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Why this hurry in relation to nuclear waste?

Tuija Hilding-Rydevik

SLU Swedish Biodiversity Centre, Department of Urban and Rural Development, Swedish University of Agricultural Sciences, Box 7012, 750 07 Uppsala, Sweden

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We need to hurry to get a decision! Most of the actors participating in the planning and development process in the beginning of the 2000s seemed to agree – e.g., the implementer¹ SKB (the Swedish Nuclear Fuel and Waste Management Company), the regulator² SKI³ and the government's scientific committee KASAM. NGOs, however, wanted a different solution from what was proposed by the implementer and did not want to hurry. This mutual sense of hurry and urgency to solve the issue of a final repository for spent nuclear fuel was my uneasy feeling after having served the first years (starting in 2002) on the Swedish government's scientific committee, the Swedish National Council for Nuclear Waste (www.karnavfallsradet.se) (hereafter called the Council).

This viewpoint is centered around a long-standing collaboration between researchers and several societal actors involved in Swedish nuclear waste management. Since 1985, this process has been supported by a body similar to the current Council, which I have been a member of the past 20 years. The viewpoint gives personal insights to some of the Council's activities, recommendations, and impacts that most recently have contributed to the Swedish government's decision to let SKB continue the construction of a final repository for spent nuclear fuel. Below is some contextual information on spent nuclear fuel in Sweden and a short introduction about the Council's tasks.

1. A final repository for spent nuclear fuel in Sweden

Today, 7500 tons of Swedish spent nuclear fuel are waiting in the interim storage Clab, in the municipality of Oskarshamn, waiting to be safely stored in the future final repository. Two municipalities, Oskarshamn and Östhammar, have agreed to be the sites of various parts of the waste system (for more information, see <https://www.government.se/articles/2022/01/final-disposal-of-spent-nuclear-fuel/>).

By 1945, the private industry and the Swedish government together decided to start research on the use of nuclear power (Svensk Kärnbränslehantering, 2010, p. 63). In the mid 1960s, the building of Swedish nuclear power plants started, but it was not until the beginning of the 1970s that the hazards of nuclear power and the spent fuel became part of the societal debate and criticism. Step by step after the 1970s, the government introduced laws and regulations that demanded the energy industry develop a safe solution and conduct research (to be reviewed by the government) to support the process (Svensk Kärnbränslehantering, 2010, p. 71, 103). No country has so far built a final repository. Finland is on the forefront of applying the KBS-3 concept (also applied in Sweden) for geological disposal (United States Nuclear Waste Technical Review Board, 2022, p. 11).

E-mail address: tuija.hilding-rydevik@slu.se.

¹ The implementer is the body responsible for siting, constructing and operating the final repository. In Sweden, this is a private corporation that includes owners of the nuclear power plants.

² The regulator is the national government body that regulates radioactive waste management.

³ SKI (Swedish Nuclear Power Inspectorate) was merged with SSI (the Swedish Radiation Protection Institute) in 2008 and is now the Swedish Radiation Safety Authority (SSM).

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2. The Swedish National Council for Nuclear Waste

In 1985, what would later become the Council was in place (Svensk Kärnbränslehantering, 2010, p. 124). The main task for the current Council⁴ (Swedish government, 2018) is to 'investigate and shed light on matters relating to management of nuclear waste and decommissioning and dismantling of nuclear facilities. The Council shall give advice to the Government in these matters'. In practice, this means that the Council reviews the implementers (SKBs) Research, Development and Demonstration Programs (RD&D programs), publishes an independent assessment of the state-of-the-art in the nuclear waste field (State-of-the-Art Reports, in Swedish and English), arranges hearings and consultations with different actors, arranges seminars, keeps track of other countries' spent fuel development programs, and participates in international work.

The multidisciplinary Council (natural science, social science and humanities competencies) consists of eleven researchers including the chairperson, all appointed by the Minister of Environment, and two appointed external experts. The multidisciplinary composition is unique compared to other country Councils.⁵ The work is supported by a secretariate with a staff of three and is funded by the Nuclear Waste Fund but overseen by the government. As members contribute with their spare time or as part of their academic positions, there is only a minor economic remuneration. The Council holds around 6–7 full day meetings per year. In addition, there are meeting preparations and work contributions (quite extensive at times) to the tasks listed above.

