



Our Research Strategy





Imprint

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for the Safety
of Nuclear Waste Management
Bundesamt
für die Sicherheit
der nuklearen Entsorgung (BASE)

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Preface



Ensuring safety in nuclear waste disposal is the overriding concern in all actions of the Federal Office for the Safety of Nuclear Waste Management (BASE)*, and research is an essential tool in this respect. Research challenges existing knowledge as well as concepts and models. It examines open questions and fills knowledge gaps. Safety can evolve on the basis of scientific findings. Safety in nuclear waste management does not only encompass the safe final storage of radioactive waste. It also includes the safe operation of remaining nuclear power plants until they are decommissioned as well as their dismantling, the safe transport of radioactive waste and the operation of interim storage facilities. Furthermore, professional expertise must be developed and maintained.

As a regulatory authority, BASE performs licensing and oversight tasks in the following areas: final storage, the site selection procedure and the interim storage and transport of radioactive waste. BASE is responsible for public involvement in the search for a repository site and provides expertise on radioactive waste management.

The scientific work carried out in-house enables BASE to assess issues on the basis of the current state of science and technology, and to interact at eye level with national and international experts. There are important tasks ahead in the years to come, and all actors must address them responsibly. The questions are diverse and complex, and answering them requires the pooling of knowledge from a wide range of disciplines. The tasks include, in particular, dealing with questions on the prolonged interim storage of high-level radioactive waste, safety in nuclear technology and the implementation of the site selection procedure. The present research strategy outlines the main features of BASE's scientific orientation for the coming years. It describes BASE's understanding of its tasks and duties as a federal institution responsible for research and development. This strategy is an invitation to scientists, involved actors and members of the general public to partake in the scientific work regarding the safety of humans and the environment.

* German translation: Bundesamt für die Sicherheit der nuklearen Entsorgung

Summary

→ To perform its tasks, BASE conducts research, in particular, on the following topics: site selection procedure and final repository safety, public participation, interim storage and transport of radioactive waste, and nuclear waste management safety.

→ BASE sees itself as responsible not only for its own, task-based research, but also for the overall organisation and coordination of research in the field of nuclear waste management and the associated framework conditions.

→ The research strategy defines the principles and overarching objectives of BASE research: to adhere to and further develop the current state of science and technology, to promote innovative solutions, to scrutinize concepts, to identify knowledge gaps and, if possible, to fill them, to prepare well-founded decisions on a scientific basis, to maintain professional exchange and, in doing so, to maintain and promote scientific competence at BASE.

→ Engagement in research is a central prerequisite for implementing BASE's self-image as a learning and self-questioning authority.

→ BASE addresses research questions both by commissioning research projects to external institutions and by working on research projects in-house.

→ BASE's research pursues the goal of supporting sustainable structures in the research landscape, counteracting the shortage of skilled workers and ensuring sufficient capacities to solve future research questions. To this end, BASE strives, for example, to supervise and promote university theses.

→ BASE is committed to plurality and competition in research. To ensure competition, quality, independence and diversity in research, BASE strives to increase the involvement of international applicants in the research commissioning process.

→ In general, research findings are always published. In addition, BASE aims to make the findings comprehensible for a non-scientific public.

→ BASE research activities are based on transparent and comprehensibly substantiated procedures. Suitable participatory formats allow for public involvement in research planning.

→ BASE networks and cooperates at national and international level. It participates in national and international committee work, with the aim of increasing nuclear safety. The research findings obtained by BASE contribute to this. In addition, cooperation and networking serve to foster the scientific exchange as well as the pursuit of the latest advances in science and technology.

→ Research planning at BASE takes place in three stages with increasing specification:

I

The research strategy of BASE defines the overarching and long-term goals.

II

The research agenda specifies these goals in greater detail. On a medium-term time axis (approx. four years), it describes the priorities of the research needs in individual subject areas.

III

BASE's annual research plan identifies specific research questions and projects in the individual subject areas in accordance with technical requirements.



1. BASE – Why and how we do research

BASE is an independent scientific and technical federal institution under the authority of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)*. The primary goal of our research is to further develop nuclear safety.

