



ANNUAL REPORT

2019



Income Statement

for the period from January 1 to December 31, 2019

	Notes	2019 T€	2018 T€
1. Turnover	(10)	6,370	4,682
2. Changes in inventories	(11)	-1,349	179
3. Other operating income	(12)	158	234
		5,179	5,095
4. Cost of materials	(13)		
a) Cost of raw materials, consumables, and supplies and of purchased merchandise		32	12
b) Cost of purchased services		1,079	1,052
		1,111	1,064
5. Personnel expenses	(14)		
a) Wages and salaries		2,642	2,633
b) Social security contributions and expenditures for pensions • thereof for pensions T€ 46 (T€ 151)		626	815
		3,268	3,448
6. Depreciation		38	41
7. Other operating expenses	(15)	484	472
		4,901	5,025
		278	70
8. Interest and similar expenses	(16)	11	7
9. Taxes on income	(17)	93	40
10. Results after taxes		174	23
11. Net profit for the year		174	23

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Welcome to the Team



Juliane Leonhard
Age 33
Mining and Mechanical Engineer,
Research and Development

»As a member of the research and development team, I have the opportunity to make an active contribution to the safe disposal of radioactive waste within the framework of repository research and to assume responsibility for innovative projects. In this challenging environment, I can use my experience in the field of special-purpose machinery in underground mining for the development of new emplacement technologies. Developing solutions for complex issues together with my colleagues is a particularly exciting part of my work.«



Dr. Alireza Hassanzadegan
Age 42
Geomechanical Engineer,
Research and Development

»BGE TECHNOLOGY GmbH offers me the opportunity to develop personally and professionally. Working in national and international projects, with the aim of solving practical problems with the help of numerical simulation, means daily challenge and excitement for me. I have been involved in geomechanical modelling and rock mechanics in various disciplines for almost 10 years.«



Rocio Paola León-Vargas
Age 35
Civil Engineer and Geotechnician,
Research and Development

»When I learned about the scope of activities and the know-how of BGE TECHNOLOGY GmbH in the field of radioactive waste disposal, I immediately identified myself with this leading company. Here, I benefit not only from the interdisciplinary knowledge exchange, but also from the know-how transfer of experienced colleagues. In addition, I look forward every day to a pleasant working atmosphere and superiors who treat me in an appreciative way.«



Dr.-Ing. Ulla Marggraf
Age 32
Mechanical Engineer,
International Projects

»Developing functional and safe machines in special machine engineering is enormous fun. To do this taking into account other specialist fields, to experience the strong support and the sense of unity in the interdisciplinary team, distinguishes BGE TECHNOLOGY GmbH for me. This diversity and the opportunity to work independently and flexibly always make me start my working day with enthusiasm.«



Tilman Fischer
Age 28
Drilling Engineer,
Repository Safety

»There are always new challenges in various national and international projects, which makes the work varied and exciting. When working with colleagues from a variety of disciplines, problems are viewed from different angles. As a deep-drilling engineer, I, too, can make my contribution to the safe disposal of radioactive waste.«



Stephanie Scotkiewicz
Age 53
Foreign Language Correspondent,
Assistant to the Managing Director

»I am very pleased that I can now bring in the experience I have gained over many years as management assistant in mainly internationally operating companies to BGE TECHNOLOGY GmbH. As one of the newest team members, I quickly realised that both my organisational skills and my regional contacts are valuable for the company. The relocation in January was an exhausting but successful example of this.«

Our Team



Dr. Thilo von Berlepsch



Niklas Bertrams



Wilhelm Bollingerfehr



Dr. Lieselotte von Borstel



Dr. Victoria Burlaka



Dr. Hans-Joachim Engelhardt



Tilman Fischer



Dr. Alireza Hassanzadegan



Dr. Bernt Haverkamp



Martin Herklotz



Philipp Herold



Astrid Hofschlag



Ali Hussein



Michael Jobmann



Andreas Keller



Dr. Thomas Lautsch



Juliane Leonard



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



Holger Schmidt



Stephanie Scotkiewicz



David Seidel



Eric Simo



Paola Rocio Leon-Vargas



Dr. Toivo Wanne



Ansgar Wunderlich



Dear Readers,

For BGE TECHNOLOGY GmbH (BGE TEC), the financial year 2019 was, as expected, a year characterised by a robust business activity. We were also able to grow in areas in which we have long been active in routine operations for our parent company Bundesgesellschaft für Endlagerung mbH (BGE), but have not yet been able to apply for external contracts. This concerns, for instance, the development of materials used in repositories in any host rock, especially for sealing systems and the related high requirements on their performance. After the relatively weak previous year due to the reorganisation, we were able to generate a clear six-digit result again in 2019.

The profit was earned within the scope of tasks and projects that BGE TECHNOLOGY GmbH has carried out for 15 national and international radioactive waste disposal programmes. The knowledge and experience gained over the years has also been passed on to BGE for the safety of their repository projects, including the search for a site for a repository for heat-generating radioactive waste. BGE in turn provides us and thus our customers, too, with their practical expertise.

We are very grateful for the opportunity of this close cooperation.

»The key to our success is our highly motivated and highly qualified team.«

In order to give you an impression of the nature of the tasks and projects entrusted to us, we would like to show you in this Annual Report various activities that are basically required in all phases of a repository programme. Accordingly, we have assigned the projects presented in this report to the fields planning, services, modelling, and analysis.

At this point I would like to thank all partners and clients for the good, trusting, and fruitful cooperation, without which our success would not be possible. However, the decisive factor for our success is the highly motivated and highly qualified team, whose expertise is well appreciated both nationally and internationally. My personal thanks therefore goes in particular to them.

