer are generating electricity.

When the answers given by the two groups are compared with each other a similar pattern emerges again. The amount of those who are aware of the fact that nuclear power generates nuclear waste is 78.7 % respectively 69 % for the two samples.

Furthermore, concerning those students that claim that they were not aware of this, i.e. 4.6% in the Polish-Slovakian sample said that this fact are attributed to their lack of knowledge and non-optimal knowledge transfer, compared with as much as 15.1% in the Kalmar sample.

Question 4 - Are you aware of that nuclear waste is generating a hazard for health and nature for more than 100 000 years?

On this question a number of 631 students, which is equal to 43.9%, replied that they were aware of that nuclear waste has negative health effects as well as negative environmental effects to mankind for more than 100 000 years. Another number of 565 respondents, which is equal to 39.2%, said that they were unsure about the long-term health effects generated from nuclear waste. Finally a number of 246 students, which is equivalent to 17.1%, gave the answer that they were uninformed of the risk.

As a comparison – it can be mentioned that - the waste majority (175/235), i.e. 74.5%, in the Kalmar cluster sample said they knew that mankind is exposed to nuclear waste in more than 100 000 years.

On the other hand in the five samples from Poland and Slovakian more than 4/5 of the students answered that they knew that the negative effects has a longitudinal and prolonged effect upon health. This difference is significant in the sampled population.

Thus, from the data it is possible to conclude that the overall awareness of the risks is substantial among younger citizens in Sweden, Poland and Slovakia. There exists no significant difference between the different samples as well. From a gender perspective no differences can be measured between the sexes.

Question 5 - Are you aware that Sweden is planning to store used nuclear fuel in rock caverns?

On this crucial and fundamental question about long-term preservation of high level nuclear waste, i.e. spent nuclear fuel, 1128 out of 1442 respondents, accounting together for 78. 2%, in the joint Polish-Slovakian sample said that they did not know anything of the Swedish plans to store spent nuclear fuel and/or other radiological waste in rock caverns in Sweden. Likewise, as few as 99 respondents out of 1442, which are equal to 6, 9% said that they had learned about the Swedish plans Another group of 14.9% gave the answer that they were unsure the Swedish plans.

In the Kalmar sample 160 out of 235, or 68 %, said that they are familiar with know about the plans. As many as 75 students, or 31.2 %, was on the other hand unsure or did not know about the plans.

When the results from the answers by the two groups of the cluster samples were compared, the conclusion was that it is significant that the level of knowledge is considerably higher in the Kalmar sample than the Polish samples. This is also what should be assumed. Nevertheless, there exist some observations of central importance to be given in this case. A consideration is given to a couple of the most obvious observations have been structured and formalised in the below two groups of questions.

It may be concluded that there are no significant differences been the five clusters that are part of the joint Polish-Slovakian sample.

Question 6 - Are you aware of that Sweden and Finland are planning to store used nuclear fuel and nuclear waste from the decommissioning of nuclear power plants in rock caverns?

The comments of this question are in principle very similar to those answers given to the previous presented question 5, but with the difference that it is a two-folded question that also includes the situation in Finland.

When the question is reformulated to a Yes/No question the results will be somewhat changed. In this case the changes are small and non- significant from a statistical point of view. This means that it may be possible to conclude that the result is fairly robust concerning the general common sense among younger citizens concerning long-term preservation of high-level nuclear fuel. In this case 593 out of 1442, of the responses in the Polish-Slovakian sample reflects that the knowledge level is 14,1% concerning the Swedish and Finnish plans to store spent nuclear fuel and/or other radiological waste in final repositories as rock caverns 500 meters down.

It may be appropriate to stress that there are no significant differences between the three clusters that together forms the Polish-Slovakian sample.

Question 7 - Who shall take care of the Swedish nuclear waste?

A total of 1277 of a total of 1450 students, which is around 88%, answered that they thought that Sweden shall take care of the used nuclear fuel and nuclear waste from the Swedish nuclear program and the dismantling and decommissioning of the Swedish nuclear power plants. This view is honouring the polluter pays principle in full.

Consequently, a total of 173 students of a total of 1450 which is equal to nearly 12% expressed the opinion that the nuclear waste generated in Sweden can be decommissioned not only by Sweden but also by other countries within the European Union. This view can also be compatible with the polluter pays principle.

The conclusion is that although the waste majority of the bulk with the following opinion of the younger citizens is expressing a strict application of the subsidiary principle, i.e. the principle that says that the responsible polluter also shall take care of the pollution. The polluter pays principle seems to have a solid foundation within the intellectual framework of the younger citizens.

Once again it seems to be appropriate to highlight that there are significant differences between the four Polish clusters. The response in Slovakian cluster is somewhat higher than in the Polish cluster.

Question 8 - Where do you think nuclear waste shall be stored?

In the Polish-Slovakian sample most of the students representing 649 answers out of a total of 1623 answers, which is equal to 40%, said that they preferred to store the nuclear waste in the rock caverns. Nearly as many, namely 645 answers also out of a total of 1623 answers accounting for 39.7% of the total assumed that rock caverns would be the most appropriate place. On the bottom of the sea was one options advocated by 4.8% of the respondents, while another 126 students or 7.8% said that they preferred the Polar ice as the best place for sustainable end-storage of nuclear waste.

The collected results from the Kalmar sample are in line with what has been derived from the Polish and Slovakian filed data cluster samples.

However, there are two minor differences that are appropriate to comment. Firstly, a somewhat higher proportion in the Kalmar sample compared to the Polish-Slovakian cluster sample is in favour of sustainable end-storage in rock caverns and on the bottom of the sea. Secondly, in the Polish-Slovakian sample a higher than expected proportions of the answers are given the suggestion to store the nuclear waste in the space. In the Polish-Slovakian samples the alternatives of rock caverns vis-à-vis in the space are the opportunity storages that are favoured by most of the respondents.

