



ANNUAL REPORT

2020



Welcome to the team

Our "newbies"



Dr. Jessica Dassow
Age 31
Geoscientist

»Right from the start, BGE TECHNOLOGY GmbH offered me the opportunity to pursue a varied range of activities in the areas of material sciences and geosciences: a wide variety of materials, working in the laboratory or at the microscope, and the exchange in a team of colleagues with different backgrounds. I really enjoy this variety that allows me to enhance my skills quickly.«



Dr. Ali Hussein
Age 32
Mechanical Engineer

»With BGE TECHNOLOGY GmbH, I have found an employer that offers me an interesting field of activity with new challenges. The company is characterised by a flat hierarchy, great professional competence, and a stimulating work climate. The opportunity to familiarise myself with new areas of responsibility and to intensively research and develop processes is very appealing to me for my future field of activity. My expertise in modelling turns out to be very useful in this job.«



Dr. Andreas Keller
Age 37
Mining Engineer

»The disposal of radioactive waste also includes a variety of tasks for me as a mining engineer. I enjoy working on national and international projects, because the different circumstances and approaches give me a better overall picture, and I am constantly learning. When I started working on the topic, my colleagues helped me a lot with their individual educational backgrounds and experiences. Now we can contribute to success together.«



Hannes Räuschel
Age 34
Geoscientist

»The long-term safe disposal of radioactive waste is one of the greatest challenges of our times worldwide. In national and international projects, competence is required in all specialist fields. As a geo-scientist and employee of BGE TECHNOLOGY GmbH, I am thus pleased to be able to make my contribution to this mammoth task.«



Torsten Regner
Age 37
Supervisor – Underground Mining

»I am excited to contribute my achieved experience from the oil and mining industry to BGE TECHNOLOGY GmbH and get involved with the work at the Asse mine. I can then put the knowledge gained into practice, which makes my tasks very varied and interesting. I am happy to be involved in the projects of BGE TECHNOLOGY GmbH and look forward to daily challenges waiting for me.«



David Seidel
Age 34
Mechanical Engineer

»At BGE TECHNOLOGY GmbH, you have the opportunity to work on solving one of the most challenging technical tasks of our time. In mechanical engineering, this often involves breaking new ground in machine development. The great variety of topics to be worked on makes for a varied job. In teamwork with colleagues from many disciplines, we work on interesting national and international projects.«



Daniel Springer
Age 33
Mechanical Engineer

»The disposal of nuclear waste is one of the biggest problems of modern times, and BGE TECHNOLOGY GmbH is working to solve it with an interdisciplinary and international team of experts. My tasks in the department of repository safety consist of using numerical methods to map the geology and the mine workings and to make predictions about long-term safety. This allows me to use and further develop my skills in simulation technology.«

Income Statement

for the period from January 1 to December 31, 2020

	Notes	2020 T€	2019 T€
1. Turnover	(8)	5,376	6,370
2. Changes in inventories	(9)	-115	-1,349
3. Other operating income	(10)	41	158
		5,302	5,179
4. Cost of materials	(11)		
a) Cost of raw materials, consumables, and supplies		6	32
b) Cost of purchased services		881	1,079
		887	1,111
5. Personnel expenses	(12)		
a) Wages and salaries		3,106	2,642
b) Social security contributions and expenditures for pensions		764	626
• thereof for pensions 66 T€ (151 T€)			
		3,870	3,268
6. Depreciation		32	38
7. Other operating expenses	(13)	316	484
		5,105	4,901
		197	278
8. Interest and similar income		1	0
9. Interest and similar expenses	(14)	24	11
10. Taxes on income	(15)	66	93
11. Results after taxes		108	174
12. Net profit for the year		108	174

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Our Team



Dr. Thilo von Berlepsch



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Wilhelm Bollingerfehr



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Dr. Jessica Dassow



Dr. Hans-Joachim Engelhardt



Tilman Fischer



Dr. Alireza Hassanzadegan



Dr. Bernt Haverkamp



Martin Herklotz



Philipp Herold



Astrid Hofschlag



Dr. Ali Hussein



Michael Jobmann



Dr. Andreas Keller



Dr. Thomas Lautsch



Juliane Leonhard



Paola Rocio León-Vargas



Christian Lerch



Gang Li



Dr. Andree Lommerzheim



Dr. Ulla Marggraf



Horst Mentzel



Dr. Christian Müller



Dr. Nina Müller-Hoeppe



Mirko Polster



Michael Rahmig



Hannes Räuschel



Torsten Regner



Holger Schmidt



Stephanie Scotkiewicz



David Seidel



Eric Simo



Daniel Springer



Ansgar Wunderlich



Dr. Toivo Wanne



Dear Readers,

A year like hardly any other is now behind us. The Covid-19 pandemic had a massive global impact on all of our personal and business lives. While we moved tighter together with the people closest to us, social challenges became clearly apparent. The constant worry about the health of relatives and friends, the lack of direct interaction with others, and the management of work and school were extremely draining. I hope that all of you have nevertheless come through this time healthy and well. My sympathies go out to all those who were not so fortunate.

We at BGE TECHNOLOGY GmbH had this luck. From the beginning of the pandemic, we were closely tied to the crisis management team set up at our parent company, Bundesgesellschaft für Endlagerung mbH (BGE), that navigated both our companies through this difficult period with a sure hand. Early on, we established the necessary conditions and took measures to ensure the health of our employees working at their desks and at the underground construction sites. Due to these measures, the discipline of all colleagues, and the

necessary bit of luck, we are happy to say that there has not been a single case of Covid-19 infection in our ranks so far.

This fortunate circumstance allows us to look back on an overall successful year. Project work and daily business had to be adapted to the special conditions of the past year, which essentially meant moving all meetings, internal and external, to the virtual world. On the one hand, this meant more flexible working hours and less travel time. On the other hand, there were obstacles to creative work, for example at workshops, and there was an increased need for communication to avoid misunderstandings. Overall, however, the advantages of virtual work largely offset the disadvantages last year, although the lack of personal exchange cannot be compensated for in the long term.

The successful work of BGE TECHNOLOGY GmbH is based on the proven concept that knowledge is developed in research projects, expanded and maintained by processing international orders, and finally applied to issues of the projects of BGE. Accordingly, this year we would like to share with you several examples of our work in the fields of Repository Safety, Research and Development as well as International Projects. An important pillar for knowledge building is the site-independent repository research funded by the Project Management Agency Karlsruhe on behalf of the German Federal Ministry for Economic Affairs and Energy and increasingly the project-related research we carry out directly for BGE. In the international field, the International Atomic Energy Agency (IAEA)

has become a very important partner and client for us over the years. What is new, however, is our commitment to the Norwegian waste management organisation NND (Norsk Nukleær Dekommisjonering). We have a very good, trusting collaboration and can contribute our experience to interesting issues in the field of disposal. I am particularly proud that despite a lot of work and despite the restrictions caused by the pandemic, we have managed to implement a QA system tailored to our needs and to have it certified according to DIN EN ISO 9001.

Before I leave you to our annual report, I would like to acknowledge the patience and professionalism of our clients as well as the excellent and friendly cooperation with our partners. Our parent company, BGE, has been very supportive, with advice and assistance as well as by providing organisational and practical help.

Last but not least, the employees of BGE TECHNOLOGY GmbH have once again shown that they are able to meet the high demands of the clients even in extraordinary situations. I would particularly like to mention our new committed and excellent new employees whose familiarisation with and integration into BGE TECHNOLOGY GmbH in 2020 has succeeded well despite the special challenges. A circumstance I am very pleased about.

My sincerest thanks go to all those who have contributed to the success of BGE TECHNOLOGY GmbH; i.e. to the organisations and individuals I have just mentioned both explicitly and implicitly.

Happy Reading!
Dr. Thilo von Berlepsch,
Managing Director

Repository Safety

Our department "Repository Safety" (TEC-ES) processes assignments on geo-technical and geomechanical issues as well as on scientific and technological issues concerning materials sciences, including the associated numerical modelling. The focus is on the geological formations that are used for the disposal of radioactive waste in Germany or that could be used for this purpose, such as salt, clay, and crystalline rock. However, the issues addressed are not limited to repositories in deep geologic formations, but also concern conventional mining.

In the context of radioactive waste disposal in rock salt, the stability of the mine workings of a repository mine and the integrity of the geologic barrier must be demonstrated by means of numerical modelling. For the Morsleben Repository for Radioactive Waste (ERAM), BGE TECHNOLOGY GmbH carries out such modelling within the framework of the licensing procedures according to the mining and nuclear laws – in the past, for example, for the mining emergency management measure Central Part or currently for the licensing procedure for the decommissioning of ERAM. For the ERAM, the identification, analysis, and assessment of geomechanical uncertainties is currently being carried out.