Happy Reading!
Dr. Thilo v. Berlepsch
Managing Director



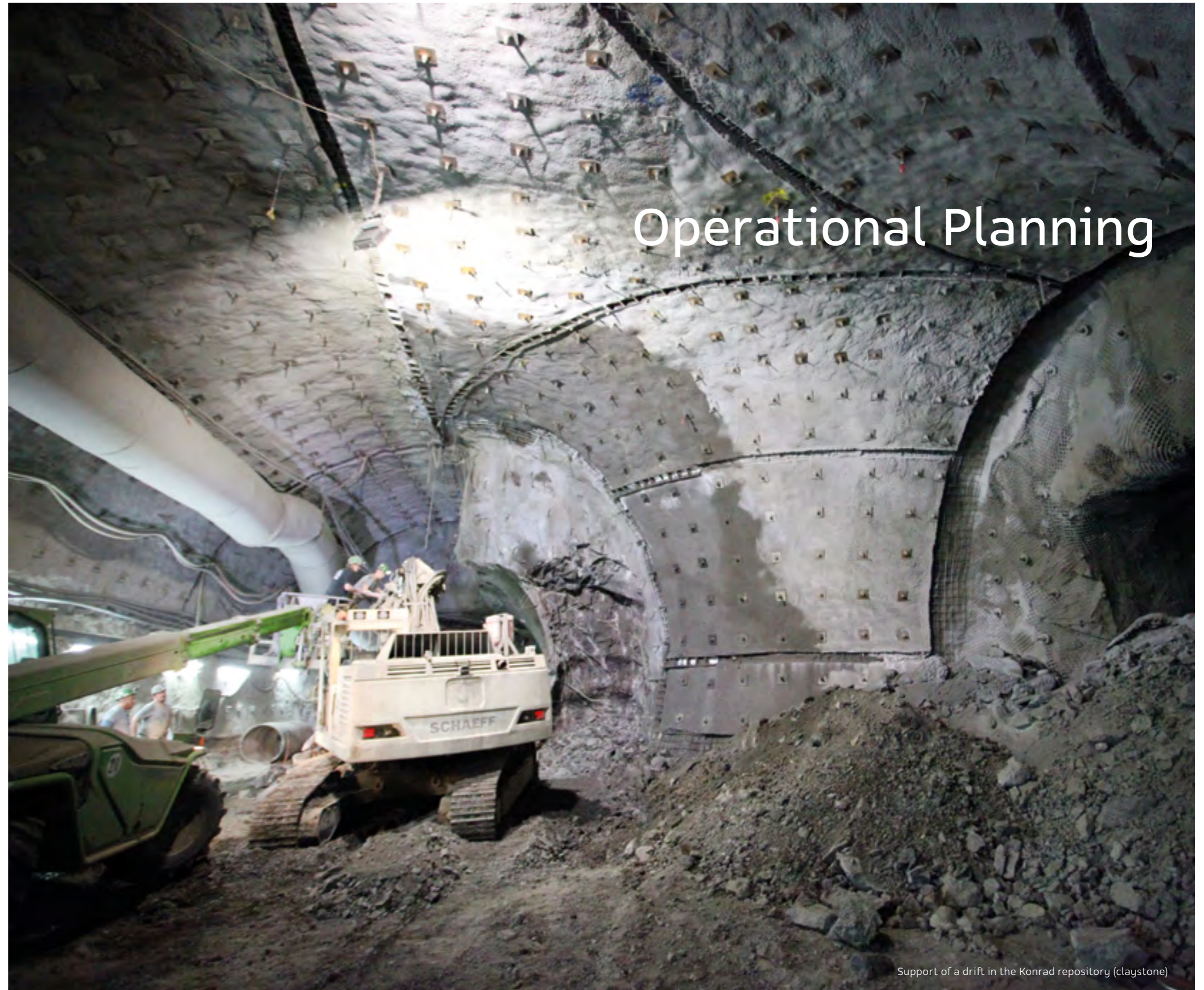


Before radioactive waste is disposed of, a specific safety concept is usually developed, which describes how safe operation and long-term containment of the radionuclides are to be achieved at a specific site. The technical implementation leads to a repository concept, which is based not only on the safety concept but also on the site-specific geology, the waste inventory, and the regulatory requirements. The repository concept includes mine and operational planning as well as the planning of transport, emplacement, and closure for the long-term safe sealing of the emplacement and mining areas.

Through our parent company, Bundesgesellschaft für Endlagerung mbH (BGE), we can draw on decades of experience in the operation of the Morsleben repository, of the Asse and Konrad mines, and of the exploration mine Gorleben. Furthermore, we have also planned and analysed operating concepts for various waste management organisations in national and international projects. Based on this experience, we establish the fundamentals for the safe and efficient operation of facilities for the disposal of radioactive material as well as of mining and cavern facilities.

One example is the R&D project AGENT where the requirements for designing support structures in the mine workings of a HLW repository in claystone are to be compiled, basic technical solutions are to be developed, and possible interactions of the construction materials in question with the other components of the repository system are to be investigated.

In another project, BGE TECHNOLOGY GmbH supports the British Radioactive Waste Management Limited organisation in the assessment of backfilling options and the development of concepts for backfill materials and backfilling strategies for different host rocks.



Operational Planning

Support of a drift in the Konrad repository (claystone)

Support Structures for HLW Repositories in Clay Formations (R&D Project AGENT)



»Project AGENT is a good example for the special challenges of repository mining. The development of a support system is a typical mining task. The necessity to take into account not only operational safety but also the long-term development until well after the end of operations entails very special requirements that always call for new, innovative, and customised solutions.«

Philipp Herold
Mining Engineer, age 35

When designing a repository for high-level radioactive waste and spent fuel elements (HLW repository) in clay formations, a stabilising support of the mine workings is essential for the safe operation of the repository. These supports include all measures necessary to ensure excavation stability in the shafts, drifts, and other mine openings. The clay properties (e.g. low to moderate strength, creep behaviour, changes in properties as a function of water content) in conjunction with the respective depth of the clay formation place high demands on the bearing capacity of the support structures used. With respect to retrievability, a massive support structure could be advantageous. Retrievability may also place further requirements on the functional period of the structure. On the other hand, the German site selection act considers the absence of a load-bearing support structure as an indicator for a positive evaluation of the rock properties of a potential site in clay. For the long-term safety of a repository, the presence of support structures is associated with rather unfavourable consequences. First of all, the tendency to form pathways, which promote the intrusion of fluids, is influenced. Second, chemical interactions of the support materials with the claystone and the sealing or backfill materials are possible. In mining and tunnelling, steel and concrete are common materials for support

structures. In HLW repository concepts, a cement-based support material with the lowest possible steel content is preferred. With regard to possible corrosion processes in steel and concrete support structures as well as to interactions between the cement-based construction materials and clay minerals of the host rock, the choice of materials is a particularly important aspect.

The R&D project AGENT, which is funded by the Project Management Agency Karlsruhe on behalf of the Federal Ministry for Economic Affairs and Energy (BMWi), is intended to resolve the conflict of objectives between operational safety, retrievability, and long-term safety as described above. AGENT is carried out in cooperation with DMT GmbH & Co. KG. For this purpose, the requirements for the design of support structures in the mine workings of a HLW repository in clay are compiled, essential technical solutions are developed, and possible interactions of the relevant building materials with the other components of the repository system are investigated. Depending on their deformability, new support structures still to be developed can lead to significant restrictions in their areas of application. This in turn can influence the choice of host rock and repository depth when selecting a site for a HLW repository.

Development of Backfilling Concepts for Repository Projects in Different Host Rocks

According to the international state of the art in science and technology, high-level radioactive waste is to be disposed of in deep geologic formations because these provide the best conditions for the long-term containment of radionuclides. This disposal option is also being pursued in the UK, where current planning is based on generic repository models developed for the potentially suitable host rocks. An integral part of these plans is a multi-barrier concept, which means that engineered barriers are of particular importance for the permanent isolation of the radionuclides from the biosphere. One prerequisite for their safe functioning is the sealing of the mine openings with backfill materials that have to take over different tasks in order to optimise the overall concept. Backfill materials generally limit the amounts of water or solutions in a repository and restrict their movement by reducing the rock convergence. They can also provide open pore space to delay pressure build-up at barriers and create preferred pathways far away from the emplacement areas. Chemically reactive materials reduce the mobility and/or solubility of radionuclides or provide a chemical environment that can limit or prevent corrosion of barriers.

The British Radioactive Waste Management Limited (RWM) organisation wants to exploit the potential offered by the proper implementation of backfilling measures and thus initiated a project with the aim to structure the development and planning work and to investigate options for backfilling. BGE TECHNOLOGY GmbH is part of the international project team. Thus, we can contribute our extensive practical experience in the development, the use, and the quality assurance of backfill materials as well as in the application of different conveying and backfilling techniques. A particular advantage for the project is that this experience covers a wide range of backfill materials.

This includes suspensions, such as mortars and concretes, as well as bulk materials, hydraulically and pneumatically conveyable construction materials, and construction materials containing very different types of binding agents, such as magnesia binders and cement-based construction materials. This way, the requirements, which include the properties of the waste types and of the geologic barrier as well as the repository concept, can always be optimally incorporated when selecting backfill materials and their fields of application. An essential component for the success of the project is the experience of BGE TECHNOLOGY GmbH in the development of repository concepts and in the planning and construction of engineered barriers. It contributes significantly to the realisation of an efficient and comprehensive package of sealing measures.

Project workshops are an important platform for the transfer of know-how and for the development of backfilling strategies. In addition, reports are prepared as guidelines for the subsequent work. This way, BGE TECHNOLOGY GmbH can support RWM in getting one step closer to the goal of safe radioactive waste disposal.



»To isolate radionuclides in the long term, damage to the barriers of a repository has to be prevented. This goal can be achieved with backfilling measures that stabilise the mine workings. The planning of these measures requires a systematic approach developed by an international project team. It was a pleasure to contribute the extensive know-how of BGE TECHNOLOGY GmbH to this project.«

Dr. Hans-Joachim Engelhardt
Geoscientist, age 57



The disposal of radioactive waste is to protect man and the environment against potential risks. This protection has to be ensured both during repository operation and after its closure. When it comes to geological repositories, special requirements concerning exploration, preservation, and modelling of the subsurface environment need to be met. During construction and operation, the geomechanical stability of the mine workings has to be ensured. If the integrity of a mine is at risk, underground cavities have to be backfilled. In order to prevent the ingress of solutions to or the transport of substances from specific areas, these areas must also be sealed to a high standard of quality. This requires sealing systems that – in some cases – are extremely complex.

BGE TECHNOLOGY GmbH provides services in all geoscientific and geotechnical disciplines in the field of radioactive waste disposal. We bundle geoscientific know-how in interdisciplinary teams and are thus able to solve a wide range of complex problems. Our team includes experts from the fields of geology, hydrology, geotechnics as well as geochemistry, and mechanical and civil engineering. They are well-experienced in strategy development, planning of site investigations and development of pertinent methodologies as well as in the fields of safety analyses and numerical modelling. Measuring and monitoring systems, demonstrations of stability, and geoscientific long-term forecasts complete these services.

Quality-assured planning and implementing of the sealing of exploratory boreholes in the Gorleben and Asse mines, developing materials for sealing and injection measures at these sites, and implementing these measures in routine operation are best examples of our competence.



