

The National Cooperative for the Disposal of Radioactive Waste (Nagra) in Switzerland was established on 4 December 1972. It is a cross-generational project to dispose of radioactive waste 'once and for all', including specialists from several scientific disciplines and communication experts. In September 2022, Nagra proposed a site for a deep geological repository for radioactive waste. Looking ahead to steps such as underground experiments or the specification of the layout for the deep geological repository, it is clear that many more important steps will have to be taken in the years following the siting decision. Nagra will adapt to new challenges in terms of competence and organization. Good cooperation with the siting region is just as essential as working at a high scientific level.

In Switzerland, Nagra has just proposed the site for the deep geological repository for radioactive waste. What does this mean for the affected communities, also in terms of participation opportunities?

Our announcement of the site on September 12 was a big milestone for the Swiss disposal program – also in terms of participation. Some ten years ago, regional conferences were formed in the six initial regions. Since then, we have developed our proposals for the surface facility in cooperation with the regional conferences.

In the coming years, the surface facility in the proposed siting area will be further detailed in a series of workshops. Possible layouts of the access road network, the location and extent of the construction area, as well as the logistics will be discussed here. The general license application will then be submitted in 2024.

What does this mean for the siting regions, where people have been dealing

Keywords • *deep geological repository, nuclear waste, long-term project*



© 2022 by the authors; licensee oekom.
This Open Access article is licensed
under a Creative Commons Attribution 4.0 International
License (CC BY).
<https://doi.org/10.14512/tatup.31.3.72>
Published online: Dec. 16, 2022 (editorial peer review)

INTERVIEW

with/mit Tim Vietor

by/von Anne Eckhardt

Swiss repositories for nuclear waste

Endlager für Atommüll

in der Schweiz

with the disposal of radioactive waste for years and where no repository is now likely to be built?

The participation process is going to be terminated in these two regions. The work in the regional conferences will be documented and archived by the Swiss Federal Office of Energy, which leads the site selection process. Some members of these regional conferences expressed regrets that they have to give up their work now. In terms of repository implementation, the two regions will be put on standby until the operational license for the repository is granted.

A deep geological repository is a major project. Is Nagra therefore transforming itself now from a rather science-based organization into a general contractor for an underground repository?

A science-based approach will always be the foundation of Nagra's activities. The Swiss plan for the disposal of radioactive

waste follows a stepwise approach. In a first step, the site selection optimizes the geological setting for repository safety. The following general license is only the decision on the location and the broad framework of the project.

Further details like the repository layout, the construction methods, and the design of the technical barriers will follow once the results from the underground characterization are available. Therefore, the construction of the access facilities, the initial excavations in the host rock, and the underground experiments (Figure 1) will have to go hand in hand in order to establish the basis for the optimization of the repository.

What impact do you expect your future tasks and challenges to have on Nagra's own organization and organizational culture?

Currently, we are a project management company with some 120 people and a strong focus on earth science and disciplines related to feasibility demonstration and safety assessment.

The optimization of the facility requires the ability to create and assess multiple solutions for the repository elements and layouts. Individual elements are strongly interdependent. Consider the high-level waste (HLW) canister and the backfill material. Steel-based canister designs are robust in closure, handling, and emplacement. Their lifetime is around 10,000 years in a bentonite backfill. Coated canisters have even longer lifetimes and the backfill requirements can be relaxed. But long-term experience with copper or nickel coatings is limited, and such canisters require careful closure and emplacement. In order to finally choose the best technical barrier system, we will have to strengthen our interdisciplinary work environment. Parallel work on multiple solutions will require additional engineers with in-depth system understanding.

On top of the optimization work leading to conceptual and design decisions, we will have to strengthen our ability to construct and implement. Our engineering department will therefore definitely grow, but the final size will heavily de-

pend on how we choose to lead our contractors.

What are the future priorities of Nagra's research and development program? How will the need for research and development in the construction and operation of a deep geological repository evolve?

