RADIOACTIVE WASTE MANAGEMENT PROGRAMMES IN OECD/NEA MEMBER COUNTRIES

GERMANY

[2013]

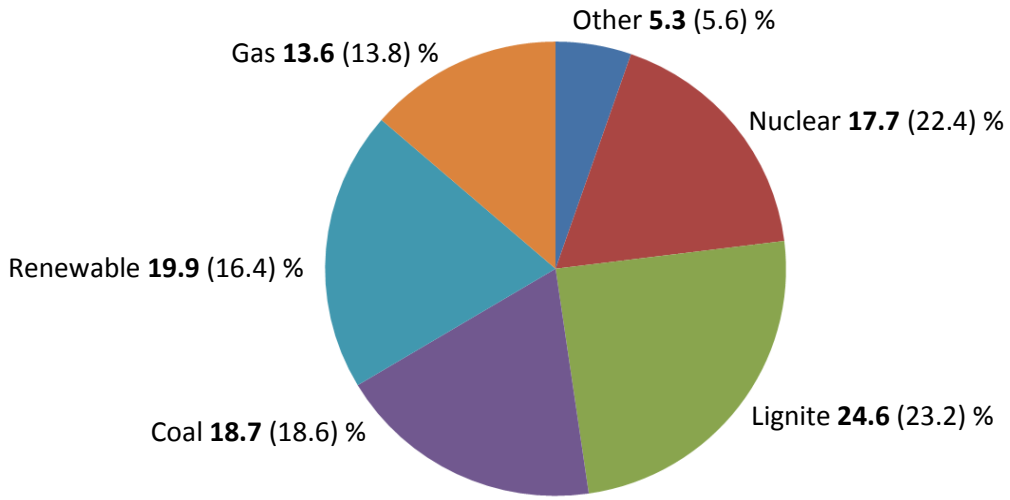
NATIONAL NUCLEAR ENERGY CONTEXT

The commercial use of nuclear power in Germany started in 1961. The peak value of installed nuclear capacity was reached in 1994, when 21 power reactors were in operation with an installed capacity of 23.9 GWe . Due to the gradual decommissioning of older reactors, the installed capacity had decreased to a value of 21.5 GWe by 2010.

With the 13th amendment of the Atomic Energy Act of 6 August 2011, the licences to operate the plants Biblis A and B, Neckarwestheim 1, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel expired. The operating licences of the remaining nine nuclear power plants, having a total capacity of 12.7 GWe, will expire between 2015 and the end of 2022. The amendment of the Atomic Energy Act was a consequence of the events in Japan in March 2011, which led to a reassessment of the risks associated with the use of nuclear energy.

At the end of 2011, the capacity for nuclear fuel fabrication was 650 tonnes of heavy metal per year (HM/year), yielding uranium fuel for light water reactors. The Gronau uranium enrichment plant had reached a capacity of 4,200 tons SWU per year (the licensed capacity is 4,500 tons SWU per year). The spent fuel storage capacity of the at-reactor dry storage facilities was 14,030 tonnes HM, and the amount of spent fuel arising annually from the operation of the nine reactors in operation was about 220 tonnes HM.

Breakdown of Electricity Sources in Germany 2011 (in brackets: 2010)
Source: AG Energiebilanzen e.V.



SOURCES, TYPES AND QUANTITIES OF WASTE

An annual survey of the volume of radioactive waste produced in Germany is carried out by the Federal Office for Radiation Protection, hereinafter shown as BfS, on behalf of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety hereinafter shown as BMU.

The main sources of radioactive waste are nuclear fuel cycle activities, including power production, related research and development and the decommissioning and dismantling of nuclear facilities.Radioactive waste is also produced by the use of radioisotopes in medical, research, and industrial applications, in addition to the activities of other bodies associated with the transfer and removal of such wastes.

The waste is classified into two categories according to the requirements for its disposal. These categories are:

- radioactive waste with negligible heat generation
- heat-generating radioactive waste

Radioactive waste with negligible heat generation includes metals and non-metals, filters and filter elements, combustible substances, carcasses, chemical fluids, sludge, slurries and biological fluids as well as oil, solvents and emulsions.

Heat-generating radioactive waste includes those wastes that arise from the reprocessing of

spent nuclear fuel elements for the recovery of reusable materials. These wastes include fission-product concentrates, fuel-element cladding and related materials. Spent nuclear fuel that is not reprocessed but is destined instead, for direct disposal as radioactive waste, also falls within this category.

The main operations involved in preparing waste for interim storage and/or disposal include the following:

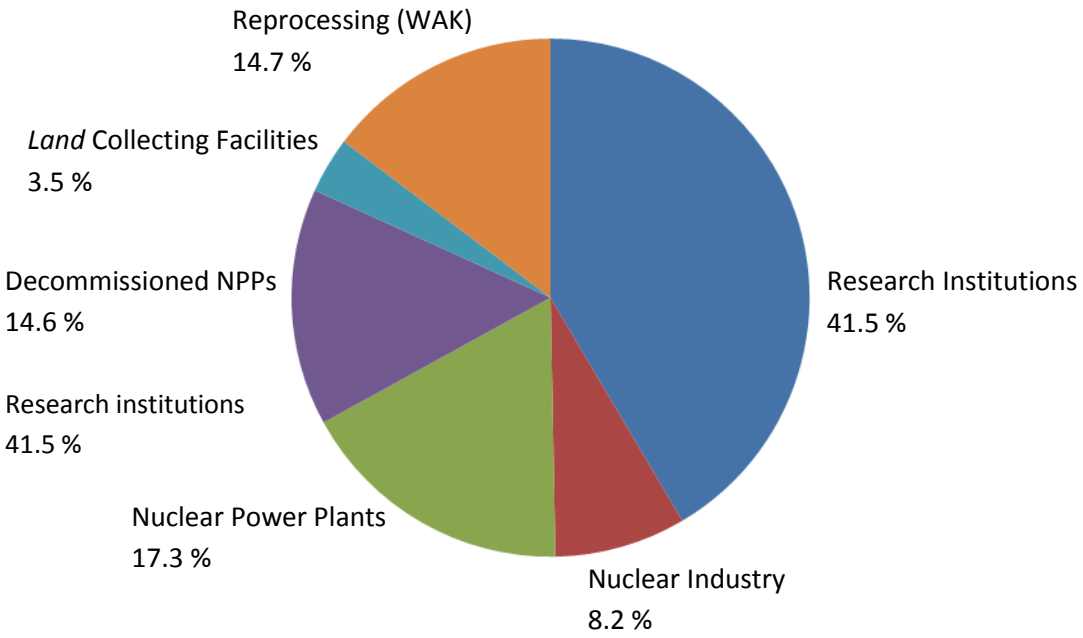
- Compaction, which is a treatment method where the bulk volume of a compressible material is reduced by the application of high external pressure.
- Immobilisation, which consists of converting waste into a solid form by embedding or encapsulating it in materials such as cement, concrete, bitumen or glass.
- Incineration, which is a waste treatment process consisting of burning combustible waste to reduce its volume.
- Solidification, which is the conversion of gaseous, liquid or liquid-like materials into a solid waste form in order to produce a physically stable material. Typical processes include calcination, drying, evaporation, cementation, bituminisation or vitrification.