Injection work on exploratory boreholes in the Gorleben mine

Sealing of Exploratory Boreholes in the Gorleben and Asse II Mines



Borehole injections in the Gorleben exploration mine

After completion of the Gorleben salt dome exploration, several exploratory boreholes still had to be backfilled. With varying borehole courses and different inclinations, these boreholes traversed rock salt, anhydrite as well as carnallite layers. Their high volumes, great lengths, and the high requirements on their long-term tightness, posed major challenges on the sealing measures and the composition of the sealing material. For reasons of long-term stability, it was decided to use magnesia binder as sealing material, and for reasons of efficiency, a tried and tested recipe was adapted to the needs. In consultation with the manufac-

turer, the workability time (pot life) of magnesium oxide binder could be prolonged by optimising its calcination process. BGE TECHNOLOGY GmbH subsequently adjusted the material composition and selected the mixing and pumping equipment to ensure optimal conditions for the sealing work. Innovative was the use of cooled magnesia binder in order to lengthen the pot life and to avoid thermal stresses, which could lead to crack formation during hardening.

The planning of the backfilling work was based on an extensive investigation of the as-is conditions, which also included camera inspections and calliper logging. All tests and the sealing of the boreholes were accompanied by a sophisticated quality assurance programme in order to guarantee smooth running of the work and to demonstrate that the property requirements were met. Due to the very positive experience gained in Gorleben, it was decided to use this mixture for sealing the boreholes in the Asse II salt mine as well. For a first sealing measure, the material was mixed with the equipment already used in Gorleben and transported in tanks to the job site on the 700-m-level. This procedure required an extremely long pot life, which was a first for high-quality magnesia binders. Due to the successful application, it was decided to use the mixture as reference material for the sealing of further boreholes that are planned for exploring the collaring point of a new mine shaft at the Asse mine.



»The Asse II mine is a special case worldwide because a large number of tasks have to be coordinated and carried out. This includes backfilling work to stabilise the mine workings, the construction of flow barriers to protect the emplacement chambers, and planning activities for the retrieval of the radioactive waste. It is extraordinarily exciting to be able to contribute to the progress of this work as part of the team.«

Astrid Hofschlag
Building Materials Engineer, age 43

Drift and Borehole Seals as well as Injection Measures in the Asse II Mine

With the aim of preventing that saline solutions access the emplacement chambers of the Asse II mine, backfilling measures are carried out with a special emphasis on the construction of flow barriers. In order to ensure the long-term functionality of these barriers, long-term stable magnesia binders are used. The sealing structures in the drifts and blind shafts are made of a concrete (sorel concrete), which is mixed underground with a semi-mobile plant to ensure the highest possible flexibility of production. The quality assurance programme includes checks of the delivery documents and examinations of the raw materials, the suspensions, and of the hardened construction material. It is divided into internal and external monitoring to ensure the conformity of the material properties with the requirements.

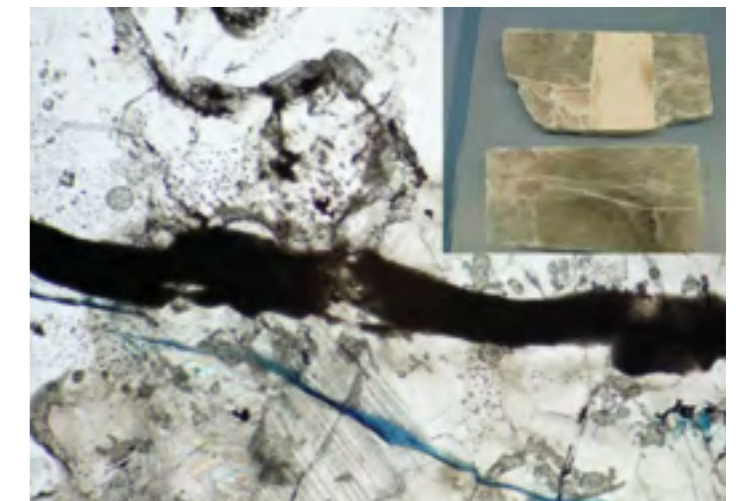
For the protection of the emplacement chambers, it is essential that no fluids bypass the barriers. Thus, boreholes have to be sealed, and pathways in the rock must be injected. Large particles can clog the material feeding lines and impede or stop the backfilling process. Consequently, boreholes are backfilled with fine-grained and easy-flowing mortars, which can be used without restrictions as magnesia binders with the sorel concretes. During material optimisation, BGE TECHNOLOGY

GmbH took into account the different production and processing conditions of concrete and mortar; e.g., high ambient and material temperatures, long workability times and conveying distances, and capacities of the available technical equipment. Several hundred successful borehole backfilling measures demonstrate the high level of viability of the mixtures.

Injection materials developed for fracture and pore space injections complete the family of magnesia binders. They are characterised by extremely fine grain sizes and maximum flowability and cover a wide range of processing times. They can be divided into magnesium oxide and/or magnesium hydroxide construction materials or according to their content of reactive and inert fillers. Together with particle-free water glass, extremely low permeabilities can be achieved. Mixtures of MgO and water glass, which have been developed by BGE TECHNOLOGY GmbH based on its wide range of experience, round off the wide range of MgO-based construction materials. Our extensive know-how results from more than a decade of experience in the planning and construction of flow barriers and is also expedient when it comes to construction measures in other salt mines.



Part of the salt processing plant for the production of sorel concrete



Crack in rock salt injected with magnesia binder MFBBa-17/3/30



Suitable technologies for the handling and transport of waste packages in mine workings are essential for the development of repository concepts. These are developed step by step to meet the increasing demands on the level of detail in the various phases of component/system development. At the same time, however, the technical development must be flexible enough to adapt the concepts in early phases to possible changes due to new findings.

Engineers from a wide range of disciplines contribute their extensive knowledge to a multitude of national and international projects, thus continuously developing it further. We develop and test components, systems, and construction materials for backfilling and sealing measures. We also design container systems and are experienced in the field of repository monitoring. Design and implementation of structural engineering verifications, especially for underground structures, complete the picture.

One good example is the R&D project TREND. In German, the acronym TREND refers to the further development of the technology for the transport and emplacement of high-level radioactive waste in a geological repository. The aim of the project is to bring the existing concepts of the transport and emplacement technologies for the various waste packages and different emplacement variants and host rocks to a comparable level of development. Technical solutions are also developed in the project "Development of technical concepts for the retrieval of waste containers with heat-generating radioactive waste and spent fuel elements from a HLW repository in crystalline rock, KOREKT". The aim is to provide the basis for a technical solution for a repository in crystalline rock that is ready for licensing.



Drift preparation for the construction of a flow barrier in the Asse mine

Transport and Emplacement Technology for a Repository for High-level Waste (R&D Project TREND)

In January 2019, the Project Management Agency Karlsruhe (PTKA) commissioned BGE TECHNOLOGY GmbH on behalf of the Federal Ministry for Economic Affairs and Energy (BMWi) with the further development of the technology needed to transport and emplace high-level radioactive waste in deep underground repositories (R&D project TREND).



Transport cart for waste containers

The aim of the project is to bring the existing concepts of the transport and emplacement technologies for the various waste packages and different emplacement options up to a comparable level of development. This is to provide a useful basis for the development of repository concepts; e.g., within the framework of safety analyses.

To this end, the technologies already tested for the drift emplacement of POLLUX® casks and for the

vertical borehole emplacement will be reviewed taking into account current regulations and the state of the art in technology. Where necessary, they will be updated in line with current conditions.

So far, only one early conceptual idea exists for the borehole emplacement in horizontal boreholes. It will be further developed with a special focus on operational safety, radiation protection, and robustness until its essential technical properties can be assessed. The further development of the transport and emplacement technology for the direct disposal of transport and storage casks has been completed. Adjustments were made in particular with regard to operational safety and the reversibility of the emplacement process.

The technical properties of the transport and emplacement equipment for repository concepts in claystone and crystalline rock have so far been derived on the basis of equipment already designed for rock salt. TREND also focuses on the different host rock-specific requirements. In the design process, preference is given to modular designs in order to facilitate future adaptations with regard to waste retrieval, changed boundary conditions, or progress in technology. At the end of the project, full 3D models of all machines considered and descriptions of the transport and emplacement processes will be available.