3. The copper cannister

Technically developing the final repository is a challenging endeavour since it is the first of its kind worldwide. Therefore, the Council has scrutinized the technical and natural science components of the work. Issues discussed include the three main barriers, according to the KBS-3 concept, that will safely contain the spent nuclear fuel until the radiation has the same radiation level as the original uranium, which will be after about 100,000 years.⁶ The barriers are the copper cannister, the bentonite clay surrounding the cannister and the rock where the cannisters are stored 500 m below ground in tunnels (for more details, see The Swedish System (skb.com)). During the 40 years of planning the final repository, the safety of the different barriers has been one of the main issues discussed and scrutinized in relation to the implementer's RD&D program. One issue dominating the scientific discussion is the choice of copper as cannister material and whether it fulfils the safety requirements for the long-lasting integrity of the container. The main issue has been whether metallic copper corrodes under the conditions expected in the final repository. Since this was first proposed in 1986, the use of copper has been heavily debated (Kärnavfallsrådet, 2022a, 2022b, p. 73). To promote clarity in this dispute, the Council has arranged hearings with international researchers (Swedish National Council for Nuclear Waste, 2009) and recently conducted a literature review to provide the actors in the planning process with an overview of research results (Swedish National Council for Nuclear Waste, 2022, chapter 5).

Through their own research or students' research, the Council members and experts have also been able to provide the most up-to-date

research, e.g., in relation to the cast iron insert in the copper cannister (Swedish National Council for Nuclear Waste, 2022, chapter 7), alerting all actors in the process of the need for more research before the KBS-3 concept can be considered safe enough. There are, however, arguments put forward that the whole idea behind the KBS-3 concept is that if one barrier fails then the others will be safe enough.

4. Perspectives from the social science and humanities

In addition to the technical and natural science perspectives, the Council has included different social science and humanities perspectives in the planning process. An ethical principle was developed at the end of the 1980s outlining the responsibility of current and future generations (KASAM, 2007, p. 83). Since then, this so-called KASAM principle has been applied by different actors in studies and debates on spent nuclear fuel (KASAM, 1998, s. 11). We also proposed, in the beginning of 2002, that funds are needed for a social science and humanities research program (KASAM, 2002, p. 115–124). This proposal created quite a discussion among planning actors. At the time, the Council was perceived to be trying, very selfishly, to get funding and control research. This was certainly not our intention (although researchers often do seek funding opportunities). We wanted the societal issues and consequences of planning for and building a final repository for spent nuclear fuel to be safe for 100,000 years and to be as thoroughly researched as the technical and natural sciences issues. In addition, we wanted the research to be broader than the perceived needs of the implementer SKB. In 2003, the Council proposed to the government that funding instead should go through established government funding organisations (KASAM, 2003).

In 2004, the implementer SKB launched a program for what they called Societal Research [Samhällsforskning] (Söderberg, 2012). It has, however, received criticism in relation to how projects were selected by the group appointed by SKB, as the projects favouring more reflexive and broader research issues were not selected and that SKB has not taken stock of the research results in relation to the development of the repository system (Swedish National Council for Nuclear Waste, 2020).

In line with the social science perspectives, recently the Council noted that the SKB RD&D program (Swedish National Council for Nuclear Waste, 2020, p. 7–14) is a democratically important document. Its contents, wording, structure, etc. must make it possible for major planning actors to perform their review properly to ensure safety. That is, the document should address several questions: Are the research questions relevant? Is the budget for different parts relevant? What questions are outstanding? What is difficult? What is easy? In meetings with SKB and SSM discussing this issue, we have, however, experienced that they do not think about the RD&D program in these terms. When the Council presented its concerns to the Parliament Defence Committee that the RD&D program was not fulfilling its democratic role, several members of the committee noted however this as an important problem.

5. Questioning EIA legitimacy

Before my appointment to the Council in 2002, I had no experience with research in nuclear power or the issue of spent nuclear fuel. Social science research in impact assessment processes, planning, and informal learning were my knowledge platforms. At a conference, a colleague had met an officer from the regulator SKI, and this led to a small research assignment for her and me. The aim was to 'get an outside view' (personal communication with SKI officers) of the 'ongoing discussions on the design and implementation of the planning process in connection with the Environmental Impact Assessment aspects of the long-term disposal of spent nuclear fuel in Sweden' (Bjarnadóttir and Hilding-Rydevik, 2001). Looking at the results today, I can see that especially one of the listed 13 'unresolved and challenging issues in the forthcoming process for final disposal of nuclear waste' is still valid. This was the question: 'What legitimacy is to be expected for the EIA process in

⁴ The current Council and its directives originate from 1992.