If the rock strength is low, as is the case in claystone, a support system is required to establish the stability of the mine workings. Depending on the geotechnical situation, support variants range

from simple anchor support systems with wire mesh lagging to double-shell shotcrete support systems, the stability of which must be demonstrated. Specific mine workings with nuclear utilisation must even have a maintenance-free design. In accordance with the nuclear rules and regulations, the stability and functionality of the support systems and installations of such mine workings under seismic loads must also be demonstrated. For the Konrad repository, which is currently being constructed, TEC-ES prepares such demonstrations using numerical modelling results.

When installing the support systems, it is important to ensure that building materials are used that are not only adapted to the functional requirements, but also to the boundary conditions of the respective site. In claystone, these are naturally completely different from those in rock salt. This applies in particular – e.g. in the context of the decommissioning of a repository mine – to sealing structures that have to fulfil their functions over a long period of time. Thus, the development of materials for site-specific conditions and their testing is also one of the tasks of TEC-ES. We are proud that, together with our parent company BGE, we have already constructed a large number of such sealing structures as part of the emergency preparedness measures at the Asse mine. Further sealing structures are currently under construction or in the planning stage – both in the Asse mine and in the ERAM.



Design of the Support Systems of the Mine Workings of the Konrad Repository

The Konrad mine is currently being converted into a repository for low- and intermediate-level radioactive waste. For this purpose, extensive excavation and re-cutting work is being carried out underground on the 2nd and 3rd levels in order to construct the infrastructure mine workings and transport drifts. For these mine workings, which are located in the future control and monitoring areas and which will be used in the long term, stabilisation and support measures are to be planned. In some cases, the support is to be designed such that it is effective for the entire operating time of the repository of approx. 40 years without a need for rehabilitation and, in some areas, even without a need for maintenance. The support system used is an adaptable anchor/shotcrete system with different anchor types (sliding anchor / fully bonded steel bar or glass fibre (GFK) anchor), with a single- or double-shell design of the shotcrete shell. Depending on the geologic and geomechanical requirements, the resistance of the support can be set to be stiff or yielding during the early stages.

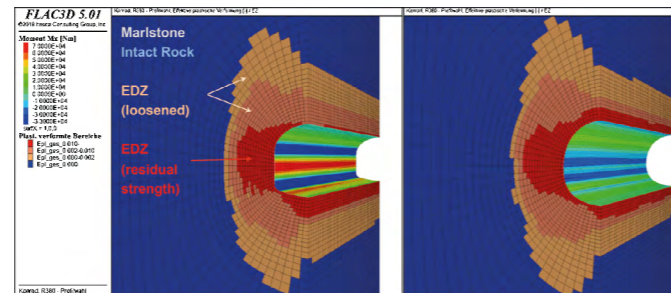
For the design, static numerical calculations are carried out which, in addition to the locally challenging geologic and tectonic conditions, also take into account the long-term rheological rock



»The conversion of the Konrad mine into a repository is progressing. After excavation to the target profile has taken place in the area close to the shaft, the forecast models are now to be adapted to the measured rock behaviour, and the final support system has to be installed. I am glad that after many years of preparatory work, the plans are becoming reality step by step.«

Mirko Polster
Age 45, Geotechnical Engineer, M. Sc.

behaviour, the excavation process, and the installation of the support system. We currently carry out such numerical calculations for drift sections within the future control area as well as the future workshop for the electric vehicle. The analyses demonstrate the stability and are the basis for planning the recutting work and designing the anchor support system. Furthermore, internal force distributions within the concrete shell are determined and made available to BGE's subcontractor, EDR GmbH, for further planning.



Konrad, ramp 380: Bending moment [Nm] in the concrete support shell – comparison of two cross-section profiles for areas in clay marlstone: horseshoe cross-section (left) & taper cross-section (right)

The distinction of the mine workings into "rehabilitation-free" and "maintenance-free" in accordance with the requirements turned out to be decisive for an economic design. The mine workings were distinguished based on their future use as well as on other criteria, such as the requirement of permanent availability, accessibility, presence of installations and possibility of their removal, etc.

Tolerating small-scale maintenance measures, such as the recutting of floor uplifts, replacement of individual anchors or local shotcrete work, allowed selecting a single-shell concrete support system with fully bonded anchors. Despite the heterogeneous geology and local faults, long drift sections can be realised with a common open-floor horseshoe profile. Circular or taper cross-sections are only chosen where necessary. This way, an optimised, easy-to-implement and economical support system could be realised.

Successful Consolidation and Sealing of Backfill in the Asse II Mine



»Due to its long and eventful history, the Asse II mine is always good for surprises. This means that individual concepts tailored to the specific tasks must always be developed and implemented. The varied activities are a daily incentive for us not only to get the balls rolling, but also to get them over the finish line efficiently. I am glad to be able to make my contribution as part of a well-coordinated team.«

Astrid Hofschlag
Age 44, Building Materials Engineer

Between 1967 and 1978, low- and intermediate-level waste was emplaced in the Asse II salt mine. As a result of the high excavation ratio, the short distance to non-saline, water-bearing rock in some areas, and the long operation time of the mine, rock fracturing and solution inflows occurred. As forecasts of the inflow rates and hydrochemistry are uncertain, it was decided to retrieve the waste. In the case of uncontrollable inflow rates, an inert salt solution will be pumped into the mine openings. In addition, flow barriers are currently built to protect the emplacement chambers, and extensive backfilling measures with magnesia binder are carried out to stabilise the mine workings.

Crushed salt that was already backfilled in chambers, compacted, and roof clefts were generated. To improve the load-bearing capacity and the tightness of the backfill, BGE TECHNOLOGY GmbH started a work programme that, after an initial survey, included the planning and implementation of backfilling and grouting activities as well as the final data evaluation. Part of the site survey was to acquire all relevant data for a detailed planning process, i.e. to determine the crack inventory and to characterise the pore spaces and the mineral composition of the salt backfill. Based on this, proven backfill and injection materials were selected, while also new, long-term stable materials were developed.

It was then possible to select the injection equipment, to define the procedure for online data

analysis, to specify the grouting strategy, and to develop a quality assurance programme. The development of a quality assurance programme created the prerequisites for a smooth course of the work. By backfilling and grouting progressively smaller cavities and thus increasing the filling degree, it was possible to gradually increase the pressures required for the grouting process, injecting first suspensions of increasing fineness and then solutions. Colouring or tracing of the injection materials proved to be advantageous with regard to the assessment of the injection success, which was based, for example, on drill cores and borehole camera inspections. The innovative data analysis of the injection data, such as pressure and injection rate, also proved beyond doubt that all project objectives had been met.

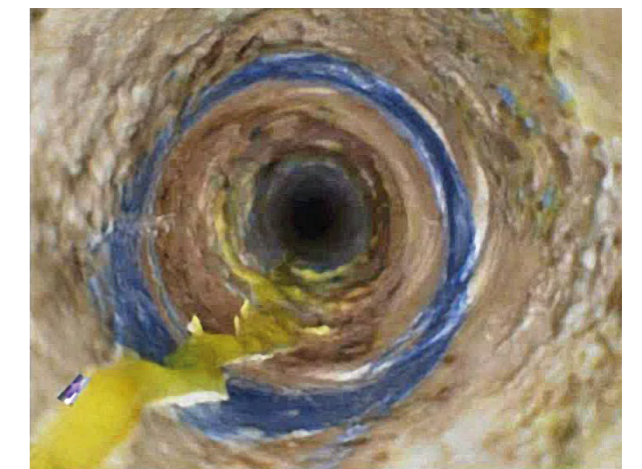
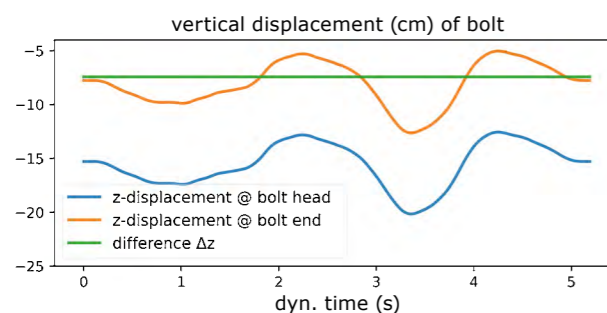
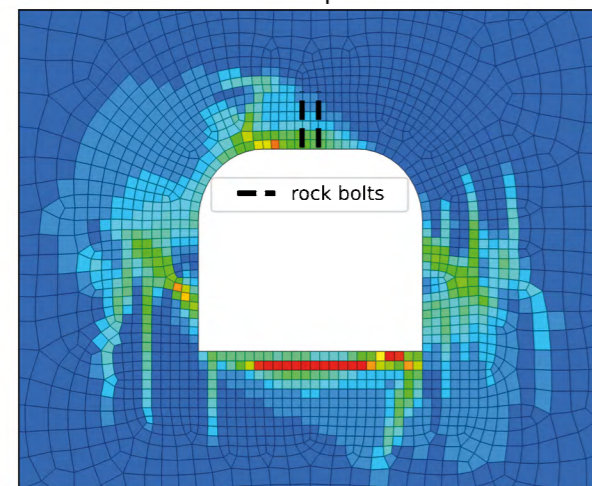


Photo with borehole camera: Cracks in the salt backfill injected with grouting material (blue) and water glass (yellow), which flows down the borehole after pore space injection

Impact of Earthquakes on Rock Bolts in the Konrad Repository

In accordance with the German nuclear rules and regulations (KTA), the functionality of safety-relevant components has to be demonstrated for the operating phase of the Konrad repository. This applies, for example, to the pipelines that

Plastic zone of the emplacement chamber



Analysis of seismic impacts on anchors in the Konrad repository

will be used to transport the cement-bound backfill material into the emplacement chambers. Like other technical components, these pipes will be fastened to the drift or chamber contours with rock bolts (anchors). Thus, numerical modelling was used to investigate whether and, if so, at what magnitude the anchors are subjected to an additional load induced by an earthquake.