»In the TREND project, the transport and emplacement technology for a HLW repository will be further developed. A particular challenge in the development of the necessary machinery is the work at the interface between mining and nuclear technology. In addition to the safety requirements of the mining regulations, the high demands of the nuclear regulations must be met.«

Ansgar Wunderlich
Mechanical Engineer, age 27

Retrievability of Waste Packages from a HLW Repository in Crystalline Rock (R&D Project KOREKT)



»The dynamics of technical progress make it necessary to continuously re-evaluate technical developments. In the context of radioactive waste retrieval, this work is brought into a new and exciting environment where an exchange between experts of different disciplines is necessary. This work enables me to make a contribution to future developments when it comes to the safety of man and the environment.«

Juliane Leonard
Mining and Mechanical Engineer, age 33

Within the framework of the R&D project KOREKT, BGE TECHNOLOGY GmbH develops on behalf of the Project Management Agency Karlsruhe (PTKA) suitable concepts for the retrieval of waste packages from future repositories for HLW and spent fuel in crystalline host rock. For the technical implementation of retrievability, the two basic disposal concepts – drift disposal of self-shielding POLLUX® casks and disposal of unshielded casks in short vertical boreholes – will be investigated. The work is based on newly developed repository concepts and on the results of a systematic review of the safety requirement "retrievability". This includes a more detailed planning of the retrieval technology and of the retrieval processes as well as an initial estimate of the time required for retrieval.

All investigations related to the retrievability of waste packages are restricted by the facts that the motives for retrieval and the start of the process cannot be predicted. Thus, the exact boundary conditions at the time of retrieval are also unknown. Within previous R&D projects, it was assumed that retrieval will be carried out at the latest possible start of retrieval; i.e., at the end of the operating period of the repository. Furthermore, it is investigated how "selective retrieval" can be taken into account. Such selective retrieval would involve the retrieval of a limited number of waste packages while retaining the repository

site and the original disposal objective. In addition, characteristic retrieval scenarios in the various stages of the repository life cycle will be investigated and described. The aim is to develop a system that is as modular as possible and allows easy adaptation to different boundary conditions and/or retrieval scenarios.



Concept of a suction bell (top section) to remove loose backfill material from an emplacement borehole



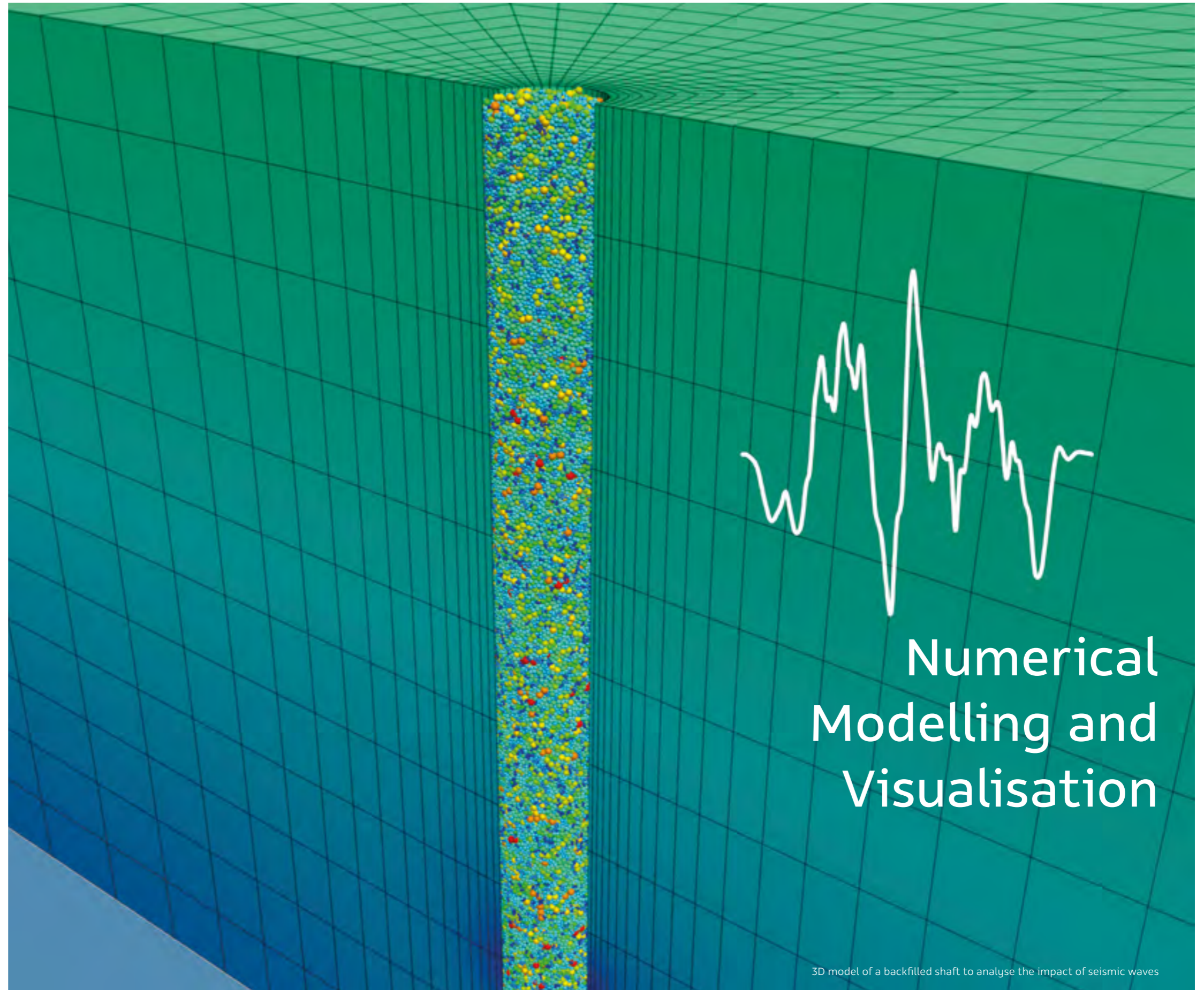
Safety analyses of mining and waste disposal facilities are extremely complex tasks. Data acquisition, modelling, calculation and metrological monitoring – all this is included in our service package, which ensures fast and end-to-end processing.

The modelling of complex structures in the rock or on the surface, the dispersion of substances via water or air, or the simulation of operating processes are the basis for many safety-related analyses.

Processing and analysing large amounts of data – these are our specialties. Our work is based on verified and validated computer programmes. Problem analyses, model development and calculations, or safety analyses are part of this service.

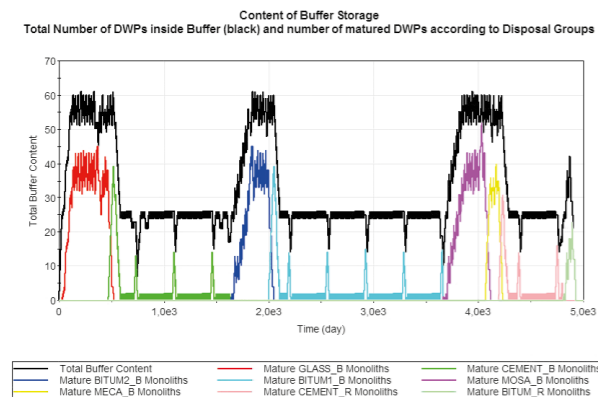
For example, BGE TECHNOLOGY GmbH conducted a logistic simulation study on the Belgian repository concept to evaluate the operational concept. The focus was on the transport and emplacement processes as well as on the backfilling of the emplacement drifts.

A current example of numerical modelling work is the joint R&D project EURAD funded by the EC, where BGE is involved. On behalf of BGE, employees of BGE TECHNOLOGY GmbH work on material models for the numerical description of clay materials and thus further develop the knowledge in the field of disposal in clay as host rock.



3D model of a backfilled shaft to analyse the impact of seismic waves

Logistic Study for the Belgian Repository Concept



The Belgian waste management organisation, ONDRAF/NIRAS, plans to carry out waste conditioning and interim storage of the resulting waste packages on the site of the future Belgian geological disposal facility (GDF). It is assumed that the waste packages will have to harden for 28 days in a buffer before they are ready to be transported and emplaced underground. After emplacement of a specific number of waste packages inside a disposal gallery, the remaining voids will be back-filled.

To optimise duration and costs of the disposal project, the operational concept must be suitable to achieve an emplacement rate that is not significantly lower than the predefined waste package production rate. In order to evaluate the overall system behaviour, BGE TECHNOLOGY GmbH carried out a study on the transport and emplacement processes as well as on the backfilling of the disposal galleries. As part of this study, a computer model was developed that simulates the work

steps during the operation of the GDF. This allowed investigating the effects of varying parameters on the emplacement rate and identifying measures to increase the operating performance.