To fulfil our legally stipulated duties, we need a wide range of expertise in many areas, e.g. the safety of nuclear facilities, interim storage and transport, and deep geological disposal:

- Supervision of the site selection procedure to identify the final repository site for high-level radioactive waste with the best possible safety
- Responsibility for the relevant public participation processes
- Approval and licensing tasks regarding the storage and transport of radioactive materials
- Planning approval, licensing, and supervision of repositories under mining and nuclear law
- Providing expertise to BMUV on questions of nuclear safety pertaining to operation, decommissioning and nuclear waste management
- Registration, evaluation and public announcement of reportable events in nuclear facilities and final repositories
- Long-term documentation of all relevant data and documents relating to the interim and final storage of radioactive waste

BASE has a comprehensive, legally incorporated mandate to carry out research in the field of nuclear safety, which goes beyond the purely supervisory and licensing-related tasks. Its research provides the basis for independent advice and decisions.

* German translation: Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz

BASE understands research to be an open-ended, systematic process based on recognised scientific methods to gain new knowledge. Research starts with the current state of science and aims to expand it step by step. It moves towards unknown territory to push the boundary between knowing and not knowing. The research process can, thus, not be predicted in detail and is never complete. Rather, it must remain permanently open to professional criticism and doubt.

Knowing



BASE is required to make legally compliant decisions in many of its areas of responsibility. It is also a federal institution tasked with research and development. BASE, thus, stands at the crossroads between research and decision-making; the idea being that research serves to ensure and further improve the quality of decisions. When it comes to a highly complex topic such as nuclear safety, research is a tool for constantly re-evaluating existing methods, analyses and knowledge. This way, safety can be continuously improved. Research can, thus, make a significant contribution to a science-based, learning and self-questioning work method.

A qualified and interdisciplinary team of employees is the basis for the complex fulfilment of tasks pursuant to the scientific and technological state of the art. These employees regularly exchange information with national and international experts, thus, continuously consolidating and expanding their knowledge and competences.

Departmental research encompasses the research and development activities of the federal government and the federal states that serve the science-based preparation, support or implementation of government decisions. These activities are, thus, inseparably linked to the performance of public tasks. Subordinate authorities and institutes, in particular, are active in departmental research. Their findings and competences constitute the scientific advisory basis for political decisions of the ministries (departments).

Not knowing

Depending on the respective scientific questions, the task-based research is either carried out by in-house staff, commissioned to external contractors, addressed in collaboration with third-party funded projects and research networks or, potentially in the long term, through funding of independent project proposals submitted for research topics specified by the BASE. To ensure a high standard of scientific work, a systematic research management system is established, quality assurance is guaranteed, and external scientific expertise is consulted. Regular evaluations also serve to continuously improve the scientific approach.

2. Objectives of our research

BASE has defined seven overarching goals for its research:

Examine open questions and fill knowledge gaps

The work of BASE gives rise to scientific questions that require answers. This concerns the safety and security of radioactive-material transport, of interim and final radioactive-material storage as well as of other nuclear facilities. The site selection procedure, conducted for the first time in this format, requires a regulatory investigation of new issues for which there is no empirical data. Research identifies previously unconsidered topics that harbour risks or uncertainties, and contributes to finding solutions. Methods for evaluating complex issues as well as those for an objective, safety-based examination are being further developed and validated.



Questioning of concepts and models

Even established scientific concepts and models can entail restrictive assumptions and limited areas of validity. These can make it difficult or even impossible to transfer such concepts and models to new or changed circumstances. Research looks at and questions established models with regard to conditions that have not been considered so far or, for example, replaces purely descriptive models with models that account for a deeper understanding of processes. This approach helps to identify and overcome previously unrecognised limitations and to make reliable statements about complex and long-term processes based on a more precise understanding of causal relationships.



Support the performance of official duties

The objective of our research is to strengthen the regulatory and supervisory competences of BASE. Research findings are prepared for the respective decision-makers in a way that is appropriate to this target audience. This facilitates transparent, goal-oriented decisions based on the current state of science and technology.

Sustainable and long-term development of competences

The Atomic Energy Act* and the Site Selection Act** stipulate that the current state of science and technology shall serve as the basis and benchmark for decisions. This requires a sustainable and long-term development of competence. Ensuring both safety as the overriding goal as well as the evaluation of corresponding issues requires researchers to critically examine the underlying scientific methods. Internal research activities promote such a critical analysis.

