KEM Strategy and Operation 2023-2027

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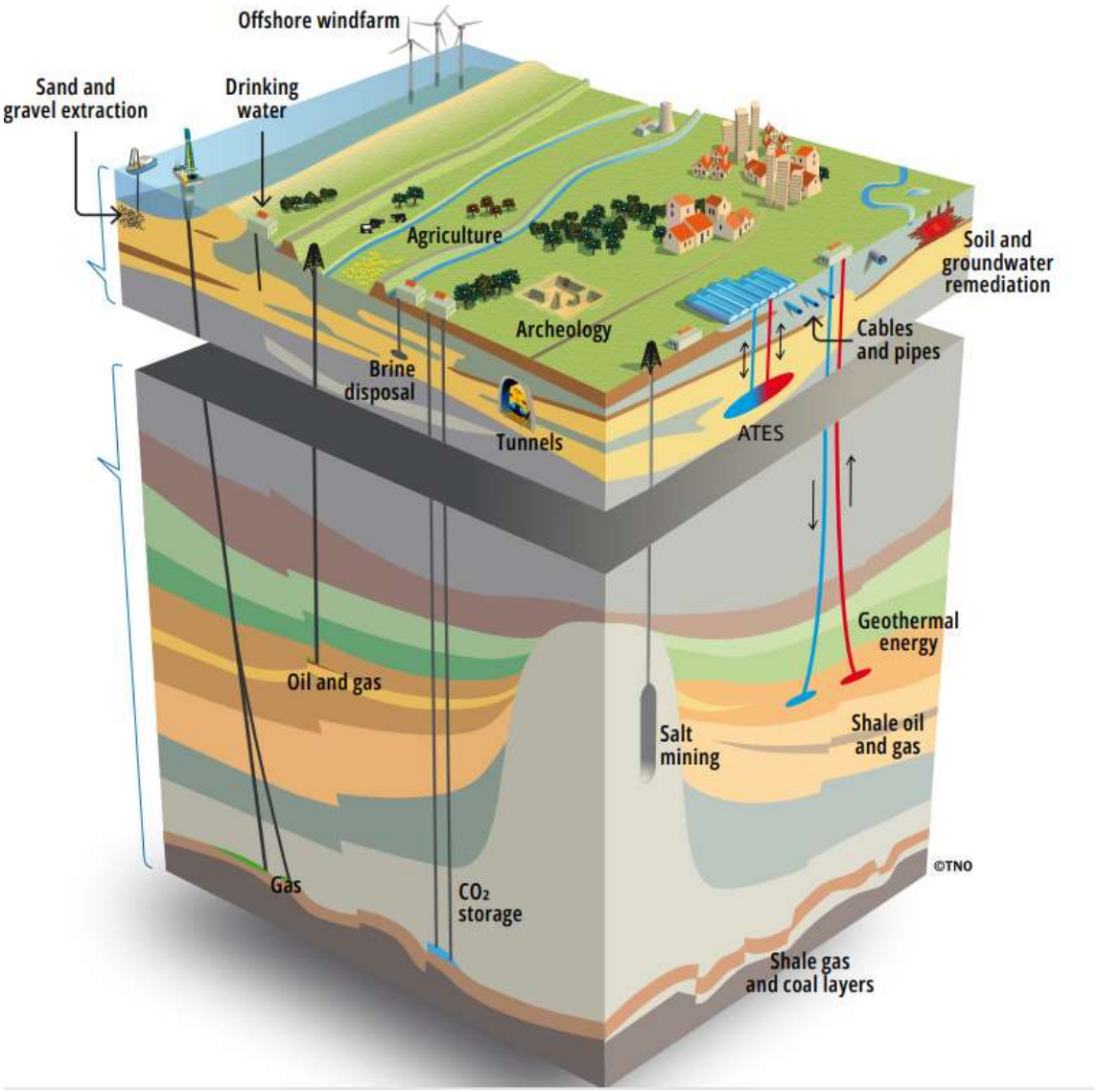


Table of Contents

1 Introduction

In their report on induced seismicity risks in Groningen (2015) the Dutch Safety Board (OVV[1]) ascertained shortcomings in the knowledge development concerning the risks of natural gas production. Specific recommendations were:

- Improve the insights in the risks and associated uncertainties;
- Conduct the research independent from the mining industry;
- Stimulate multidisciplinary research projects and put more effort in integrating research results of the various scientific disciplines.

The OVV stated that these recommendations should also apply to all other mining activities and risks, including for example risks associated with geothermal energy, underground storages operations and their long-term effect after abandonment.

The Dutch Ministry of Economic Affairs and Climate (EZK[2]), State Supervision of Mines (SodM[3]) and the Groningen regional organisation National Coordinator Groningen (NCG) were - each in their own role on behalf of the public - responsible for addressing these recommendations. To meet these recommendations these parties decided to initiate a knowledge development program specifically aimed at mining activities and associated risks: the knowledge program on effects of mining (KEM[4]). The goals of this applied research program were[5]:

- Acceleration of substantive progress of knowledge development with regard to the possible effects of mining;
- Intensification of (multidisciplinary) cooperation between knowledge institutions;
- Developing independent, accessible and authoritative knowledge.

These goals are implemented by:

- The actual applied research program (KEM research projects);
- A knowledge exchange platform, including a website and consolidation of results in HRA instruments and external meetings to disseminate scientific results with professionals and society;
- An independent scientific expert panel (=WEP[6]) on mining effects, which ensures quality, relevance, completeness, fitness and independence of the conducted research.

The intended impact of KEM was to contribute to the establishment of authoritative knowledge, publicly available mining risk assessment instruments and underpinning evidence for mining risk mitigation and adaptation strategies.

After five years, in 2022, KEM was evaluated by an external party, AEF[7]. AEF concluded that KEM was largely effective and efficient. The main recommendation was to continue the main task of KEM

[1] In Dutch this is called “Onderzoeksraad voor Veiligheid”, abbreviated to OVV.
[2] In Dutch this is nowadays called “Economische Zaken en Klimaat”, abbreviated to EZK.
[3] In Dutch this is called “Staatstoezicht op de Mijnen”, abbreviated to SodM.
[4] In Dutch this is called “Kennisprogramma Effecten Mijnbouw”, abbreviated to KEM.
[5] These goals are mentioned in the letter to Parliament by the ministry of EZ (TK 32849 nr. 80. 2015-2016). In Dutch they were formulated as follows: “Versnelling inhoudelijke voortgang van de kennisontwikkeling met betrekking tot de mogelijke effecten van mijnbouw; Intensivering van (multidisciplinaire) samenwerking tussen kennisinstellingen; Ontwikkeling van onafhankelijke, toegankelijke en gezaghebbende kennis.”
[6] In Dutch this is called the “Wetenschappelijk Expert Panel”, abbreviated to WEP.
[7] For the resulting report, see letter to Parliament by the ministry of EZK (TK 32849 nr. 213. 2022-2023), https://www.rijksoverheid.nl/documenten/kamerstukken/2022/12/20/kennisprogramma-effecten-mijnbouw-kem.

which is independent execution of research on the effects of mining. The ministry and SodM has decided to continue with KEM for at least the period 2023-2027 with a slightly adjusted goal (§2.1), in order to meet some of the recommendations of AEF.

