

Federal Ministry of Education and Research

Call for proposals

Regulations of the Geosciences for Sustainability (GEO:N) programme governing the funding of projects on the topic of

Digital geosystems: virtual methods and digital tools for geoscientific applications

The Federal Ministry of Education and Research (BMBF) calls on interested parties to submit their proposals for the Using Underground Geosystems focus under the Geosciences for Sustainability (GEO:N) programme.

of 28. November 2022

1 Aim and purpose of funding, legal basis

1.1 Aim of funding

The utilization of underground geosystems continues to be increasingly important especially with regard to the ongoing energy transition. In future, efficient digital tools must be available for planning and environmental impact analysis, in particular for knowledge- and data-based assessment and approval procedures. This call for proposals aims to further accelerate the process of digitalization in the geosciences and to tap the potential of cooperation with information science. In addition to further methodical research (both in the geosciences and in information science), this mainly requires the development of corresponding workflows (e.g. data and model integration in the context of virtual realities) and of digital tools up to and including digital twins. This also involves extensive quality assurance for new models and software systems to be developed. Digital geosystems offer a broad range of applications in the sustainable management of the subsurface. For example, this includes the value chain of geoenergy – including geothermal energy and energy storage – as well as the upper surface as the interface of sustainable land use.

So, the present funding regulations contribute to Field of Action 1: Avoiding and reducing greenhouse gases (mitigation) and Field of Action 2: Improving adaptability and risk prevention (adaptation) of the BMBF's Research for Sustainability (FONA) strategy as well as to the United Nations Sustainable Development Goals SDG 7 Affordable and Clean Energy, SDG 11 Sustainable Cities and Communities, and SDG 13 Climate Action.

The results from funded projects must be used only in the Federal Republic of Germany or the European Economic Area (EEA) and in Switzerland.

1.2 Funding purpose

The purpose of funding is to support the development of digital tools for reliable forecasting of effects of geotechnological interventions in the subsurface. The aim is to be able to map complex physical, chemical and biological processes and interaction on very different spatial and temporal scales.

Based on a well-founded understanding of processes, the newly developed models will enable the assessment of risks, show possible conflicting use and serve as a basis for economic viability analysis.

The funded research projects are expected to develop a new generation of numerical simulation tools and to link and upgrade existing tools.

1.3 Legal basis

The Federal Government will award grants in accordance with these funding regulations, sections 23 and 44 of the Federal Budget Code (BHO) and the administrative regulations adopted thereunder as well as the BMBF's regulations governing applications for expenditure-based grants (AZA) and/or cost-based grants (AZK). There is no legal entitlement to a grant. The granting authority will decide freely after due assessment of the circumstances within the framework of the budget funds available.

Under these funding regulations, state aid will be granted on the basis of Article 25 (1) and (2)(a) to (d) and Article 28 (1) of the General Block Exemption Regulation (GBER) of the European Commission.¹ Funding is provided in accordance with the Common Provisions set out in Chapter I GBER, in particular taking account of the definitions given in Article 2 of the Regulation (cf. Annex for the requirements of state aid legislation applying to these funding regulations).

2 Object of funding

Funding will be provided for research and development projects which contribute to at least one of the following three thematic fields (TF): Methodical (1) and software (2) developments as well as demonstration by different geoscientific applications (3). It is desirable that projects combine these thematic fields. In particular, consideration should be given to the aspects of geosystem digitalization as listed in the thematic fields.

2.1 Thematic field 1: Development of methods

- Adequate method development is crucial for a successful digitalization process. A major distinctive feature of geosystems is that the sub-processes described interact with each other at different spatial and temporal scales and semantic levels. One aim is the further development of data-driven and process-based methods for seamless data and model integration of multiphysical process descriptions on different scales. . Another aim is to use the potential of modern data science, such as new schemes for intelligent adaptive model coupling, machine learning for efficient substitute models and virtual realities, in order to develop a new generation of geoscientific models. Data-based methods: Data assimilation methods should be used and developed further to integrate different observations and series of measurements into models. Measuring

¹ Commission Regulation (EU) No 651/2014 of 17 June 2014 Declaring Certain Categories of Aid Compatible with the Internal Market in Application of Articles 107 and 108 of the Treaty on the Functioning of the European Union (OJ L 187 of 26 June 2014, p.1) in the version of the Regulation (EU) 2017/1084 of 14 June 2017 (OJ L 156 of 20 June 2017, p.1) and Regulation (EU) 2020/972 of 2 July 2020 amending Regulation (EU) 1407/2013 as regards its prolongation and amending Regulation (EU) 651/2014 as regards its prolongation and relevant adjustments (OJ L 215 of 7 July 2020, p.3).

and modelling uncertainties has to be taken into account. The aim is to improve models and their projections and to reduce projection uncertainties. Methods of machine learning are to be used in particular to visualize model errors and efficiently substitute models.