⁵ See examples of technical boards: NWTRB (USA) (www.nwtrb.gov/about-us/members); ESK (Germany) (www.bmu.de/en/ministry/tasks-and-structure/independent-advisory-bodies/esk) and KNS (Switzerland) (www.bfe.admin.ch/bfe/en/home/swiss-federal-office-of-energy/swiss-federal-office-of-energy/federal-nuclear-safety-commission-nsc.html). More information can be found at the Swedish National Council of Nuclear Waste, 2019.

⁶ After 1 million years, the radiation level is the same as the background radiation.

relation to other planning and decision processes?’ (Bjarnadóttir and Hilding-Rydevik, 2001, p. 8).

The requirements of conducting an Environmental Impact Assessment (EIA) as part of the application process for a final repository for spent nuclear fuel have led to many important inputs to the planning and decision process, including a description of environmental factors and impacts, which would not have been the case otherwise, the discussion of existing alternatives in addition to the KBS-3 concept, and the requirement for public consultations. However, it is an open question how much of the EIA work has impacted the overall design and location of the repository. This is partly due to the fact that the more elaborate EIA legislative demands from 1999⁷ came in later in the planning process compared to the demands in the existing Swedish Act on Nuclear Activities (Nuclear Act) (Swedish National Council for Nuclear waste, 2018, p. 38–55). The start of the planning process was mainly guided by the Nuclear Act, which asked for one solution and the best available technology (BAT), a request contrary to the EIA legislative demand to explore several alternatives.

6. Visualizing a community of practice

As outlined above, the need to hurry a decision about a repository for spent nuclear fuel continued to bother me during my first years on the Council. I also experienced that the same type of actors, and to a large extent the same individuals, had been interacting during this outstretched planning period. In addition, stories circulated about how the implementer SKB and the regulator SKI had arrived in the same car to the same meeting with different municipalities and the general public. This caused accusations of the SKI being too close to the implementer SKB.

So, I created a project, applied for funding, and received funds for a PhD study from one of the Swedish national government funding organisations. The conclusion from the PhD study (Wärnbäck et al., 2013) was that the implementer SKB and the regulator SKI had developed what is labelled a Community of Practice (Wenger, 1998). That is, their practice of meeting often and year after year developed into gaining similar views on issues to be solved in the planning process. Therefore, we expressed concerns that the critical eye of the SKI, which is needed in the review of the Environmental Impact Statement, the SKB RD&D program, and the application, could be jeopardised.

We presented our results as a scientific paper in an international planning research journal, as we are expected to do as researchers in order to contribute to research and fulfil our promises towards our funding organisation. Results were also presented to the implementer SKB, the regulator SKI, and the Council at an international OECD meeting – i.e., the main actors in the planning process for the repository. Our expectation was that these results would cause some unease by the government and by the government regulator SKI. We thought the results presented quite a strong critique. In hindsight, however, I cannot detect any changes to the practical relations between SKI and SKB. To what extent it has changed the internal approaches and attitudes at SKI and SKB, I do not know (yet).

7. Opening up the process for different views and perspectives

Elam and Sundqvist (2009) discuss EIA consultation in terms of an industrial strategy and a facade to favour the organiser’s own objectives. Most actors in the final disposal of nuclear waste process (e.g., the government, national and regional authorities, NGOs, and other interest organisations) favour their own objectives and perspectives. Surely the Council also has this bias, although it is difficult to detect

⁷ The Impact Assessment legislation from 1992 was unclear on several points and years were spent discussing among actors how to interpret these legislative unclearities (see KASAM, 1994).

one’s own biases.

Therefore, the Council aims to include a broad range of actors in our seminars, hearings, newsletters, etc. Giving voice to both pros and cons politically and scientifically has been our goal in order to provide broad information and knowledge to all process actors, information that they can base their views and decisions on. This has been one of the main contributions to the planning and licensing process for the final disposal of nuclear waste in Sweden. And this has been conveyed to us as important on many occasions and from many actors in the process. The Council has been (most of the time) appreciated as an important and independent voice and actor during the process and this role has also been encouraged by the Ministry of Environment.