The model area for the numerical calculations was chosen between 858.5 m and 935 m depth and includes an emplacement chamber, which, however, captures the conditions of an emplacement field due to the chosen symmetry conditions. At the level of the emplacement chambers, the sedimentary strata of the rock have a dip of about 25°. As a result, the rock exhibits anisotropic behaviour. In order to verify the suitability of the model and its parameters, the excavation of the emplacement chamber and its behaviour during its service life to date were modelled first, and the calculated convergence behaviour was compared with the measured convergence behaviour. Due to the agreement between calculated and measured values, the calculated plastic rock state was considered to be suitable to serve as the initial state for the earthquake simulation.

After simulating an earthquake, the modelling results at two designated anchor positions of the emplacement chamber were analysed. In order to determine the additional stresses induced on the anchors by the earthquake, the calculated displacements at the anchor head and anchor foot were analysed and the resulting additional strains related to an anchor length of 1.80 m were calculated. The results showed that the rock bolts were also subject to vibrations. However, the additionally induced strains proved to be negligible. Thus, the empirical experience that earthquakes usually do not cause significant damage in the deep subsurface was confirmed by the results of the numerical calculations.



»Earthquake resistance is an important aspect of operational safety for the Konrad repository. Our investigations provided important safety-related evidence for the emplacement process.«

Gang Li
Age 35, Geotechnical Engineer, M. Sc.

Addressing Uncertainties in Assessing the Integrity of a Salt Barrier

As part of the licensing procedure for the decommissioning of the repository for radioactive waste Morsleben (ERAM), BGE currently processes the safety case. Part of the safety case is the demonstration of the integrity and tightness of the geologic salt barrier. The corresponding work is being carried out jointly by BGE and BGE TECHNOLOGY GmbH.

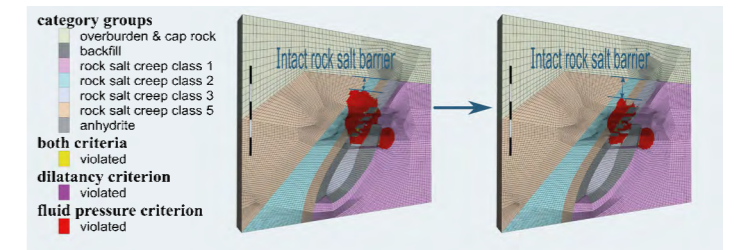
The integrity of the salt rock barrier can be compromised by geomechanically induced stress conditions:

- (1) fluid pressure-induced widening and opening of grain boundaries when the applied fluid pressure exceeds the compressive normal stresses and tensile strength; and
- (2) the initiation and growth of cracks and their interconnection by deviatoric stresses.

The determination of the geomechanical stress on the salt barriers and the associated chronological evolution of their integrity is carried out using numerical calculations.

This way, it is possible to assess the evolution of the stability of the mine workings and of the integrity of the salt barrier. However, it must be taken into account that the results of the numerical calculations are influenced by model assumptions and simplifications as well as by data, parameter, and model uncertainties, and their variability.

In order to systematically identify the influence of these uncertainties, a step-by-step approach was chosen with the aim of determining the scope of possible solutions and identifying the relevant influencing variables and parameters. First, a catalogue of uncertainties was prepared, which, after screening, covered the entire modelling sequence from input data to modelling results, including their presentation. The identified uncertainties and the other potentially relevant



Thermo-hydro-mechanical modelling for two time steps during the rock mechanics development of the Morsleben repository

issues were categorised, as the numerical model is based on models that build on each other – the mine workings model, repository model, backfill plan, structural model, numerical model, and material models and their parameterisation. The algorithmic implementation realised in the calculation codes must also be taken into account. Once the uncertainties had been quantified, bandwidths were assigned to them. In a second step, bandwidth studies were carried out on generic models for different field sections of the ERAM. This made it possible to analyse the influence of the individual uncertainties on the integrity of the salt barrier. The calculation results allowed an assessment of the chronological development of the salt barrier, taking into account uncertainties. In order to evaluate the significance of an uncertainty, the thickness of the intact salt barrier as a function of time was chosen as a benchmark. This made it possible to identify the factors that most strongly influence the demonstration of integrity.



»We have contributed to the clarification of an important aspect of the safety assessment of a repository by deriving an evaluation measure for the relevance of uncertainties.«

Dr. Nina Müller-Hoeppe
Age 63, Civil Engineer, M. Sc.

The Research and Development Division of BGE TECHNOLOGY GmbH (TEC-FE) initiates research and development projects (R&D projects) in the field of disposal of high-level radioactive waste and carries them out either itself or with partners. For many years, these R&D projects have essentially been financed by the Federal Ministry for Economic Affairs and Energy (BMWi), represented by the Karlsruhe project management agency; in individual cases, co-financing is also provided by the EU. The foci of the topics proposed by BGE TECHNOLOGY GmbH relate to the respective funding concept of BMWi and are in the fields of designing, constructing, operating, decommissioning, and closure of deep geological repositories for radioactive waste in different host rocks. Within the framework of application-oriented basic research, questions on repository technology (e.g. transport, emplacement, and retrieval technology) as well as on repository safety (operational and long-term safety) are addressed and solutions developed. Furthermore, R&D work is pursued in connection with the dismantling of nuclear facilities and concerning near-surface repositories, although the latter is of no relevance to Germany.

Through intensive and continuous work on R&D topics relating to the disposal of high-level radioactive waste, TEC-FE helps to ensure that the state of the art in science and technology is constantly being further developed. We preserve and transfer the expertise acquired this way through the successive integration of new employees and the formation of teams to work on projects. We make this knowledge accessible to the professional world through publications on research results and also on interim results. This includes, for example, reporting on current work in the DAEF, a German working group on repository research.

The need for R&D work depends on the respective state of the art in science and technology required to implement a repository for high-level radioactive waste in Germany. Until the new site selection act came into force in 2013, the focus was on a possible repository in rock salt. Since then, more projects have been carried out to investigate a possible repository in claystone or crystalline rock.

Examples of R&D projects that have been and are being carried out on behalf of BMWi with various partners are described in this annual report. One is a joint project with the Federal Institute for Materials Research and Testing (BAM) with the acronym KoBra, in which the requirements for waste containers for high-level radioactive waste were systematically derived. For this purpose, a methodical approach was developed that can be used to derive quantified requirements for waste containers for the host rocks rock salt, claystone, and crystalline rock. In a second R&D project with the acronym ELSA, technical concepts for shaft seals for repositories in rock salt and claystone were developed and the functionality of the individual components was investigated by means of numerical calculations and experiments. The third R&D project described in this report has the acronym SUSE. In this project, safety analyses of repository systems in crystalline rock at the Yeniseysky site in Russia were carried out with the participation of Russian partners. The investigations included the development of sealing concepts, a characterisation of the fracturing of the crystalline rock, and the performance of hydrogeological flow and transport calculations. The fourth example concerns a project (acronym WERA) led by Öko-Institut, which deals with analysing the waste management steps for high-level radioactive waste as planned to date, from the interim storage facility to the repository, and with developing possible alternatives to them.



Research and Development

Requirements and Concepts for Waste Containers – R&D Project KOBRA

The KoBra research project was carried out as a joint project of BGE TECHNOLOGY GmbH and the Federal Institute for Materials Research and Testing (BAM). In this project, BGE TECHNOLOGY GmbH and BAM identified requirements for containers for the disposal of high-level radioactive waste and spent fuel elements in different host rocks. Subsequently, international, existing container concepts were compared with the identified requirements and initial ideas for new container concepts that meet the requirements were developed. To derive the container requirements and concepts, a “top-down” approach was developed. Requirements important for the container design, such as the radionuclide inventory, the surrounding geosphere, regulations and laws to be observed, and requirements from repository operation and long-term safety, were examined first and translated into container requirements. As container requirements, requirements for the containment of the radioactive inventory, adequate shielding of ionising radiation, prevention of corrosion and gas production, temperature limitation, and manageability were derived and – if possible – quantified. Finally, existing national and international container concepts were compared with these requirements and initial ideas for new container concepts were outlined.

In addition, a literature study was prepared that recorded and explained the existing container concepts worldwide.



POLLUX® cask at the maintenance point of the pilot conditioning plant in Gorleben (Source: GNS)

The R&D project KoBra was funded by the Project Management Agency Karlsruhe on behalf of the Federal Ministry for Economic Affairs and Energy.