The safety of a repository in Opalinus Clay is broadly accepted. Clay rocks have very low hydraulic conductivities and good sorption properties. Their self-sealing capability makes them fail-safe. We can show that there are large safety margins toward the regulatory limit.

After locating the best site for the repository within the site selection program, R & D will focus on the optimization of the repository elements at the site. As mentioned, the HLW and Spent fuel (SF) canister designs will be a key point. Smaller canisters reduce local heat input, while larger canisters reduce the total number of handling steps and possibly also the size of the repository. Other engineering topics, i. e., the detailed design of the HLW/SF encapsulation plant as well as handling and operation workflows, will follow thereafter.

Does social science and humanities research have a place in Nagra's research program? Do you expect changes here over time as the deep disposal project goes ahead?

We follow the public discussion on Switzerland's energy strategy, but our mission is a technical one. Nagra acts as the implementer of the repository. We propose a concept as well as the best-suited site and implement the repository according to the best scientific and technical understanding. We act within the legal framework defined in a legislative process based on a broad discussion. This stable framework allows us to develop a project that takes more than 100 years from the site decision to the sealing of the last access.

War has once again become a realistic scenario in Europe. Are you thinking about contingency plans, for example, in the event of war or a profound financial

crisis during the long construction and operation phase of a deep geological repository?

We actually have contingency measures in place for various scenarios. The repository project is financed from a fund under the oversight of the federal government. The fund is filled by the waste producers during nuclear power plant operation based on a cost calculation for the repository project. The calculation is periodically updated and includes a considerable safety margin. The financial basis for the repository project is therefore solid, also with respect to a possible financial crisis.

On top of that, we also have to provide concepts for temporary closure of the repository in its operation phase. The tunnels and caverns are immediately backfilled and sealed after waste emplacement. If necessary, a temporary closure must be possible to avoid damage to the repository during prolonged times of inactivity. Therefore, we must provide means for a temporary closure on site. This will mostly include backfill material. It is a

regulatory requirement that the technique for the temporary closure is demonstrated before any waste is emplaced.

In your view, are there currently any human activities, social, and technological developments that could profoundly change our perception and understanding of the safety of a deep geological repository?

An entire series of barriers ensure the highest level of safety for the repository. The performance of the natural barriers relies on diffusion-dominated transport and self-sealing of claystone. These processes are very well understood and have been repeatedly observed in the siting region. The performance of the technical barriers and the underlying process understanding have been demonstrated in underground laboratory experiments. Long lifetimes of HLW and SF canisters are ensured by low corrosion rates of steel under repository conditions. The backfill material in the emplacement tunnels protects the canisters and has excellent retention properties. All this means that a repository will have the highest safety standard under the widest range of conceivable scenarios. However, we continue research and development work to further optimize the repository.

Are there any current developments in research and technology that Nagra may wish to exploit for safety cases and for the exploration, construction, operation, and decommissioning of a repository in the future?

A safe repository can be constructed in a clay formation today. However, Nagra will exploit new developments as they arise to improve construction techniques and operational procedures. Remote handling and monitoring techniques are rapidly evolving and can be of use in an underground environment. There are also interesting developments in canister materials. However, we will always assess such developments in terms of safety, reliability, and costs.

How do you see the view of politics and society on deep geological disposal de-



Tim Viotor

is head of the Safety, Geology and Radioactive Materials division at Nagra. As a geologist, he has expertise in planning and implementing the exploration work for a new disposal site for radioactive waste, including seismic measurements, deep boreholes, and key experiments in the rock laboratories.

veloping? What can we possibly expect in the future?

The approach of a deep geological repository for the safe disposal of radioactive waste is widely accepted in Swiss society. Surveys show a stable approval rate of 60

In the underground, the repository will be protected by hundreds of meters of rock. Marking of the repository requires decisions when the repository is sealed in around 100 years. We closely follow the relevant research in this field.

For the construction of the repository, we will however rely on well-established methods from the mining and tunneling industry, which has a long tradition in Switzerland. Here, we will most likely continue to work with experienced contractors.