Collectively, these processes are termed "conditioning", and "conditioned waste" refers to processed and/or packaged radioactive waste ready for interim storage and/or disposal.

The total volume of conditioned radioactive waste with negligible heat generation accumulated by the end of 2010 was 96,513 m^3. The percentage breakdown of this stock, by source, is shown in the figure below.

Breakdown of Conditioned Radioactive Waste with Negligible Heat Generation

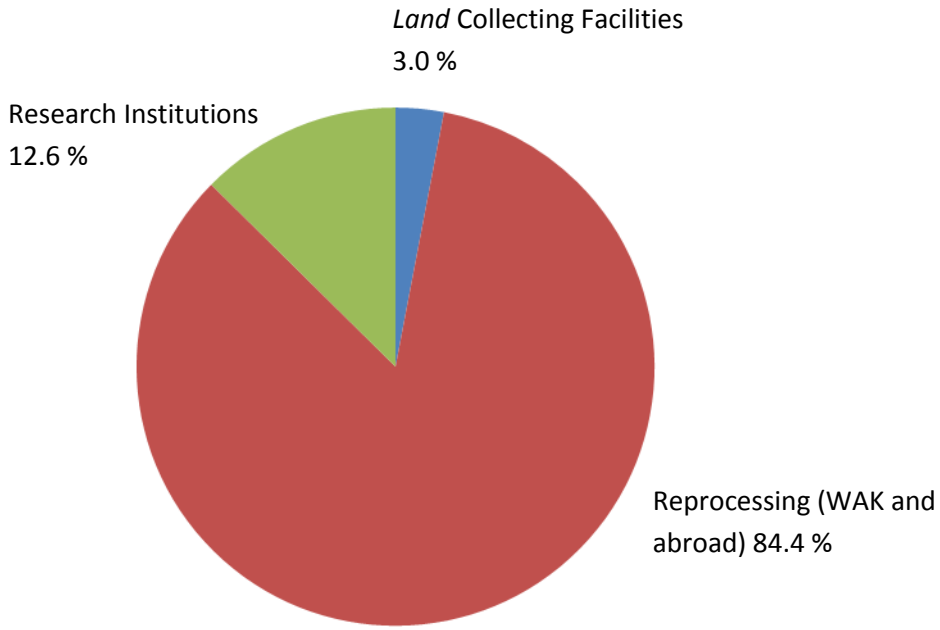
Source: BfS/BMU



The total volume of conditioned heat-generating radioactive waste, accumulated by the end of 2010, was 593 m³. The percentage breakdown of this stock, by source, is shown in the figure below.