In the evaluation report, AEF also suggests issues which could be improved, such as clearer reference documents, better process for gathering the research questions and communication.

These suggestions have led to strategic and operational adjustments in KEM. These changes are addressed in this document. During the improvements of this document, the report of the parliamentary inquiry Groningen was published. The committee was positive on the KEM program and stresses the need for continuing research on the activities (new and old) in the subsurface. The committee also advised that research on the physical effects and non-physical effects should be brought together. In this document KEM focuses on the physical effects. Including the non-physical effects in KEM needs more planning and possibly a larger change of the current KEM at a later time.

This document basically consists of two parts: the KEM research framework (chapter 2) and the KEM modus operandi (chapter 3). The KEM research framework chapter describes how KEM translates the concerns of citizens and the research questions of stakeholders as effectively as possible into high-quality and targeted applied research. The KEM modus operandi chapter describes how KEM envisages to run KEM processes efficiently. Chapter 4 defines the smart strategic and operational success criteria for KEM. These criteria will help in managing and evaluating KEM in the coming period, 2023-2027. This document is a joint collaboration between EZK, SodM and WEP.

2 KEM Strategic Research Framework 2023-2027

This chapter is the **strategic reference** for KEM in 2023-2027. It is a follow up of the "KEM Strategic framework 2018" and this chapter also addresses the strategic recommendations of the KEM evaluation performed in 2022. This chapter describes the KEM ambition (§2.1), the KEM actors (§2.2), explains the principles of KEM (§2.3), it defines the approach of the research agenda (§2.4) and what is done with the research results (§2.5). This chapter is mainly focused on why and to which extent KEM activities take place.
The next chapter (chapter 3) is dedicated to how these activities are carried out.

2.1 KEM ambition

2.1.1 Goal

The goals of KEM in 2023-2027 are:

- Independent applied research to enhance insight in the possible effects, including their uncertainties, of mining activities in The Netherlands;
- Bringing together multidisciplinary knowledge in methods and tools to quantify effects and use these for policy and supervision in the energy transition;
- Contribute to the understanding of and the trust in the Dutch mining activities by communication on KEM-projects to experts and other stakeholders (a.o. citizens).

These altered and improved KEM goals have been made public in a letter to parliament[8] in December 2022. In general, KEM focuses on past, current and future mining or subsurface activities in de Dutch subsurface. KEM contributes to state of the art, transparent, validated, efficient and effective risk approaches for these activities.

As KEM focuses on addressing applied research questions, mainly research projects requiring a maximum of two years of work of (international) scientific experts in the field are included in KEM. The more fundamental, longer term, research questions are expected to be part of programs of the Dutch Research Council, like the DEEP-NL program[9]. Research questions which can be answered at short notice using widely available knowledge will not be answered by KEM.

2.1.2 Scope

KEM is focused on the effects of mining activities in the Netherlands. KEM encompasses all past, current and future **subsurface activities** falling under the Dutch Mining Law. These subsurface activities include gas and oil production and storage, geothermal energy, salt and coal mining and storage of energy products (Hydrocarbons, H_2, N_2) and residues (CO_2). In addition, facility reuse, abandonment and removal (wells and installations) are subsurface activities which will play a large role in the coming years. All these activities may have effects in the subsurface, in some case leading to effects at the surface. The subsurface effects include all currently known physical **subsurface hazards**, like seismicity, subsidence and uplift, containment, leakages and emissions, including the long-term effects and interferences in the exploitation of the subsurface of The Netherlands.
For risk analysis, also possible impacts are included in terms of safety and damage caused on the natural and built environment by hazards from subsurface activities. Apart from physical mining effects, also social or economic effects may occur. In 2023, it will be investigated whether and how applied research on these effects can be incorporated into the KEM.

[8] Kamerbrief over Kennisprogramma Effecten Mijnbouw | Kamerstuk | Rijksoverheid.nl
[9] DeepNL | NWO

The results of the KEM projects should contribute in validating and improving methods and tools to assess and quantify subsurface hazards and risks and in using these for policy and supervision in the energy transition.

2.2 KEM actors

The three main actors are EZK, SodM and WEP. They are described below. In a separate section, the other stakeholders are described as well.

2.2.1 EZK – Ministry of Economic Affairs and Climate

The ministry of Economic Affairs and Climate (EZK) is responsible for the energy transition and mining activities in The Netherlands. It is concerned with developing and executing energy transition and mining policies, ranging from changes in the mining law, mining guidelines, permitting, norms and initiating research to underpin policies from development of a mining activity to the post-abandonment stage. EZK obtains (scientific) advice for the energy transition and the mining activities from multiple parties depending on the topic of the advice (see other stakeholders in 2.2.4). The Ministry leans on fundamental and applied research on technical issues important to energy and mining policies. KEM is one of the authorities to initiate applied research and the initial development of mining hazard and risk analysis instruments.

The Ministry has a coordinator, who coordinates KEM activities on behalf of EZK.

2.2.2 SodM – State Supervision of Mines

The State Supervision of Mines (SodM) is responsible for the supervision of mining activities in the Netherlands. SodM is focused on mining operations to safeguard humans as well as for the environment. SodM follows a full life-cycle approach: from development of a mining activity until post-abandonment care. SodM also advises EZK on permitting of mining activities and on energy transition and mining policies. SodM follows and uses fundamental and applied research and commissions, when appropriate, as well as applied research on technical issues important to its main tasks. KEM is one of the options for SodM to issue this kind of applied research.

The SodM has a coordinator, who coordinates KEM activities on behalf of SodM.

2.2.3 WEP – scientific expert panel

The scientific expert panel of KEM, WEP, independently advises EZK and SodM on the applied research projects of KEM. The role of the WEP is to ensure that specifications of research requests coming from EZK, SodM and other stakeholders that bring forward research questions to KEM meet criteria of relevance, scientific quality and completeness in the context of issues they are supposed to address. The WEP also advises on the selection of parties who are best qualified to carry out the proposed research. Additionally, the WEP follows the research execution and reporting, as well as the scientific interpretation and evaluation of the scientific content of the projects. The WEP was installed by the Minister of EZK in 2017. The individual members act without a mandate or instruction from their organisations. They are selected based on their expertise and scientific reputation. The panel members have an overview on their field of expertise and, as such, are capable to advise on the research projects of the KEM. The WEP members.