Efficient knowledge transfer and an open professional exchange between staff members help to ensure the long-term development of competence. The integration of academic theses (diploma/master's, doctorate) into BASE's research is done with the intention of supporting young scientists, and fostering cooperation and scientific exchange with universities and research institutions. The involvement of BASE scientists in academic teaching also is intended to support these goals. Research funding and the commissioning of research projects also contribute to the goals of supporting efficient structures in the research landscape and promoting competence development at research institutions.

National and international networking

Internal research activities are necessary to provide expertise for national and international cooperation. In return, the exchange with national and international experts serves to strengthen the professional competences of BASE staff, thus, promoting the development and expansion of national and international cooperation at BASE. Research findings are to be increasingly published internationally, so as to facilitate international exchange and increase BASE's visibility in professional circles worldwide.

* German translation: Gesetz über die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren (AtG)

** German translation: Gesetz zur Suche und Auswahl eines Standortes für ein Endlager für hochradioaktive Abfälle (Standortauswahlgesetz - StandAG)

Supporting participation

The active communication of research questions and findings is a prerequisite for public trust in the work of BASE. BASE uses participative approaches and formats such as workshops and internet consultations in research planning and in the discussion and evaluation of research findings. Interested citizens and civil society organisations are, thus, encouraged to independently reflect on current issues and follow the work of BASE and other actors. BASE strives for a stronger public involvement in research. BASE will review information and scientific findings published by civil society actors with an open mind and, where necessary, incorporate them into its own scientific work.

In principle, BASE will publish information about research projects and the resulting findings. The addressees include other authorities and institutions, the scientific community and the interested public. Furthermore, BASE considers it essential to prepare research findings in a way that is comprehensible also to a non-scientific public, and to communicate said findings using suitable formats.

BASE will align and prioritise its research activities according to a comprehensible procedure. In addition, processes will be evaluated at regular intervals to ensure continuous improvement.

Use time horizons for further improvement of safety

The tasks involved in nuclear waste management - from interim storage and the search for a repository site to the construction, operation and closure of the repository - will take decades. Knowledge gains in all areas can be expected for this period. Therefore, one aspect of research is to pursue new approaches and to test procedures or technologies at an early stage to ensure the highest possible safety level at all times. In this context, BASE's research mission includes the investigation of the technical and temporal feasibility of concepts that have not yet been fully developed, for example, to improve the safety of repositories or safety assessments. Where required, BASE will also launch its own research projects to investigate the advantages and disadvantages of new developments in external research. In doing so, BASE must be able to follow up on research needs identified at short notice.

3. Our fields of research

The research fields named here result directly from the legally defined tasks of BASE. The specific research questions are presented in the separately published research agenda for the next four years. Interfaces between the research fields require comprehensive, interdisciplinary cooperation:



**Nuclear disposal
and safety of final
repository**



**Information management
and long-term
documentation**



Site selection procedure for a final repository for high-level radioactive waste



Interim storage of high-level radioactive waste

Research fields



Safety of nuclear facilities in operation, decommissioning and dismantling as well as nuclear security



Transports of radioactive materials and approval procedure for packages (containers)

Dealing with uncertainties and lack of knowledge (including risk communication)



Public participation

Social science and socio-technological questions



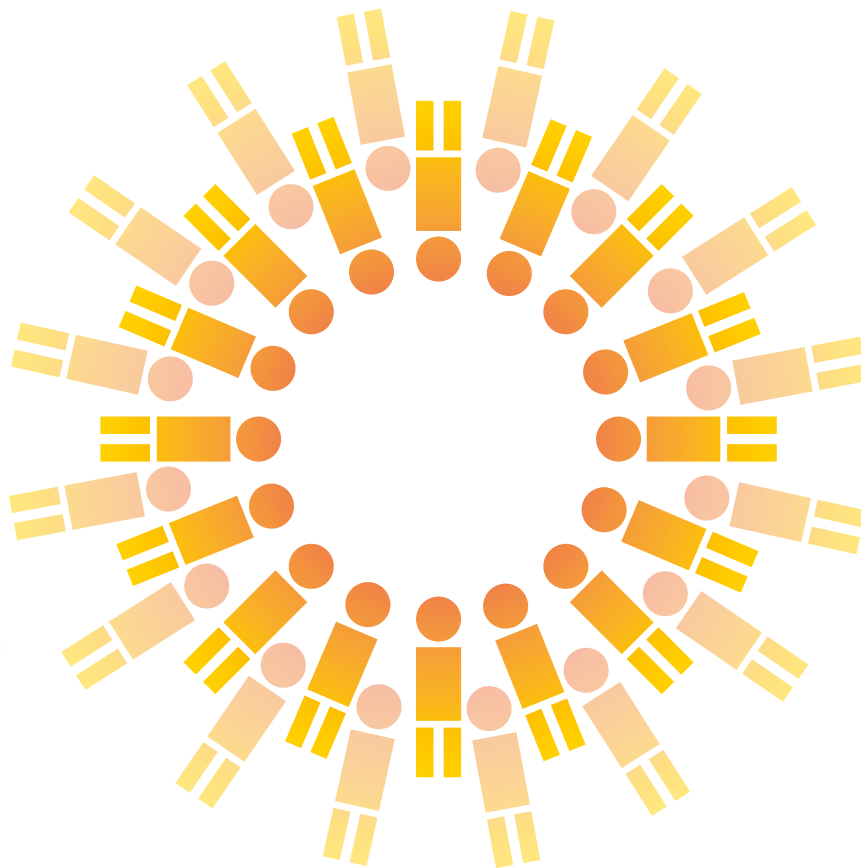
Safety management and safety culture as well as human and organisational factors