Breakdown of Conditioned Heat-Generating Radioactive Waste

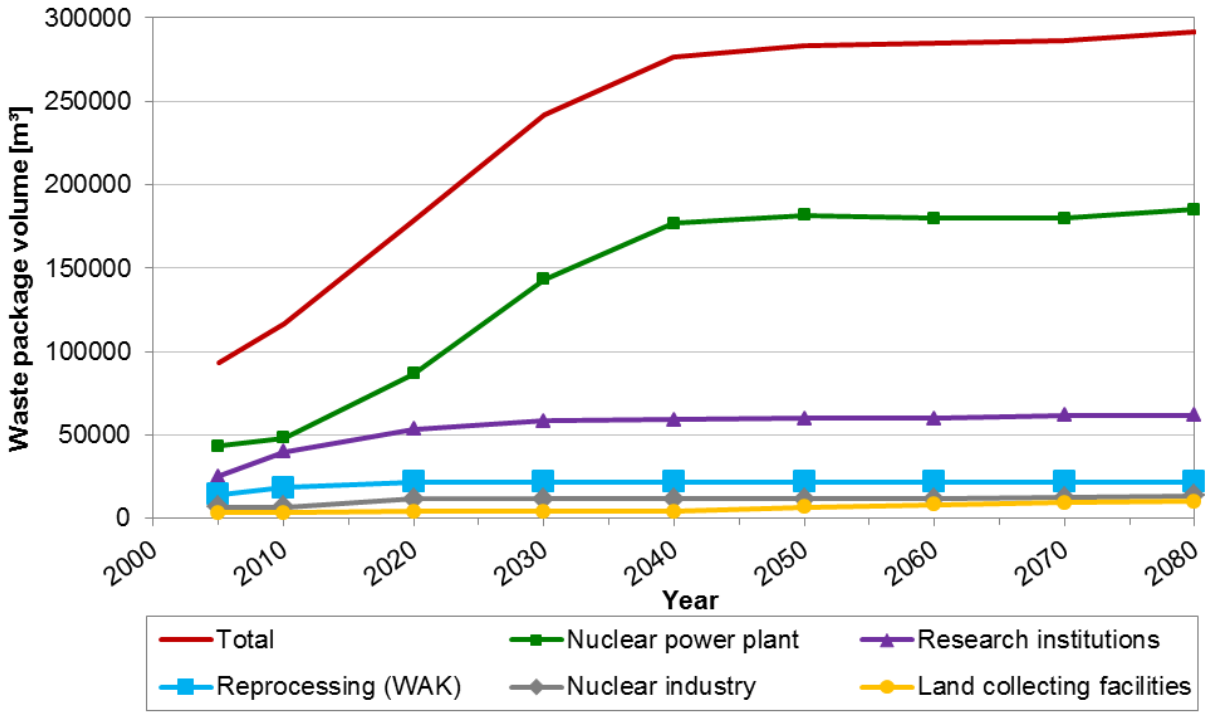
Source: BfS/BMU



The accumulation of conditioned radioactive waste in Germany has been forecast until 2080, on the basis of waste surveys and disposal plans submitted by the utilities. The figures are as follows:

- Conditioned radioactive waste with negligible heat generation: 290,000 m³ (approx.)
- Conditioned heat-generating radioactive waste: 28,000 m³ (approx.)

The time-dependent accumulation of radioactive waste to be generated in the future, expected by the waste producers, is shown in the following graph.



Time-dependent accumulation of radioactive waste

RADIOACTIVE WASTE MANAGEMENT POLICIES AND PROGRAMMES

Spent Fuel Management

Germany's objective regarding the management of spent fuel has changed. Until 1994, the Atomic Energy Act (AtG) included the requirement of re-using the fissile material in the spent fuel. This requirement changed in 1994, and the operators of nuclear power stations then had the option of either re-use by means of reprocessing, or else direct disposal. Since 1 July 2005, the delivery of spent fuel from power reactors for the purposes of reprocessing has been prohibited in accordance with an amendment of the Atomic Energy Act of 2002. Now, it is only permissible to directly dispose of the spent fuel existing and being generated in Germany in the future.

For the spent fuel which until 30 June 2005 was delivered for reprocessing to France and the United Kingdom, proof of the non-hazardous re-use of the plutonium separated during reprocessing must be furnished by the licensees. This is designed to ensure that throughout the remaining residual operating lives of the nuclear power plants, all separated plutonium is processed in the fabrication of MOX fuel and thus re-used.

The remaining and future generated spent fuel in Germany will be stored intermediately at the sites where it was generated until a repository is commissioned. An application to construct an interim storage facility for the dry storage of fuel assemblies has been submitted for the Obrigheim nuclear power plant under decommissioning, where a wet storage facility is presently in operation.

As there is yet no repository available for the spent fuel, it will be stored intermediately at the sites where it was generated; corresponding storage facilities are available as needed. Usually, the spent fuel from research reactors will be returned to its country of origin. If this is not possible, this too will be intermediately stored until its final transportation to the repository.

There are conceptual considerations regarding the design of a repository. The concept of direct disposal provides that following the interim storage for several decades, spent fuel will be packed into containers suitable for disposal and that these will be sealed leak-tight and emplaced in drifts or boreholes in deep geological formations. The prototype of a facility for packaging spent fuel in containers suitable for disposal has been built. The aim is for the repository to be in operation around the year 2035.

Facilities for the management of spent fuel are:

- the interim storage facilities at the nuclear power plant sites,
- the central interim storage facilities at Gorleben (TBL-G) and Ahaus (TBL-A),
- the interim storage facility "*Zwischenlager Nord*" (ZLN) near Greifswald for the spent fuel from the Rheinsberg and Greifswald nuclear power plants, as well as the interim storage facility at Jülich for the spent fuel of the AVR reactor,
- the pilot conditioning plant at Gorleben (PKA).

On-site interim storage facilities

At twelve nuclear power plant sites, decentralised interim storage facilities for spent fuel have been licensed, constructed and put into operation under atomic law. They are designed as dry storage facilities in which transport and storage casks loaded with spent fuel are emplaced.

The interim storage facilities are cooled by passive air convection which removes the heat from the casks without any active technical systems. The leak-tight and accident-resistant casks ensure safe enclosure, as well as the necessary degree of radiation shielding and criticality safety during both normal operation and in case of incidents. The heat is released into the environment by means of cooling fins. Protection against external impacts, such as earthquakes, explosions

and aircraft crashes, is ensured by the thick walls of the casks. It was demonstrated and confirmed in the licensing procedure that the casks are suitable for at least 40 years of storage; the licenses limit the storage period correspondingly (starting with the emplacement of the first cask). An extension of the storage period requires an authorisation.

Interim storage facilities at Gorleben and Ahaus

Central storage facilities containing fuel assemblies from various German nuclear power plants have been licensed at Gorleben and Ahaus. Both facilities are designed as dry storage facilities. The Ahaus facility is additionally licensed for the storage of transport and storage casks of the types CASTOR® THTR/AVR (in all 305 casks) und MTR 2 (in all 18 casks).

It is intended to use the Ahaus interim storage facility, if necessary, for the storage of further fuel assemblies from the three operating research reactors BER-II, FRM II and FRMZ in casks of the type CASTOR® MTR 2. No decision about this possibility has yet been made as it is intended to repatriate the fuel assemblies from BER-II and FRMZ as well as from the already shut-down MTR facilities in Geesthacht and Jülich to the USA. For the FRM II, the road to the USA is not open. The fuel assemblies are therefore also to be put in interim storage at Ahaus, with a view for them later to be disposed of in a repository. The modification of the FRM II to use lower-enriched uranium instead of high-enriched uranium (93 % U-235) is intended for 2018. In addition, the spent fuel from the decommissioned research reactor at Rossendorf is also stored at Ahaus.

In September 2009, the Transport Cask Storage Facility Ahaus and the *Gesellschaft für Nuklear-Service mbH* applied for the storage of nuclear fuels in form of spent fuel of the former research reactor AVR GmbH Jülich in a total of 152 transport and storage casks of the type CASTOR® THTR/AVR in the Ahaus interim storage facility. Furthermore, they applied for the storage of high-pressure-compacted radioactive waste (the so called CSD-C resulting from reprocessing at La Hague) in transport and storage casks type TGC36.