The WEP consists of a chairperson and at least 4 members. The WEP and its members should have an outstanding scientific reputation, function independently and should also be perceived as such; they should have no relationship with the mining industry in general and should not be involved in research commissioned by (operating) companies in the Dutch mining sector.

The WEP meets four times per year (two in-person and two online meetings). The language of the WEP is English due to the international members of the WEP. The WEP has a secretary, who coordinates the activities of the WEP and is a direct contact for the coordinators of EZK and SodM.

2.2.4 Other stakeholders

In the Netherlands various stakeholders have concerns with respect to the effects of mining. These stakeholders are, for instance, regional authorities, citizens and ngo's, confronted with mining effects in their neighbourhood. Also, professionals active in the mining sectors may have concerns. It is important that concerns and (research) questions of these stakeholders are channelled into the research agendas of current or new research programs (like KEM and DEEP-NL[10]).

EZK and SodM regularly ask scientific advice from national research institutes (such as TNO[11], Deltares[12], KNMI[13]). EZK also asks advice on permitting (the Mining Council[14], SodM, Tcbb[15] and TNO-AGE[16]). These institutes are the ones harbouring the knowledge in the Netherlands. As such, they will both learn from KEM studies and be the contractor of some of these studies. KEM also has a relation to other Dutch mining professionals, ranging from universities and research institutes to consultancies and mining companies. KEM is an addition to the knowledge development already taking place in the Netherlands by these professionals. Knowledge developed in KEM projects is meant to be publicly available.

KEM projects are commissioned to national and international research groups. They execute the projects, which are later evaluated by the WEP. These research groups are stimulated to share their knowledge and disseminate project results. This means that the other stakeholders of KEM form a broad group of experts and non-experts.

2.3 KEM principles

2.3.1 Independency of KEM

Independency of KEM is achieved by the independent role of the WEP. The WEP is responsible for the scientific focus and quality of KEM.

As described before in the scope of KEM, the research in KEM has a multidisciplinary character. The composition of the WEP should reflect that character. Each member of the WEP brings his/her own expertise into KEM complementing the existing expertise in the WEP. Currently, the main areas of expertise to be covered by the expertise of the individual WEP members are:

- Seismology (induced seismicity);
- Geomechanics (subsidence, movement on faults);
- Structural Engineering (effect of ground movement on buildings);
- Hydrology (flow of fluids and substances in the subsurface; containment and confinement leakage);
- Modelling (of coupled processes).

[10] DEEP-NL is the scientific research program on subsurface activities
[11] TNO is the applied research and innovation institute, which also includes the Dutch Geological Survey
[12] Deltares is the applied research and innovation institute in the field of water and (shallow) subsurface
[13] KNMI is the Dutch meteorological institute, including the seismological department
[14] The Mining Council is an independent commission advising EZK on exploration, storage and production licensing
[15] Tcbb is the technical commission on ground movement advising citizens on mining related damages
[16] TNO-AGE is the department within TNO advising EZK on mining policies and licensing

All WEP members will be involved in the formulation of the KEM research questions and projects. However, depending on the scope of the research, members follow KEM research projects that are closest to their own expertise, ensuring scientific quality for the evaluation and feedback to the researches involved. If additional expertise is required, the WEP can be assisted by guest experts. This is similar to EU procedures.

2.3.2 Transparency

KEM is designed to be as transparent as possible. The members of the WEP can communicate about the jointly approved status of the KEM research framework and program. On the KEM website, the procedures of the KEM are published as well as the research questions, their status and outcomes, including evaluations by the WEP.
Transparency is achieved by the communication of KEM through the website. All KEM research questions, project results and evaluations will be made public as soon as possible. In addition, KEM encourages publications in scientific journals and requires that (new) data and developed tools from the projects adhere to FAIR principles.

2.3.3 Confidentiality

KEM is a public program and transparency on KEM project is considered to be important. However, the WEP will not disclose any information from on-going research projects, as this may lead to irrelevant discussions on tentative and uncertain conclusions. Hired experts, who are temporarily deployed for specific expertise, are also bound by this working method. They must keep confidential both the information received and the outcome of their work, until the project is completed and published on the KEM website.

2.3.4 Relevance

KEM aims to carry out independent applied research to enhance insight in the possible effects of mining activities in The Netherlands and the uncertainties of those effects. This research also needs to be relevant in the Dutch context. Relevant means, in the first place, that the research addresses Dutch public interests (questions or worries of citizens or authorities); there needs to be public demand for the research. Relevant also means that the research addresses practical or scientific challenges (within the scope of KEM); there must be a need to do research. If proposed questions can be answered with existing research, they are not included in KEM.

2.4 KEM research agenda

Within the ambition and principles of KEM given above, much research could be possible and/or needed, but time and means are restricted. KEM ensures a wise choice of research by adopting a three-pronged approach to achieve a dynamic research agenda. This approach is based on the two main factors of relevance: public demand and the need for research. The third element is combining the two and prioritizing what has to be done. These three elements are further described in the following paragraphs.

2.4.1 Public demand

EZK and SodM are primarily responsible for regularly collecting and articulating citizen concerns and research questions. They do this by consulting citizens, professionals inside and outside their organization, and practitioners and researchers in the field. Research questions can also be submitted directly to WEP in meetings or through the KEM website. WEP may also bring in research questions which can be answered with new scientific knowledge, by networking in scientific communities and following scientific research.

Mining activity versus H&R type		Seismic hazards and risks	Subsidence hazards and risks	Environmental hazards and risks
Oil and gas reservoir production	Groningen			
	Small gas fields			
	Oil fields			
Underground storage and disposal in porous reservoirs	Methane cyclic storage			
	Hydrogen cyclic storage			
	Nitrogen cyclic storage			
	CO2 disposal			
Geothermal reservoir energy production	Conventional doublet systems			
	Enhanced Geoth. Systems (EGS)			
Salt cavern development and production	Shallow caverns (<750m)			
	Deep Caverns (>750m)			
Underground storage & disposal in caverns	Methane cyclic storage			
	Oil strategic storage			
	Hydrogen cyclic storage			
	Nitrogen cyclic storage			
	Brines			
Mining infrastructures	Wells			
	Installations			
	Pipelines			
Coal mining domains and infrastructure	Limburg			

H&R measures vs H&R type		Seismic risks	Subsidence risks	Leakage risks
Public HRA instruments				
Public monitoring systems				
Public norms, TL systems and mitigating actions				

Legend: Priorities to intensify applied (a.o. KEM) research	Criteria: NL-urgency and status of the public knowledge and tools	3 = high	2 = medium	1 = low

Figure 1. Dashboard format (empty) for showing research priority areas for KEM. The priority will be based on (1) the urgency in the Netherlands for additional (applied) research and (2) the current status of the knowledge/knowledge tools in the respective area of research.