Historical and social science research (in the context of nuclear safety)

Due to the nature of its tasks, BASE's range of research topics will partially overlap with the research activities of other actors - in particular the Federal Company for Radioactive Waste Disposal (BGE mbH)*, which serves as the implementer. Despite these overlaps, BASE strives to minimise the duplication of research, even if redundant research may be necessary in some cases for verification and/or for ensuring quality and knowledge retention. Occasional overlaps are unavoidable because each institution must look at the same questions from a different perspective, and assess them independently.

* German translation: Bundesgesellschaft für Endlagerung mbh



Public participation

In the context of nuclear safety, BASE understands public participation to include all procedures in which the public can actively partake in governmental planning and decision-making processes. This also includes formats that go beyond legal requirements. Public participation can help governmental decision-making processes achieve better results, or at least promote the acceptance of a decision. To achieve this, different viewpoints and interests are considered and discussed. At BASE, participation encompasses the following three elements:

- Informing the public in an active and activating way: an informed public is a necessary prerequisite for the further stages of public involvement. Yet, informing the public does not mean involving the public.
- Creating spaces for discussion between BASE and the various stakeholders in the run-up to decisions. Stakeholders are persons or groups who have an interest in the course and outcome of a decision-making process: this can be citizens, initiatives and associations, companies (e.g. BGE mbH and the Federal Company for the Intermediate Storage of Radioactive Waste (BGZ)**), committees (e.g. the National Citizens' Oversight Committee (NBG)***) and representatives of federal and local politics as well as of the federal states.
- Co-designing of procedures according to predefined rules.

Participation in the work of BASE must be safety-oriented and does not apply to areas for which the legislator has directly transferred the responsibility for safety-relevant decisions to BASE.