»With the KoBra project, BGE TECHNOLOGY GmbH and BAM have derived the requirements for waste containers according to current national regulations and summarised the principles of already existing international container concepts. This has established an important basis for the future development of waste containers in Germany – containers that meet the requirements for the safe disposal of high-level radioactive waste and spent fuel elements.«

Ansgar Wunderlich
Age 28, Mechanical Engineer, M.Sc.

Successful Completion of R&D Project ELSA

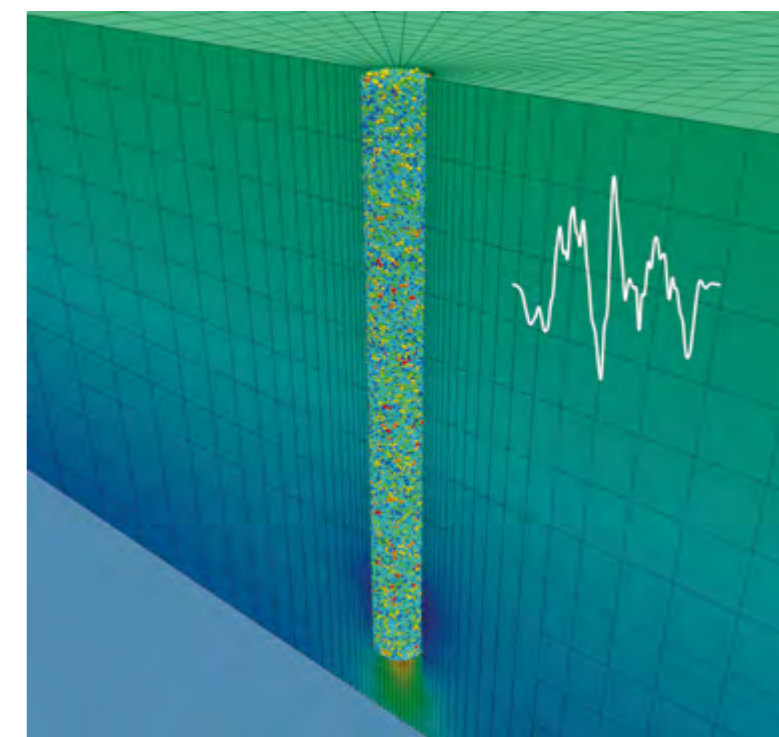


»The work of the ELSA project on bitumen/asphalt elements shows very well how in-situ and “in-silico” experiments can be used to develop sealing elements. Corresponding experiments by colleagues from TU Freiberg demonstrate the technical feasibility of the sealing concept. With our simulation calculations, we were also able to learn more about the behaviour of the shaft sealing elements.«

Philip Herold
Age 36, Mining Engineer, M.Sc.

R&D project ELSA II was a cooperation between BGE TECHNOLOGY GmbH and Technical University Bergakademie Freiberg and was successfully completed in 2020. The two main goals of developing shaft sealing concepts as site-independent basic concepts for salt and claystone formations and testing individual functional elements in the laboratory and in large-scale tests involving the development, testing, and calibration of material models to describe the material behaviour for computational verification were achieved. While TU Bergakademie Freiberg focused on laboratory and in-situ experiments, BGE TECHNOLOGY GmbH concentrated on the numerical investigation or in-silico experiments of the processes relevant to shaft seals, especially in clay formations. One objective was to determine to what extent the settlements of a gravel column due to an earthquake can be estimated. To simulate the mechanical properties of gravel particles, PFC3D was used and additionally coupled with the continuum code FLAC3D. The results show that the applied earthquake impulse is too weak to cause critical settlement of the gravel column. Further issues were the technical necessity of a partial removal of the excavation damaged zone at the shaft contour or the risk of additional damage due to the hot installation of bitumen. A quantitative analysis of the permeability changes in the excavation damaged zone shows that the sinking of the shaft already significantly changes the permeability in the rock area close to the contour.

The thermal impacts due to the bitumen installation, however, are minor. More pronounced effects are observed during the recutting of the contour, which is related to an additional reorientation of the stress field. Bitumen as a mixture of different hydrocarbons can always be assigned a liquid character. Additionally, temperature and stress dependencies have to be taken into account. Based on a comparison of different approaches and a calibration with laboratory tests, the material behaviour was discretised numerically and now represents a useful tool for the further investigation of bitumen-based sealing elements.



3D model of a backfilled shaft subjected to seismic waves

Safety Analyses of Repository Systems in Crystalline Rock – R&D Project SUSE



»With the SUSE project, we have continued the valuable exchange of experience with our Russian colleagues and expanded German expertise regarding the disposal of radioactive waste in crystalline rock. This is of particular importance due to the consideration of these rock formations in the German site selection procedure for a HLW repository.«

Dr. Christian Müller
Age 43, Geoscientist

SUSE is a joint project of BGE TECHNOLOGY GmbH, GRS, and BGR in cooperation with Russian colleagues, which is based on an agreement on German–Russian cooperation in the field of international research and development regarding the disposal of high–level radioactive waste in crystalline rock.



Modelling of fracture systems in crystalline rock

In Germany, crystalline rock, e.g. granite, is to be considered as a potential host rock for the disposal of high–level radioactive waste. Crystalline rock has several favourable properties for the disposal of radioactive waste, e.g. high mechanical and thermal stability. However, crystalline rock is fractured to varying degrees in the underground, which can lead to increased permeability. This aspect has to be taken into account in numerical safety analyses. A major goal of SUSE is thus the optimisation of numerical codes for the description of flow and material transport processes in fracture networks of crystalline host rock. In literature, a number of approaches are described on how fractures can be modelled numerically. Currently, an approach based on the modelling of fracture networks using continuum numerical models is being pursued. The necessary input parameters are being developed in cooperation with Russian colleagues or determined in laboratory investigations. The implemented approach is to be compared qualitatively and quantitatively with other approaches in the future. This is to identify model uncertainties resulting both from the transfer of the geological model into the numerical model and from the calculation approach itself.

SUSE is funded by the Project Management Agency Karlsruhe on behalf of the Federal Ministry for Economic Affairs and Energy.

Management of High–level Radioactive Waste in Germany – R&D Project WERA

BGE TECHNOLOGY GmbH was commissioned by Öko–Institut e.V. Freiburg with providing its expertise for R&D project WERA, which is funded by the Project Management Agency Karlsruhe on behalf of the Federal Ministry for Economic Affairs and Energy. The main goal of the 18–month project WERA is to identify potential steps and needs for action with regard to the waste management routes for spent nuclear fuel and high–level radioactive waste in Germany while integrating the different waste management steps; i.e. interim storage, waste conditioning, transport, and eventual disposal. In addition, future R&D needs are to be identified, and a basis for considering specific waste management options from an economic point of view is to be developed. In its first task, BGE TECHNOLOGY GmbH briefly described the waste management steps “waste conditioning” and “waste disposal” and identified links and dependencies with preceding and following steps. What became obvious is that the delivery of a sufficient number of waste packages to the conditioning facility in due time is one of the most important steps that impacts the processes waste conditioning and disposal. Another result was that the concentration of several waste management steps; e.g., interim storage, waste conditioning, and waste disposal, at a single site minimises the amounts of waste transport and consequently the number of possible complications.



Reloading of a CASTOR® cask (Source: GNS)

In the following steps, BGE TECHNOLOGY GmbH will act as a consultant to Öko–Institut e.V. and will give advice and recommendations for developing scenarios for waste management steps and for deriving courses of and options for action. The project results are to be published in summer 2021.



»Project WERA gives me the opportunity to work with the Öko–Institut on all the individual steps of the entire waste management path for high–level radioactive waste. The analysis of dependencies and complex interactions when considering optional paths is highly fascinating.«

Wilhelm Bollingerfehr
Age 64, Civil Engineer, M. Sc.

International Projects

The tasks of the "International Projects" division at BGE TECHNOLOGY GmbH (TEC-IP) include the acquisition and execution of work for international clients in the fields of repository technology, numerics, and geotechnical structures as well as the exchange of expertise with international colleagues. The main objective here is to apply the information gained from international activities to the national tasks of BGE TECHNOLOGY GmbH and BGE.

In order to accomplish these tasks, TEC-IP carries out acquisition activities in the international field and handles assigned tasks with the support of employees of the other divisions of BGE TECHNOLOGY GmbH and/or BGE. The acquisition efforts focus on projects in the fields of design, planning, construction, operation, decommissioning, and dismantling of surface, near surface, and deep geological repositories for radioactive waste.

In addition, TEC-IP actively maintains and expands existing international collaborations in the field of waste management. This concerns both bilateral relations, e.g. with international partner organisations, and participation in international bodies such as the International Atomic Energy Agency (IAEA) or the Nuclear Energy Agency within the

Organisation for Economic Co-operation and Development (OECD/NEA).