In the Kalmar sample the major answers are concentrated to the alternative to store the nuclear waste in rock caverns. This result may be explained by the fact that there

is a rock laboratory located in the town of Oskarshamn in the northern part of the region.

Question 9 - Do you have confidence and trust in the decisions makers' capability in the decommissioning process?

In the Polish-Slovakian cluster samples less than one fifth, or more precisely 16.7% said that they have trust in the decision maker´s capabilities concerning their ability to solve the matter about how end storage for spent nuclear fuel and radioactive waste from decommission of nuclear power plants should be planned, constructed, build and operate.

On the other hand a good 1/4th or more exactly 29% said that they mistrust the decision maker's capabilities (determination) in this context. However, the bulk of respondents representing more than the half (54.3%) of the sample population claimed that they did not have a clear position in this matter or were unsure. The reason for this was a low level of knowledge transfer.

The response from the Kalmar sample shows a similar pattern. This field data shows that a little more than 25 % said that they trust the decision makers and a little more than 50 % said they were unsure. Finally, an almost quarter said that they do not trust that the decision makers enough competence in this question.

Based on the collected field data it can be stated that there are a striking similarity in the answers given by the different cluster samples in Sweden respectively Poland and Slovakia. There exists no statistical significant difference between the answers given from the different samples.

Once again, it is important to emphasize that there is a difference in the Polish clusters, including the Slovakian cluster sample, and that this difference in opinions have a divider between the samples in terms of the coast versus inland location. The difference is not statistical significant from a pure technical view.

Question 10 - Can you consider having a site for final disposal of nuclear waste near to your home?

In the Polish-Slovakian sample only 15.6% or 226 out of a total of 1444 responses from the students are in favour of the alternative that they can consider a final disposal for nuclear waste from dismantling of older nuclear facilities be located near their homes. Consequently the major number of the respondents was against having a site for final disposal of nuclear waste in the surrounding vicinity of their homes and living space. Thus, 84.4% of the younger citizens object to have a final repository for spent nuclear fuel or nuclear waste from dismantling of nuclear facilities near their houses or living area.

If these responses taken from the five Polish-Slovakian samples are compared with the responses from the Kalmar sample it is again possible to find a striking similarity in the answers given. In the Kalmar sample 80.9 % of the students said that they are against having a site for final disposal of nuclear waste in the surrounding area of their homes and living space.

There is in fact no difference statistically between the two populations in these questions. This means that we have fairly robust data to make a statement that younger citizens in general do not favour to have a site for nuclear waste from dismantling of older nuclear facilities in their neighbourhood. Furthermore, there is no statistical difference between the samples neither between the propensities to avoid living close to a repository for nuclear waste between the sexes. This is also true for the locations. The validity of this question has a clear statistical significance.

Question 11 - What is your opinion regarding a site for final disposal of nuclear waste?

When a question are reformulated in a more general form, e.g. without any reference to any geographical location, there tends to be a slightly stronger propensity to accept, or an increase in the acceptance level for, a site for older nuclear waste. However, it ought to be stressed, that the acceptance levels is still in the boundary of one 1/4th of the sampled field data.

In the Polish-Slovakian samples it is recognised that just below 25%, or more specific 24.2%, of the answers given are in favour of a site for disposal of nuclear waste. Meanwhile it can be seen that roughly half of the answers 50.2% (which represents 722 out of 1438 answers) were opposing it. As many as 367 out of 1438, which represents approximately a quarter of the samples (25.5%) from the group sampled populations, did not express any preferences about this matter.

In the Kalmar sample as many as 44.3 % disclosed preferences in favour of a site for final disposal of nuclear waste and 29.4 % said that they were indifferent to the question.

When all samples are compared it is possible to see that the answers given by the subgroups that are negative towards a final disposal have striking similarities and are almost identical. The groups that declared they were indifferent to the subject are scattered within the interval of one fourth to one third. The difference in the material is that there are more positive students in the Kalmar sample. On the other side, the Polish-Slovakian data are robust and statistic significant.

Question 12 - Which of these values do you base your opinion upon?

In the combined Polish-Slovakian samples a total of 189 given answers by the students out of a total of 1646, which is equal to 11.5%, expressed that their opinion was based on trust for the determination and skills of the involved stakeholders. Yet another group of answers that can explain 10.1% for the value base said that their opinion was based on the opportunities linked to major decommissioning projects as such. The second largest group, that in total accounts for as much as 34.6% of the given responses expressed that their opinions are based on insufficient knowledge, i.e. they expressed a concern about lack of efficiency in knowledge transfer. However, in the largest group as many as 39.5% claimed that their opinion was grounded in uneasiness about the risks connected to dismantling and decommissioning of older nuclear facilities and storage, handling and management of the nuclear waste. Finally, the smallest group with 72 out of 1636 given responses, which account for 4.3% of the total, gave other reasons for their opinion base.

In the Kalmar sample 21.7 % said that they based their opinion on trust for the involved stakeholders. This is a significantly higher than the corresponding level of responses from the Polish-Slovakian samples. In the Kalmar sample another 15.2 % said that their opinion is based on opportunities linked to the project to build a final repository in Oskarshamn. These responses are on a somewhat higher level as the responses given by the Polish-Slovakian samples in which a good 10% gave this view. In the Kalmar sample 28.7 % said that their opinion was based on lack of knowledge, which is a little lower than what has been registered in the Polish-Slovakian samples were 34.6% held this position. Finally, 31.1 % gave uneasiness about the risks connected to construction, building and operating of a final storage for spent nuclear fuel as the base for their values. This view is significantly higher in the Polish-Slovakian samples were 39.5% expressed this view.