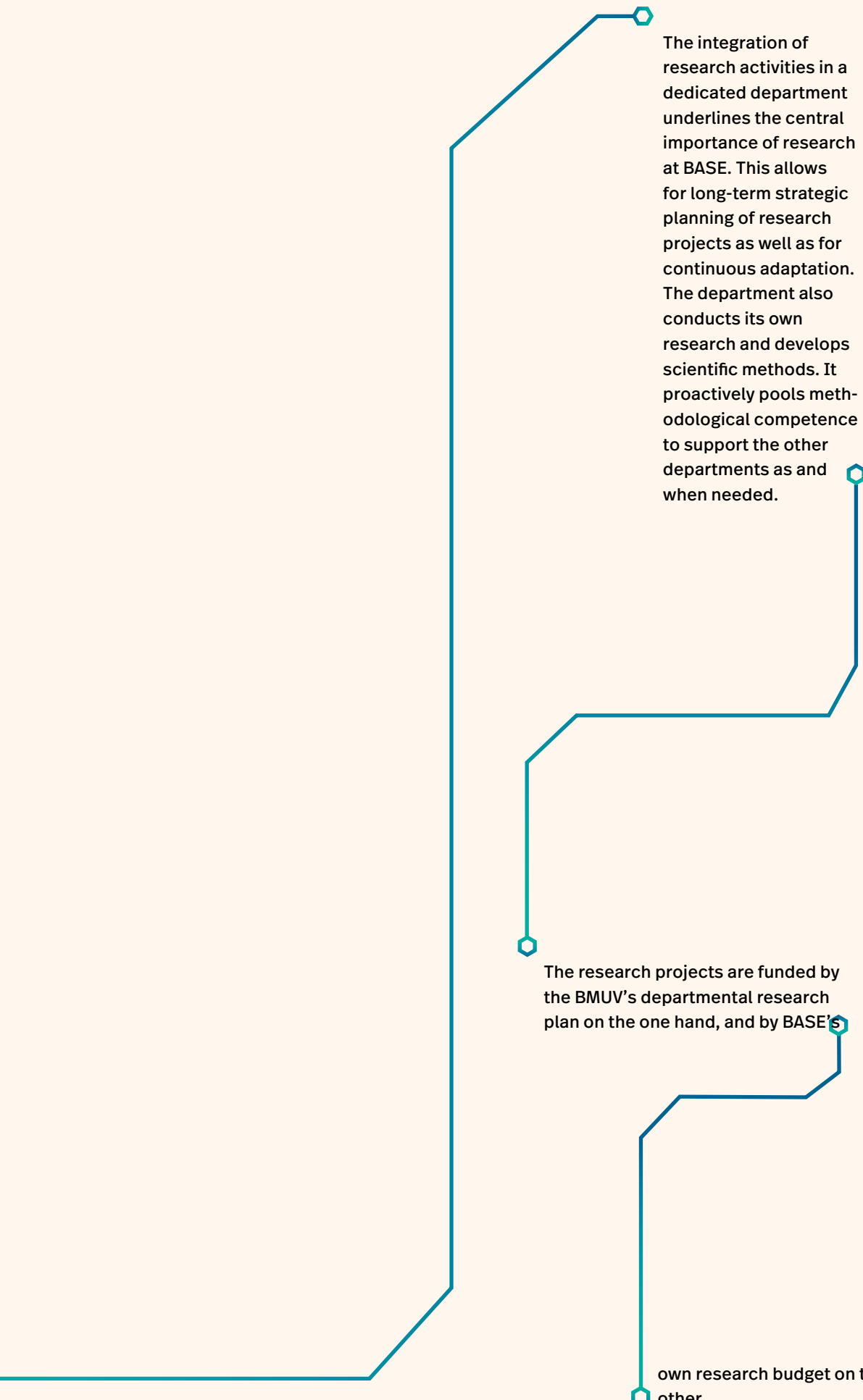
** German translation: BGZ Gesellschaft für Zwischenlagerung mbH

*** German translation: Nationales Begleitgremium

4. Research management

In the course of its duties, BASE must always use the current state of science and technology as the basis and benchmark for its decisions. To keep abreast of developments and to foster scientific work, BASE continuously assesses the need for research in all of its departments.





The integration of research activities in a dedicated department underlines the central importance of research at BASE. This allows for long-term strategic planning of research projects as well as for continuous adaptation. The department also conducts its own research and develops scientific methods. It proactively pools methodological competence to support the other departments as and when needed.

The research projects are funded by the BMUV's departmental research plan on the one hand, and by BASE'S

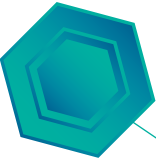
own research budget on the other.

Third-party funded research projects are also planned for the future.



Research planning

The research agenda is a central tool for research planning, and serves as a guideline for BASE's research activities. It is used to determine task-related research needs for a period of four years. The research needs arise primarily from BASE's actual statutory tasks. However, the research agenda also identifies further research needs in the field of nuclear safety that go beyond BASE's own research activities. Furthermore, it considers topics that require long-term, forward-looking preparatory work to participate in foreseeable developments early and to be able to adequately react to future requirements. This so-called preliminary research looks at time horizons of five years and more. The research agenda is developed by the research department in cooperation with other departments.



In accordance with the federal government's „Concept of Modern Departmental Research“, BASE will update its research agenda every four years. Specific BASE research projects based on the agenda will be formulated annually and prioritised in BASE's research plan. The prioritisation is based on the importance of the content as well as the urgency or, more specifically, the time by which the need for knowledge must be met at the latest.

BASE considers the content of the projects of other ministries in its research planning by means of early inter-ministerial coordination.