This annual report presents several current examples to provide a brief insight into the projects and activities carried out by TEC-IP. The selected contributions are, for example, international activities related to borehole disposal of radioactive waste. Here, TEC-IP actively supports a corresponding working group of IAEA and is also entrusted with the development of a specially tailored repository concept for the Norwegian waste management organisation NND. The overall project for NND, which includes the work on borehole disposal, is also presented as a separate contribution. The objective is to support NND in the conceptual development and technical design of a repository for all national radioactive waste.

Another contribution deals with a similar task, the preparation of a preliminary feasibility study for the disposal of all radioactive waste in the Republic of Moldova. This project was carried out by BGE TECHNOLOGY GmbH together with its Slovakian partner JAVYS on behalf of IAEA. TEC-IP also cooperates regularly with IAEA by participating in expert missions as well as in a number of IAEA working groups. One of these working groups, the "Working Group on Monitoring", is also briefly presented in this annual report.



Disposal of Radioactive Waste in Deep Boreholes

Deep boreholes are drilled for scientific purposes and for the exploration or extraction of raw materials or thermal energy. The boreholes can reach depths outside the biosphere, where no fluid transport took place during geologic time periods. In addition, technical developments opened up the possibility of operating and sealing boreholes even at very high pressures and temperatures. Consequently, it is obvious to use deep boreholes also for the isolation of radionuclides, especially if small waste quantities do not justify the construction of a repository and there are no special requirements for retrieving the waste. Nevertheless, deep borehole disposal is a challenge. For example, borehole diameters are required that have so far only been drilled in exceptional cases. Waste containers and reliable emplacement technology need to be developed. Furthermore, the requirements for the tightness of the host rock and the functional life of the seals are extremely high.



Drilling rig of the world's deepest geothermal borehole in Espoo, Finland

In this case, the most efficient way to realise the borehole disposal project is to adapt and optimise proven technologies used in the construction, operation, and decommissioning of repository mines, especially since the concept of borehole emplacement is also being pursued in these projects. BGE TECHNOLOGY GmbH bundles this knowledge and can propose innovative solutions for the new tasks based on in-depth expertise in the field of research. This way, BGE TECHNOLOGY GmbH is the ideal partner for waste management organisations of countries, for which deep borehole disposal could be an optimal solution due to their low waste volumes.

Examples to be highlighted are the cooperation with Norsk Nukleær Dekommissionering (NND) in Norway and with the International Atomic Energy Agency (IAEA). Technical assistance for NND involves detailed but still site-independent planning work that takes into account the specific conditions of the crystalline rock formations in Norway. Cooperation with IAEA mainly takes place in the framework of working groups, the aim of which is to exchange knowledge gained in the course of ongoing projects and research activities. At the invitation of NND, BGE TECHNOLOGY GmbH also participates in workshops of the European Repository Development Organisation (ERDO). This organisation was established to promote the development of transnational options to complement national waste management programmes. This way, BGE TECHNOLOGY GmbH supports many countries in their efforts to protect man and the environment against the dangers posed by radioactive waste.

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»The disposal of radioactive waste requires country-specific solutions. For small quantities, one option may be to dispose of the waste in deep boreholes. There is still development work to be done before a project can be realised, and it makes sense to make use of the wealth of experience in repository mining. For me, it is very exciting to be able to support international partner organisations in this way and to develop innovative concepts.«

Dr. Hans-Joachim Engelhardt
Age 58, Mineralogist

Feasibility Study on the Disposal of Radioactive Waste in Moldova

Moldova is located between Romania and Ukraine and partially borders the Black Sea. Moldova has no nuclear power plants or research reactors. The radioactive waste originates mainly from medical applications, research projects, education, and industrial activities. Most of the radioactive waste is stored near the capital city Chişinău. The waste is stored in surface-based reinforced concrete vaults that were built in the 1960s. The solution does no longer satisfy the current international understanding of safe long-term isolation of radioactive waste. There is a need to develop a safe disposal solution for the radioactive waste in Moldova. Thus, the International Atomic Energy Agency (IAEA) commissioned a consortium of BGE TECHNOLOGY GmbH and JAVYS to carry out a pre-feasibility study on the disposal options for this radioactive waste.

The study provided a comprehensive overview of the current conditions in Moldova and several recommendations based on international best practice. The work included a review of the waste inventory and classification as well as possible waste management solutions. The consortium presented generic site selection criteria and procedures. Recommendations were also provided on the principles for safety analyses and the safety case. The study found discrepancies and uncertainties in the waste inventory. In addition, it was noted that the Moldovan legislation has gaps with respect to the handling of the radioactive waste. The consortium recommended a detailed characterisation of the waste inventory and an assessment of the waste streams to be expected in the future. In addition, it was recommended that relevant laws and regulations covering radioactive waste management issues be developed and implemented in accordance with the IAEA recommendations. The consortium concluded that the optimal disposal solution would be a combined waste management facility consisting of a near-surface repository and an area designated for borehole emplacement. It was also recommended to investigate whether the existing site could be



»Starting a new radioactive waste management programme without an existing and adequate organisational structure and legal framework is a challenge that should not be underestimated. We are happy to have been able to support Moldova in this endeavour with the preparation of this comprehensive feasibility study.«

Dr. Bernt Haverkamp
Age 64, Geophysicist

used as a repository. The work identified and discussed the most severe risks for the waste management.

The results of this project provide the basis for the next steps in developing a national disposal programme in Moldova.



Visit to the Moldovan conditioning plant in Chişinău

IAEA Working Group on Monitoring



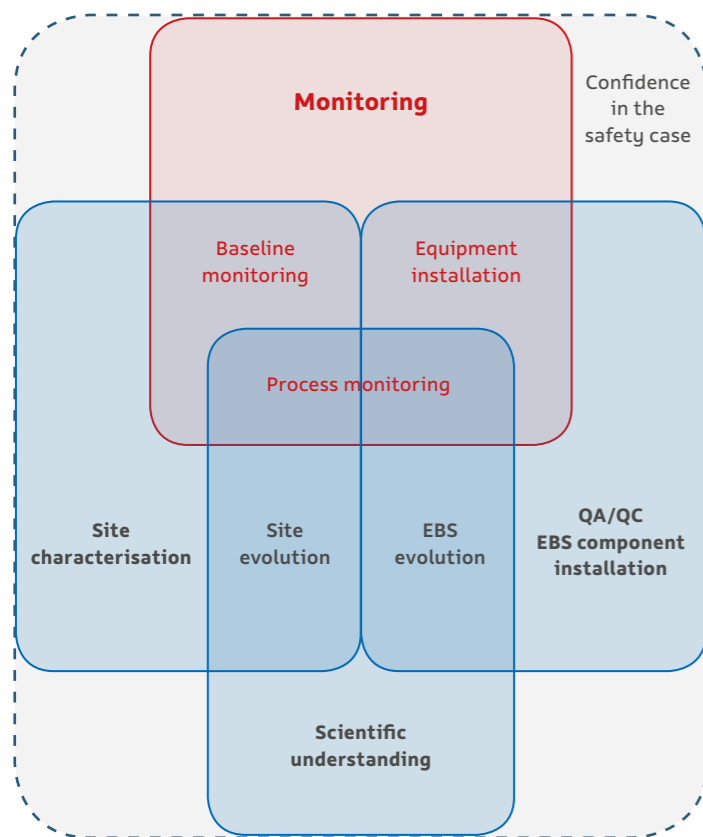
»The monitoring of a repository for high-level radioactive waste has been a much-discussed topic at the international level for years. I have had the fortune to accompany this, sometimes controversial, discussion for two decades and to help shape the "maturing process" for the development of monitoring concepts. This work is also reflected in the new "Technical Document" of IAEA. I am proud of this.«

Michael Jobmann
Age, 64, Geophysicist, M. Sc. eq

Upon request of IAEA, BGE TECHNOLOGY GmbH participates in a working group that focuses on specific aspects of repository monitoring. The question is whether and how monitoring results can and should be used to informatively support decision-making processes within the scope of a waste management programme and thus make them transparent and traceable.

In addition to site characterisation, technical/scientific process understanding combined with a quality assurance and management programme for the construction of geotechnical barrier, a monitoring programme can be an important component in generating confidence in the expected evolution of a repository. Consistent with a stepwise implementation of the waste management programme, periodic updates of the safety case will be prepared during the operational phase, using the monitoring results as input. Information obtained in the course of repository monitoring can be compared with the arguments used to build the safety case to check whether the parameters of the repository system evolve in line with the predictions of the safety case. However, a monitoring programme should not be considered as an external part of the safety case but as an inherent one. This allows assessing and ultimately also preventing that monitoring activities have any unwanted impacts on repository safety.

As a result of this working group's activities, a report will be prepared that, after discussion and agreement by all member states, will be published as a "Technical Document" by IAEA. One important aspect discussed in this document is an explanation of the general possibilities of monitoring but also of its limitations, especially in terms of applicability. This clarification is important in order to avoid the impression that monitoring can be used to control the safety of a repository.