In the Kalmar sample 3.7 % of the answers were linked to other explanations, compared to 4.3% for the data from the Polish-Slovakian samples.

The sampled data gives that around ¾ of the younger citizens base their values on either the risks connected to the handling of nuclear waste and/or lack of knowledge and low efficiency in the knowledge transfer. This may be seen in terms of a conservative approach towards the total risks.

The values bases also enclose trust for the involved stakeholders. This factor seems to have an explanatory power of around one 1/10 to one 1/6. Finally, the opportunities linked to a disposal of nuclear waste has just a somewhat lower explanation value, which is firm in the region of one 1/10.

It may be possible from this data to give a statement that younger citizens have a value-base that is funded in fundamental questions concerning risks of inefficient knowledge transfer and lack of availability or access to nuclear waste information compared to more opportunistic questions like future benefits to the region from a nuclear waste storage and trust for the stakeholders involved in the decision making process.

Question 13 - Which aspects are in your opinion crucial for the acceptance of a final disposal for nuclear waste?

In the Polish-Slovakian aggregated samples 859 answers out of a total of 2235 answers, which equals no less than 38.4%, gave the response that the safety aspect is the most important factor to consider in the process of dismantling and decommissioning of nuclear power plant and associated handling of nuclear waste.

The environmental aspect was seen as the second most important factor with a total answer frequency of 27.8 % of all answers given.

The fact that geographic localization of premises for the disposal of nuclear and radioactive waste is as far from home as possible was described as the third most important factor. This factor was stressed as crucial in 475 answers out of a total of 2235 answers, hence this factor may account for 21.2% of the total amount of given answers.

In the Polish-Slovakian sample these three reasons are together given an explanatory power of nearly seven eights, or more exactly 87.4%.

The acceptance of storage of nuclear waste may be added together in two explanatory factors. These are methods and techniques used (8.6%), economic growth or financial wealth (3.2%) and other explanations (0.8%). The residual is of such a low magnitude that it from a statistical point of view may be overlooked.

Question 14 - In which ways do you think that younger people can participate and contribute to the information process about nuclear waste?

This question has multiple answers. In the five Polish-Slovakian samples from Gdansk, Elblag, Lublin and Trnava in Slovakia and Katowice a total of 2155 alternatives was ticked in the questionnaires. Please look below for a presentation of the suggestions that were given.

In the Polish-Slovakian cluster samples the respondents gave a lot of suggestions for possible developments concerning the channels of information in the area of decommissioning of nuclear power plants.

- It may be appropriate to notice that the alternative to participate in project groups (collective learning) was the most popular alternative that was suggested in nearly one 1/3rd (32%) of the cases.
- The alternative of producing a film was mentioned as possible in as much as 18% of the cases.
- The suggestion to plan, organise and conduct exhibitions on the subject was given in 15.4% of the cases.
- The alternative to use IT and to create and construct websites was given in 13.5% of the case.
- The suggestion to use power point presentations was suggested in 14.4 of the cases.
- The alternative to make a theatre play was ticked in 4.4% of the cases.
- Other suggestion was accounted for in 2.3% of the given responses.

If a comparison is made with the responses from the Kalmar sample there are clear similarities in the answers. In the Kalmar sample 24.8% of the responses suggested project work, collective learning and 16.6% suggested using exhibitions. Presentation by power point was given in 11.2% of the answers. To construct webpages and use IT was suggested as a measure in 12.9% of the cases. To put up a theatre play was suggested in 13.2% and film in 9.3% of the cases. Other alternatives were suggested in 11.8% of the cases, e.g. study trips and writing articles.

The main difference between the answers from the Kalmar sample compared to the Polish-Slovakian samples is that there is some variety concerning the use of theatre versus film as a media. Where the answers in the Kalmar sample was more in favour of using theatre as a media for expression prior to film. The opposite is true for the Polish-Slovakian samples.

There are only minor differences between the Polish data and the Slovakian data. The latter is more in favour of project groups, while the former is somewhat more in favour of exhibitions.

11. The Field Data

The overall reliability and validity of the collected field data from the five different cluster samples in Poland and Slovakia are appropriate and similar in nature. The bulk of the collected data are statistical significant and may can therefore be used for inferences about younger peoples values concerning dismantling and decommissioning. There is also a certain similarity in the responses in the retrieved material in the Polish-Slovakian samples and the Kalmar sample. However it must be recognised that the latter sample is not designed to be adapted for statistical inference analysis.

The retrieved data from the file study that has been presented in section 10 makes it possible to give some statements of the critical similarities in the attitudes and values among the younger citizens in all five samples. These similarities are advocated, articulated and expressed in the answers given by the respondents in the different stratified samples. The described differences are, for the reason given concerning the Kalmar sample, not comparable in general from a pure statistical point of view. The data from Poland and Slovakia has not got this draw-back.

The Cluster Samples

The reasons for anticipated divergences between the five different cluster samples needs to be dealt with before the material can be used for making inferences. Hence, in the following section some remarks of these expected differences are presented. Furthermore, some explanations will be presented concerning the topic of expected "biased".

One evident example of difference in the quality of the responses is that questions in Questionnaire that was used in the Polish and Slovakian field studies is more complex and the questions are stricter defined. This may be explained with way that the responsible research team for the collection of the field data in Poland gave a clear and explanatory introduction to the subject prior to the handling out of the Questionnaires. A second such example is that the quality of the responses may have been enhanced by the active participation of personal from the research team all time during the students answered the Questionnaire. If any student par example needed any help or assistance, personnel was present to direct support, and thereby motivate, the individual student.

Hence, the didactical design and procedure of data gathering may have a significant way contributed to premium quality response to the Polish and Slovakian field data. This can in turn give a reason for the difference in the quality of responses. In the process of collection of the Polish and Slovakian field data there is a very low frequency of less appropriate responses, and non-relevant comments are more or less not available.