- Uncertainty analysis: Optimization and development of effective procedures for the evaluation of uncertainties in modelling results and their dependence on underlying input data (e.g. geometries, material properties or specific conditions), of which only a certain extent is known in geoscientific work.
- Multi-semantic model coupling: Partial model encapsulation using multi-agent systems (MAS) allows the partially automated detection of possible multi-form (event-driven or stochastic) partial model coupling and the implementation of a digital twin for central control in a highly distributed virtual simulation environment.
- Virtual and augmented realities (VR/AR): Innovative VR methods are needed to enable visual data and model integration, explore large/heterogeneous data stocks, visualize coupled processes in complex geosystems, and provide the general public with easy-to-grasp information. This is to be supplemented by an in-situ augmented reality (AR) visualization (interactive superimposition of measured and modelled data).

2.2 Thematic field 2: Digital tools

The second thematic field is devoted to the development and systematic introduction of digital tools as an essential information technology element to accelerate the digitalization of the geosciences. In particular, technologies for system solutions are to be developed and provided. These include modular software systems that enable the seamless linking of typical simulation steps in workflows as well as the concept of digital twins as virtual labs for future scenarios regarding the potential and limits of geoscientific applications. The thematic field of digital tools is expected to bridge the gap between methodical development (TF1) and geoscientific applications (TF3) in accordance with the requirements of universal usability, continuity in software development and computing efficiency of modern hardware architectures.

- Composable software tools: Modular software systems (e.g. using Julia or Python) are to be developed to seamlessly link essential components of numerical modelling in workflows. The aim is to develop, test and document these novel tools with a special focus on universal usability and numerical efficiency. This is to enable comparability and links between process- and data-based approaches to geoscientific applications.
- Workflows: Corresponding workflows must be implemented for the seamless linking of information from data collection, suitable model selection including parameterization, data- and/or process-based simulation as well as data and model analysis.
- Digital twins: The developed methods and tools are to be used to create virtual labs to test variants and future scenarios for selected geoscientific applications supported by a sufficiently broad and constantly growing database.

2.3 Thematic field 3: Geoscientific applications

The third thematic field deals with using the methods (TF1) and developed tools (TF2) to address selected geoscientific issues mainly in the context of transition to renewable energy. As a rule, this includes all the parts of a value chain such as the exploitation and utilization of georesources, transport and energy transfer, geological energy and mass

storage, underground energy conversion, and the transformation of post-mining landscapes. Specific geoscientific applications will be selected to validate and demonstrate the developed methods and tools, also in cross-collaboration exchange about methods. Possible fields of application will involve complementary requirements to enable the broad development of methods and digital tools needed.

- Geothermal systems: In order to enable geothermal systems to be used in an ecologically and economically sustainable way, particularly in urban areas, researchers need to develop holistic approaches and workflows that consistently combine extensive and heterogeneous data (including energy data) of varying characteristics with different prediction models and visualization and to validate them using the data of existing demonstration sites.
- Post-mining landscapes: Digital twins of these changing near-surface geosystems are to demonstrate holistic workflows using mainly heterogeneous data sources, geokinetic, geophysical, geochemical and geotechnical models as well as approaches for target group-specific visualization and communication, thus opening up new possibilities for monitoring, recovery and re-use.
- Energy storage: The digitalization of deeper geological structures will help researchers to find out more about the possibilities and capacities for energy storage (e.g. compressed air, heat, hydrogen). Digital twins may be used for modelling and validating the multi-physical and geochemical interactive processes in the geosystem and for visualizing them in the geological context.

Funding can be provided for project-related standardization activities (e.g. DIN SPEC) if the project provides a suitable basis for this.

3 Funding recipients

Commercial companies, universities and non-university research institutions, municipal and German State organizations as well as associations and other societal organizations (e.g. foundations and registered societies) are eligible for funding. Applicants are required to have a plant or branch (company) or another entity serving the non-commercial activity of the funding recipient (university, research institution, municipal and German State organizations, associations, societal organizations) in Germany at the time of payment of the grant.

Research institutions which receive joint basic funding from the Federal Government and/or the German States can only be granted project funding supplementary to their institutional funding to cover additional project-related expenditure or costs under certain conditions.