According to the ONDRAF/NIRAS concept for intermediate level waste, only waste packages of one out of eight waste families will be disposed of in each disposal gallery. Five of these families are assigned to only a single disposal gallery, which precludes that transport and emplacement operations are carried out in parallel to backfilling operations. This means that the emplacement rate is lower than for the waste streams where parallel emplacement and backfilling of drift sections is possible. For the normal operating scenario, the emplacement rates are slightly higher than the production rates for waste families with several emplacement drifts and slightly lower if only one drift is available. In the latter case the buffer is consequently being filled with waste packages, and – if the maximum capacity is reached – the conditioning facility comes to a standstill. If more than one disposal gallery is available for emplacement, the buffer stock is being reduced and eventually emplacement operation even has to wait for waste packages to harden. This evolution is visualised in the figure above, which shows the total number of waste packages inside the buffer during the entire emplacement phase. The black curve represents the total number of containers in the buffer and the coloured ones indicate the number of cured containers for the different waste streams.



»We have been working for our Belgian colleagues for over 15 years now. Over the years, a very good, trusting, and open relationship has developed where the work to be done is planned jointly. Accordingly, all colleagues enjoy working with ONDRAF/NIRAS. At the same time, the good cooperation is an incentive to do everything possible to further consolidate the existing trust.«

Bernt Haverkamp
Geophysicist, age 63

Research Activities in EURAD: Development of Material Models for Clay Materials

EURAD stands for European Joint Programme on Radioactive Waste Management, an ongoing pan-European research project with the aim to coordinate research activities on outstanding issues in the area of radioactive waste disposal in deep geologic formations. The research plan has been developed by the European Waste Management Organisations and Research Institutions based on agreed priorities of common interest. On behalf of BGE, employees of BGE TECHNOLOGY GmbH participate in the work packages GAS and HITEC, where it is intended to develop constitutive material models for clay materials.

Work package GAS has the objective to improve the mechanistic understanding of gas transport processes in natural and engineered clay materials and to evaluate the gas transport regimes relevant for a geological disposal system and their potential impact on barrier integrity and repository performance. Together with its partners from the Centre for Environmental Research (UFZ) and the Federal Institute for Geosciences and Natural Resources (BGR), it is planned to develop constitutive material models for advective gas transport in clayey materials. The developed models will be combined with existing mechanical models for expansive clays in order to describe the general TH²M behaviour of bentonites. The results are to increase the confidence in model-based long-term safety and integrity analyses of geotechnical barrier systems.

Work package HITEC deals with the influence of temperature on the behaviour of clay-based materials. The main objective is to improve the understanding concerning the THM behaviour of clay rock and engineered clay materials under high temperatures and to provide suitable THM models for both clay host rock and buffer materials. In this context, a time-dependent anisotropic THM model for argillaceous rock that incorporates strength and stiffness anisotropy and time-dependent deformation is to be developed. The model is also to visualise the dependency of permeability on



»More than 100 institutions from 23 countries work together in the EURAD project on questions concerning radioactive waste disposal. Our work on modelling clay materials is based on decades of experience and site-specific research of our European partners. This is a unique opportunity that we otherwise would not have at the beginning of the site selection process in Germany.«

Eric Simo
Civil Engineer, age 31

irreversible strains and the hydro-mechanical behaviour in saturated conditions and must take into account the influence of thermal effects on the claystone. The developed THM constitutive model will be validated based on in-situ benchmark experiments. Finally, the developed models will be implemented in the process level code OpenGeoSys, which is an open source simulation software for handling coupled thermal, hydraulic, mechanical, and chemical processes in Environmental Geosciences and Geotechnics.



In-situ experiment (LASGIT) within the framework of EURAD
(Source: British Geological Survey – BGS)



To protect man and the environment and to ensure safe operation of industrial plants, the legislator has defined a wide range of requirements for all operators of such facilities. BGE TECHNOLOGY GmbH develops solutions to meet these legally defined safety requirements, always bearing in mind environmental protection and facility safety. Problem or accident analyses, radiation protection concepts, or long-term safety analyses – our services cover all aspects of nuclear safety, operational safety, environmental protection, and facility safety.

Sealing structures are often constructed entirely or partially from concrete. For their proper functioning, these sealing structures may not feature any cracks. In project UVERSTOFF, partial material models for salt, sores, and low-pH concrete and their combined model are tested and validated by means of complex laboratory tests.

Another example for our services is a study on the feasibility of a partial retrieval of waste from Stocamine, a repository in Alsace. An essential condition in this case is that the work must not impair the construction of sealing structures for the closure of the underground mine openings.

Safety-related Tests and Assessments



Laboratory investigations on borehole injections

Studies to Complete Material Models for Salt and Sorel Concrete (R&D Project UVERSTOFF)



»A material model combines experimental findings with computational verifications for structural designs and integrity demonstrations concerning long-term behaviour. It is a mathematical component for numerical simulation, which can be used to determine the expected real behaviour of a structure in its spatial and temporal development. The investigated salt and sorel concretes are construction materials that have been adapted by BGE TECHNOLOGY GmbH with regard to the special safety requirements on long-term effective sealing structures.«

Christian Lerch
Mechanical Engineer, age 60

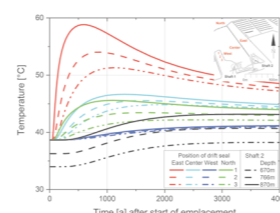
Designs for sealing systems for HLW repositories in different host rocks include sealing structures in the vicinity of the emplacement areas. After several years or decades, these sealing structures are subject to a prolonged temperature increase. According to existing concepts, some of these sealing structures will be constructed entirely or partially of concrete. To ensure their proper functioning, no cracks, which are potential pathways for gas and solutions, may be present in the sealing structures; i.e., crack limitation has to be demonstrated. As is well known, the setting heat must be taken into account for structures made of mass concrete, if thermally induced crack formation is to be avoided. Extensive studies have already been carried out on this issue. The steps necessary to determine the required parameters and to model the temperature development in the production phase of the mass concrete structure are known. In the case of heat-generating waste disposal, however, the concrete is exposed to a significant temperature increase only after it has hardened. Although it is known that hardened concrete also exhibits a thermally activated behaviour, systematic investigations are still to be carried out.

The Project Management Agency Karlsruhe has commissioned BGE TECHNOLOGY GmbH on behalf of the Federal Ministry for Economic Affairs and Energy (BMWi) with the R&D project UVERSTOFF to close this gap.

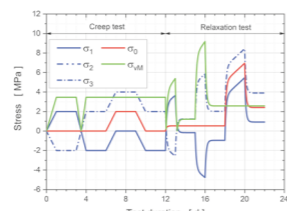
Based on the existing state of knowledge, GRS gGmbH, Braunschweig, carried out exemplary tests on cured samples of salt and sorel concrete, where a load in the form of a sudden temperature increase was applied. BGE TECHNOLOGY GmbH then used a sophisticated material model for concrete, also known as the Braunschweig model, to recalculate the experiment. The results obtained so far show that the concrete model used is qualitatively capable of describing the processes observed. The quantitative adaptation of all parameters is still pending.



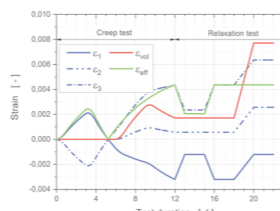
Placing of sorel concrete as mass concrete in the Asse mine



Temperature loads on sealing structures in a HLW repository



Modelling of creep and relaxation phases – test of the exemplary functionality of the material model for concrete



Study on the Partial Retrieval of Waste from Stocamine

In September 2019, BGE TECHNOLOGY GmbH was invited by Tractebel Engie, Belgium, to take part in a technical and financial study on the feasibility of partial retrieval of waste from Stocamine. An essential condition is that the work must not impair the construction of sealing structures for closing the underground site.

Stocamine is a geological repository for hazardous and highly toxic waste and was operated between 1999 and 2002. A fire in the so-called block 15 put an end to the operation in 2002, and in 2003, it was decided to irrevocably stop operations. Following several studies, a license for closure of the site was obtained provided that the mercury waste be retrieved from the underground before closure. Between 2014 and 2017, 97 % of this waste was retrieved from the mine.

However, the retrieval of the other waste continued to be in the focus of the public. Hence, further retrieval options have been investigated in several

studies since 2018. These studies all take into account the requirement that retrieval has to be realised in parallel to the closure operations without impeding them. Another major constraint is the continuous geomechanical degradation of the rock salt, which progressively leads to an enclosure of waste containers in the converging rock. Based on this process, it is assumed that retrieval will only be possible until 2029 at the latest.