The Questionnaire that was used in the collection of field data from the four Polish cluster samples done in Gdansk, Elblag, Lublin and Jaworzno, is a more developed Questionnaire compared to the original Questionnaire that was used in the Kalmar sample. The former have more questions than the latter which can explain a part of the difference on the quality of the answers given[5].

[5] In is appropriate to remember that one of the aims of the present field study was to develop the Questionnaire to be more adapted to a pan European audience.

The overall judgement is that the qualities of responses given in the four Polish cluster samples as well as in the Slovakian sample are of an appropriate quality level. This makes it appropriate to use the gathered field data for formulating statements about the value functions of younger citizens towards decommissioning of older nuclear facilities and associated waste handling. This field study supports the conclusions in this part from what is concluded form the earlier samples.

Sweden has during the latest two decades worked with operation of nuclear power plants as an integrated part of the Swedish energy infrastructure. At the same time parallel work has been carried out to make research and development and demonstration of a concept for long-term storage of spent nuclear fuel elements. According to the original plans for the Swedish nuclear waste programme there should have been a number of storage facilities for final disposal of Swedish nuclear waste in operation from year 2010 (The repository for decommissioning waste). The aim of this facility was to find final storage for low and medium level (short-lived) nuclear waste from dismantling of the Swedish nuclear power plants. Another facility for long lived low and medium level nuclear waste should be designed, build and taken into operations in the mid 2030´s.

Based on this plans it is therefore appropriate to assume that there should been a higher knowledge base among the respondents from the Kalmar sample compared to the Polish-Slovakian samples. If also the fact that Sweden in the past has been a country with accessible environmental information and an early adapter to give financial transfers to non-governmental groups are taken into consideration there is a political and public tradition that everything equal would stimulate to a higher degree of inclusion of younger citizens.

Hence, in the first part of the current survey study it was assumed that there should be a biased in the knowledge base in favour of the Kalmar sample. After that the full survey now had been done and the retrieved data had been analysed there is no evidence that suggested that there should be a biased in the knowledge transfer between the Polish and Slovakian samples and the Kalmar sample.

It is possible to conclude that there is no major difference in the answers given by the different cluster samples.

Reasonableness of the Samples

The description of the collection of the field data in the preceding section 11.1 has focused on the validity of the quality of the survey data. The quality level of the later cluster samples are of a higher quality than the earlier. This impact is not critical for making statements of younger stakeholder's values. Hence, from a pure statistical point of view there is no biased in the material that in a significant way have can be anticipated to influence on the reliability and validity of the material that can be assumed to dilute the precision in the inference from the field study in Poland and Slovakia.

The aggregated numbers of responses are nearly 2000 and are sufficient for presenting general statements of younger citizen's values on dismantling and decommissioning of older nuclear facilities.

12. Results

In this part some statements, or hypothesis, about the value structure of younger citizens are presented on the subject of planning for decommissioning of nuclear facilities in Europe.

Younger Peoples Value Functions

The question concerning energy production in general, and power production by nuclear power plants in particular, has been on the political and public agenda in many European countries since the end of the Second World War. Hence, the nuclear technique is a little more than 50 years old and there is no general consensus within the European community for which production levels of electricity that nuclear power plant should contribute with on the Pan European deregulated energy market.

In Sweden where the second reactor at the nuclear power plant in Barsebäck, in the south of Sweden and close to the city Malmö, was permanently closed in year 2004. The first reactor was closed already more than ten years ago in 1999. The current Swedish case is that the dismantling of the nuclear power plant at Barsebäck is in a transition phase a waiting that a long-term storage for nuclear waste from dismantling will be taken into operation in Sweden. The current estimate is that a storage facility for nuclear waste from dismantling of the Swedish nuclear power plant will be in full operation during the beginning of the 2020´s.

Based on data from this authentic example it is a fair assumed that storage for nuclear waste will be in operation in year 2024. Based on this example it is possible to deduct that the length of the transition phase is 25 years for the first reactor and 20 years for the second reactor. Hence, the length of the transition period, i.e. the time elapsed between the final shutdown and the last day of the dismantling, is in the range of one generation. In the case for Sweden this means that it will be the next generation, not the present one, that will be responsible for the dismantling of the nuclear power plants in Sweden and the decide the final way to handle the nuclear waste from dis-mantling.

This example pin-point the crucial characteristic for nuclear power production as having a longer time span in the process of taking care of the rest products from production compared to other sources of energy. Since nuclear energy production has got substantial costs (environmental costs) in the back-end of the production cycle. Furthermore, these costs are also unsure due to the fact that there is little knowledge transfer from dismantling projects within of the European Community. In general it can be assumed that the decommissioning of older permanent shut-off nuclear power plants can have a time span in the range of one to two generations. This longitudinal aspect of the dismantling and decommissioning process demands an efficient planning cycle. Thus, one crucial task is to include the younger citizens in the process already today, so that an efficient knowledge transfer can be done between generations.

In the environmental codex in Europe it is perceived that the costs to take care of negative effects from environmental harmful activities shall be estimated and financial resources must be accrued for in the annual accounts. In Sweden there is par example for nuclear waste liabilities a direct obligation to make a direct contribution

to a segregated fund during the first quarter in the year following the current accounting year.

This accruals and allowances to a segregated fund are demanded by the subsidiary principle that guards the property rights of future generations. This is normally referred to as the polluter pays principle. This principle states that the responsible part for the activity also shall take care of the negative effects in a prudent, efficient and trustworthy way. In the case of nuclear power production all the effects from the activities in the backend takes a so long time that the effects are more or less uncountable.