In November 2009, the license according to § 7 of the Radiation Protection Ordinance (StrlSchV) for the interim storage of low- and intermediate-level waste at Ahaus was granted. The storage period is limited to 10 years. On 21 July 2010, first waste packages were emplaced.

The interim storage facility at Gorleben is additionally licensed for the storage of vitrified HAW glass canisters. In January 2010, a license for the storage of casks of the type CASTOR® HAW 28M was granted. By the end of the year 2011, there were a total of 128 casks with vitrified waste. The storage of other conditioned radioactive materials in waste packages in separate areas of the interim storage facility is in preparation.

Interim Storage Facility "Zwischenlager Nord" (ZLN) at Greifswald and interim storage facility at Jülich

Spent fuel from the Soviet-type reactors at Rheinsberg and Greifswald that were shut down in 1990 is stored in the interim storage facility "*Zwischenlager Nord*" (ZLN) at Greifswald.

The facility furthermore, accommodates spent and fresh fuel from the Compact Sodium-cooled Nuclear Reactor Plant (KNK II) and from the Nuclear Ship Otto Hahn. The four transport and storage casks of the type CASTOR® KNK were taken back from France and emplaced in the ZLN in December 2010. The ZLN is also licensed to store vitrified waste from the Karlsruhe vitrification plant (VEK). By the end of 2010, the about 60 m³ of HAWC solution that arose during the operation of the Karlsruhe reprocessing plant (WAK) had been vitrified in 140 stainless-steel canisters at the VEK. These canisters were then placed in five CASTOR® HAW 20/28 CG transport and storage casks and shipped to the ZLN in February 2011.

The interim storage facility at Jülich, licensed until 30 June 2013, contains the spent fuel spheres from the operation of the experimental nuclear power plant in Jülich (AVR). The interim storage facility is to be closed and the 152 stored transport and storage casks of the type CASTOR® THTR/AVR are to be removed. One option under consideration is their transfer into the interim storage facility at Ahaus.

Gorleben pilot conditioning plant (PKA)

The reference concept for the disposal of spent fuel has the intention of removing the fuel rods from the fuel assemblies in an above- ground plant, packaging the fuel rods in self-shielded and sealed thick-walled casks and emplacing them in deep geological formations for disposal. In order to demonstrate the conditioning technique, a pilot conditioning plant (PKA) was constructed at Gorleben in the year 2000. The plant is licensed for a throughput of 35 Mg HM/a. Pursuant to the agreement between the Federal Government and the utilities of 11 June 2001, the licensing procedure is complete, but use of the facility is licensed only for the repair of defect casks for spent fuel from light-water reactors and for vitrified HAW from reprocessing, as well as for the handling of other radioactive materials. As a prerequisite for the start of pilot operation, the license requires the repository site be named and the qualification of the conditioning procedure.

Radioactive Waste Management

Only stable (or fixed) radioactive waste will be accepted for disposal in deep geological formations; liquid and gaseous waste is excluded from acceptance. The controlled, safe disposal of radioactive waste therefore requires its conditioning.

Conditioning comprises several stages, depending on the quality and nature of the raw waste. After targeted collection or grading (where necessary), the raw waste may first be pre-treated

and then either processed into interim products or directly into packages suitable for storage or disposal.

Proven methods and reliable mobile or stationary installations already exist for the pre-treatment and conditioning of radioactive waste. Mobile conditioning installations are the preferred choice for the treatment and packaging of operational waste from nuclear power plants. Stationary installations which are capable of conditioning various different types of raw waste tend to be used primarily at the major research centres; there are also a number of other stationary conditioning installations which are operated on site by the respective waste generators.

In addition to German facilities, facilities in other European countries are also used for waste management. Radioactive waste generated from the operation of nuclear installations is delivered to Sweden for conditioning and subsequently returned to Germany. Waste from the reprocessing of spent fuel from German power reactors is conditioned in France and the United Kingdom (e.g. vitrification of the high-level fission product solutions) and is then also returned to Germany.

Both centralised and decentralised storage facilities are available for the interim storage of radioactive waste with negligible heat generation from nuclear power plants and the nuclear industry. For waste generated from the use and handling of radioisotopes in research, industry and medicine, state collecting facilities operated by the Federal States (*Länder*) are available for interim storage.

For the interim storage of heat-generating radioactive waste, local and central interim storage facilities are available as well; the waste from the reprocessing of spent fuel of German utilities in France and the UK is stored or will be stored at two centralised storage facilities at Gorleben and Ahaus. In addition, heat-generating radioactive waste is stored at research institutions and, to a low extent, also in state collecting facilities.

Compliance with the waste acceptance requirements is verified within the scope of the product control procedure. Here, the waste acceptance requirements for disposal, as they apply to the licensed Konrad repository, which is currently under construction, are the relevant criteria. The product control measures refer to the already conditioned waste as well as to the radioactive waste to be conditioned in future. They are devised such that waste packages that are not in compliance with the specifications are reliably detected.

Programmes and Projects

In Germany, the handling of radioactive materials and the disposal of radioactive waste are governed by the *Atomic Energy Act.* According to this act, radioactive residues must be properly disposed of as radioactive waste. Also, after waste conditioning, packaged wastes are to be placed in interim storage facilities that ensure their proper storage until disposal. The conditioning method that is used depends on the characteristics of the waste.