2.4.2 Need for research

To effectively and transparently manage such a large field of interest, KEM will use a **dashboard** based on types of mining activities and types of risks into specific, smaller areas of interest (see figure above). Each combination of row/column (activity/risk) is a specific area of research. In Q1 2024 KEM will present the starting position for this dashboard. This will be done by two separate actions for each of the criteria:

1. Action 1: The *urgency for the Netherlands* will be estimated based on e.g. (near) future policy or economic developments; the number and status of citizen concerns; and experienced knowledge gaps in the respective areas or tools. The urgency can be low, medium or high.
2. Action 2: The status of the current knowledge position for the respective area of research or tool will be assessed by consulting relevant public knowledge institutes in that area or tool. The status can be poor, medium or sufficient.

Avaraged these two scores lead to a score om *priorities for research questions*. This score defines which areas of research need attention and budget. All dark-blue activity-risk fields indicate a need for more (public) knowledge and/or tools. The outcome is discussed with the WEP. When the WEP does not recognize the outcome or does not agree with the outcome, a discussion with the parties that have filled in the dashboard will be organized by the KEM coordinators, with the aim on arriving at a dashboard which is supported by the WEP.

The dashboard will be updated biennially and reported in the yearly reports of KEM. This will be a joint responsibility of EZK, SodM and WEP. This dashboard is slightly different than the one used since the start of KEM to communicate on scope, progress and results of the KEM research program.

2.4.3 Combining, allocating, and prioritizing

The collected research questions (§2.4.1) are combined with the need for research (§2.4.2) to assess the allocation to the KEM or other parties as well as determine their priority.

First, research questions which are not suitable for KEM are identified. These questions can be categorized in three types:

- directly answerable – these questions are allocated to advisors (inside EZK or SodM; or consultants). These are questions which can be answered by widely available professionals;
- fit to existing programs – research that naturally ties in with existing programs that are already running. These questions can be assigned to those existing programs (such as programs at TNO, Deltares and KNMI). These are research questions that typically require less than 2 years of effort, and fit very well into current research programs and are therefore not primarily suited for KEM;
- fundamental scientific – these questions should be covered by scientific programs (such as DeepNL). These are fundamental scientific research questions requiring more than 2 years of effort, typically as PhD projects.

On request of EZK or SodM, WEP can be asked to review and advise on these projects external to KEM (see 4.3.3).

Together, WEP, EZK and SodM, identify – keeping the state of public knowledge as indicated in the dashboard in mind - the research questions that will be addressed in KEM based on urgency (defined by EZK, SodM or WEP) and scientific feasibility (effort required and identified research groups). These questions form the KEM research agenda.

2.5 Follow-up of KEM research results

As stated in the goal, KEM aims to improve the insight in the effects of mining activities. To achieve that goal, KEM focuses on two activities: dissemination and consolidation. Dissemination is achieved by actively offering the KEM results to relevant target groups, including at least citizens, administrators, mining professionals and scientists.

Consolidation is achieved when the parties involved use the knowledge as much as possible in their design, decision-making, advice and supervision of mining activities, e.g., EZK and SodM will use the results of KEM research to improve their legal tasks. A special place for the consolidation of research results are public hazard and risk assessment instruments and protocols. The WEP has a special responsibility to advise EZK or SodM on the development of these mining effect hazard and risk assessment tools applied in practice.

3 KEM Operation 2023-2027

This chapter is used as the **operational reference** for KEM in 2023-2027. It is a follow up of the KEM Modus operandi 2018. It addresses operational recommendations of the KEM evaluation performed in 2022. This chapter describes the main activities in KEM, the scientific governance of KEM by the scientific expert panel (WEP) and the administrative governance of KEM to ensure an efficient, transparent, focused, and scientifically independent execution of research.

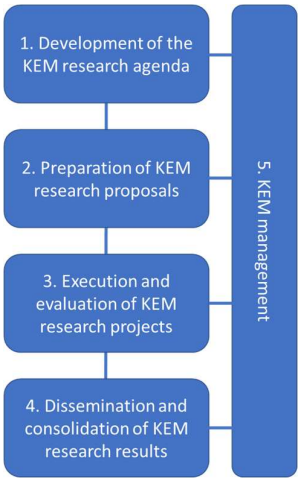


Figure 2. Workflow of primary KEM processes, as described below.

The primary processes are specified in more detailed workflows in subsequent paragraphs. Each process is defined, including the anticipated output, the responsible entity, the repetition frequency, and relevant criteria and decisions for the process.

3.1 Development of the KEM research agenda

This process starts with the collection of mining effects research questions and ends with a proposal on the research questions that should be addressed by KEM.

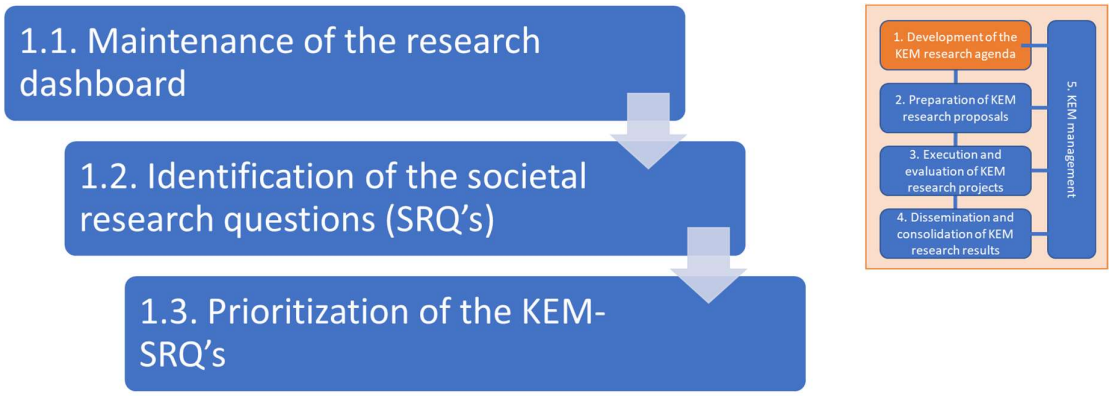


Figure 3. KEM research agenda. The processes 1.1 and 1.2 are not strictly KEM-only processes, but important to achieve clear transparency and traceability of addressing societal concerns and research questions.