On challenge is to enhance the precision or accuracy in these accruals. This may be done by develop models that in a systematic way can provide unbiased and generation neutral financial accruals for future nuclear liabilities. If this kind of multidisciplinary models are designed without any function (algorithm) that incorporates the values of younger generations there is a clear risk that the future generations property rights may be treated unfairly by underestimation of future nuclear liabilities. An underestimation of these liabilities may ultimately lead to an underbalanced funding which in turn may demand additional injections to the funds. If such a situation should arise after that the nuclear power plant has stopped produced electricity there will be no receivables for the individual company. Hence, in this situation the responsibility to cope with this burden will be rolled-over to the next generation. This is equivalent to a reduction of the future generations' consumption levels and is violating the polluter pays principle.

The context of this question and the strategies that lies before us demands that that there is a need to include younger citizens in today's processes to develop, facilitate and broaden the democratic dimension of a crucial and highly controversial part of the energy debate for many decades to come.

Within this process the younger citizens and the future generations have to build an energy system for a more unified Europe. In this perspective the question of decommissioning of nuclear facilities is one crucial question that is not only valid for specific countries, but also only one that cross the boarders of most member countries.

In order to make prudent costs estimations of the future costs to handle long term nuclear waste liabilities it is vital to develop an appropriate infrastructure for the calculations of the accruals need to balance the nuclear waste liabilities and the corresponding assets.

This task has to include all activities in the back-end of the nuclear cycle with high precision. One natural starting point is to study if there is any biased in the calculations that steams from the fact that younger generations are not present in the process, and therefore has limited possibilities to protect the property rights of future generations. Thus, our ability to understand value structures of different generations may contribute to enhance both the accuracy in the estimated liabilities and the level of the funded assets.

Authentic Values

The sampled cluster data from the field study in the four regions in Poland and one region in Slovakia enables the presentation of contemporary characteristics of the younger generations' values towards dismantling of older nuclear facilities. In this context it is appropriate to remember that one of the most important considerations in planning a field study is the number of observations require to insure that the resulting statistical analysis will reach the desired precision or sensitivity. In the search of statistical inference the distributions of the five cluster samples has been studied and some bypassing of the most technical part of the statistical analysis by assuming that the total sample and the five partitioning are fulfilling the criteria for a best linear un-biased estimator.

The collected field data contributes to an unbiased and generational neutral description of younger citizens' values to dismantling of nuclear power plants. The value that has been deducted in the study can be summarised in five theses.

- The younger generation priorities sustainable energy sources, like e.g. hydro-power, sun energy and windmills, in favour of techniques, like e.g. nuclear power and carbon based fossil fuels.

- The younger generation priorities factors as health, safety and environmental (HSE) aspects in the planning for dismantling of nuclear facilities. On the other hand other aspects like contribution to future economic growth and development of technological processes seems to be somewhat less focused upon.

- The younger generation refers to a deficit of knowledge and lack of efficient knowledge transfer, like par example information and debates, as a basis for their judgement of the anticipation of present generations ability to achieve an optimal planning process for dismantling of older nuclear facilities

- The younger generation has an out-spelled interest to become included in the current processes in planning for optimal system for deposition of nuclear waste.

- The younger generation demonstrates suggestions how more contemporary in-formation may be made more public. They are able to contribute with methods, ways and modes to make the public more engaged in the topic and enhance the propensity to be included in the democratic processes. In the wide range of methods presented there are collective learning techniques, use of audio visual tools as well as more traditional forms as handling of flyers and holding meetings. However, it ought to be remembered that also other modes of communications as making movies and theatre plays should be a part of the didactic base.

Lesson Learned

One major experience is that it is possible to give the students rather complex questions. Hence, in this area there seems be no need for trying to find less complex

questions, since the students demonstrated that they very well can answer complex questions in intelligent and trustworthy ways.

Furthermore, we also found that the number of in-depth interviews that were as a help to develop the original questionnaire from the Kalmar Study, could have been longer. However, it is advisable to enhance the interest and degree of participation of the students in an open interview and discussion to a motivator, like for example tickets to an event or give-aways or vouchers.

In the collecting phase of the field study it was seen that a success in the data gathering are supported by the following measures.

- Communication and cooperation with the schools and responsible tutors of the classes are essential.

- A brief introduction to the topic and the aim of the survey needs to be presented by at least one of the researchers in cooperation with the responsible teacher prior to the handling out of the questionnaires.

- It must be remembered that one of the researchers must participate in handling out as well as collecting the questionnaires. The physical appearances will automatically strength the motivation of the students to perform well. Please no-tice that guidance or help to fill in the questionnaire should not be underestimated!

Future Research Tasks

Many research tasks are waiting to be dealt with in the area of risk assessment, communication and inclusion of stakeholders in longitudinal democratic decision making processes.

Sweden is normally regarded as a good example on a country that has worked with the question about nuclear waste repositories. To focus on ways to motivate stakeholders to be more inclusive in the processes can contribute to promoting transparency and public involvement so proposed solutions for nuclear waste long term storage can be legitimated.

Proposed future applied research projects identified during the study are:

- A field data survey for how communication and information are spread in Sweden in the area of nuclear waste. In this perspective it is essential to describe the structure for interaction between the stakeholders, authorities and the Swedish nuclear industry in the context of nuclear waste information with the younger part of the society.

- It is often advocated that future costs for dismantling of nuclear facilities and its corresponding environmental liability is heavily dependent upon the length of the total time to dismantle. In this perspective it may be of critical importance to find an unbiased and generational neutral estimate of the transition period, i.e. the time that elapse between the dates of permanently shut down to dismantling has been fulfilled and the land restored for re-use. The length of the transition period can be seen as a substantial cost driver. The length of the transition period is much based upon the length of the

democratic processes according to the environmental codex. Within this context an enclosure of younger citizens from participation in the stakeholder processes can be cost driving.