Asse mine

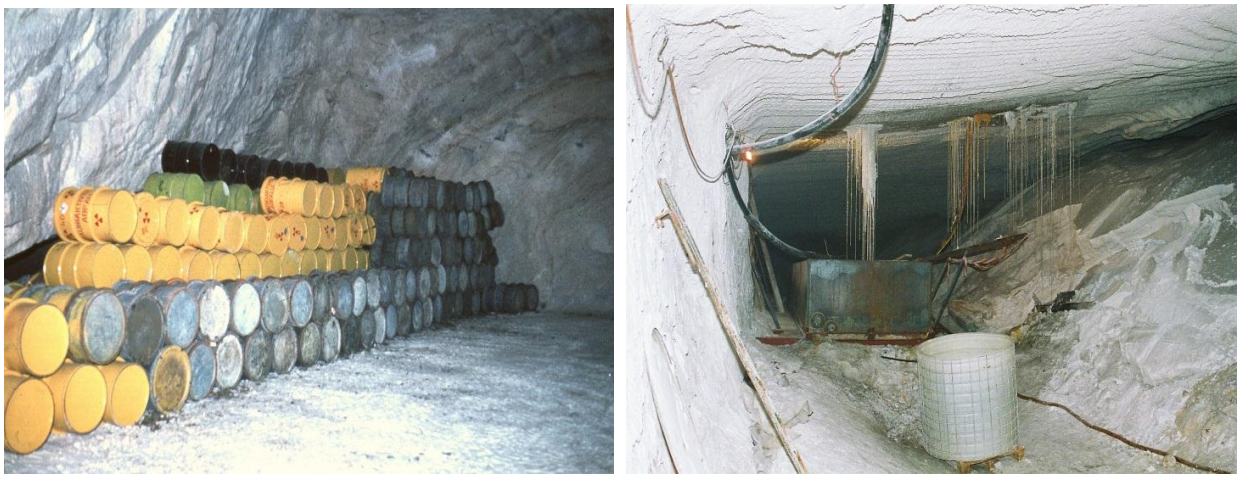
Development work in the field of repositories began in 1965 with the installation of the Asse II mine in a disused salt mine, where low- and medium-active waste was emplaced between 1967 and the end of 1978. According to § 57b of the Atomic Energy Act (AtG), the Asse II mine must be decommissioned without delay. Here, the provision applicable to federal installations referred to in § 9b AtG shall be applied mutatis mutandis. The BfS, as the responsible operator of the facility, applied for the initiation of a plan approval procedure under nuclear law at the Ministry for the Environment and Climate Protection in Lower Saxony in written form on 11 February 2009.

The BfS has examined in the context of a comparison of three closure options how the Asse II mine can be shut down safely. The possibilities of retrieval, an internal rearrangement of the waste and a complete backfill of the mine were studied.

Since 1988, there has been a continuous inflow of groundwater from the overburden into the mine. At the same time, the stability of the mine started to deteriorate successively due to the pressure of the overlying overburden and the decreasing load-carrying capacity of the mine workings. Within the framework of a comparison of three closure options, the BfS examined how the Asse mine can be safely closed. The options considered were the retrieval of the radioactive waste, the internal relocation of the radioactive waste, and the complete backfilling of the mine.

On 15 January 2010, the BfS, as the operator, announced that, taking the present state of knowledge into account, the complete retrieval of all waste would be the best closure option. However, the retrieval of the waste requires more detailed knowledge of the boundary conditions to be able to ensure the safety of the employees and the public ("fact finding"). On 21 April 2011, the Lower Saxony Ministry for the Environment and Climate Protection granted the licence for drilling into two representative emplacement chambers upon application of the BfS as a first step of fact finding.

The Nuclear Waste Management Commission (ESK) has pointed out that in the case of a retrieval of the waste from the Asse II mine it is currently not possible to make substantiated estimates of the radiation exposure of personnel and the public. In the case of a complete retrieval of the waste, additional radiation exposure of the operating personnel and the public over the next decades would have to be accepted. If the waste were to remain in the Asse II mine, the conservatively calculated hypothetical doses in the future must be weighed against this.



Repository Asse II mine (left: chamber during emplacement, right: dropping point) (Copyright: BfS)

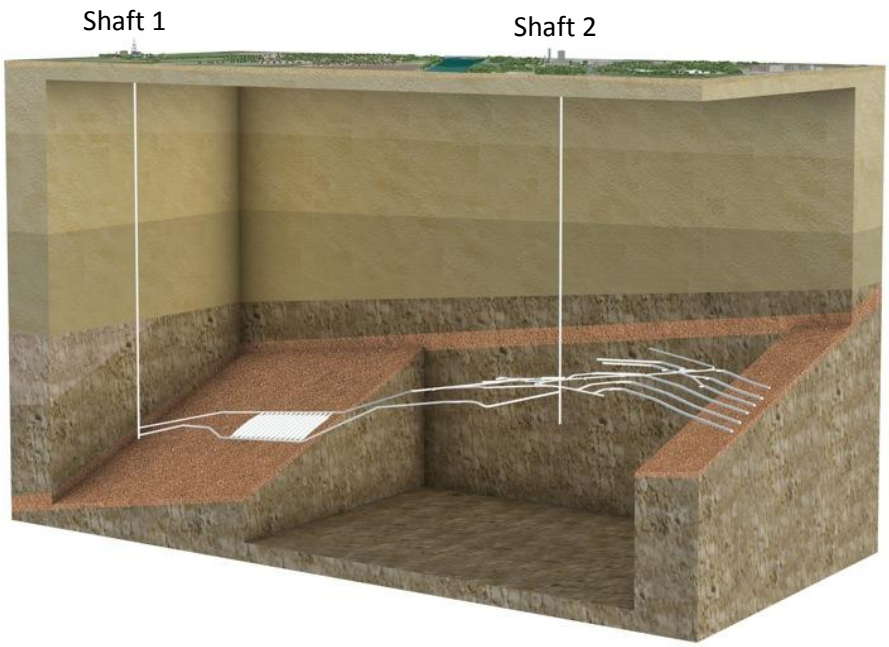
Morsleben

In the former GDR, the Morsleben repository (ERAM) located in a disused salt mine was available for the disposal of low- and medium-active waste; following German reunification, this repository was used for the emplacement of further low- and medium-active waste from the whole of the reunified Germany up until September 1998. Meanwhile, documents for the plan approval procedure for the backfilling and sealing of the Morsleben repository have been submitted to the competent licensing authority, the Ministry of Agriculture and the Environment of Saxony-Anhalt (MLU), and were laid down for public inspection from 22 October to 21 December 2009. During the period of public inspection, the MLU received more than 12,000 objections. The MLU conducted the hearing from 13 October to 25 October 2011.