Funding applications from small and medium-sized enterprises (SMEs) are explicit welcome. SMEs within the meaning of these funding regulations are companies that meet the requirements of the EU definition of SMEs.² Applicants will declare their classification according to Annex I of the GBER to the granting authority in their written application for funding. A model declaration can be provided by the project management organization.

² cf. Annex I of the GBER or the Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises (notified under document number C (2003) 1422 (2003/361/EC)) (OJ L 124 of 20 May 2003, p. 36): [<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003H0361&from=EN>].

Concerning the conditions for when state aid is or is not deemed to be involved and the extent to which funding can be provided without constituting aid, please consult the Community Framework for State Aid for R&D&I.³

4 Special prerequisites for funding

The integrative and interdisciplinary approach of BMBF research projects requires addressing the research questions raised in larger collaborative projects. In view of this requirement, applicants are expected to form collaborations for addressing the issues outlined in 2.1 to 2.3 above in a cooperative and interdisciplinary manner. Know-how transfer from science to practical application is to be promoted by application-oriented projects in particular. This requires the active involvement of commercial companies. Potential users (e.g. public authorities, municipalities, end users) must be involved in the development process at an early stage.

A coordinator must be appointed for each collaboration. The project coordinators assume responsibility for the implementation of research work during the entire project period.

The partners in a collaborative project will set out the terms of cooperation in a written agreement. All the collaboration partners including research institutions within the meaning of Article 2 (83) GBER must ensure that companies do not receive any form of indirect aid as part of the collaboration. The provisions of No. 2.2 of the Community Framework for State aid for research and development and innovation must be observed. Before a funding decision on a collaborative project is taken, the cooperation partners must prove that they have reached a basic consensus on further criteria stipulated by the BMBF (cf. BMBF leaflet no. 0110).⁴

In their own interest, applicants should familiarize themselves with the EU's Framework Programme for Research and Innovation "Horizon Europe" in the context of the planned national project. They should check whether the intended project is eligible for exclusive EU funding. Furthermore, they should check whether an additional application for funding can be submitted to the EU in the context of the intended national project. Applicants should briefly state the result of such checks in their proposal.

5 Type, scope and rates of funding

Funding will be awarded in the form of a non-repayable project grant.

Grants for commercial companies and for projects of research institutions which fall into the category of economic activities⁵ will be calculated on the basis of the eligible project-related costs. Part of these can be covered in individual cases, taking legislation on state aid into account (see Annex). The BMBF's policy requires that applicants make an appropriate contribution of their own towards the eligible costs incurred.

Grants for higher education institutions, research and science institutions and similar establishments that do not fall into the category of economic activities are calculated on the basis of the eligible project-related expenditure (in the case of the Helmholtz centres

³ Commission communication (2014/C 198/01) of 27 June 2014 (OJ C 198 of 27 June 2014 p. 1) as amended by Commission communication C(2020) 4355 final of 2 July 2020 (OJ C 224 of 8 July 2020, p. 2), in particular section 2.

⁴ https://foerderportal.bund.de/easy/easy_index.php?auswahl=easy_formulare, Bereich BMBF Allgemeine Vordrucke und Vorlagen für Berichte.

⁵ For the definition of 'economic activity' please refer to No. 2 of the Commission Notice on the notion of state aid (OJ C 262 of 19 July 2016, p. 1) and No. 2 of the R&D&I State Aid Framework.

and Fraunhofer, eligible project-related costs), up to 100% of which can be funded in individual cases, taking legislation on state aid into account.

In the case of non-commercial research projects at universities, a flat-rate grant amounting to 20% of total expenditure will be awarded in addition to the eligible expenditure funded by the BMBF.

Eligible expenditure/costs are governed by the BMBF's regulations governing applications for expenditure-based grants (AZA) and/or cost-based grants (AZK).

The determination of the respective eligible costs and rates of funding must take account of the requirements stipulated in the GBER (see Annex).

6 Other terms and conditions

The *Nebenbestimmungen für Zuwendungen auf Kostenbasis des Bundesministeriums für Bildung und Forschung an gewerbliche Unternehmen für Forschungs- und Entwicklungsvorhaben* (NKBF 2017) (Auxiliary Terms and Conditions for Funds Provided by the Federal Ministry of Education and Research to Commercial Companies for Research and Development Projects on a Cost Basis) will be part of the notification of award for grants on a cost basis.

Notification of award for grants on an expenditure basis will include the *Nebenbestimmungen für Zuwendungen auf Ausgabenbasis des Bundesministeriums für Bildung und Forschung zur Projektförderung* (NABF) (Auxiliary Terms and Conditions for Funds Provided by the Federal Ministry of Education and Research for the Promotion of Projects on an Expenditure Basis) and the *Besondere Nebenbestimmungen für den Abruf von Zuwendungen im mittelbaren Abrufverfahren im Geschäftsbereich des BMBF* (BNBest-mittelbarer Abruf-BMBF) for the drawdown of funds.