Headframe of shaft Else at Stocamine (France)

BGE TECHNOLOGY GmbH develops proposals for securing the underground openings for a maximum operating period of 10 years. Several ideas concerning the refurbishment of the shaft hoisting systems to prepare them for regular operation during retrieval have already been developed; e.g., it is recommended to analyse the inner state of the reinforced concrete of the hoisting tower of shaft Else (s. figure). In addition, BGE TECHNOLOGY GmbH supports Tractebel Engie in the detailing of the retrieval procedures within the emplacement drifts. Cost estimates for all proposals are also part of the project.



»If you google "Stocamine", you will immediately find the entry: "Die kleine Asse am Oberrhein" (The little Asse at the Upper-Rhine); here chemotoxic waste is stored in rock salt at a depth of approx. 500 m. BGE TECHNOLOGY GmbH took a thorough look at Stocamine and developed proposals for the implementation of retrieval operations. Some of the technology at site dates back to the 1960s and 1970s, and convergence rates reach up to 40 mm per year.«

Niklas Betrams
Mining Engineer, age 31



The knowledge required for the disposal of radioactive waste is often very programme- and project-specific. However, many issues have already been addressed in the various international waste management programmes and are often transferable. Drawing on the knowledge and experience of others, waste management organisations can effectively prepare themselves for their tasks. In this context, training courses, consulting services, and status reports are common and well-established instruments to provide the required knowledge in a customised way.

Over the years, BGE TECHNOLOGY GmbH has acquired extensive know-how in all areas of radioactive waste management and is always happy to make this knowledge available to others. Strategic planning, feasibility studies, or comparisons of variants are supplemented by cost analyses or the preparation of safety demonstrations. BGE TECHNOLOGY GmbH offers to summarise and share this knowledge taking into account the specific needs of the client. This can be in the form of status reports, individual presentations, or in one- or two-week training courses.

A good example is the request from NAGRA – responsible for the long-term management of radioactive waste in Switzerland – to prepare a status report on the international experience concerning retrievability in various waste management programmes. Special training was made available to colleagues from Pakistan – within the framework of an IAEA programme – and from China, specifically on long-term safety analyses or, more generally, on repository development.



Pakistani participants of a training course of BGE TECHNOLOGY GmbH on long-term safety analyses

Knowledge Transfer through Training



»Preparing tailor-made training courses is very time-consuming, because, in most cases, standard documents cannot be used. But the effort is worth it, because the participants are very interested and enthusiastic when they recognise themselves and their questions. This is also reflected in the conversations during breaks or after the training, when everyone is still sitting together comfortably and talks about matters beyond work.«

Dr. Thilo von Berlepesch
Managing Director, age 51

BGE TECHNOLOGY GmbH offers training courses to interested organisations and companies. The contents of these courses are based on the experience gained in numerous projects in all areas of radioactive waste management. The scope of the training courses ranges from individual lectures and presentations to one- or two-week tailor-made courses.

From November 11 to 16, 2019, two employees of BGE TECHNOLOGY GmbH and one employee of Bundesgesellschaft für Endlagerung mbh (BGE) held a training course in Beijing, which was organised by China Nuclear Power Engineering Co (CNPE) and was attended by more than 30 participants. Among other things, CNPE is responsible for the planning of the technology for repositories for high-level radioactive waste, for the safety assessments of repositories for low- and intermediate-level waste, and for the conceptual planning of the possible use of an existing mine as a repository in China.

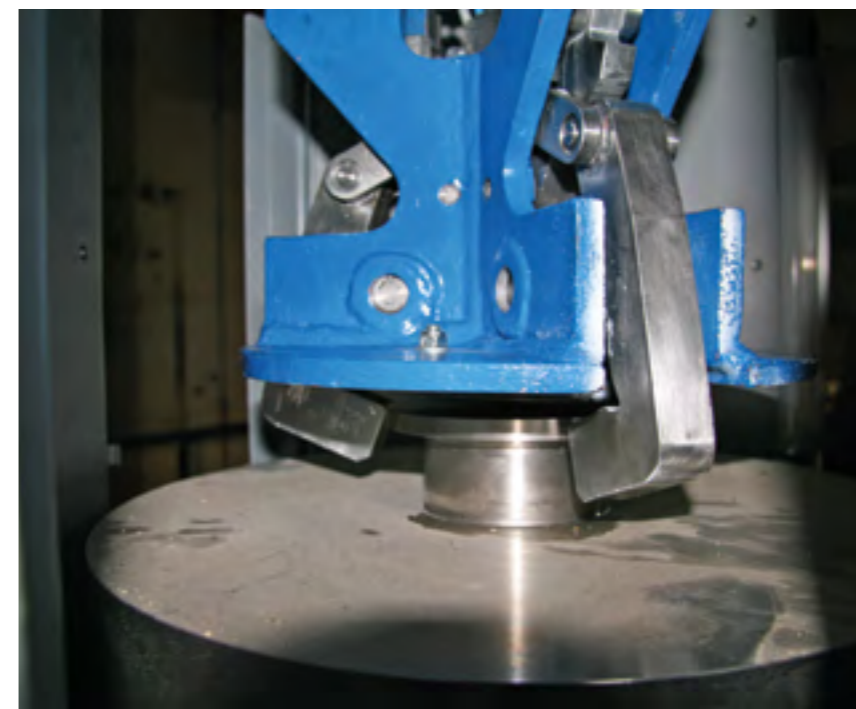
The training first dealt with the status of the site selection procedure for a repository for high-level radioactive waste in Germany and the related research and development work required. Another important module of the course was an introduction to the Konrad repository for low- and intermediate-level waste in Germany. In particular, the work and fundamentals necessary for the conversion of the mine into a repository were described, and the planning of the transport and emplacement processes was explained. Finally,

the comprehensive work of BGE TECHNOLOGY GmbH on the disposal of low- and intermediate-level radioactive waste was presented based on examples of repository concepts for Bulgaria and Iraq.

The second recent training seminar was a course on long-term safety analyses. Within the framework of the technical cooperation programme of the International Atomic Energy Agency (IAEA), BGE TECHNOLOGY GmbH organised a training course for two employees of the Pakistan Atomic Energy Commission (PAEC) and one employee of the Pakistan Nuclear Regulatory Authority (INRA) from November 18 to 29, 2019. The focus of the training at BGE TECHNOLOGY GmbH was the transfer of knowledge and experience in the field of long-term safety analyses for near-surface repositories for low- and intermediate-level waste. Within the framework of this practice-oriented training course, a first rough mathematical model was developed, which is to serve as a basis for a safety analysis of the planned Pakistani repository.

In addition to the mere transfer of knowledge, these training courses enable a lively exchange of information far beyond the training contents. With the organisations and their employees, very good relationships have been established that outlasted the training period and are mutually beneficial.

Status Report on Retrievability for NAGRA



Demonstration test for the retrieval of a spent fuel canister from a borehole carried out by BGE TECHNOLOGY GmbH in Landesbergen (Germany)

NAGRA is in charge of the long-term management of radioactive waste in Switzerland. The Swiss waste management concept focuses on a deep geological repository. There are three regulatory licence milestones in repository licensing: general licence, construction licence, and operating licence.

The operating licence for a HLW repository requires that retrievability of the waste be possible during the operating period of the repository. Furthermore, prior to the start of repository operation, the technical feasibility of retrieval has to be demonstrated by testing respective retrieval techniques.

Thus, NAGRA will integrate waste retrieval strategies in its deep geological repository concepts. These concepts have to be developed before submission of the general licence application, which is planned for 2024. As a starting point, NAGRA commissioned BGE TECHNOLOGY GmbH with the preparation of a status report on international experience concerning retrievability in different repository programmes. Hence, BGE TECHNOLOGY

GmbH outlined the concepts and approaches for radioactive waste retrieval in selected international waste programmes, with special focus on Belgium, Canada, Finland, France, Germany, Japan, the Netherlands, Sweden, U.K. (excluding Scotland), and U.S.A. All national programmes consider retrievability only for high-level waste from reprocessing or spent nuclear fuel. The conceptual approaches for retrieval and, where existing, the technical concepts were summarised. Furthermore, the respective national regulatory boundary conditions were described.



»The possibilities to retrieve and recover emplaced radioactive waste are of great importance in the public and political debate. The project for NAGRA thus provides important background information for possible future discussions with various stakeholders.«

Dr. Toivo Wanne
Mining Engineer, age 46

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, in particular in deep geologic formations and in various host rocks (claystone in Belgium and France as well as magmatic host rock in Norway, Russia, and Ukraine) are of particular importance.