Morsleben repository for radioactive waste (ERAM) (left: aerial photograph, right: emplacement chamber with stacked drums holding low-level waste) (Copyright: BfS)

Konrad mine

For the Konrad mine, a former iron ore mine, plan approval was applied for in 1982 regarding the construction and operation of a repository for radioactive waste with negligible heat generation. The corresponding plan approval decision was served in May 2002. The complaints raised against the decision were rejected by several courts up to the Federal Administrative Court. The decision has thereby become definitive. On 30 May 2007, the BfS was commissioned by the BMU, in written form, to convert the Konrad mine into a repository for radioactive waste with negligible heat generation. The related work is in progress. The demolition of the above-ground infrastructure no longer needed is well advanced now; the reconstruction of the shafts Konrad 1 and 2 has started. Underground, the repair of large-size vehicles as well as hoisting and transport equipment is underway. Parts of the emplacement area are being prepared. Emplacement operation is expected to start not before 2019.



Model of the emplacement layers and the overburden of the Konrad mine (Source: BfS)

Gorleben

At the Gorleben site, underground exploration of the salt dome started in 1986. The exploration was to establish whether the salt dome was suitable for a repository, especially for heat-generating radioactive waste. Between 2001 and 2010, exploration work was temporarily suspended to clarify conceptual and safety-related questions. In October 2010, the exploration of the Gorleben salt dome was resumed. In parallel, a preliminary safety analysis on the issue of long-term safety was prepared in March 2013.

Site selection for a HLW repository

The long-lasting dispute on the suitability of the Gorleben site to host a deep geological repository for high-level waste was the most serious obstacle on the way to finding a final solution for the management of high-level radioactive waste in Germany. In order to overcome the gridlocked situation and to achieve a consensus between the opposing parties and groups in German society, the German government decided to initiate a new site selection process for a HLW repository. This new policy is supported by most of the political parties in Germany. In April 2013, the Minister-Presedents of the German Federal States and the chairmen of five parliamentary groups in the German *Bundestag* agreed to suspend the exploration of the Gorleben salt dome again and to impartially extend the site selection process to other geographical areas, starting with a blank map of Germany. As a first step, a new law is to be prepared in which the key elements of such a site selection process are to be laid down. It stipulates that the site selection procedure shall be prepared by a joint Federal Government/*Länder* committee of 24 members representing different interests. The committee will have until the end of 2015 to work on proposals in relation to issues such as safety requirements and exclusion and selection criteria for each type of geology. These will then form the basis for determining the location of the site as well as the kinds of rock that are best suited to the purpose. Decisions on the individual phases of the selection procedure will be taken by the Bundestag via the adoption of corresponding legislation and include, in the final stage of the procedure, decisions on locations for surface and underground exploration. The procedure will include the following phases:

- Evaluation phase for the review of legal provisions and the definition of basic criteria,
- Identification of suitable regions, surface and underground exploration, site comparisons and proposals, selected site to be written into federal legislation,
- Plan approval procedure for the safety assessment of the selected site,
- If possible, construction of the repository after judicial review of the plan approval procedure.

The decision for a repository site shall be taken by 2031. For the present, the Gorleben salt dome will not be excluded as a possible candidate. However, there will be no further shipments of radioactive waste to the Gorleben interim storage facility for the time being.

RESEARCH AND DEVELOPMENT

Research on radioactive waste management in Germany follows two distinct categories:

(1) Research necessary for the construction of German waste disposal repositories.

(2) Research that is independent of preparatory work on repositories, and comes under the general objective of continually improving the protection of man and the environment.

Research projects are carried out mainly by the major research centres at Karlsruhe and

Jülich, and by Gesellschaft für Anlagen- und Reaktorsicherheit, hereinafter shown as GRS, the Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resources; BGR), the Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe (German Company for the Construction and Operation of Final Repositories for Waste Materials; DBE), and by universities and other bodies.

As subordinate authority of the BMU, the BfS performs implementation tasks of the Federation in accordance with the Atomic Energy Act and the Radiation Protection Ordinance fulfilling tasks in the fields of radiation protection, nuclear safety, the transport of radioactive material and the disposal of radioactive waste. The BfS supports the BMU technically and by scientific research in its responsibility, among others, regarding the disposal of radioactive waste. The BfS co-operates with universities and non-university institutions in Germany and abroad. This scientific co-operation include working together in general terms (i.e. general arrangements with scientific organisations or universities stipulating basic parameters such as financial expenditures, staff assignment / exchange, as well as co-operation in education), carrying out joint projects (i.e. research and development co-operation related to specific topics), and sharing research infrastructure (with the emphasis laid on infrastructure that is either cost-intensive or only rarely/singularly available).

The GRS is the central scientific and technical expert organisation advising the federal government. GRS performs scientific research in the field of nuclear safety and radiation protection, predominantly under federal contracts, including radioactive waste management and disposal, and supports the BMU in technical issues.

The financial means available to the authorities for their own personnel and for the consultation of experts are fixed by the *Bundestag* (Federal Parliament) in the respective budgets.

The BMU has a budget for studies related to reactor safety, including nuclear fuel supply, waste management, and radiation protection. The funds are used for the financing of the work of its advisory commissions (RSK, SSK and ESK), for the direct support of the BMU, for scientific and technical support as well as for the participation of external experts in international co-operation.

The Federal Ministry of Economics and Technology (BMWi) also provides a budget for reactor safety research. Two thirds of this budget is allocated to reactor safety research, within the framework of which about 100 research projects are performed in parallel on average. In the field of basic research on the disposal of radioactive waste, about 70 projects are performed in parallel using one third of the budget.
Moreover, the Federal Institute for Geosciences and Natural Resources (BGR), a subordinate authority of the BMWi, works on geoscientific issues for German repository projects. The BGR is generally financed from the BMWi budget. However, special tasks in the field of disposal are refinanced by the waste producers.