Notification of award for grants on an expenditure basis will include the *Allgemeine Nebenbestimmungen für Zuwendungen zur Projektförderung an Gebietskörperschaften und Zusammenschlüsse von Gebietskörperschaften* (ANBest-GK) (General Auxiliary Conditions for Grants awarded to Territorial Authorities and Associations of Territorial Authorities), the *Besondere Nebenbestimmungen für Zuwendungen des BMBF zur Projektförderung auf Ausgabenbasis* (BNBest-BMBF 98) (Special Auxiliary Terms and Conditions for Funds Provided by the BMBF for the Promotion of Projects on Expenditure Basis), and the *Besondere Nebenbestimmungen für den Abruf von Zuwendungen im mittelbaren Abrufverfahren im Geschäftsbereich des Bundesministeriums für Bildung und Forschung* (BNBest-mittelbarer Abruf-BMBF) for the drawdown of funds.

Further auxiliary terms and conditions and information of the BMBF regarding this funding measure may also form part of the notification of award of funds.

The progress of the funding measure will be reviewed as part of the evaluation of the GEO:N programme. For the purpose of conducting progress reviews within the meaning of administrative regulation 11a pertaining to section 44 of the Federal Budget Code (BHO), funding recipients are required to provide the BMBF or reviewing institutions with the data necessary for the progress review without delay. The information will be used exclusively for the purposes of accompanying research and any subsequent evaluation; it will be treated confidentially and published in anonymized form, making it impossible to trace it back to individual persons or organizations.

Funding recipients are expected to ensure open electronic access if they publish the results of the research project in a scientific journal. This can be done through publication in an electronic journal which is accessible to the public free of charge. If the results are not initially published in a journal which is electronically accessible to the public free of charge, they must be made publicly available free of charge by electronic means, following a suitable embargo period where appropriate (secondary publication). Embargo periods for secondary publication should not exceed 12 months. The BMBF expressly welcomes secondary open access publication of scientific monographs resulting from the project.

7 Procedure

7.1 Involvement of a project management organization, application documents, other documents and use of the electronic application system

The BMBF has currently entrusted the following project management organization (PT) with implementing the funding measure:

Project Management Resources, Circular Economy, Geosciences
Forschungszentrum Jülich GmbH
Project Management Jülich (PTJ)
Rostock Office
Marine and Maritime Research, Geosciences and Shipping (PTJ-MGS)
Schweriner Straße 44
18069 Rostock

Contact for information relating to the research topic:

Dr. Ulf Hünken
Phone: +49 (0)381 20356 299
u.huenken@fz-juelich.de

Any modifications will be announced in the *Bundesanzeiger* (Federal Gazette) or in another suitable form in German.

Application forms, guidelines, information for applicants and the auxiliary terms and conditions are available online at:

https://foerderportal.bund.de/easy/easy_index.php?auswahl=easy_formulare&formulars_chrank=bmbf

The "easy-Online" electronic application system must be used for drafting project outlines and formal proposals: <https://foerderportal.bund.de/easyonline>.

7.2 Two-phase application procedure

The application procedure consists of two phases.

The BMBF will take a decision following a final review based on the evaluation of outlines by external experts. Applicants will be informed in writing of the results of the selection procedure. An open and competitive procedure is applied.

7.2.1 Submission and selection of project outlines

In the first phase, project outlines are to be submitted to PTJ-MGS

by 15. February 2023 at the latest

using the "easy-Online" electronic application system (<https://foerderportal.bund.de/easyonline/>). Outlines can be submitted electronically after choosing the Ministry (here: BMBF) under *Fördermaßnahme GEO:N – Geoforschung für Nachhaltigkeit, Förderbereich: Digitale Geosysteme (Skizze)*.

For collaborative projects, the joint project outline must be submitted by the coordinating entity.

The informal project outlines must be submitted in German. They should not exceed 30 A4 pages (Arial 11, 1.5-spaced, margin 2 cm) including cover page and attachments.

Project outlines which do not meet the requirements regarding the number and form of pages cannot be considered.

The deadline for submission is not a cut-off deadline. However, it may not be possible to consider project outlines received after the above date.

Applicants are advised to contact the relevant project management organization before submitting their documents. The organization will provide further information.