3.1.1 Maintenance of the research dashboard

The dashboard as developed earlier at the start of KEM, further elaborated in 2021 by TNO, has to be redeveloped in 2023 (see also §2.4.2). After that redevelopment, the appreciation of the state of knowledge (the color of the cells in the dashboard, **Fout! Verwijzingsbron niet gevonden.**) will be updated every two years.

- Output: actual dashboard for research needs in effects of mining.
- Who: commissioned and supervised by the WEP, EZK, SodM.
- Process: Update every two years.
- Relevant criteria are: societal concerns and urgency, professional judgement of state of science and tools, level of consensus.
- Decision: actual dashboard at the start of every calendar year.

3.1.2 Identification of Research questions (RQ's)

Research questions can be identified by society, being EZK (e.g. raised by stakeholders as a reaction to mining policy or energy transition policy), SodM (e.g. raised by stakeholders or supervisors as reaction to supervision of mining activities), research groups (e.g. universities, knowledge institutes or technical), regional interest groups or platforms or other organisations. The WEP itself can also identify and bring forward research questions.

To each societal research question an identification number is given (**RQ-nr**). The RQ will be attributed to the question owner(s) (organisations, persons, researchers) primarily interested in the answer and placed on a dashboard indicating for which type of risk and type of mining activity the question is relevant.

The RQ will also be assessed on matching with current fundamental (e.g. DeepNL) or applied research programs (of Research Institutes) or HRA instruments and protocols developments.

- Output: List of numbered and clearly identified societal research questions (placed in the dashboard).

- Who: KEM coordinators.
- Process: To be repeated/updated at least once a year.
- Relevant criteria: Is the question related to mining effects? Is fundamental or applied research needed or not? Are answers already known? What is the place in the mining effect dashboard scheme? Thus, status mining activity and risk type.
- Decision: Each RQ is attributed in the gross list for the research agenda and allocated to a specific program. The RQ's for other programs than KEM will be shared with the managements of those programs. It is up to the individual program to accept and address the research question. The research questions allocated to KEM will be sent to WEP for further expert discussion.

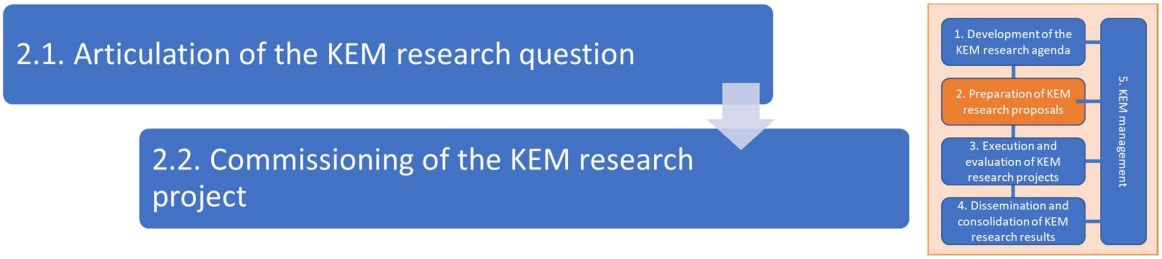
3.1.3 Prioritisation of KEM-RQ's

The WEP and the KEM coordinators will annually discuss the societal questions that were attributed to KEM. Goal of that discussion is to come to several RQ's that should have a high priority to be executed.

- Output: KEM research agenda, the annual short list of KEM-RQ's.
- Who: WEP and KEM coordinators.
- Process: Repeated quarterly and published once a year. Results are reported in relation to the dashboard.
- Relevant criteria: Fit with KEM strategic goals? Fit with KEM financial conditions and time horizon for applied research? Quality and viability of answering the RQ?
- Decision: Advice to prioritize the short list of RQ's.

3.2 Preparation of KEM research proposals

This process aims to translate KEM research questions in such a way that that the research can be commissioned to high quality research groups. The result of this process is a contract with a research group or a consortium of research groups to perform the research for a certain KEM research question. In this process, also the IUC[17]-EZK can play a role, since they are designated to support the procurement of contracts of any form for EZK and SodM, so also those of research projects.



3.2.1 Articulation of the KEM research question

A RQ on the shortlist will be converted into a KEM research question using the available template (see annex A). An owner in EZK or SodM or WEP (or someone hired to do this) will be assigned to take up de specification of the research question. In case of the ownership of EZK or SodM, also a member of the WEP will be assigned to the project development based on their expertise. The research question should make clear how the answers will contribute to better insight in mining hazard and risks and associated uncertainties. Also, it is preferable that it is linked to the practical application, where this insight is needed. Finally, the WEP will give their opinion on (approval of) the content and feasibility of the KEM research question. After WEP approval, the research question will get an own ID for inclusion in the KEM: KEM-nr. WEP also will give advice on the internationally best[18] research groups to perform the research. A shortlist is added to the KEM research question. In case of equal capabilities, Dutch research groups are top listed[19].

- Output: KEM research question formulated in KEM format including: Owner (EZK or SodM or WEP), WEP member, KEM RQ id (**KEM-nr**), Shortlist of relevant research groups and Estimated budget.
- Who: KEM coordinators and WEP.
- Process: All year round, the decisions every 3 months in WEP meetings (if needed a fast track is possible in between meetings).
- Relevant criteria: See annex 2 (RQ decision criteria).
- Decision: Accepted by all WEP members or not.

3.2.2 Commissioning the KEM research project

The KEM project owner will organise the commissioning. Depending on the type of research, they outsource this research:

(a) by requests for offer in a tender process in accordance with IUC guidelines (and fitting to European guidelines on tendering);
(b) to research institutes having a framework agreement with the Dutch government (TNO, KNMI, Deltares, etc.);
(c) as part of a legal task at TNO-AGE.

[17] IUC = Inkoop- en uitvoeringscentrum (purchase and execution center).
[18] preferably European, in order to simplify (online) meetings (time zones, time to travel)
[19] For practicality as well as ensuring knowledge assurance in the Netherlands.

The attributed WEP member is asked by EZK or SodM to give his/her independent advice on tender documents in evaluation or project proposals addressing the research question with arguments (in principle fast and offline).

- Output: Accepted bid for executing the KEM RQ.
- Who: RQ Owner, WEP member and IUC.
- Process: Once for each project.
- Relevant criteria: Primarily the scientific quality of the proposal and the research team and secondarily the price and project management.
- Decision: Decision on submitted proposals to address the KEM research question.