To cover the necessary expenses for federal facilities, the BfS receives advance payments from the future users of a repository. The determination of the contributions to be paid is based on the eligible expenses of the federal authorities for the repository projects.

For the decision on license applications, costs will be charged to the applicant by the competent authorities (Federal and *Land* authorities), which cover the expenses of the authorities and the costs for the consultation of authorised experts.

DECOMMISSIONING AND DISMANTLING POLICIES AND PROJECTS

In Germany, 27 nuclear power reactors and prototype reactors, 39 research reactors and critical assemblies, and 9 fuel cycle facilities have been permanently shut down. Three of the power reactors, 26 of the research reactors and critical assemblies, and seven of the fuel cycle facilities have already been dismantled. One other facility is now used for conventional purposes. The sites of three power reactors, KKN in Niederaichbach, HDR in Großwelzheim and VAK in Kahl, were restored to "green-field conditions" and released from regulatory control. Dismantling is in progress for other power reactors, and restoration to "green-field conditions" is the plan in most cases. Deferred dismantling has been chosen for two power reactors, KWL in Lingen and THTR-300 in Hamm-Uentrop, where a system of safe enclosure has been licensed. Deferred dismantling has also been selected for four research reactors, which are in safe enclosure mode as well. According to the respective licenses, the concept for completing all decommissioning steps has to be submitted to the regulatory body, no license for deferred dismantling will be granted without this.

The operator of a nuclear facility may choose between dismantling and deferred dismantling after a safe enclosure period. Recent decisions by operators of power reactors have been in favour of immediate dismantling, mainly because of cost considerations, societal aspects and the availability of qualified and trained staff.

An important aspect of nuclear facility decommissioning is the disposal of the radioactive waste generated and the re-use of residual substances. Future decommissioning of nuclear power plants in Germany is expected to generate a significant amount of radioactive waste. The rate at which it is generated is expected to increase gradually over the years. This waste will be managed in accordance with the provisions of the Atomic Energy Act and the Radiological Protection Ordinance. The conditions for the release of materials, buildings and sites from nuclear regulatory control, the respective monitoring of such materials and the systematic approach to the management of radioactive waste are regulated in the legal framework.

TRANSPORT

The safety regulations for the transport of radioactive waste are prescribed by the Atomic Energy Act and the regulations on the transportation of dangerous goods, primarily the Dangerous

Goods Ordinances concerning Road and Rail Transport. A transport licence must be obtained from the Federal Office for Radiation Protection for the transport of nuclear fuels and large radioactive sources. Large radioactive sources have an activity of more than 1,000 TBq and include, for example, cobalt-60 radiation sources which are used in the medical field. The Federal State (*Länder*) Authorities, the Federal Railway Authority and the Federal Air Transport Authority are responsible for supervising transport operations.

COMPETENT AUTHORITIES

Responsibility for take-over and disposal of radioactive waste

The management of spent fuel and radioactive waste is based on the polluter-pays principle. According to the Atomic Energy Act, the producers of residual radioactive materials are required to ensure their non-hazardous recycling or their orderly disposal as radioactive waste. This also means that, as a general principle, the producers are responsible for the conditioning and interim storage of the spent fuel and the radioactive waste. When delivering radioactive waste to a state collecting facility, ownership is transferred to this facility. Thus, the responsibility for conditioning is assumed by the operator of the state collecting facility.

As a general principle, anyone possessing radioactive waste must deliver it to a repository or to a state collecting facility. The *Länder* are required to establish state collecting facilities for the storage of radioactive waste arising within their territory. Radioactive waste from research, medicine and industry is delivered to these facilities. The producers of radioactive waste arising from the use of nuclear energy are responsible for its interim storage and conditioning.

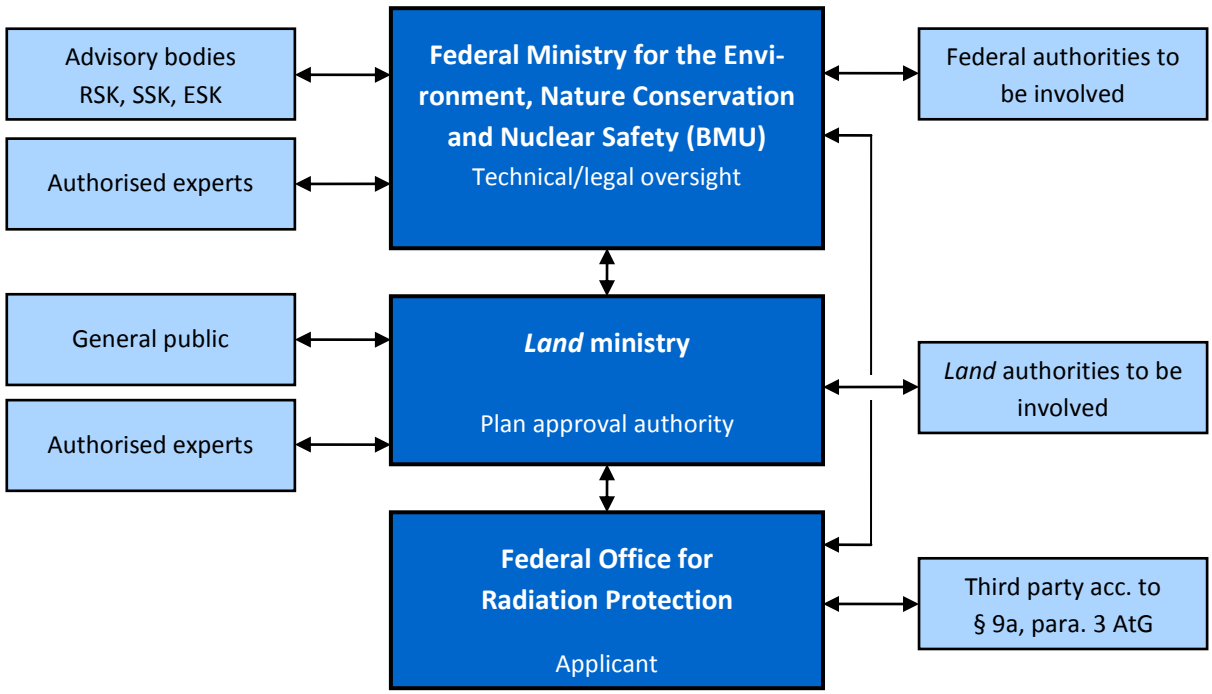
The Federation is required to establish radioactive waste repositories. The BfS is responsible for the planning, construction and operation of radioactive waste repositories as well as for the compliance with the legal requirements and the requirements stipulated in the license. The other waste management facilities are supervised by the *Länder* within the frame of federal executive administration. The licenses for waste management facilities, with the exception of interim storage facilities for nuclear fuel, are granted by the *Länder*. Interim storage facilities for nuclear fuel are licensed by a federal authority (BfS).