The contributions of the collaboration partners to the overall project must be clearly identified in the outline. The self-explanatory project description must allow evaluation without further enquiry and be structured as follows:

- Cover page with information about the coordinating entity and collaboration partners as well as assignment of the topic to the above-listed funding priorities,
- Informative summary (goals, research priorities),
- Originality of the research approach,
- Project description,
- Goals (overall objectives of the project, scientific and/or technological deliverables),
- Relevance of the project to the funding goals of the call,
- State of the art in science and technology,
- Previous work of the applicants,
- Work plan (description of work),
- Project management and work sharing between the partners (overview in tabular form or as web chart: synergies and dependencies, assignment to major work packages, cooperation with third parties),
- Utilization of results,
- Data management,
- Financial plan in tabular form presenting the estimated expenditure/costs broken down by cooperation partner and basic heading (planned staffing, non-cash resources, travel, investments).

The evaluation of the project outlines will involve external experts and be based on the following criteria:

- Scientific quality and originality as well as possible uses and innovation potential of the planned research,
- Compliance with the thematic priorities of the call,
- Interdisciplinary nature of the project,
- Expected knowledge gain,
- Qualifications of the applicants, suitability of the consortium,
- Quality of the work plans and of data and project management, utilization of results for scientific, societal and political purposes,

- Appropriateness of budget planning.

Suitable project ideas will be selected for funding on the basis of the above criteria and evaluation. Applicants will be informed in writing of the result of the selection (via the coordinating entity in the case of collaborative projects).

The project outlines and any other documents submitted in this phase of the procedure will not be returned.

No legal claim to funding can be derived from the submission of a project outline.

7.2.2 Submission of formal proposals and decision-making procedure

In the second phase of the procedure, applicants whose project outlines have been evaluated positively can submit formal proposals (application form).

The project management organization will provide the applicants with further details in writing regarding submission (via the coordinator in the case of collaborative projects).

A formal proposal is only considered complete if at least the requirements of Article 6 (2) GBER (cf. Annex) are fulfilled.

The "easy-Online" electronic application system must be used for drafting formal proposals (taking into account the requirements set out in the Annex) (<https://foerderportal.bund.de/easyonline/>). Proposals can be submitted electronically after choosing the Ministry (here: BMBF) under *Fördermaßnahme GEO:N – Geoforschung für Nachhaltigkeit, Förderbereich: Digitale Geosysteme (Antrag)*. This portal enables the electronic submission of proposals which must be submitted in writing. An electronic document that bears a qualified electronic signature is sufficient for electronic submission.

Should no qualified electronic signature be possible, applicants are requested to print the final version of the formal proposal, sign it and send it by post to PTJ-MGS. Formal proposals for collaborative projects must be submitted in consultation with the coordinating entity.

The proposals must include the following information which is supplementary to the project outline:

- Detailed financial plan of the project,
- Detailed utilization plan of the project,
- Presentation of reasons for funding requirement,
- Detailed work and resources plan.

Any conditions formulated in the first phase of the procedure must be observed. More detailed information on requirements will be provided when applicants are invited to submit formal proposals.

The proposals received will be carefully reviewed in accordance with the criteria of the first phase, including consideration of the fulfilment of any conditions. The following additional criteria will be applied in the review and evaluation:

- Necessity and appropriateness of and eligibility for the requested funding
- Quality and significance of the utilization plan, also in terms of the funding objectives of this call.

After final consideration of the proposal, a funding decision will be taken on the basis of the above criteria and evaluation.

7.3 Relevant regulations

The approval and payment of and accounting for the funds as well as the proof and examination of the proper use and, if necessary, the revocation of the award and the reclaiming of the funds awarded are governed by sections 48 to 49a of the Administrative Procedure Act (VwVfG), sections 23 and 44 of the Federal Budget Code (BHO) and the related general administrative regulations, unless the present funding regulations allow deviation from the general administrative regulations. The *Bundesrechnungshof* (Germany's Supreme Audit Institution) is entitled to carry out audits in accordance with section 91 of the BHO.

8 Validity

These funding regulations will enter into force on the day of their publication in the Federal Gazette (*Bundesanzeiger*).

These funding regulations will be valid until the day of expiry of their legal basis for state aid, the GBER, to which a six-month adaptation period is added, that is, until 30 June 2024. If the period of the GBER is extended without relevant amendments concerning state aid rules, the duration of these funding regulations will be extended accordingly, though not beyond 31 December 2027. If the GBER is not extended but replaced by a new GBER or if relevant amendments are made to the content of the currently applicable GBER, follow-up funding regulations will be adopted which will comply with the then applicable exemption provisions and remain effective at least until 31 December 2027.

Bonn, 25. October 2022

Federal Ministry of Education and Research

Dr. W. Junker