Invest in top quality data and remember that scientific excellence is nothing without public acceptance.

to 70 percent over the past decades. Currently, this is the internationally accepted disposal option.

Other approaches, such as transmutation, entail an entire industry including new nuclear installations. Although currently not foreseen, it may become a possibility in some decades. However, this technique is not applicable to the 632 vitrified waste packages we have from past reprocessing of spent fuel. For this category of high-level radioactive waste, a deep geological repository will always be required.

In Switzerland, the law provides for permanent marking of the repository. Are there already specific ideas about this? How do you assess the necessity of a marking?

The future is about people. Will you find enough well-trained and motivated young employees to be able to tackle and manage Nagra's tasks well in the future?

We are running a large technology-driven project with a clear and good purpose. We work for the safe disposal of nuclear waste today, so that future generations remain safe. This is a good basis for recruitment.

We cooperate with leading universities and competence centers in Switzerland to preserve and develop the knowledge at the core of the project. Nagra also takes part in research initiatives and networks at European and international level. These initiatives enlarge our network and allow us to identify qualified candidates in relevant research fields.

In your experience, what interests young people about deep disposal?

We have an interesting mission, and we are scientifically driven. You could say: The successful implementation requires a scientifically sound concept, a good and stable cooperation with the selected region, and finally the ability to construct and operate a multi-billion infrastructure project. So there will be job opportunities for a wide variety of qualifications.

What else would you like to share with us on the topic of 'The future of high-level radioactive waste disposal'?

With site-selection coming to an end after years of fieldwork and data interpretation, my personal lesson is: Invest in top quality data and remember that scientific excellence is nothing without public acceptance.

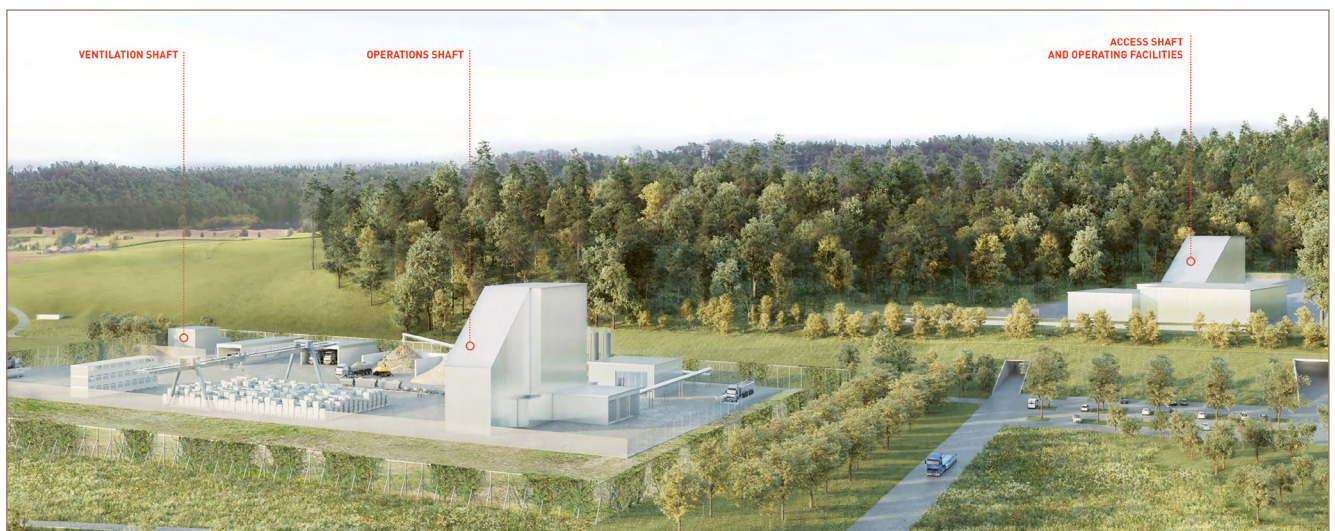


Fig. 1: A deep geological repository requires not only underground facilities, but also surface facilities that are in operation for a longer period of time. Source: Nagra