8. 70 or more years of a continuing process

In January 2022, the Swedish government accepted the SKB application from 2011 to construct a final repository for spent nuclear fuel (Regeringen [Swedish government], 2022a, 2022b). Now follows a more than 70 year process before the repository is finalized and sealed. There exists, however, several unclear and unresolved issues. Therefore, in May 2022, the Council gathered the so-called ‘nuclear family’ [kärnfamiljen] (Johansson, 2008, p. 90). Since the pandemic started, seminars, meetings, etc. had been less frequent, but now meetings were again possible. We wanted to present the Council’s State-of-the-Art Report but most importantly give the most involved actors a possibility to outline their view of the coming 70-year process. What do we know? What do we not know? What do we want to know? These were our seminar questions. One main conclusion from the seminar was the need for continuing a transparent, democratic and inclusive process. For the concerned two municipalities and the NGOs, the funding and participation in the process was unclear after 2022. Making clear the possibility to participate was a very important issue for those concerned, especially for the two municipalities where the different parts of the system are going to be located. The seminar and its documentation (Kärnavfallsrådet, 2022a, 2022b) have contributed to getting most actors up to date with and gain at least some mutual understanding of the process for the coming 70 years.

9. What kind of co-operation

The Council is charged with advising the government. The Council has done so in different written forms to the government, and we have met representatives of the Ministry (sometimes also the Minister of Environment). It has been, however, from my point of view, mainly a one-sided sending of information and messages, but with few dialogues and feedback to the Council. One kind of indirect feedback is the government’s decision in January 2022 to follow the Council’s main recommendations (more in Swedish National Council for Nuclear Waste, 2022, chapter 2).

I must, however, commend the Swedish government in its support of the interdisciplinary and reflexive work of the Council for so many years. The perspectives, conclusions and scientific inputs in our reviews of the SKB RD&D programs, our main State-of-the-Art Reports, arrangements of seminars, remittance answers, etc. have brought in new and different perspectives in relation to other actor inputs in the planning process and in terms of providing the process with the latest results from research (e.g., in the fields of impact assessment, copper corrosion, the cast iron insert, the need for securing future professional competence in the spent nuclear field, the need for early and broad measures in relation to societal memory, and finally in the field of ethics). I am also convinced the Council has improved the process in terms of openness and creating arenas for dialogue.

In relation to the other important Swedish actors in the planning and licensing process for a repository for spent nuclear fuel (i.e., the implementer SKB, the national regulator SSM, the municipalities and the NGOs), the interaction has been frequent. During my 20-year period on

the Council, there have been many active and ongoing contacts (at seminars, meetings, etc.), dialogues in different forms, and exchanges of views.

I have experienced what could be labelled as a kind of a trans-disciplinary planning process – i.e., a process aimed at solving a complex societal problem through ‘involvement of multiple disciplines and a diversity of societal actors in research situated in real-life contexts’ (Westberg and Polk, 2016). As such it has been a privilege to be part of the Swedish National Council for Nuclear Waste for 20 years. The interdisciplinary collaboration and dialogues within the Council, with highly qualified researchers in different fields such as radiation biology and ethics, has been rewarding professionally as well as socially. Taking part in such a unique and important planning process for a project of huge societal and environmental importance is un-comparable for a researcher in my field.

Open minded, curious and reflexive inputs in order to not leave any issues in the dark (in spite of the sense of hurry put forward at times) has been and will continue to be important for the next 70 years, after which the repository will be sealed for 100,000 years.⁸

Declaration of Competing Interest

None.

Data availability

No data was used for the research described in the article.