* German translation: Konzept einer modernen Ressortforschung

The role of BASE in departmental research on the safety of nuclear disposal

The role and responsibilities of BASE in the site selection procedure and the changes in responsibility and perspective as a result of the decision to phase out the use of nuclear energy have also changed the research landscape. As the central federal authority for the safety of nuclear waste management, BASE sees itself in the responsibility for giving important impetus in this field. To support the search for the repository site with the best possible safety, and to purposefully develop and maintain competence in nuclear waste management, interdepartmental agreement and coordination of research is necessary. BASE aims to play a decisive role within this framework. For this, it strives to promote an intensive (interdepartmental) exchange of research findings, as well as the subsequently identified research needs and programmes.

Working on research questions at BASE

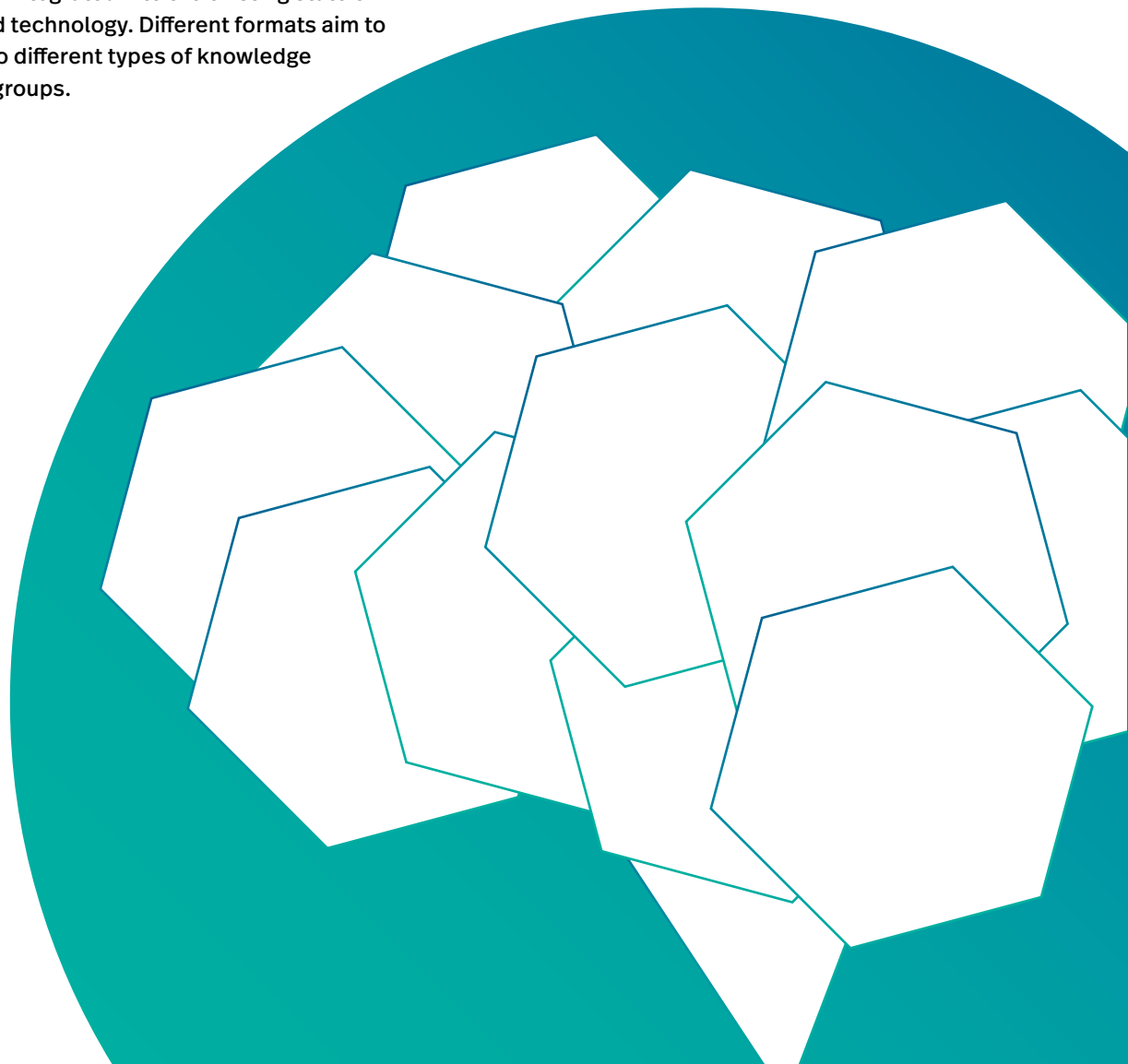
Depending on the complexity of a scientific question as well as the experience, resources and tools needed to address it, research is carried out either by BASE scientists or by external contractors. In this process, BASE continuously develops its own research capacities. This contributes, in particular, to promoting and maintaining competence at BASE, and allows for collaboration at eye level with other actors in the research community. BASE must be able to perform responsible and legally compliant assessments, and to review expert opinions and statements by third parties in a substantiated manner. The often complex and interdisciplinary issues BASE deals with require an in-depth understanding of the relevant processes. Internal research can contribute greatly to acquiring the necessary knowledge.

