Safely Stored for All Eternity

How the Bundesgesellschaft für Endlagerung is Conducting its Search for a Repository for High-level Radioactive Waste

Steffen Kanitz

Germany has spent the last three years with a restart for its attempts at selecting a site for a repository for high-level radioactive waste. In fall 2020, the Federal Company for Radioactive Waste Disposal (Bundesgesellschaft für Endlagerung, BGE) is due to present an initial evaluation of data on the deep geological conditions, which is intended to provide some guidance on which areas are unsuitable and which may be suitable for a geological repository. The Federal Office for the Safety of Nuclear Waste Management (Bundesamt für die Sicherheit der nuklearen Entsorgung, BASE) will then take the first step towards formal public participation and issue invitations to the specialist Subareas Conference. And a new player has come onto the field, the National Monitoring Panel (Nationales Begleitgremium NBG), which recently completed its line-up. Whereas the 18th legislative session of the Federal Parliament (2013 to 2017) concentrated on the organizational restructuring of the repository landscape, the focus has now shifted to realization.

The principle of a blank map of Germany applies. No site is excluded right from the outset, no site is included right from the outset. This is a political compromise supported by a broad parliamentary majority for a task which has spanned several generations and previously been marked by major conflicts. This compromise forms the basis for the work being undertaken by the BGE to search for the site in Germany which offers optimum safety for a million years.

Looking back

For decades, the disposal of high-level radioactive waste in Germany seemed to be a problem that had almost been solved - at least as far as the two main political groupings, CDU/CSU and SPD, were concerned. In 1977, Ernst Albrecht (CDU), then Minister President of Lower Saxony, chose Gorleben as the site of a nuclear disposal facility and hence the site of a repository for high-level radioactive waste, too. This decision was supported by the Federal Government of Helmut Schmidt (SPD) in Bonn.

But more than 40 years on from this, it has to be admitted that the first attempt at solving the repository issue in Germany has been a failure. The selection process, considered by some sections of the public to be very intransparent, stirred up resistance not only in the region around Gorleben (Wendland) itself, but across the whole of Germany – and kept it alive for decades. Wendland, a remote region in the state of Lower Saxony on the borders to Saxony-Anhalt and Brandenburg, has moreover even experienced a large influx of people, namely those wanting to express their resistance against nuclear energy and, at times, against the government, too. The resistance movement grew with every Castor transport into the Gorleben interim storage facility.

Fresh start in the search for a repository site

The Federal Parliament resolution of 2011 to phase out nuclear power after the nuclear disaster in Fukushima, Japan, which followed in the wake of a powerful earthquake and a tsunami, paved the way for a new attempt at finding a consensus for a repository. Norbert Röttgen (CDU), then Secretary of State for the Environment, and Winfried Kretschmann (Green Party), Minister President of Baden-Württemberg, started a dialog at that time which produced an initial result two years later. In 2013, the first Repository Site Selection Act (StandAG) was passed, and provided for a fresh start in the search for a repository. Between 2014 and 2016, the Repository Commission – a body of scientists, various social groups, the Federal Parliament, and the Federal Council (although the politicians had no voting rights) – conducted its deliberations, which were chaired by Ursula Heinen-Esser (CDU) and Michael Müller (SPD). It drew up the scientific criteria for the procedure, and the principles for full public participation, too. These results were taken as the basis for the amendment to the StandAG in 2017, and the definition of the site selection procedure: The search is to be undertaken by way of a science-based, transparent, participative, self-scrutinizing and learning process. This is the foundation on which the new search for a repository is to be conducted.

What does the search aim to do?

Its aim is to find a site in Germany deep underground where the high-level radioactive waste can be safely sealed off from the environment and from us humans for a million years. The waste comprises around 10,200 metric tons of spent fuel elements and approx. 6,000 cubic meters of vitrified waste from the Sellafield and La Hague reprocessing plants. At present, this waste is safely stored in casks (Castors) in interim facilities. Its volume is small compared to that of the low-level and intermediate-level radioactive waste, but these materials are the source of more than 99 percent of the radiation from the radioactive waste in Germany.

Are there any alternatives to a repository?

The Repository Commission gave thorough consideration to alternative forms of disposal, but ultimately rejected them for reasons which are easy to comprehend. In times of global climate change, a repository in the pack ice cannot be viewed as a long-term solution. Although the idea of disposing of the radioactive waste in outer space may sound logical, it would only need a failed rocket launch to cause a nuclear disaster. Constructing thick-walled, ground-level storage facilities imposes the responsibility for protecting and maintaining these facilities in the long term on future generations, not to mention the fact that such facilities would be potential targets for terrorist attacks.