The polluter-pays principle also applies to the financing of spent fuel and radioactive waste management activities. The federal state refinances the necessary expenses for the planning and construction of repositories at the parties' obliged to deliver material by means of advance payments on contributions. The use of radioactive waste repositories and state collecting facilities is financed or refinanced by costs (fees and expenses) that are payable by the party delivering radioactive waste.

Licensing procedures

The Atomic Energy Act provides the legal framework for the licensing of the construction

and operation of a radioactive waste disposal site. According to this Act, the construction and operation of radioactive waste repositories require a special licence known as 'plan approval' (*Planfeststellung*). The BfS is the applicant and the licensing bodies are the regional authorities. In the case of the Konrad repository, the Lower Saxony Environment Ministry (NMU) is the licensing authority. Public participation is an important factor in the licensing procedure, and information about a project application is made available to members of the public, who may express objections. These objections are then discussed at a hearing involving the applicant and its experts, the licensing authority and its experts, and the objectors and their experts. In addition, all mining activities must also be approved by the competent mining authorities.



Parties involved in the nuclear plan approval procedure for a repository

Institutional Framework

The Federal Republic of Germany is a federal state. The responsibilities for law-making and law enforcement are assigned differently to the organs of the federation and the *Länder* according to the respective regulatory duties. Specifications are regulated by the provisions in the Basic Law of the Federal Republic of Germany.

The legislative competence for the use of nuclear energy for peaceful purposes lies with the federal state. The further development of nuclear law is also a task of the federal state. The *Länder* will be involved in the procedure dependent on the subject matter.

The Atomic Energy Act and the statutory ordinances based thereon are implemented by federal authorities and the *Länder* authorities, with many tasks performed by the *Länder* on behalf of the

federal state. With respect to the lawfulness and appropriateness of their action, the competent *Länder* authorities are subject to the oversight by the federal state, which is represented in this area by the BMU.

The Reactor Safety Commission (RSK), the Commission on Radiological Protection (SSK) and the Nuclear Waste Management Commission (ESK) advise the BMU on all major issues concerning nuclear reactors, the nuclear fuel cycle and radiation protection.

The regulatory authorities are assisted by technical safety organisations such as the Technical Inspection Agencies (TÜV) or GRS.

The BfS is a federal authority subject to supervision by the BMU. The BfS has its own integrated supervisory unit (independent unit). It implements particular federal administrative tasks in the field of radiation protection including precautionary radiation protection as well as nuclear safety, the storage of nuclear fuel, government custody, the transport of radioactive substances and the management of radioactive waste including the construction and operation of federal installations for safekeeping and final disposal. It supports the BMU on a technical and scientific level in these fields.

On behalf of the federal government the *Länder* carry out administrative duties (licensing and supervision) under nuclear and radiation protection law as delegated by the federal authorities. Thus, the *Länder* are the competent licensing authorities for all nuclear installations within their territory, except centralised and decentralised interim storage facilities for spent nuclear fuel. They supervise all nuclear facilities, repositories excluded. To ensure the uniform implementation of the Atomic Energy Act, the *Länder* are subject to federal supervision by the BMU. The BMU has the right to issue directives to the competent nuclear authority of the respective *Land*, particularly in order to get consistent and suitable regulatory decisions. Federal supervision covers both legality and expediency of the way of proceeding of the *Länder*. The *Länder* have to operate *Landessammelstellen* (state collecting facilities), i.e. interim storage facilities for radioactive waste originating in particular from isotope applications in industry, research and development as well as medicine.

For the construction and operation of repositories, the BfS may make use of "third parties". In 1979, the DBE was founded as such a third party according to the Atomic Energy Act. DBE is the main contractor of BfS with regard to construction and operation of repositories.

FINANCING

The costs of the conditioning, interim storage and disposal of radioactive waste from nuclear power plants, including the waste from the reprocessing of spent fuel elements abroad, are paid by the electricity utilities and are incorporated into the price of electricity. All waste producers including the power utilities and the federal government, on behalf of its research centres, finance the planning and preparation of future German radioactive waste disposal, in

accordance with the Prepayment Ordinance. The actual operation of the disposal facility will be financed by all waste producers according to the provisions of Article 21a of the Atomic Energy Act.

PUBLIC INFORMATION

In addition to the information available locally from individual companies and facilities, information has also been provided by federal government agencies, federal authorities, individual *Länder* governments and their agencies, and by the industry.

For more information, the websites of some relevant authorities and organisations are listed below.

Government

Bundesamt für Strahlenschutz (BfS), Postfach 10 01 49, 38201 Salzgitter
E-mail: ePost@bfs.de
Website: http://www.bfs.de

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), Referat Öffentlichkeitsarbeit, Stresemannstraße 128 – 130, 10117 Berlin
E-Mail: service@bmu.bind.de
Website: www.bmu.de

Industry

GNS Gesellschaft für Nuklear-Service mbH, Frohnhauser Str. 67, 45127 Essen
E-mail: info@gns.de
Website: www.gns.de