Monitoring as a confidence-building component, including interaction with other essential components of a safety case

Design of a National Radioactive Waste Management Facility in Norway

Two Norwegian research reactors, in Halden and Kjeller, were permanently taken out of operation several years ago. In 2018, Norwegian Nuclear Decommissioning (NND) was established as the waste management authority in Norway. NND is responsible for developing disposal solutions for all radioactive waste in Norway. This waste consists of small volumes of high-level waste (~16.5 tonnes), low- and intermediate-level waste from planned decommissioning, and small quantities of institutional waste. NND commissioned a consortium consisting of the Finnish AINS Group, VTT (Technical Research Centre of Finland), and BGE TECHNOLOGY GmbH to provide technical assistance in developing disposal solutions for all the waste streams in Norway. The work started in January 2020 and included a wide range of individual work packages, from disposal concept development for the different waste types, cost estimates for the disposal solutions, feasibility and framework studies for alternative disposal solutions to detailed studies on deep borehole disposal of high-level waste including canister design and borehole sealing systems. The work packages currently in progress, for which BGE TECHNOLOGY GmbH has the main responsibility, cover topics related to the deep borehole disposal of high-level waste. NND is considering both, a geological repository mine (DGR) with KBS-3 copper containers and deep borehole disposal for their high-level radioactive waste. Borehole disposal is a particularly attractive solution for Norway due to their very limited radioactive



Signing the contract with the Norwegian Waste Management Authority NND: from left to right: Toivo Wanne (BGE TECHNOLOGY GmbH), Suvi Karvonen (VTT), Tmo Saanio (AINS), Pål Mikkelsen, Director at NND, Antti Ikonen (AINS). (Source: NND/Nils Böhmer)

waste volumes. However, deep borehole disposal is not as far developed as DGR disposal, which is technically fairly advanced in Finland and Sweden. Thus, NND is prioritising work on advancing the borehole disposal concept in order to prepare a concept evaluation study later in 2022. This study will be the basis for the decision on which concept will be chosen in Norway for the disposal of high-level radioactive waste: DGR or deep borehole. The work of the currently ongoing project will provide the basis for this assessment.



»The continuous fruitful cooperation with our Finnish project partners has proven to be very satisfying for the Norwegian client. It is a pleasure to have the best experts to support Norway on the road to radioactive waste disposal.«

Dr. Toivo Wanne
Age 47, Mining Engineer, M.Sc.

Management Report



Management Report

Sphere of Activities

The main business areas of BGE TECHNOLOGY GmbH (hereinafter referred to as BGE TEC) as a highly specialised engineering company operating at both national and international level continue to be engineering and consulting services for the disposal of radioactive waste. This includes national and international research and development projects for the safe disposal of these wastes, in particular of high-level waste and spent fuel elements. International projects on various aspects of the disposal of radioactive waste, especially in deep geologic formations and in various host rocks (claystone in Belgium and Switzerland as well as magmatic host rock in Norway, Russia, and Ukraine) are of particular importance.

Furthermore, the company leads and participates in international consortia that – on behalf of international organisations – contribute to ensuring the safe disposal of radioactive waste. For example, BGE TEC is involved in the development of repository concepts for all types of radioactive waste in Ukraine. On behalf of the International Atomic Energy Agency (IAEA), we carried out a feasibility study for the disposal of radioactive waste in Moldova. In Norway, we are involved in planning a repository for all types of radioactive waste, while a number of smaller projects are being carried out for clients in the UK. Most recently, we contributed to a study on the sealing of boreholes drilled for site characterisation.

Of particular importance for developing know-how and in support of future tasks in Germany are the management of and participation in joint cooperation projects with other leading research institutions involved in radioactive waste disposal, in particular concerning safety and safety demonstration concepts for repositories in various deep rock formations and concerning retrievability, cask designs, as well as the compaction of crushed salt. The knowledge and experience gained in the joint projects, but also in other interactions with various waste management organisations,

is made directly available to our parent company Bundes-Gesellschaft für Endlagerung mbH (BGE); e.g. within the framework of the project "Basic development for representative preliminary safety investigations and for the safety-oriented weighting of sub-areas with particularly favourable geologic conditions for the safe disposal of heat-generating radioactive waste (RESUS)". Within this project, the basis for a significance assessment of the geoscientific criteria to be considered in the site selection procedure for a repository for heat-generating waste is to be developed.

BGE TEC makes its knowledge available to BGE in a variety of ways. In addition to the RESUS project already mentioned, BGE TEC assists BGE with other issues related to the selection of a suitable repository site. Furthermore, the company supports BGE in the handling of licensing requirements related to the decommissioning procedure of the Morsleben repository and in the implementation of the recommendations of the Nuclear Waste Management Commission, ESK. Thus, in addition to the integrity analyses carried out for the geologic barrier, the associated uncertainties are analysed and evaluated. Within the scope of the construction of the Konrad repository, BGE TEC is also working on rock mechanics tasks. In addition to providing technical support to BGE's subcontractors, BGE TEC itself carries out numerical calculations to assess the stability of the mine workings and their support structures. The company also provides services for the Asse II mine concerning several major tasks related to hazard prevention and emergency planning activities. In addition, BGE TEC is involved in the design and construction of sealing structures and the assessment of their functionality.

This also includes the planning and implementation of injection measures. The requirements of environmentally responsible action are taken into account by the company's activities, which specifically focus on protecting the environment.

MANAGEMENT

The company uses the annual results as financial performance indicator to manage the company. Further performance indicators are outlined in the business development, results of operations, and net assets and financial position sections.

RESEARCH & DEVELOPMENT

A high priority is the processing of projects for research and development (R&D). The R&D projects carried out by BGE TEC on behalf of BGE are divided into independent work, which is financed within the framework of the research programme funded by the budget of the Federal Ministry for Economic Affairs and Energy (BMWi), and into additional work for R&D projects of BGE.

In conjunction with BGE, BGE TEC thus ensures that the expertise for the planning, construction, operation, and closure of radioactive waste repositories is preserved and further developed based on the state of the art in science and technology. In the reporting period, the company was involved in a total of 14 national and international research and development projects. The related expenditures amounted to T€ 1,750 (previous year T€ 1,173).

Financial Report

BUSINESS DEVELOPMENT

According to the Federal Statistical Office (Destatis), the gross domestic product (GDP) of bn* € 3.3 in 2020 decreased compared with 2019 (bn € 3.4). Adjusted for price and calendar effects, there is a change of -5.3%. Due to the company's business model, the overall economic development in Germany has neither a short-term nor an immediate decisive influence on BGE TEC. Nationally and internationally, BGE TEC is active in very long-term, partly independently financed pro-

grammes with large planning horizons. In addition, R&D projects are financed via the federal budget within the framework of multi-year funding programmes. This considerably reduces the risk that a company can be subjected to due to economic fluctuations.

Of particular importance for the financial year 2020 was the impact of the pandemic caused by Covid-19. BGE TEC consistently implemented the directives of the crisis team set up at BGE. In addition to hygiene rules, this essentially meant almost completely stopping business trips and allowing mobile working to a large extent. None of the employees of BGE TEC has been infected with Covid-19, thus, BGE TEC was able to provide all services owed.

The Covid-19 pandemic affected BGE TEC's business activities in 2020 mainly in terms of administrative processes and project management. In particular due to the more difficult cooperation with partners and clients, individual tasks and work packages and thus project deadlines had to be postponed. No services had to be reduced or work stopped completely. The potentially negative impact of longer project durations was largely offset by savings, mainly in travel costs due to reduced travel in the projects. Overall, the 2020 business result of T€ 108 even exceeds the projected result by more than T€ 30.

Taking into account the special effects from the settlement of two major projects in 2019 and the extension of project terms, 2020 can thus be considered another good business year. Turnover amounted to T€ 5,376 (previous year: T€ 6,370), and a net profit for the year of T€ 108 (previous year: T€ 174) was generated. As of December 31, 2020, the company had orders on hand amounting to T€ 3,465.

RESULTS OF OPERATIONS

Compared with the previous year, turnover decreased by T€ 994 to T€ 5,376.

* In accordance with Destatis 1bn = 10¹²

Other operating income (T€ 41) decreased by T€ 117 due to a change in the collection of advance payments by the German Social Accident Insurance Institution for the Raw Materials and Chemical Industry (BG RCI). Refunds of contributions are not expected in subsequent years. The main item under operating income is a refund of insurance premiums in the amount of T€ 20 (previous year: T€ 13).

The cost of materials includes expenses for purchased services for project assistance by third parties and by the parent company BGE as well as maintenance costs for assistance to orders relating to the Asse II mine.

In line with the increase in the average number of employees, personnel expenses increased by T€ 602 to T€ 3,870 compared with the previous year.

Other operating expenses amounting to T€ 316 (previous year: T€ 484) mainly include rental expenses for office space, insurance, and ancillary personnel costs.

Income taxes are divided into T€ 32 for trade tax and T€ 34 for corporate income tax (including solidarity surcharge).

The net income for the year of T€ 108 (previous year: T€ 174) corresponds to the development of turnover.