Some people say that so-called partitioning and transmutation offers a solution to the nuclear waste problem. The idea here is that long-lived radionuclides are converted into

shorter-lived radioactive materials through targeted irradiation in a new generation of reactors, thus restricting the length of time they have to be stored, and that the materials processed in this way are reused as nuclear fuel. This technology has remained stuck at the experimental stage for decades, however. Moreover, a geological repository would be needed for the waste from this process, too. And: Using partitioning and transmutation to help get rid of the quantities of radioactive waste which have already accrued in Germany would require the technology to be in operation for at least 150 years – the problem would be passed on to future generations instead of relieving them of the burden of high-level radioactive waste.

The Repository Commission agrees with the assessment of international experts that a geological barrier deep underground is the only way to guarantee that the radioactive waste is permanently and safely sealed in.

How will the site search be undertaken?

The first phase of the site selection involves the BGE working with the data on the deep geological conditions which are already available from the federal government and federal state authorities. The exclusion criteria, minimum requirements, and the geoscientific assessment criteria defined in the StandAG will then be applied to the data which already exist. Thus, the work initially involves studying the records documenting our existing knowledge on the deep geological conditions in Germany which are available from the federal state and federal government authorities. The Geological Surveys of the federal states, and the Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geologie und Rohstoffe, BGR), have made substantial volumes of existing data available to the BGE.

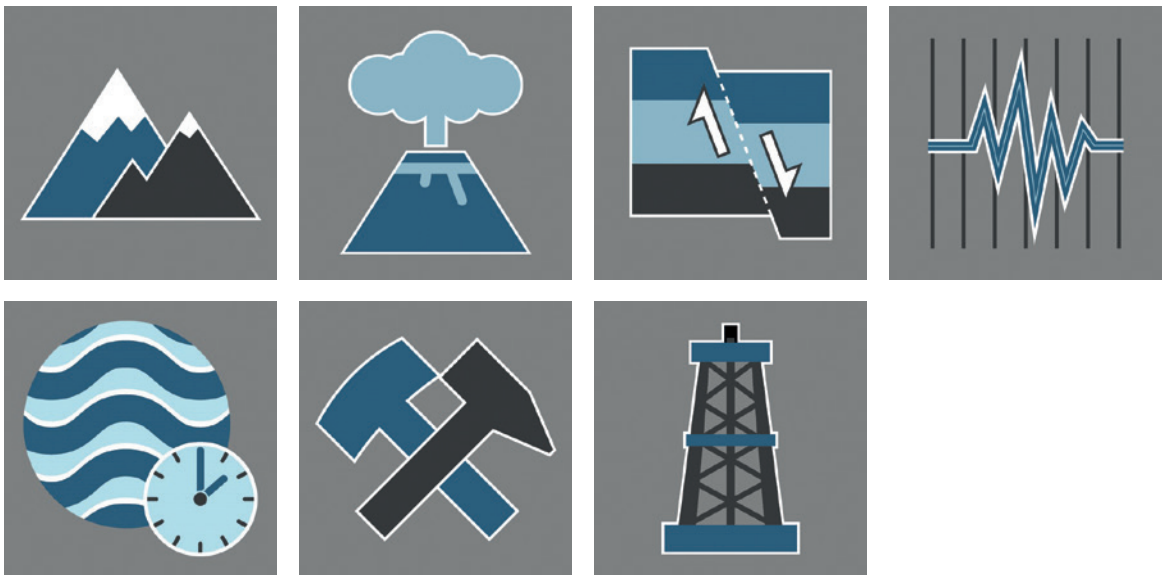
Exclusion criteria

The BGE now examines whether these pools of data can already be used to deduce which areas are not suitable for a repository (exclusion criteria). These are areas in which geogenic uplifts of more than a millimeter per year are observed, or are to be expected over the course of a million years. Regions where mining is still taking place or used to take place, or where there are boreholes at depths of between 300 and 1500 meters, are also to be excluded, because the integrity of the rock has been weakened. Active fault zones, where the layers of rock are shifting against each other, are also to be excluded. Other exclusion criteria are volcanic activity, seismic zones above zone 1, and so-called young groundwater. All the exclusion criteria indicate rock movements which prevent the permanent, safe storage of high-level radioactive waste.