- It is crucial that calculation for future costs for dismantling of nuclear facilities are done based upon generation neutral assumptions. If there should be a biased in the form of a non-neutral distribution of the cost between generations it may be possible to enhance the quality in this estimate by adding a factor (scalar) for the length of the transition period. In this area there are demands for the development of models for cost assessment

- Occasionally, probabilistic methods are used to calculate future nuclear waste liabilities. It is essential to develop a model that contributes to generation neutral best estimates. One part of this work is to facilitate for younger citizens to participate in think tanks like expert or analyst groups.

References

[1] Swedish Nuclear Power Inspectorate (SKI), *Methodology for description and evaluation of cost profiles and cost structures during transition period*, SKI Report 2008:38, May 2008.

[2] OECD, *Société et énergie nucléaire: vers une meilleure comprehension*, 2002.

[3] OECD, *Geological Repositories: Political and Technical Progress*, 2005.

[4] OECD, *Decommissioning Funding: Ethics, Implementation, Uncertainties – A Status Report*, NEA No. 5996, OECD 2006.

[5] Swedish Nuclear Power Inspectorate (SKI), *Structure for Transparency in Nuclear Waste Management, Comparative Review of the Structures for Nuclear Waste Management in France, Sweden and the UK*, Raul Espejo, SKI Report 2003:26, November 2002, page 30.

[6] Swedish Nuclear Power Inspectorate (SKI), *Design and Evaluation of Public Hearings for Swedish Site Selection, A Report from the RISCOM II Project*, Kjell Andersson et. al. Stockholm August 2003.

[7]] Swedish Nuclear Power Inspectorate (SKI), *Public Values and Stakeholder Involvement – A New framework for Performance Assessment, A Report from the RIS-COM II Project*, Kjell Anderson et. al., October 2003.

[8]] Swedish Nuclear Power Inspectorate (SKI), *Stakeholder Involvement in Swedish Nuclear Waste Management*, SKI Report 2007:02, Mark Elam & Groan Sundqvist, September 2006.

[9] McQuail, Dennis, *Mass Communication Theory*, 4th edition, SAGE Publications, 2000.

[10] The Regional Council in Kalmar, *Skolungdomars inställning till slutförvar av kärnavfall, (The attitude of students to final storage of nuclear waste) only available Swedish, Kalmar*, Sweden, 2007

[11] Swedish Nuclear Fuel and Waste Management Company (SKB), Sjöberg, L., *Attityd till slutförvar av använt kärnbränsle – Struktur och orsaker, (Attitudes to a final repository for spent nuclear fuel) In Swedish*, Sept 2008.

[12] Labor, B et. al., *Values held by younger stakeholders on financial planning regarding liabilities for nuclear decommissioning*, Environmental Economics and In-vestment Assessment III, 3-5 May 2010, Limassol, Cyprus, WIT Transaction on Ecology and the Environment, Vol. 131. Wit Press, 2010, ISBN 978-1-84564-436-9.

Appendix A

Question 1 - Which form of energy do you prefer?

City		Gdansk-Elbląg- Lublin			Trnava			Jaworzno (Katowice)			SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total	Man	Woman	Total	Man	Woman	Total				
Coal	M	9		9	0		0	11		11	29		88	4,4%
	W		22	22		8	8		29	29		59		
Nuclear Power	M	168		168	77		77	31		31	276		489	24,7%
	W		115	115		56	56		42	42		213		
Hydro Power	M	182		182	52		52	33		33	267		630	31,8%
	W		181	181		122	122		60	60		363		
Windmills	M	184		184	52		52	34		34	270		657	33,2%
	W		213	213		117	117		57	57		387		
Misc.*	M	25		25	24		24	9		9	58		115	5,8%
	W		24	24		24	24		9	9		57		
Total		568	555	1 123	205	327	532	118	197	315	900	1 079	1 979	100%

Question 2 - Are you aware of that nuclear power not only produces electricity but also gives radioactive waste?

City		Gdansk-Elbląg- Lublin			Trnava Elbląg			Jaworzno (Katowice)			SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total	Man	Woman	Total	Man	Woman	Total				
Yes	M	315		315	156		156	50		50	521		1137	78,7%
	W		281	281		245	245		90	90		616		
Partial	M	57		57	15		15	13		13	85		241	16,7%
	W		86	86		43	43		27	27		156		
No	M	20		20	3		3	4		4	27		66	4,6%
	W		21	21		9	9		9	9		39		
Total		392	388	780	174	297	471	67	126	193	633	811	1444	100,0%

Question 3 - Do you know that nuclear power plants need to be dismantled after it has stopped producing electricity?

City		Gdansk-Elbląg- Lublin			Trnava			Jaworzno (Katowice)			SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total	Man	Woman	Total	Man	Woman	Total				
Yes	M	177		177	135		135	30		30	342		757	52,5%
	W		168	168		205	205		42	42		415		
No	M	214		214	39		39	37		37	290		685	47,5%
	W		220	220		92	92		83	83		395		
Total		391	388	779	174	297	471	67	125	192	632	810	1442	100%

Question 4 - Are you aware of that nuclear waste is generating a hazard for health and nature for more than 100 000 years?

City		Gdansk-Elbląg- Lublin					Trnava					Jaworzno (Katowice)					SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total		%	Man	Woman	Total		%	Man	Woman	Total		%				
Yes	M	161		161	350	44,9	84		84	209	44,5	24		24	72	37,5	269		631	43,7
	W		189	189				125	125				48	48				362		
Partial	M	156		156	298	38,2	68		68	184	39,1	23		23	83	43,2	247		565	39,2
	W		142	142				116	116				60	60				318		
No	M	75		75	132	16,9	22		22	77	16,4	20		20	37	19,3	117		246	17,1
	W		57	57				55	55				17	17				129		
Total		392	388	780	780	100,0	174	296	470	470	100,0	67	125	192	192	100,0	633	809	1442	100,0

Question 5 - Are you aware that Sweden is planning to store used nuclear fuel in rock caverns?