NET ASSETS AND FINANCIAL POSITION

Compared with the previous year, the balance sheet total has decreased by T€ 615 and amounts to T€ 4,173.

On the assets side, inventories increased by a total of T€ 240 to T€ 907, in particular due to the increase in advance payments made for ongoing projects.

Receivables and other assets decreased compared with the previous year due to lower receivables from affiliated companies. They include, in partic-

ular, claims against BGE from the intercompany invoicing of services.

The bank balances decreased by T€ 671 to T€ 2,307 compared with the previous year's balance sheet date.

On the liabilities side, equity decreased by T€ 89 to T€ 2,721. The net income for 2020 of T€ 108 is offset by the distribution of the profit carried forward for 2018 and the net income for 2019 totalling T€ 197 to BGE.

The provisions mainly comprise pension obligations (T€ 391; previous year T€ 324) and other provisions amounting to T€ 315 (previous year T€ 338). The other provisions were set aside in particular for personnel expenses. Overall, the level of provisions increased slightly from T€ 679 to T€ 706.

Liabilities decreased by T€ 553. The largest single item, T€ 421, relates to advance payments received for orders that have not yet been completed and for which the final invoice has not yet been issued.

Compared with the previous year, the equity ratio increased from 58.7 % to 65.2 % due to the decrease in liabilities. The equity capital continues to completely finance the fixed assets and inventories.

The company is solvent at all times, as current liabilities are fully covered by cash and cash equivalents.

Personnel and Social Report

As of December 31, 2020, the company's workforce consisted of 37 employees. The proportion of women is 27 %. The handling of the tasks of the company is supported by employees of BGE under the terms of an agency and service agreement with BGE. This primarily involves the provision of commercial services. The company is integrated into the industrial safety concept and compliance organisation of BGE.

Forecast, Risk, and Opportunity Report

Risks from order processing are controlled promptly by means of controls accompanying the order. There is adequate insurance cover for risks that the company can usually expect to encounter. There are no risks threatening the company's continued existence.

Several large contracts were completed in 2020. However, there are several new contracts and promising offers, so that the company's capacity utilisation is almost fully secured for 2021 and partially secured for 2022. Against this background, the order volume as of December 31, 2020, amounting to T€ 3,465 continues to be at a solid level. However, this circumstance has an impact on the planned result, which will be approximately T€ 50 below the previous year's level due to the reduction in inventory in recent years and the increase in inventory resulting from the new orders. In the medium term, a positive annual result is still expected.

The company's activities continue to focus on developing and expanding the core competence of the BGE/BGE TECHNOLOGY GmbH group in order to be able to offer high-quality services on a national and international level. In 2021, it is intended to expand and intensify activities to further attractive and interesting markets. In addition, the transfer of knowledge to and as support for BGE is to be intensified by making available scientific and technical personnel. This concerns the site selection for a repository for heat-generating waste, safety analyses by means of numerical calculations, and the further development of construction materials for the existing repository projects. In the future, it is expected that there will be a growing need for the project management agency to carry out R&D work in the area of site selection for a repository, especially for heat-generating waste.

At the same time, it is becoming apparent that the volume of R&D work funded via the BMWi budget will be at a lower level than before.

The constraints imposed by the Covid-19 pandemic have been taken into account in the project work. In addition, the measures of the crisis management team are being implemented. As a result, the probability that services cannot be provided due to personnel shortfalls is considered to be low. However, the company's acquisition activities will remain difficult for at least a large part of the year. Thus, the company will focus on cultivating its established network in the field of waste management in particular. Irrespective of this, the company will continue to participate in tenders in 2021, as a large part of the contracts in the field of radioactive waste management are awarded via tender procedures. For 2021, a positive result of approximately T€ 50 is expected.

Annex to the Financial Year 2020

General Information

BGE TECHNOLOGY GmbH has its registered office in 31224 Peine, Eschenstraße 55, and is registered with the commercial register at the Local Court of Hildesheim, HRB no. 101385.

The company is a small corporation within the meaning of Section 267 (1) HGB. The annual financial statements of BGE TEC are prepared voluntarily in accordance with the regulations applicable for large corporations.

To improve the overall clarity of presentation, individual items have been combined in the balance sheet and income statement and are shown separately in the notes to the financial statements.

The accounting and valuation methods have remained unchanged as against the previous year.

The income statement was prepared according to the total expenditure format.

Accounting and Valuation Methods

Figures shown in the balance sheet for intangible assets and tangible assets are based on the cost of purchase. Intangible assets – consisting exclusively of software – are written off by straight-line method over a period of three to five years, and tangible assets are written off by straight-line method over their expected useful life (three to fifteen years). Minor value assets with acquisition or production costs of more than € 250 but not more than € 1,000 are combined into an annual collective item and written off uniformly over a period of five years.

Orders that have been commenced (work in progress) are valued at the directly attributable production costs in accordance with the minimum valuation threshold under commercial law.

Advance payments are recognised at nominal value.

Receivables, other assets, and cash and cash equivalents are reported at nominal value.

Identifiable individual risks are taken into account by value adjustments on receivables. Other assets are reported at nominal value.

Prepaid expenses and deferred charges consist of payments made before the balance sheet date insofar as they relate to a specific period after that point in time.

Subscribed capital is reported at nominal value.

Provisions are reported at the amount deemed necessary for the fulfilment thereof according to sound business judgment.

Other provisions with a term of more than one year are discounted at the average market interest rate prevailing over the past seven financial years corresponding to their remaining term.

Provisions for pensions are calculated on the basis of actuarial calculations using the projected unit credit method, taking into account the "Mortality Tables 2018 C" of Prof. Dr. Klaus Heubeck, Cologne. The reported pension obligations for individual commitments are governed by the benefit regulations and the contribution-based pension scheme of Bochumer Verband (Bochum Association). Provisions for pensions are discounted at the average market interest rate of the past ten financial years as published by Deutsche Bundesbank (Section 253 (2) HGB), which corresponds to 2.31 % (previous year 2.72 %). Salary dynamics remain unchanged at 2.5 %, while pension dynamics continue to be taken into account at 1.0 %.

The difference resulting from the valuation of the pension provisions at the 7- or 10-year discount rate amounts to T€ 57. Due to sufficient reserves

in accordance with Section 272 (2) Clause 4 HGB, the amount is not subject to a distribution block.

Provisions for archiving costs serve to fulfil legal and contractual archiving obligations for business documents and records. The provisions are calculated based on an average remaining archiving period of ten years and an estimated cost increase of an unchanged 2.5 % p.a. The provisions are discounted at the corresponding average market interest rate of 1.26 % (previous year 1.59 %).

The other provisions take into account all identifiable risks and contingent liabilities.

Liabilities are reported at the settlement amount.

The deferred tax asset surplus was not reported. The valuation of deferred taxes is based on a tax rate of 29.3 % (15.82 % for corporate income tax including solidarity surcharge and 13.48 % for trade tax). Differences between commercial law and fiscal law arise in particular with regard to pension provisions.

Receivables and liabilities in foreign currency are valued at the mean exchange rate applicable at the time of the business transaction. The valuation on the balance sheet date is based on the mean spot exchange rate. If the remaining term is one year or less, Section 253 (1) Clause 1 and Section 252 (1) Clause 4 Subclause 2 HGB are not applied.



Balance Sheet as of December 31, 2020

Assets

	Notes	31.12.2020 T€	31.12.2019 T€
A. Fixed assets	(1)		
I. Intangible Assets		1	2
II. Tangible assets		36	47
III. Financial assets		(€ 250.00)	(€ 250.00)
		37	49
B. Current assets			
I. Inventories			
1. Work in progress		463	578
2. Advance payments		444	89
		907	667
II. Receivables and other assets	(2)		
1. Trade accounts receivable		202	232
2. Receivables from affiliated companies		688	847
3. Other assets		32	8
		922	1,087
III. Cash on hand, bank balances		2,307	2,978
		4,136	4,732
C. Prepaid expenses and deferred charges		0	7
		4,173	4,788

Equity and Liabilities

	Notes	31.12.2020 T€	31.12.2019 T€
A. Equity			
I. Subscribed capital	(3)	511	511
II. Capital reserves	(4)	179	179
III. Revenue reserves	(5)	1,923	1,923
IV. Profit carried forward		0	23
V. Net profit for the year		108	174
		2,721	2,810
B. Provisions			
1. Provisions for pensions		391	324
2. Tax provisions		0	17
3. Other provisions	(6)	315	338
		706	679
C. Liabilities	(7)		
1. Advance payments received		421	1,002
2. Trade payables		49	56
• Thereof with a remaining term of up to one year 49 T€ (56 T€)			
3. Payables to affiliated companies		122	10
• Thereof with a remaining term of up to one year 122 T€ (10 T€)			
4. Other liabilities		154	231
• Thereof with a remaining term of up to one year 154 T€ (231 T€)			
• Thereof taxes 152 T€ (210 T€)			
		746	1,299
		4,173	4,788

Notes to the Balance Sheet

Assets

1. Fixed assets

Movements of individual items of fixed assets are shown in the fixed assets movement schedule.