3.3 Execution and evaluation of KEM research projects

After the commissioning, the research project will be executed and, after final delivery, be evaluated. This process aims to timely and effective execution of KEM research projects and to assessing the quality of the execution, the results and the recommendations of a project. In general, the KEM coordinator organizes that a project supervisor is appointed by the commissioning entity for this research project. This project supervisor is responsible for the content and the process of the research. One WEP member will be designated to follow the execution of that specific KEM research project and has to be consulted for strategic project decisions. This WEP member, together with the relevant KEM-coordinator, is responsible for the reporting on the project in WEP meetings. The WEP (as a whole) is responsible for the evaluation of the project.

3.3.1 Research project kick-off

Each KEM research project will start with a kick-off meeting. The goal of this meeting is to agree on the project plan and timeline. The project supervisor and the WEP member will help to focus the research activities and support the search for optimal answers.

- Output: accepted project plan,
- Who: project supervisor, WEP member and research team.
- Process: one for each project.
- Relevant criteria: clarity of phases (for go-no-go's decisions), timeline, deliverables and final products.
- Decision: project plan is alright.

3.3.2 Support of the execution

The project supervisor and the designated WEP member monitor the progress of the research (and utilization of the research budget) and organize periodic technical consultations. At special or decisive moments (like go - no go decisions) other WEP members can be asked for their opinion.

- Output: scientific feedback on project progress and project deliverables.
- Who: project supervisor and WEP member.
- Process: periodical meetings during research period.
- Decision criteria: adherence to planning and content in terms of deliverables, time, budget, etc.

- Decision: adjustments to the project, where necessary.

3.3.3 Delivery of final report

The research team will deliver the draft of the final report of the KEM project to the project supervisor and KEM coordinator. The project owner has to formally accept the final report. By accepting the final report, the project owner confirms that the research has been carried out as stipulated in the research contract.

- Output: accepting final report of the KEM project.
- Who: project supervisor and KEM coordinator.
- Process: once for a project.
- Decision criteria: all criteria mentioned in the research contract.
- Decision: the final report has been accepted.

3.3.4 Evaluation and approval of the final report

The KEM coordinator of the project owner sends the final report of the KEM project directly to the WEP and evaluation by WEP will be executed before the next WEP meeting. The assigned WEP member assesses the quality of the executed research and results, together with at least one other, non-involved, WEP member. Has the project delivered the answers to the research question? Clarity of the recommendations are made. If the WEP is the project owner, this step is carried out together with the preceding step (delivery of the final report, §3.3.3). The project owner and the WEP members share their findings in the next quarterly WEP meeting.

- Output: KEM project evaluation and approval.
- Who: WEP.
- Process: WEP evaluation is discussed and amended/accepted in next quarterly WEP meetings.
- Relevant criteria: Quality of the research, insights and answers obtained and the reporting.
- Decision: Approval of the KEM research project and final report.

3.3.5 Interpreting the results

The results of KEM projects can have consequences. In the WEP evaluation, the WEP can give a scientific or practical interpretation of the results in order to give recommendations on two issues:

(1) follow-up actions in the policy or practice of EZK, SodM or others;
(2) identification of remaining or new research questions that can be used for the next round of the KEM research agenda.

- Output: Recommendations for use of the results or follow-up research.
- Who: WEP.
- Process: WEP recommendations in the evaluation are discussed in the quarterly WEP meetings with the project owners.
- Relevant criteria: SMART scientific interpretation and follow up actions.
- Decision: is follow-up KEM research needed, or not.

3.3.6 Publication of results, evaluation and recommendations

After the finalisation of the research report, the evaluation including recommendations of the WEP, the KEM coordinator of the project owner will carry out its internal interpretation of the results. This leads to either a factual answer to citizens' questions (in the case of EZK) or to an interpretation of

the consequences of the results for the performance of one's own tasks (in the case of SodM). All documents will be published on the website of KEM within three months after finalizing the evaluation during a KEM meeting regardless of the availability of the publication of the project owner on their internal interpretation of the results. The documents on the KEM website are, at least: the original research questions, the final report (including annexes, if any) and the evaluation report of the WEP (this document includes the results of steps 3.3.4 and 3.3.5). The website for this project will also contain connecting text with highlights of the project and the results. Also (a link to) the interpretation results of the project owner will be included in the website text.

- Output: KEM project details on the website.
- Who: KEM website manager after consultation of the project owner.
- Process: Offline, ongoing.
- Decision criteria: project has reached its end.
- Decision: publish the project details.

3.4 Dissemination and consolidation of KEM research results

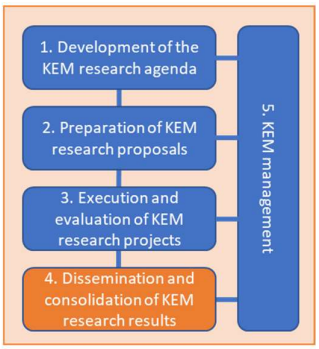
This process has as a goal to disseminate results of KEM projects to primarily the professional community and to some extend to the general public. It includes reporting on impact of KEM.

4.1. Maintaining the KEM website

4.2. Co-organising external meetings of regional platforms and scientific colloquia

4.3. Publishing KEM year reports

4.4. Consolidation in policy and practice



3.4.1 Maintaining the KEM website

The KEM website will be updated and maintained by the KEM secretariat with the help of a professional website builder and a communication professional. New content for the KEM website (on projects, meetings, advises, etc,) will at least be quarterly uploaded. The news and feedback functionality will be checked biweekly and reactions to e-mails sent to the KEM website will be answered within 2 weeks.

- Output: monthly update of website, with a major revision in 2023.
- Who: KEM secretariat and communication experts from project owners.
- Process: monthly.
- Decisions criteria: availability of outcome meetings/colloquia, updates of KEM research questions and projects.
- Decision: changes to KEM website.

3.4.2 Co-organising external meetings of regional platforms and scientific colloquia

Firstly, regular meetings or colloquia will be co-organised with the Dutch scientific community, specifically DeepNL, to share research results and stimulate exchange of ideas. Secondly, on request the WEP secretary or members will participate in regional meetings discussing mining effect concerns. Thirdly, on request the WEP secretary or members will attend technical meetings on mining effects research and development.

- Output: Information exchanges on research questions, results and outcome. Identification of research questions.
- Who: KEM coordinators, optionally WEP members.
- Process: circa 3 colloquia a year connecting the DEEP-NL community with the KEM.

- Relevant criteria: New project results to be disseminated, Requests of regional platforms.
- Decision: Participation in organisation of meetings.