City		Gdansk-Elbląg- Lublin					Trnava					Jaworzno (Katowice)					SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total		%	Man	Woman	Total		%	Man	Woman	Total		%				
Yes	M	29		29	49	6,3%	17		17	33	7%	9		9	17	8,9%	55		99	6,9%
	W		20	20				16	16				8	8				44		
Partial	M	41		41	96	12,3%	30		30	83	17,7%	10		10	36	18,8%	81		215	14,9%
	W		55	55				53	53				26	26				134		
No	M	322		322	635	81,4%	126		126	354	75,3%	48		48	139	72,4%	496		1128	78,2%
	W		313	313				228	228				91	91				632		
Total		392	388	780	780	100%	173	297	470	470	100%	67	125	192	192	100%	632	810	1442	100%

Question 6 - Are you aware of that Sweden and Finland are planning to store used nuclear fuel and nuclear waste from the decommissioning of nuclear power plants in rock caverns?

City		Gdansk-Elbląg- Lublin				Trnava				Jaworzno (Katowice)				Sub SUM Man	Sub SUM Woman	Total	%
Gender / Answer		Man	Woman	Total		%	Man	Woman	Total	%	Man	Woman	Total	%					
Yes	M	56		56			34		34		14		14		104			
	W		58	58	114	14,6%		25	25	59	12,5%		16	16	30	15,6%		99	203	14,1%
No	M	336		336			140		140		53		53		529			
	W		330	330	666	85,4%		272	272	412	87,5%		109	109	162	84,4%		711	1204	85,9%
Total		392	388	780	780	100%	174	297	471	471	100%	67	124	192		100%	633	810	1443	100%

Question 7 - Who shall take care of the Swedish nuclear waste?

City		Gdansk-Elbląg- Lublin					Trnava					Jaworzno (Katowice)					SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total		%	Man	Woman	Total		%	Man	Woman	Total		%				
Sweden	M	348		348	692	88,0%	51		51	163	84%	155		155	422	89,8%	554		1277	88,1%
	W		344	344				112	112				267	267				723		
Other Contries	M	46		46	94	12,0%	18		18	31	16%	19		19	48	10,2%	83		173	11,9%
	W		48	48				13	13				29	29				90		
Total		394	392	786	786	100,0%	69	125	194	194	100,0%	174	296	470	470	100,0%	637	813	1450	100,0%

Question 8 - Where do you think nuclear waste best shall be deposited?

City		Gdansk-Elbląg- Lublin					Trnava					Jaworzno (Katowice)					SubS	SubS	Total	%
Gender / Answer		M	W	Total		%	M	W	Total		%	M	W	Total		%	M	W		
In the space	M	237		237	410	46,0	78		78	145	29,7	26		26	90	37,2	341		645	39,7 %
	W		173	173				67	67				64	64				304		
On the bottom of the sea	M	13		13	32	3,6	11		11	25	5,1	10		10	21	8,7%	34		78	4,8%
	W		19	19				14	14				11	11				44		
In the polare ice	M	30		30	64	7,2	6		6	31	6,3	7		7	31	12,8	43		126	7,8%
	W		34	34				25	25				24	24				83		
In rock coverns	M	143		143	339	38,0	72		72	227	46,4	27		27	83	34,3	242		649	40%
	W		196	196				155	155				56	56				407		
Misc.	M	24		24	47	5,3	16		16	61	12,5	4		4	17	7	44		125	7,7%
	W		23	23				45	45				13	13				81		
Total		447	445	892	892	100	183	306	489	489	100	74	168	242	242	100	704	919	1623	100%

Question 9 - Do you have confidence and trust in the decisions maker´s capability in the decommissioning process?

City		Gdansk-Elbląg- Lublin					Trnava					Jaworzno (Katowice)					SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		M	W	Total		%	M	W	Total		%	M	W	Total		%				
Yes	M	79		79	139	17,8%	27		27	78	16,5%	7		7	25	13%	113		242	16,7%
	W		60	60				51	51				18	18				129		
Do not unsure	M	209		209	443	56,7%	89		89	238	50,4%	36		36	103	61,4%	334		784	54,3%
	W		234	234				149	149				67	67				450		
No	M	104		104	199	25,5%	58		58	156	33,1%	24		24	64	33,3%	186		419	29%
	W		95	95				98	98				40	40				233		
Total		392	389	369	781	100,0%	174	298	472	472	100,0%	67	125	192	192	100,0%	633	812	1445	100,0%

Question 10 - Can you consider having a site for final disposal of nuclear waste near to your home?

City		Gdansk-Elbląg- Lublin			Trnava			Jaworzno (Katowice)			SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total	Man	Woman	Total	Man	Woman	Total				
Yes	M	90		90	17		17	19		19	126		226	15,6%
	W		62	62		22	22		16	16		100		
No	M	303		303	157		157	48		48	508		1218	84,4%
	W		326	326		275	275		109	109		710		
Total		393	388	781	174	297	471	67	125	192	634	388	1444	100,0%

Question 11 - What is your opinion towards a site for final disposal of nuclear waste?

City		Gdansk-Elbląg- Lublin					Trnava					Jaworzno (Katowice)					SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total		%	Man	Woman	Total		%	Man	Woman	Total		%				
In favour	M	112		112	195	25,0%	37		37	101	21,6%	22		22	53	27,6%	171		349	24,3%
	W		83	83				64	64				31	31				178		
Against	M	179		179	388	49,8%	82		82	240	51,4%	33		33	94	49%	294		722	50,2%
	W		209	209				158	158				61	61				428		
Indifferent	M	100		100	196	25,2%	51		51	126	27%	12		19	45	23,4%	163		367	25,5%
	W		96	96				75	75				33	43				204		
Total		391	388	779	779	100%	170	297	467	467	100%	67	125	192	192	100%	628	810	1438	100%

Question 12 - Which of these values do you base your opinion upon?