BASE will announce research projects to a wide circle of potential contractors to promote competition and strengthen diversity in the research landscape, thus, ensuring transparency. To be open to ideas from outside in the scope of the „learning process“ and to create incentives for outsiders, the option of a more flexible funding of independent research proposals in relevant subject areas is also to be considered. The decisive factor for potential funding is that such research proposals must demonstrate advances in the fields of activity of BASE and be particularly promising from a scientific point of view.

Research as part of a self-questioning authority

It goes without saying that the current state of knowledge must be evaluated, taking into account the remaining uncertainties, and represented publicly. In the sense of a „self-questioning process“, BASE aims to systematically reflect upon its actions and knowledge, and to critically analyse and examine the achieved state on an ongoing basis. Research is based on this guiding principle, which should also and particularly apply to all scientific employees at BASE. This way, research will contribute to achieving set goals. BASE fosters an open internal and external communication, and promotes scientific diversity of opinion. This serves to support continuous professional improvement and to promote mutual, constructive criticism at and between all levels, making research an element of the safety culture at BASE.

Understanding research at BASE as a learning system means working on the continuous development and consolidation of knowledge. The challenge is to see the extension of knowledge as an opportunity to learn as an institution, and to review and, if necessary, correct past decisions. Findings from research must therefore be documented in a comprehensible manner and integrated into the existing state of science and technology. Different formats aim to do justice to different types of knowledge and target groups.



Quality assurance and documentation

In addition to internal approaches to quality management at BASE, all research projects are based on the common quality standards for scientific work, such as the recommendations of the German Research Foundation (DFG)** for good scientific practice. Upon completion, research projects are to be evaluated with regard to the achievement of objectives. If necessary, BASE will determine the need for further research. BASE will publish research results in project reports and scientific publications, and present them at conferences and in committees. BASE will publish articles and conference contributions in journals with scientific quality assurance (peer review). Peer-reviewed publications are also encouraged on the part of the contractors. Publications should be freely accessible to the public. Research results will be prepared for the public in a generally understandable way, and be made available for discussion as and when needed. A critical, professional exchange with external scientists and the interested public is a necessary component of good research.

** German translation: Deutsche Forschungsgemeinschaft

Peer-Review is a method of reviewing and assessing (research) work by experts from the same field of research (peers), who act as independent, usually anonymous, reviewers. Peer review procedures serve to ensure quality, and have been common practice in the scientific community for a long time. Due to external quality assurance, peer-reviewed publications are considered to be more scientifically recognised.



Outlook

The research strategy establishes a long-term framework for research activities at BASE. It not only considers the purely scientific aspects of a research activity, it also reflects BASE's self-image as a modern regulatory authority.

Thus, it not only has an outward effect on the public and the scientific community, it also serves as a framework of orientation for all scientific employees at BASE. As the time periods to be considered are very long, research fields, topics and questions as well as the national and international research landscape itself will be subject to continuous change. The research strategy must therefore be broad and flexible, to be able to react to these changes. At the same time, it is robust enough to support current and future research activities under conditions that are acceptable to BASE, as well as the public and other stakeholders.

BASE invites the public to actively and critically accompany its research activities. The research strategy can serve as a benchmark for all research activities at BASE.

Our research:
open-ended
interdisciplinary
scientifically
substantiated

Research is the basis of the learning, self-questioning system.

What are our objectives?