The financial assets consist of a cooperative share acquired in 2012.

2. Receivables and other assets

As in the previous year, all receivables and other assets have a remaining term of less than one year.

Receivables and other assets include receivables from affiliated companies (T€ 688; previous year T€ 847) arising from claims for project work and receivables from the final settlement of orders with foreign customers. The other assets relate to tax refund claims.

Equity and Liabilities

3. Subscribed capital

Subscribed capital remains unchanged at T€ 511. It is fully paid up and is held to 100 % by BGE.

4. Capital reserves

The capital reserves amounting to T€ 179 originate from other contributions according to Section 272 (2) Clause 4 HGB.

5. Revenue reserves

Revenue reserves amount to T€ 1,923. Of this amount, T€ 1,794 consist of retained earnings from previous financial years and T€ 129 from a change in accounting method resulting from the German Accounting Law Modernisation Act (Bil-MoG) as of January 1, 2010.

6. Other provisions

	31.12.2020 T€	31.12.2019 T€
Employee-related provisions	287	295
Archiving costs	21	21
Other obligations	7	22
	315	338

Employee-related provisions amounted to T€ 287 and include costs for special compensations and vacation remunerations.

7. Liabilities

Advance payments received in the amount of T€ 421 (previous year T€ 1,002) consist primarily of contractually agreed advance payments for work in progress from foreign customers.

Liabilities to affiliated companies amounting to T€ 122 (previous year T€ 10) are attributable in full to the sole shareholder and, as in the previous year, result from trade payables.

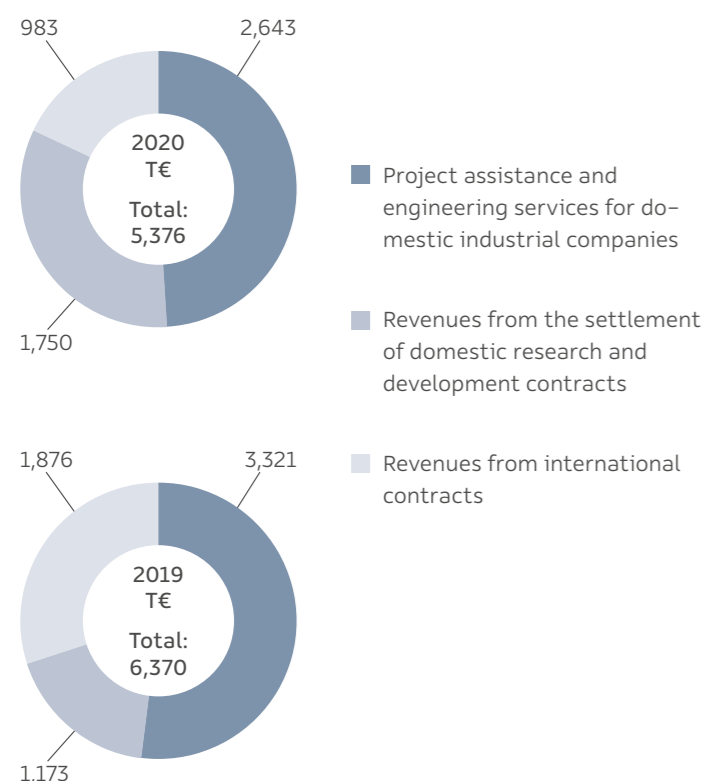
Other liabilities (T€ 154; previous year T€ 231) consist primarily of value-added tax and wage tax obligations, which are still outstanding to an amount of T€ 152.

As in the previous year, all liabilities amounting to T€ 746 have a remaining term of less than one year and are unsecured.



Notes to the Income Statement

8. Turnover



Revenues from project assistance and engineering services for industrial companies were generated exclusively in Germany. Revenues from international contracts were generated by engineering services.

9. Change in inventory

The decrease in inventories of T€ 115 results from orders settled as of the balance sheet date.

10. Other operating income

Other operating income decreased on balance by T€ 117 to T€ 41. In 2020, income unrelated to the accounting period amounting to T€ 27 (previous year T€ 110) was realised. This resulted from credits from the architects' liability insurance (T€ 20; previous year T€ 13), the 2020 service charge statement for rented office space (T€ 5;

previous year € 0) as well as provisions for year-end expenses that were not required.

11. Cost of materials

The cost of materials includes expenses for purchased services from project work by the parent company and third parties (T€ 868; previous year T€ 1,013), energy costs and fuel (T€ 3; previous year 3) as well as expenses for repairs and maintenance work (T€ 10; previous year 63).

12. Personnel expenses

Personnel expenses increased by T€ 602 to T€ 3,870, corresponding to the increase in the number of employees compared with the previous year.

13. Other operating expenses

Other operating expenses (T€ 316; previous year T€ 484) are mainly attributable to rents (T€ 123; previous year T€ 133), insurance expenses (T€ 65; previous year T€ 65), ancillary personnel costs (T€ 40; previous year 24), travel expenses (T€ 31; previous year T€ 148), and other general administrative expenses amounting to T€ 57; previous year 114. As in the previous year, they do not include any expenses unrelated to the accounting period.

14. Interest and similar expenses

	2020 T€	2019 T€
Interest on pension provisions	9	9
Interest and similar expenses	15	2
	24	11

15. Taxes on income

For the current financial year, taxes on income include trade tax (T€ 32) and corporate income tax (incl. solidarity surcharge) at T€ 34.

Contingent Liabilities and Other Financial Obligations

The company conducts its business operations in rented office premises. This results in payment obligations in the amount of T€ 140.

As of the balance sheet date, there are no other significant contingent liabilities or other financial obligations.

Other Disclosures

Corporate bodies

In 2020, the company was managed by the following managing directors:

- Dr. Thilo von Berlepsch, Niedernwöhren, Managing Director
- Dr. Thomas Lautsch, Peine, Technical Managing Director of Bundes-Gesellschaft für Endlagerung mbH (BGE), Peine

Deviating from section 5.2.5 of the Public Corporate Governance Code (PCGK) of the Federal Republic of Germany, no age limit has been set for the management of BGE TECHNOLOGY GmbH so far. The contracts of the current management are limited in time so that no member of the management will reach the legal age limit before expiry of the contract.

The remuneration of the Management Board in the reporting year 2020 comprises the fixed salary payments including ancillary benefits. Performance-related remuneration bonuses are paid.

Managing Director	Base salary	Retirement pension indemnity	Others	Total remuneration 2020
	T€	T€	T€	T€
Dr. Thilo von Berlepsch	140	0	24	164
Dr. Thomas Lautsch	0	0	0	0
Total	140	0	24	164

Pension obligations to former members of the management of a merged legal entity are accrued in the total amount of T€ 211, their current remuneration amounted to T€ 10 in 2020.

Auditor's fees

The total auditor's fees charged for the financial year are presented in the consolidated financial statements of BGE.

Annual average number of employees

The average number of employees during the year was 36 (previous year 29). Of these, 9 are female and 27 male.

Appropriation of net income

Subject to the approval of the sole shareholder, the net profit for the year of T€ 108 is to be distributed.

Group affiliation

BGE TEC is subject to the uniform management of BGE. In its capacity as parent company, the latter prepares consolidated financial statements for the smallest and largest group of companies, in which the annual financial statements of BGE TEC are included. The consolidated financial statements are submitted to the operator of the *Electronic Federal Gazette* (Bundesanzeiger) and are published in the *Electronic Federal Gazette*.

Public Corporate Governance Code

For the company, the compliance declaration for 2020 will be rendered in 2021 in accordance with the Public Corporate Governance Code of the Federal Republic of Germany, which will be published on the company's website.

Peine, March 31, 2021

Dr. Thilo von Berlepsch
Managing Director

Dr. Thomas Lautsch
Managing Director

Fixed Assets Movement Schedule

Acquisition and Production Costs

	As of 01.01.2020	Additions	Disposals	Re- transfers	As of 31.12.2020
	T€	T€	T€	T€	T€
I. Intangible assets					
1. Purchased concessions, industrial property and similar rights and assets, and licenses to such rights and assets	141	0	1	0	140
	141	0	1	0	140
II. Tangible assets					
1. Other equipment, operating, and office equipment	241	21	1	0	261
	241	21	1	0	261
Sub-total	382	21	2	0	401
III. Financial assets					
1. Other loans	(250 €)	0	0	0	(250 €)
	(250 €)	0	0	0	(250 €)
Total fixed assets	382	21	2	0	401

Value Adjustments

Net Book Values

Accumulated depreciation 01.01.2020	Additions	Disposals	Re- transfers	Accumulated depreciation 31.12.2020	As of 31.12.2020	As of 31.12.2019
T€	T€	T€	T€	T€	T€	T€
139	1	1	0	139	1	2
139	1	1	0	139	1	2
194	32	2	0	224	37	47
194	32	2	0	224	37	47
333	33	3	0	363	38	49
0	0	0	0	0	(250 €)	(250 €)
0	0	0	0	0	(250 €)	(250 €)
333	33	3	0	363	38	49



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