Furthermore, BGE TECHNOLOGY GmbH is involved in international consortia – in some as leader – on behalf of the European Union. The work includes the design of a repository for the safe disposal of radioactive waste in Iraq and the development of repository concepts for all types of radioactive waste in Ukraine. On behalf of the International Atomic Energy Agency (IAEA), the Company conducts a feasibility study for the final disposal of radioactive waste in Moldova. In France, the Company is involved in the planning of the French repository for high-level radioactive waste and spent fuel, while a number of smaller projects are being carried out for clients in the UK. Most recently, BGE TEC participated in a study on the sealing of boreholes 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 institutes 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 the parent company, 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 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.

RESEARCH & DEVELOPMENT

Research and development projects continue to be of major importance. In conjunction with BGE, BGE TEC thus ensures that the know-how 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, including one research project for BGE. Expenditures for research and development in the reporting period amounted to T€ 1,173 (previous year T€ 1,084).

Financial Report

BUSINESS DEVELOPMENT

According to the Federal Statistical Office (Destatis), the gross domestic product (GDP) in 2019 of bn* € 3.4 increased compared with 2018 (bn € 3.3). Adjusted for price and calendar effects, there is a slight increase of +0.6%. Due to the BGE TEC’s business model, the overall economic development in Germany has neither a short-term nor an immediate decisive influence on the Company. BGE TEC is generally active in very long-term, partly independently financed programmes with large planning horizons. R&D work is primarily divided into work for BGE and site-independent work within the framework of the Research Framework Programme, which is financed by the budget of the Federal Ministry for Economic Affairs and Energy (BMWi). As funds will continue to be assigned to the Research Framework Programme, no short-term change in the R&D framework conditions is expected.

* In accordance with Destatis 1bn = 10¹²

The Company continued its successful development over the past financial year. Turnover amounted to T€ 6,370 (previous year T€ 4,682). The net profit for the year amounted to T€ 174 (previous year T€ 23). The increase in annual result results from the final invoicing of two major projects that were scheduled for 2018. As a result, the annual result was T€ 24 higher than forecast in the previous year.

As of December 31, 2019, the Company had orders on hand amounting to T€ 4,771. Because of the extremely specialist nature of the Company’s activities, the macro-economic situation does not have any major impact on the course of business and the volume of incoming orders.

RESULTS OF OPERATIONS

Compared with the previous year, turnover increased by T€ 1,688 to T€ 6,370. This is mainly the result of two major orders with foreign contract partners invoiced in the financial year 2019. This is also reflected in the change in inventories.

The main item of other operating income is a reimbursement of T€ 97 from the German Social Accident Insurance Institution for the Raw Materials and Chemical Industry (BG RCI).

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.

Due to the slight reduction in the average number of employees, personnel expenses decreased by T€ 180 to T€ 3,268 compared with the previous year.

Other operating expenses amounting to T€ 484 (previous year T€ 472) mainly include rental expenses for office space, insurance and travel expenses.

Income taxes are divided into T€ 45 for trade tax and T€ 48 for corporate income tax (including solidarity surcharge).

The net income for the year of T€ 174 (previous year: T€ 23) corresponds to the increase in turnover.

NET ASSETS AND FINANCIAL POSITION

Compared with the previous year, the balance sheet total decreased by T€ 999 to T€ 4,788.

On the assets side, inventories decreased to T€ 667, mainly due to the final invoicing of two foreign orders.

Receivables and other assets remained largely unchanged compared with the previous year. In particular, they include claims arising from intercompany performance accounting for services rendered to BGE.

The item "cash on hand and bank balances" increased by T€ 523 to T€ 2,978 compared with the previous year's reporting date.

On the liabilities side, equity increased to T€ 2,810 and includes the profit brought forward in 2018 of T€ 23.

Provisions mainly comprise pension obligations (T€ 324; previous year T€ 272) and other provisions mainly for personnel-related expenses (T€ 338, previous year T€ 229). Overall, the level of provisions increased slightly from T€ 651 to T€ 679.

Corresponding to the decrease in inventories, liabilities decreased by T€ 1,201 to T€ 1,299 compared with the previous year. The largest single item at T€ 1,002 relates to customer advances received in the form of financial advances for uncompleted and not yet finalised orders.

The equity ratio increased from 45.6 % to 58.7 % due to the decrease in liabilities. Equity capital

continues to completely finance 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, 2019, the Company's workforce consisted of 32 employees. The proportion of women is 31 %. 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.

The order volume as of December 31, 2019, amounting to T€ 4,771 continues to be at a high level. Utilisation of employee capacity is almost fully secured for 2020 and partially for 2021. The Company's activities continue to focus on developing and expanding the unique know-how of the BGE/BGE TECHNOLOGY GmbH group in order to be able to offer high-quality services on a national and international level. In 2020, 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.

With a consistent level of orders on hand but without taking into account extraordinary incidents, the Company expects a positive level of earnings of approximately T€ 75 in 2020. A positive annual result is also expected in the medium term. This is a sign of economic stability even though is not the determining corporate purpose.

The pandemic caused by the coronavirus in 2020 requires a reassessment of the risks of BGE TEC. For simplification, a distinction is made between internal and external risks.

The internal risk lies in the potential infection of employees and the resulting possibility of orders not being processed. In extreme cases, this may result in breaches of contract and loss of earnings. However, the probability that this will occur is considered to be low. On the one hand, work packages can usually be postponed by several weeks without endangering the related overall projects. On the other hand, BGE TEC and BGE had implemented measures to protect their employees at a very early stage. These include in particular the strict restriction of business trips, increased mobile working, and distance rules. To date, none of the employees of BGE TEC or their immediate families have reported infection with coronavirus. The already low sickness rate of 2.69 % in the first quarter of 2020 will probably even be undercut. As the annual forecast assumed a sickness rate of about 4%, individual infections probably had no effect on the result.

However, the relatively low risk is offset by additional expenses, particularly for coordination and organisational processes. Especially the provision of technical equipment for mobile working was very time-consuming. There is

also an increased need for coordination in order to organise work and coordinate measures. At this time, a quantitative assessment of the expenditures is not possible.

External risks exist primarily where BGE TEC works together with partners. However, the projects of BGE TEC are essentially characterised by the fact that the individual work packages can be processed independently. Although various work packages require input from others, the projects are organised in such a way that work packages can be postponed over several weeks. Thus, the external risk is low.

Overall, a slight decline in turnover and business result due to the coronavirus restrictions is expected. At this stage, quantification is not yet possible. There is only a low risk for reduced work capacity and breach of contracts. Potential effects of reduced opportunities for business initiation and more difficult coordination before and during project implementation will become effective only after 2020 and can be reliably assessed only in a long-term review. Furthermore, there are sufficient liquidity reserves to secure continued existence of BGE TEC for several months.

Annex to the Financial Year 2019

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 TECHNOLOGY GmbH 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 were calculated on the basis of actuarial calculations using the projected unit credit method taking into account the "Mortality Tables 2018 G" of Prof. Dr. Klaus Heubeck, Cologne. The reported pension obligations for individual commitments are governed exclusively 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 2.72 % (previous year 3.21 %). Salary dynamics remain unchanged at 2.5 %, while pension dynamics continue to be taken into account at 1.0 %. In accordance with Section 253 (6) Clause 3 HGB, the difference between the 7-year average interest rate (1.97%; previous year 2.33%) and the 10-year average interest rate

amounts to T€ 49. 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 were calculated based on average archiving periods 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 1.59 % (previous year 1.93 %).

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

Liabilities are reported at the settlement amount.