Expanding knowledge

Answering open questions

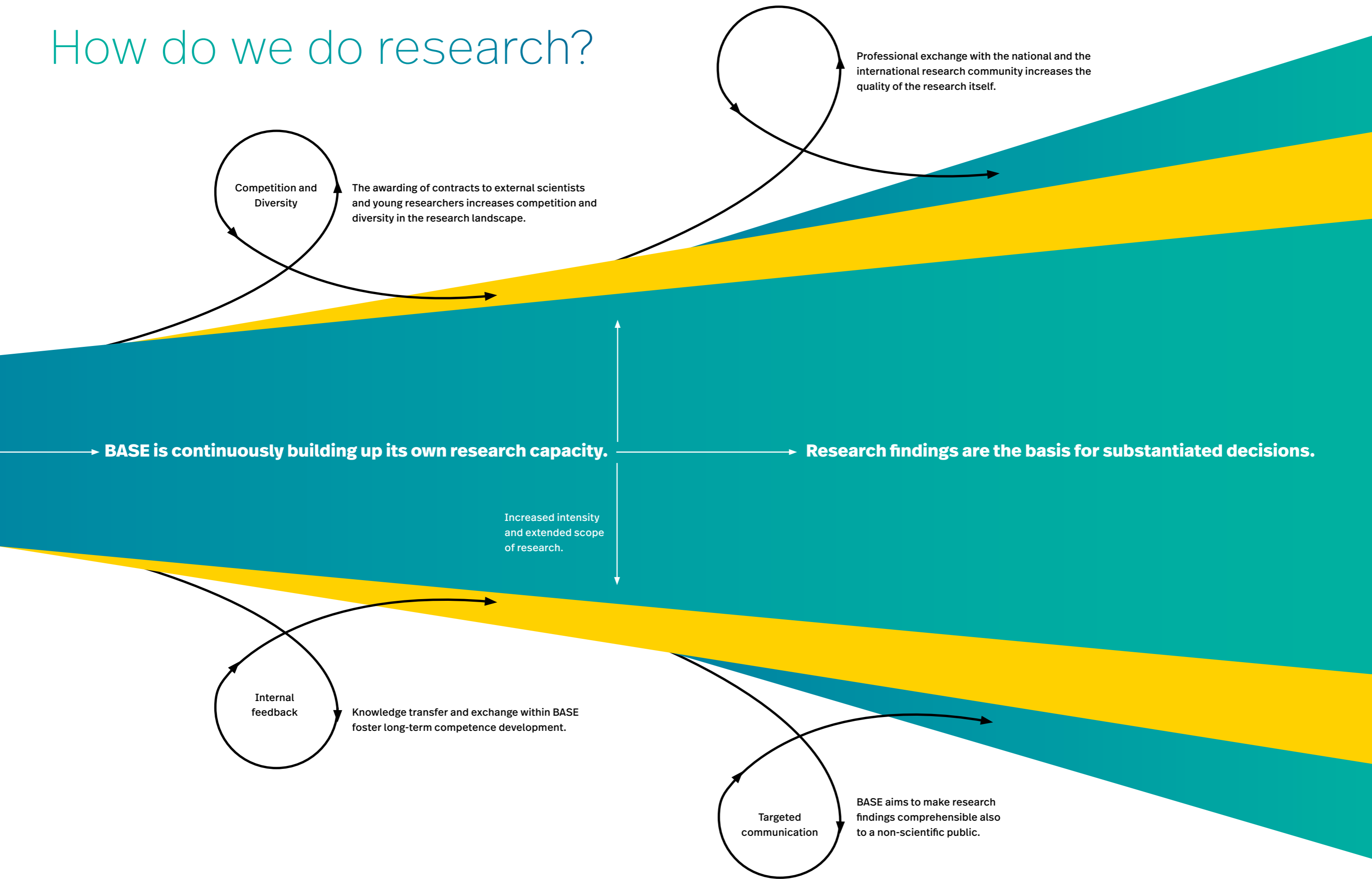
New concepts and models for complex issues

Sustainable competence development

Networking and effective exchange of knowledge

Public trust and acceptance

How do we do research?



What are our research fields?

Safety of nuclear facilities during operation, decommissioning and dismantling

Transport of radioactive materials and approval procedures for packages (containers)

Interim storage of high-level radioactive waste

Site selection procedure for a repository for high-level radioactive waste

Public participation

Repository safety

Why is research important to us?

The tasks of BASE require a high level of scientific expertise.

Quality-assured research results are the basis for independent decisions.

Based on scientific findings, safety can be continuously developed.