The BGE has developed an exclusion methodology for each exclusion criterion. The mining criterion is subdivided into mines and boreholes, because the impact of these two anthropogenic effects is different. The guideline followed by the BGE is the maxim of excluding as little as possible the first time the criteria are applied, so as not to overlook or discount an area which may possibly be suitable. Each exclusion methodology follows a strict schematic and is easy to understand. It also covers how to deal with cases which cannot be definitively assessed from behind a desk, such as the question of whether a fault zone is active or passive, and what its precise course is, for example. The BGE therefore proposes that fault zones reported as active by the Geological Surveys are taken to be active in the first step. The BGE assesses rock movements which are more recent than 34 million years ago as a further indication of the activity of a fault zone. The so-called Rupel stratum in the geological models and maps is an indicator of rock movement which occurred less than 34 million years ago. In addition, the BGE has specified a further condition as a result of information from the online consultation on the methodology: Fault zones which are located in tectonically active major systems – one example would be the Upper Rhine Graben – are also assessed as being active. When concrete information is available on the course of an active fault zone, a one-kilometer protection zone is placed around it, and the area is then projected onto the surface and "cut out" of the blank map. If no information is available, it is initially simply excluded together with its surrounding protection zone in the vertical direction.

Minimum requirements

The minimum requirements are then applied in a second step to establish which areas in Germany could in principle host a repository. The BGE is searching for a stable rock formation



| Exclusion Criteria

which is as impervious as possible at a depth of between 300 and 1500 meters. Three rock formations are suitable to retain radionuclides over a period of a million years: Rock salt, clay rock, and crystalline rock. The BGE will present the definitions for the host rocks it has used before the publication of the Subareas Interim Report. The rock layer in which a storage location is to be found must be at least 100 meters thick. Slightly different requirements apply to salt in a steeply inclined formation, i. e., salt domes, and also to crystalline rock, but these are likewise clearly defined in the StandAG. Furthermore, it is important that the rock is as impervious as possible to water, and even retains gases, because radionuclides could migrate with the aid of water or gas.

To identify areas in which the minimum requirements are met, the BGE has utilized a great many databases and maps, and a wealth of expertise. When a 3D model of the deep geological conditions was available for a federal state or parts of a federal state, the BGE used it to determine host rock formations and their thickness, for example. The BGE has used paleogeographic and geological maps, ground profiles from boreholes, and other suitable sources of information, to fill the gaps between the models with knowledge and justified assumptions.

Geo-scientific assessment criteria

In the third step, the BGE evaluates the areas in which all the minimum requirements are met and no reason for exclusion exists, in order to identify subareas that lead one to expect a favorable geological situation. To be able to systematically process the eleven geoscientific assessment criteria, which are evaluated with the aid of 40 indicators, the BGE specialists developed an Access-based evaluation tool which is used to individually assess each of the areas identified. The evaluation results are documented in a comprehensible way.

Subareas Interim Report

In fall 2020, the BGE will present a Subareas Interim Report which will contain the evaluation of this initial exploratory phase. The Interim Report will explain for one how the subareas identified have been arrived at. The methodology used to apply the criteria from the Repository Site Selection Act will be described, fundamental stipulations and definitions will be derived, and an overview of the database used will be provided. These steps, as well as the history of how aspects such as an exclusion methodology were derived or developed, will be described in more detail in a series of supporting documents. Even before the first step of full public participation is taken, results of an online consultation on the methodologies will be included in the Interim Report. In addition, the BGE has organized several specialist workshops with the Geological Surveys over the past three years, and also sought the dialog with the scientific community. Worthy of mention is a specialist workshop on the research needs for the site selection in January 2019, and in particular the "Site Selection Conference" in Braunschweig in December 2019. The findings from the talks, poster sessions, and short presentations by scientists from universities and institutes are also reflected in the work, and have sometimes already been incorporated.

After publication of the Subareas Interim Report, the BASE will issue invitations to a specialist Subareas Conference, at which the BGE will present the results of the Interim Report. The BGE will incorporate the results of the conference into its subsequent work. At the same time, the BGE will conduct the first, still very generalized safety studies in the subareas which have then been identified. It will propose survey programs whereby the conditions underground can be explored in more detail. The issue is initially to survey the areas from the surface, by means of boreholes, seismic measuring programs, or other methods.

What happens next?

A BGE proposal for site regions where a surface survey appears to be worthwhile marks the end of the first phase. The BASE will examine the BGE proposal and either accept it or make a modified proposal to the Federal Ministry for the Environment, which will submit the proposal to the Federal Parliament in the form of a draft bill. Parliament will then decide where surveys are to be undertaken. The next stage is the surface surveys, which will then be used to derive a proposal for the areas where underground surveys also are to be carried out. Parliament will again make the decision on this. Finally (target date 2031), there will be a site proposal on which the Federal Parliament will make the decision. The goal is for the repository to be available in 2050. After another 50 or so years, the disposal process will be complete, the repository will then be sealed. Only then will the nuclear relics of the peaceful utilization of nuclear energy in Germany have been disposed of safely and permanently.

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