City		Gdansk-Elbląg- Lublin					Trnava					Katowice (Jaworzno)					SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total		%	Man	Woman	Total		%	Man	Woman	Total		%				
Trust for the involved stakeholders	M	78		78	137	14,9%	15		15	28	5,6%	9		9	24	10,1%	102		189	11,5%
	W		59	59				13	13				15	15				87		
Opportunities linked to a disposal for nuclear waste	M	64		64	108	11,7%	15		15	29	6,1%	11		11	29	12,2%	90		166	10,1%
	W		44	44				14	14				18	18				76		
Lack of knowledge	M	120		120	269	29,2%	57		57	211	44,1%	22		22	79	33,3%	199		569	34,6%
	W		149	149				154	154				67	57				370		
Uneasy of the risks	M	157		157	350	38,0%	81		81	204	42,6%	29		29	96	40,6%	267		650	39,5%
	W		193	193				123	123				67	67				383		
Misc.*	M	34		34	56	6,1%	7		7	7	1,5%	3		3	9	3,8%	44		72	4,3%
	W		22	22				0	0				6	6				28		
Total		453	467	920	920	100%	175	304	479	479	100%	74	163	237	237	100%	702	944	1646	100%

Question 13 - Which aspects is in your opinion crucial for the acceptance of a final disposal for nuclear waste?

City		Gdansk-Elbląg- Lublin					Trnava					Katowice (Jaworzno)					SubSUM Man	SubSUM Woman	Total	%
Gender / Answer		Man	Woman	Total		%	Man	Woman	Total		%	Man	Woman	Total		%				
Safety aspect	M	210		210	442	38,0%	96		96	261	42,8%	52		52	156	34,2%	358		859	38,4%
	W		232	232				165	165				104	104				501		
Environmental aspect	M	143		143	309	26,5%	62		62	185	30,3%	41		41	127	27,9%	246		621	27,8%
	W		166	166				123	123				86	86				375		
Location aspect, so far from home as possible	M	118		118	264	22,7%	29		29	98	16,1%	36		36	113	24,8%	183		475	21,2%
	W		146	146				69	69				77	77				292		
Methods and techniques	M	53		53	109	9,4%	21		21	47	7,7%	17		17	37	8,1%	91		193	8,6%
	W		56	56				26	26				20	20				102		
Economic growth	M	19		19	29	2,5%	8		8	19	3,1%	12		12	23	5%	39		71	3,2%
	W		10	10				11	11				11	11				32		
Misc.*	M	7		7	11	0,9%	5		5	5	0,0%	0		0	0	0,0%	12		16	0,8%
	W		4	4				0	0				0	0				4		
100%		550	1614	1614	1 164	100%	221	394	610	610	100%	241	445	686	686	100%	929	1303	2235	

Question 14 - In which ways/forms do you think that younger people can participate and contribute to the information process about nuclear waste?

City		Gdansk-Elbląg- Lublin					Trnava					Katowice (Jaworzno)					SubS M	SubS W	Total	%
Gender / Answer		M	W	Total		%	M	W	Total		%	M	W	Total		%				
Project work	M	145		145	332	29,3%	79		79	227	37,2%	43		43	130	31,6%	267		689	32%
	W		187	187				148	148				87	87				422		
Exhibitions	M	74		74	185	16,3%	29		29	72	11,8%	22		22	74	18,0%	125		331	15,4%
	W		111	111				43	43				52	52				206		
Power-Point presentation	M	67		67	144	12,7%	48		48	109	17,8%	23		23	57	13,9%	138		310	14,4%
	W		77	77				61	61				34	34				172		
Create web pages	M	81		81	167	14,7%	21		21	68	11,1%	19		19	57	13,9%	121		292	13,5%
	W		86	86				47	47				38	38				171		
Theatre	M	18		18	56	4,9%	7		7	19	3,1%	3		3	19	4,6%	28		94	4,4%
	W		38	38				12	12				16	16				66		
Film	M	103		103	214	18,9%	41		41	104	17%	23		23	71	17,3%	167		389	18%
	W		111	111				63	63				48	48				222		
Other*	M	19		19	35	3,1%	6		6	12	2%	2		2	3	0,7%	27		50	2,3%
	W		16	16				6	6				1	1				23		
Total		507	626	1133	1 133	100%	231	380	611	611	100%	135	276	411	411	100%	873	1282	2155	100%

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The Swedish Radiation Safety Authority has a comprehensive responsibility to ensure that society is safe from the effects of radiation. The Authority works to achieve radiation safety in a number of areas: nuclear power, medical care as well as commercial products and services. The Authority also works to achieve protection from natural radiation and to increase the level of radiation safety internationally.

The Swedish Radiation Safety Authority works proactively and preventively to protect people and the environment from the harmful effects of radiation, now and in the future. The Authority issues regulations and supervises compliance, while also supporting research, providing training and information, and issuing advice. Often, activities involving radiation require licences issued by the Authority. The Swedish Radiation Safety Authority maintains emergency preparedness around the clock with the aim of limiting the aftermath of radiation accidents and the unintentional spreading of radioactive substances. The Authority participates in international co-operation in order to promote radiation safety and finances projects aiming to raise the level of radiation safety in certain Eastern European countries.

The Authority reports to the Ministry of the Environment and has around 270 employees with competencies in the fields of engineering, natural and behavioural sciences, law, economics and communications. We have received quality, environmental and working environment certification.

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