The asset surplus of deferred taxes was not reported. The measurement 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, 2019

Assets

	Notes	31.12.2019 T€	31.12.2018 T€
A. Fixed assets	(1)		
I. Intangible assets		2	4
II. Tangible assets		47	78
III. Financial assets		(€ 250,00)	(€ 250,00)
		49	82
B. Current assets			
I. Inventories	(2)		
1. Work in progress		578	1,928
2. Advance payments		89	207
		667	2,135
II. Receivables and other assets	(3)		
1. Trade accounts receivable		232	217
2. Receivables from affiliated companies		847	743
3. Other assets		8	151
		1,087	1,111
III. Cash on hand, bank balances		2,978	2,455
		4,732	5,701
C. Prepaid expenses and deferred charges		7	4
		4,788	5,787

Equity and Liabilities

	Notes	31.12.2019 T€	31.12.2018 T€
A. Equity			
I. Subscribed capital	(4)	511	511
II. Capital reserves	(5)	179	179
III. Revenue reserves	(6)	1,923	1,923
IV. Profit brought forward		23	0
V. Net profit for the year		174	23
		2,810	2,636
B. Provisions			
1. Provisions for pensions		324	272
2. Tax provisions	(7)	17	150
3. Other provisions	(8)	338	229
		679	651
C. Liabilities	(9)		
1. Advance payments received		1,002	2,149
2. Trade payables		56	70
• thereof with a remaining term of up to one year T€ 56 (T€ 70)			
3. Payables to affiliated companies		10	59
• thereof with a remaining term of up to one year T€ 10 (T€ 59)			
4. Other liabilities		231	222
• thereof with a remaining term of up to one year T€ 231 (T€ 222)			
• thereof taxes T€ 210 (T€ 211)			
		1,299	2,500
		4,788	5,787

Notes to the Balance Sheet

Assets

1. Fixed assets

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

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

2. Inventories

	31.12.2019 T€	31.12.2018 T€
Work in progress	578	1,928
Advance payments	89	207
	667	2,135

3. Receivables and other assets

	31.12.2019 T€	31.12.2018 T€
Trade accounts receivable	232	217
Receivables from affiliated companies	847	743
Other assets	8	151
	1,087	1,111

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

Receivables from shareholders amount to T€ 847 (previous year: T€ 743) and mainly consist of claims against the parent company for project work and of the final settlement of orders with foreign customers. The other assets relate to tax refund claims.

Equity and Liabilities

4. Subscribed capital

Subscribed capital remains unchanged at T€ 511. It is fully paid up and is held to 100 % by Bundesgesellschaft für Endlagerung mbH (BGE), Peine.

5. Capital reserves

Capital reserves originate from other contributions according to (Section 272 (2) Clause 4 HGB).

6. 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.

7. Tax provisions

The tax provisions amounting to T€ 17 relate to expected payments for corporate income tax and trade tax for the financial year 2019.

8. Other provisions

	31.12.2019 T€	31.12.2018 T€
Employee-related provisions	295	186
Archiving costs	21	21
Other obligations	22	22
	338	229

Employee-related provisions amounted to T€ 295 and include in particular costs for special compensations and vacation remunerations.

9. Liabilities

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

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

Other liabilities consist primarily of value-added tax and wage tax obligations, which are still outstanding to an amount of T€ 210.

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

Contingencies and Other Financial Obligations

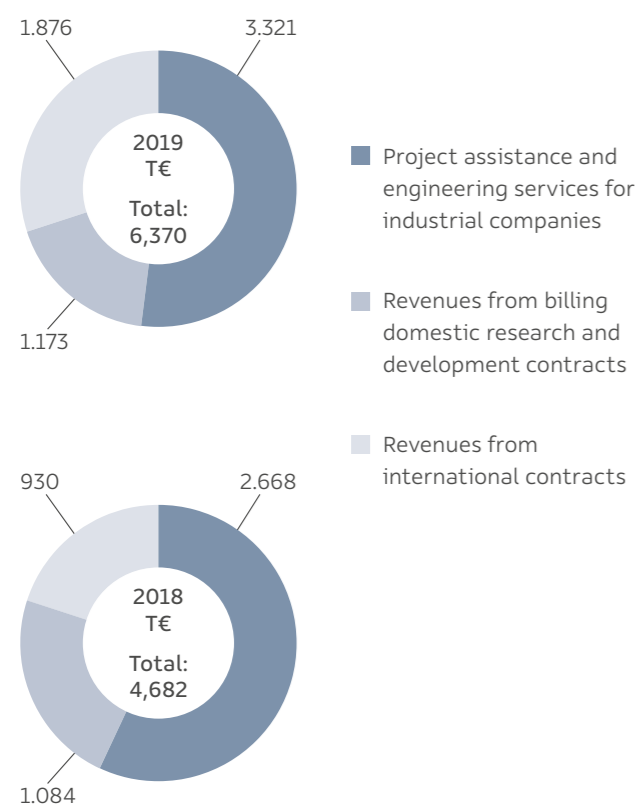
The Company conducts its business activities in rented office space. This results in payment obligations of T€ 304.

As of the balance sheet date, there were no significant contingencies or other financial obligations.



Notes to the Income Statement

10. 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.

11. Changes in inventories

The decrease in inventories of T€ 1,349 results from orders settled as of the balance sheet date.

12. Other operating income

Other operating income decreased on balance by T€ 76 to T€ 158. In 2019, income unrelated to the accounting period amounting to T€ 110

(previous year T€ 167) was recorded. Income unrelated to the accounting period results from the reimbursement of contributions to the German Social Accident Insurance Institution for the raw materials and chemical industry (BG RCI) for 2018 (T€ 97) and a credit of T€ 13 from the architects' liability insurance.

13. Cost of materials

	2019 T€	2018 T€
Cost of raw materials, consumables and supplies and of purchased merchandise	32	12
Cost of purchased services	1,079	1,052
	1,111	1,064

The cost of materials includes expenses for purchased services, mainly for project assistance by third parties and by the parent company (T€ 1,013; previous year T€ 1,026) as well as maintenance costs for assistance to orders relating to the Asse mine (T€ 59; previous year T€ 20).

14. Personnel expenses

Personnel expensed decreased by T€ 180 to T€ 2,642, corresponding with the slight year-on-year decline in the number of employees.

15. Other operating expenses

The other operating expenses of T€ 484 (previous year T€ 472) mainly relate to rents (T€ 133; previous year T€ 151), insurance expenses (T€ 65; previous year T€ 75) and travel expenses (T€ 148; previous year T€ 111). As in the previous year, they do not include any expenses relating to other periods. This item includes currency conversion expenses of T€ 1 (previous year T€ 0).

16. Interest and similar expenses

	2019 T€	2018 T€
Interest on pension provisions	9	5
Interest and similar expenses	2	2
	11	7

17. Taxes on income

For the current financial year, taxes on income include trade tax (T€ 45) and corporate income tax (incl. solidarity surcharge) at T€ 48.

Other Disclosures

Annual average number of employees

On an annual average, the company had 29 employees (previous year 30 employees).

Remuneration of corporate bodies

Details concerning total remuneration of management have not been disclosed with reference to Section 286 (4) HGB.

Auditor's fees

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

As there are sufficient free reserves, distribution restrictions do not apply.

Appropriation of Net Income

Subject to the approval of the sole shareholder, the net profit for the year (T€ 174) and the profit brought forward from 2018 (T€ 23) are to be distributed.

Group Affiliation

BGE TECHNOLOGY GmbH, Peine, 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 the Company 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.

Management

Dr. Thilo von Berlepsch, Peine

Dr. Thomas Lautsch, Peine

Events after the Reporting Period

Due to the restrictions imposed by the coronavirus, a slight decline in turnover and earnings is expected in 2020. At this stage, quantification is not yet possible. There is only a low risk for reduced work capacity and breach of contracts. Potential effects of reduced opportunities for business initiation and more difficult coordination before and during project implementation will become effective only after 2020 and can be reliably assessed only in a long-term review. Furthermore, there are sufficient liquidity reserves to secure continued existence of BGE TEC for several months.

Peine, March 31, 2020

Dr. Thilo von Berlepsch
Managing Director

Dr. Thomas Lautsch
Managing Director

Fixed Assets Movement Schedule

Acquisition and Production Costs

	As of 01.01.2019	Additions	Disposals	Re- transfers	As of 31.12.2019
	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	0	0	141
	141	0	0	0	141
II. Tangible assets					
1. Other equipment, operating, and office equipment	252	5	16	0	241
	252	5	16	0	241
Sub-total	393	5	16	0	382
III. Financial assets					
1. Other loans	(250 €)	0	0	0	(250 €)
	(250 €)	0	0	0	(250 €)
Total fixed assets	393	5	16	0	382

Impairments

Net Book Values

Accumulated depreciation 01.01.2019	Additions	Disposals	Re- transfers	Accumulated depreciation 31.12.2019	As of 31.12.2019	As of 31.12.2018
T€	T€	T€	T€	T€	T€	T€
137	2	0	0	139	2	4
137	2	0	0	139	2	4
174	36	16	0	194	47	78
174	36	16	0	194	47	78
311	38	16	0	333	49	82
0	0	0	0	0	(250 €)	(250 €)
0	0	0	0	0	(250 €)	(250 €)
311	38	16	0	333	49	82



Training courses of BGE TECHNOLOGY GmbH



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