3.4.3 Consolidation in policy and practice

One of KEM's goals is that the research contributes to improving mining policy and practice in The Netherlands. EZK and SodM will each independently examine how they will use the results of the KEM study for their activities. They will also make this publicly known.
EZK and SodM may also ask for ad hoc advice to WEP or WEP members on specific mining risk or KEM project related issues.

- Output: improved and validated policy, guidelines and risk instruments.
- Who: EZK and SodM (on request supported by WEP subpanel).
- Process: continuously. EZK publishes in the annual letter to Parliament. SodM publishes on their website.
- Relevant criteria: what are the impacts of the results of the research projects for current mining policy and current mining practice, including advice for policy and supervision of mining activities.
- Decision: adapt existing policies and practices in a way that does justice to the results of the research.

3.4.4 Consolidation in Groningen hazard and risk instruments

KEM has a subpanel that has a role in evaluating the development of public hazard and risk assessment instruments for Groningen, being an important basis for consolidation of knowledge.

In late 2020, a subpanel of KEM (Knowledge Programme on Effects of Mining) was established by the Ministry of Economic Affairs and Climate (EZK) of the Netherlands to closely follow the development of the public seismic hazard and risk assessment (the public SHRA or pSHRA) tool for Groningen, accompanying the transition of the responsibility for the SHRA from NAM to TNO. The purpose of the subpanel is to advise EZK on the scientific aspects of public SHRA and its development.
The KEM subpanel is composed of independent researchers, partly of WEP, with specific expertise on probabilistic hazard and risk assessment overall and on three main modules of risk analysis, namely: the seismological source model (SSM); the ground motion model (GMM); and the fragility and consequence model (FCM). The specific goals of the subpanel are: (i) to review the studies for their potential to be part of the public SHRA development, (ii) to advice to State Supervision of Mines on the Status of the TNO model chain Groningen and to EZK on the proposed public SHRA development plan of TNO, both on a yearly basis; (iii) to report to the WEP about the public SHRA progress and development.

- Output: advices on pSHRA model Groningen versions and development plans.
- Who: KEM subpanel (on request of SodM or EZK).
- Process: On demand.
- Relevant criteria: scientific robustness of HRA tools.
- Decision: Input for next year pSHRA model versions to be used and development activities to be commissioned to TNO.

3.4.5 Publishing KEM annual reports

The KEM progress is reported in KEM annual reports. The annual report includes: the KEM research executed in the context of the dashboard (research questions discussed, the KEM projects started, in

operation, finished and evaluated), the dissemination and consolidation actions (website, meetings and hra advise) and the activities of the KEM scientific expert panel.
These are published on the KEM website after the yearly strategic discussion with the KEM management board. EZK sends a KEM progress letter to the Parliament, annually.

- Output: KEM annual report on website and EZK letter to Parliament.
- Who: WEP-secretary and WEP-chair for the report; EZK, and KEM coordinators for the letter to Parliament.
- Process: Yearly.
- Relevant criteria: Completeness and accuracy of the annual report.
- Decision: Publish the report and send the letter.

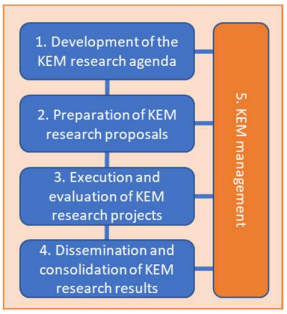
3.5 KEM Management

This process has as a goal to responsibly manage KEM.

5.1. Operational meetings

5.2. WEP meetings

5.3. Management Board (MB)



3.5.1 Operational meetings

KEM operational meetings are meetings of the KEM coordinators. These meetings are meant to closely monitor and operationally steer the research pipeline progress and organize all meetings, KEM research questions, KEM projects, results and evaluations (status and go/no-go) and follow up.

- Output: action lists;
- Who: KEM coordinators;
- Decision criteria: smart division of labour aimed at an effective implementation of KEM and KEM projects;
- Decision: (re)distribution of actions and information to (current or new) action holder;
- Process: bi-weekly.

3.5.2 WEP meetings

The WEP meetings are meant to discuss the (scientific) progress of the research pipeline: KEM research questions, KEM projects, results and evaluations (status and go/no-go) and follow up (prepared by the KEM coordinators). The KEM Strategic Research Framework (SRF; chapter 2 of this document) is used to assess added value of individual research questions. Research questions and research projects will be assembled in a KEM research status overview. At the end, the project results will be evaluated, the fit to the research question assessed and linked to the objectives of the RQ.

The WEP has four formal meeting moments in any given year. The WEP is expected to meet physically twice a year in The Netherlands. The two other meetings and any ad hoc requirements are expected to be conducted by teleconferencing apart from usual email correspondence. The WEP is supported by a secretariat. The secretariat (appointed by the chair and financed by EZK) takes care of all documents, communication issues and meeting logistics. The members receive a remuneration and compensation for their time, travel, and expenses.

- Output: minutes, meeting documents, progress overview table, action lists.
- Who: WEP and KEM coordinators.
- Process: Quarterly.

- Relevant criteria: scientific quality assurance, smart division of labour aimed at an effective implementation of KEM and KEM projects.
- Decision: (re)distribution of actions and information to (current or new) action holder.

3.5.3 Management Board

The KEM management board (MB) consists of the WEP chair, the program director-general of EZK (dgGO) and the inspector general of the Mines (igM). The MB meets once a year. The annual MB meeting is meant to reflect and discuss the KEM annual report, WEP evaluations and the WEP composition. After the annual MB meeting the KEM annual report and letter to parliament of EZK are published. Other topics may be included in the MB meetings if added to the agenda at least one week before the MB meeting. At any time, the WEP chair can report any urgent suggestions to the MB and ask for a meeting.

- Output: strategic decisions.
- Who: WEP Chair, director-general of GO and inspector-general of SodM (KEM coordinators are also present).
- Process: yearly meeting.
- Relevant criteria: mission of the KEM, KEM progress and actuality.
- Decision: continuation or adjustments in KEM conditions inputs (budget, staff, strategy, modus operandi).

3.6 Summary of responsibilities

In the following table the responsibilities of the defined tasks are summarized. In the following RACI table the number of the task refers to the previous sections and the responsibilities of the actors are summarized: R=responsible, A=accountable, C=consulted, I=informed.