References

- Bjarnadóttir, H., Hilding-Rydevik, T., 2001. Final disposal of spent nuclear fuel in Sweden – some unresolved issues and challenges in the design and implementation of the forthcoming planning and EIA processes. In: Nordregio Electronic Paper 2001, p. 3.
- Elam, M., Sundqvist, G., 2009. The Swedish KBS project: a last word in nuclear fuel safety prepares to conquer the world? *J. Risk Res.* 12 (7–8), 969–988.
- Johansson, H.S., 2008. Demokrati på delegation. Lokaliseringen av det svenska avfallet. In: STS Research Report No 16. Gothenburg.
- Kärnavfallsrådet, 2022a. Kunskapsläget på kärnavfallsområdet 2022. Samhället, tekniken och etiken, p. SOU 2022:7.
- Kärnavfallsrådet, 2022b. Informationsblad. Vad vet vi och vad behöver vi veta – ett seminarium om den kommande processen för ett slutförvar för använt kärnbränsle. In: Informationsblad Nr 1:2022.
- KASAM, 1994. Kärnavfall och miljö. Rapport från internationellt seminarium om miljökonsekvensbeskrivning (MKB) och dess roll inför slutförvaringen av kärnavfall, Luleå 24-26 oktober, 1994.
- KASAM, 1998. Kunskapsläget på kärnavfallsområdet 1998. SOU 1998:68.
- KASAM, 2002. Kärnavfall – forskning och teknikutveckling. SOU 2002:63.
- KASAM, 2003. Stora, tekniskt avancerade projekt i ett samhälle med hållbar utveckling. Opinion 2003-12-16, Dnr KASAM 26/03.
- KASAM, 2007. Nuclear Waste State-of-the-Art Report 2007 - responsibility of current generation, freedom of future generations. SOU 2007:38.
- Regeringen, 2022a. Ansökan om tillstånd enligt lagen (1984:3) om kärnteknisk verksamhet till anläggningar i ett sammanhängande system för slutförvaring av använt kärnbränsle. Regeringsbeslut 2022-01-27, M2018/00221.
- Regeringen, 2022b. Tillåtlighetsprövning enligt 17 kap. miljöbalken av anläggningar i ett sammanhängande system för slutförvaring av använt kärnbränsle. Regeringsbeslut 2022-01-27, M2018/00217, M2017/02796, M2021/00969.
- Regeringen, 2022c. Tydlig och förutsägbar finansiering till kommuner och miljöorganisationer för att arbeta med slutförvaret. Press release, 11 July 2022, from Ministry of Environment. <https://www.regeringen.se/pressmeddelanden/2022/07/tydlig-och-forutsagbar-finansiering-till-kommuner-och-miljoorganisationer-for-att-arbeta-med-slutforvaret/>.
- Söderberg, O., 2012. SKB:s program för samhällsforskning 2004-2011. In: En utvärdering. Svensk Kärnbränslehantering AB. P-12-14. Stockholm.
- Svensk Kärnbränslehantering, A.B., 2010. Utvecklingen av KBS-3-metoden. R-10-40. Stockholm.
- Swedish government, 2018. Supplementary terms of reference for the Swedish National Council for Nuclear Waste (M 1992:A). www.karnavfallsradet.se/sites/default/files/appendix_3_2018_18.pdf.
- Swedish National Council for Nuclear waste, 2009. Mechanisms of Copper Corrosion in Aqueous Environments. A report from the Swedish National Council for Nuclear Waste's scientific workshop, on November 16, 2009. SOU 2009:4e.
- Swedish National Council for Nuclear waste, 2018. Nuclear Waste State-of-the-Art Report 2018. Decision-making in the face of uncertainty. SOU 2018:8.
- Swedish National Council for Nuclear waste, 2019. Overview of eight countries – status April 2019. In: Report 2019, p. 1. <https://www.karnavfallsradet.se/en/report-2019/191-overview-of-eight-countries-status-april-2019>, 8.
- Swedish National Council for Nuclear waste, 2020. The Swedish National Council for Nuclear Waste, Review of SKB's RD&D Programme 2019. SOU 2020:39.
- Swedish National Council for Nuclear Waste, 2022. Swedish National Council for Nuclear Waste, 2022. Society, Technology and Ethics. SOU 2022:7. https://www.karnavfallsradet.se/en/publications?field_category_term_ref_tid=17#views-exposed-form-publications-block-1.
- United States Nuclear Waste Technical Review Board, 2022. Survey of National Programs for Managing High-Level Radioactive Waste and Spent Nuclear Fuel: 2022 Update. A Report to Congress and the Secretary of Energy.
- Wärnbäck, A., Soneryd, L., Hilding-Rydevik, T., 2013. Shared practice and converging views in nuclear waste management: long-term relations between implementer and regulator in Sweden. *Environ. Plan. A* 2013 (45), 2212–2226. <https://doi.org/10.1068/a45305>.
- Wenger, E., 1998. Communities of Practice. Learning, Meaning and Identity. Cambridge Univ. Press, USA.
- Westberg, L., Polk, M., 2016. The role of learning in transdisciplinary research: moving from a normative concept to an analytical tool through a practice based approach. *Sustain. Sci.* <https://doi.org/10.1007/s11625-016-0358-4>.

⁸ The government decided, however, in July 2022 (quite surprisingly) to end the Council's work by the end of December 2022 (Regeringen, 2022c).