	WEP	Management Board	Project owner	KEM secretary	KEM coordinators	KEM research groups	Profes-sionals	Public
1.1 Maintenance of the research dashboard	C	A	C	R	R		C	
1.2 Identification RQ's	C	A	C	C	R	C	C	C
1.3 Prioritisation of the KEM-RQ's	R	A		R	R		I	I
2.1 Articulation KEM Research Question	R		A	C	R			
2.2 Commissioning the KEM research	C		A	I/C	R	I	I	I
3.1 Research project kick-off	R (one member)		A	I	R	R		
3.2 Execution and support	R (one member)		A	I	R	R		
3.3 Delivery final reports	I		A	I	C	R		
3.4 Evaluation of the project	A		C	R	C		I	I
3.5 Publication of results, etc.	I	A		R	C		I	I
4.1 Maintaining the KEM website	C	A		R	C		I	I
4.2 Co-organising external meetings for ..	C	A		R	C		I/C	I
4.3 Consolidation in policy and practice	C	A		I	R		I	I
4.4 Consolidation in hazard & risk instruments	R	A		C	R		I	I
4.5 Publishing KEM year reports	C	A		R	C		I	I
5.1 Operational meetings		A		R	R			
5.2 Quarterly WEP meetings	R			A	C			
5.3 Board meetings	C	A		C	R			

4 Success criteria

The KEM evaluation in 2022 indicated that SMART success criteria will improve the management of KEM and, in the end, future evaluations. They are as follows:

KEM goal

- > 4 projects a year with impact on mining policy, supervision or citizen concerns. At least X projects for EZK and Y projects of SodM reflecting the individual budgets of EZK and SodM.
- use in public management and debate (increase in the number of references to KEM reports in that area) and publications;
- Number of KEM website visits (>2000 per annum);
- Positive appreciation of EZK and SodM during yearly MB meetings expressed in the yearly letter to Parliament;
- Positive evaluation in 2027 by external stakeholders.

KEM scope and outcome

- Biennial assessment of status on insight and availability of public hazard and risk; quantification instruments in NL of each area of interest in the dashboard;
- Yearly updated pipeline with knowledge gaps agenda, KEM research questions, projects and impact in seismic, subsidence, leakage and abandonment hazard and risks.

KEM disciplines and scientific quality

- Number experts in various disciplines working on KEM projects and Multi-disciplinarity of KEM scientific expert panel and subpanel members, at least 4 different expertise;
- Scientific papers produced in or after KEM projects (one per finished project if the project is suitable for publication, in the case of a project creating a tool it is the published tool).

Advices on risk assessment instrument

- One advice on Groningen SHRA model status and developments plan reports per year

Communication

- Website upgrade in 2023 and All research questions, project results and evaluation published within 3 months of finalizing the KEM evaluation during a KEM meeting.
- Four meetings KEM panel, EZK, SodM
- At least 3 scientific colloquia on KEM results
- At least one meeting with regional stakeholders per year

Annex 1. Template for Research Questions.

KEM Innovation/Research Question			
TITLE ***full text***			
Title acronym	*Acronym*	**RQ origin**	*stakeholder*
Initiator	*EZK/SodM/NCG*	**RQ number(s)**	*number*
Project owner	*Name*		
Contact person	*Name*	**Max. duration**	*Man month*
KEM subtheme	*See list*	**Est. Budget**	*range in euros*
KEM project code	*KEM-number*	**Contractors**	*first*
Research category	*ST/MT/LT*	**Contractors**	*second*
Risk instr. Innovation	*yes/no*	**Contractors**	*third*

Budget/cashflow constraints (k€)

Agency	2023a	2023b	2024a	2024b	2025a	2025b
EZK						
SodM						
NCG						
Other						
Total						

Objective

Maximum 800 characters (which public concerns or risk management innovations have to addressed

State of the art, background

Maximum 800 characters (description earlier work and data, software and reports available, list of partners involved in the past, refer to rest in reference list)

Research Question

Maximum 400 characters (what to be addressed and what not *AND Link to KEM Research Agenda)*

Deliverables expected

Maximum 400 characters (list of deliverables expected, way of publication and intended usage by client)

Timeline

Maximum 200 characters (phases, milestones, end of project dates)

Expected use

Maximum 200 characters (general knowledge, contribution to risk instrument, contribution to risk assessment

Expertise and tools preferred for the team

Maximum 200 characters (lists of expertise expected, including skills in tools to be used)

Quality assurance, Organizational and communication requirements

Maximum 200 characters (Review level, location, collaboration and meeting schedule wishes)

Remarks and Suggestions

Maximum 200 characters (Extra information concerning the Innovation/Research question)

References

No limit (Reference list of papers, tools and reports)

Annex 2. KEM research question eligibility criteria and research group recommendation template

Selection ranking criteria (only for KEM expert panel only). *Scale: 1(no) - 5(yes) and short comment*

	Considerations		PE 1	PE 2	PE3	PE4	PE5
Scientific	State of the art OK?						
	Valid I/R question?						
	Realistic expectation?						
	Categorization OK?						
	Scientific publishable?						
	RA Tool improvement?						
	….						
Feasibility	Deliverables?						
	Deadlines?						
	Budget allocated?						
	Openness?						
	…						
	….						
Building trust	Concerns addressed?						
	Risk reduction focus?						
	Quality assured?						
	Communication OK?						
	Reputation team OK?						
	Open products?						
	….						
Total (weighted) score							

Suggestions of experts and/or research entities

PE	**Organization name**		**Names of experts**
PE 1			
PE 2			
PE 3			
PE 4			
PE 5			

Annex 3. KEM project evaluation criteria template

KEM Research review, evaluation and interpretation (max. 4 pages + annex)			
TITLE …….			
Title acronym	……	**RQ origin**	*stakeholder*
Initiator	*EZK/SodM/NCG*	**RQ number(s)**	*number*
Project owner	*Name*		
Contact person	*Name*	**Max. duration**	*man month*
KEM subtheme	*See list*	**Est. Budget**	*range in euros*
KEM project code	*KEM-number*	**Contractors**	*first*
Research category	*ST/MT/LT*	**Contractors**	*second*
Risk instr. Innovation	*yes/no*	**Contractors**	*third*

KEM Quality review

Description of the scientific quality of the results (team, research method, research results, quality of the products, …), if needed external review result (project evaluation text website)
Optional: Confidential comments and recommendation for EZK and SodM (KEM only)

KEM Evaluation of the results

Evaluation whether the research questions are addressed adequately (questions answered, precision and uncertainties on outcomes, potential consequences on current practice addressed, ..) (project evaluation text website)
Optional: Confidential comments and recommendation for EZK and SodM (KEM only)

KEM interpretation of the outcome

The interpretation of the results (consequences on methods/data to be used in practice, con risk instrument modules, on inspection procedures and operator procedures, ..) (project evaluation text website)
Optional: Confidential comments and recommendation for EZK and SodM (KEM only)

Closure text for the website

A summary in simple terms of the goal, the outcome and impact on mining policies or toolboxes of the research project (project evaluation text website)