Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe

Technical review report for project GARAH

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 731166.

INTRODUCTION

Technical review report is part of GeoERA's Monitoring and evaluation process for co-funded projects (*hereinafter: project*). The aim of a technical review is to assess the work carried out under the project over a certain period and provide recommendations. Such technical review evaluates the project reports and deliverables, the proper use of resources, the management of the project and the expected impact.

Technical review report consists of four sections, each representing one level of monitoring and/or evaluation of the project:

Level	Monitor / Reviewer	Input	Aim
1 – Monitoring of progress indicators	Monitoring and reporting officer (GeoZS)	MPPR* FPPR**	Monitoring of the effectiveness of implementation of selected projects with respect to finance, time and administration.
2 – Scientific review	Reviewers (GeoZS)	Submitted deliverables MPPR FPPR	Quality review of the deliverables and review of achieving scientific and professional goals.
3 – Review of the theme progress	Theme coordinators	MPPR FPPR	Review of achieving theme objectives.
4 – GeoERA Progress evaluation	Stakeholder Council member(s)	Sections 1 and 2 of this report Review meetings	Overall project progress and general recommendations.

*MPPR = Midterm Project Progress Report (see PI doc no 2)
**FPPR = Final Project Progress Report (see PI doc no 2)

Monitoring and evaluation process:

M0 = End of reporting period
M1 = Submitted (Final) Project progress Report (MPPR / FPPR)
M2 = 1 – Monitoring & 2 – Evaluation
M3 = 3 – Evaluation of the theme progress
M3 = (Final) Review Meeting & 4 – Progress evaluation

Each project will be reviewed twice: for first project period M1-M18 – Technical review report, and second project period M19-M36 – Final review report.
Technical review report is based on Horizon 2020 templates but adopted to GeoERA needs. Technical reviews of projects shall be carried out on a confidential basis.

GENERAL INFORMATION

ERA-NET Cofund Grant Agreement:	731166
ERA-NET Cofund acronym:	GeoERA
Call identifier:	H2020-LCE-2016-2017/H2020-LCE-2016-ERA
Project full title:	Geological Analysis and Resource Assessment of selected Hydrocarbon systems
Project acronym:	GARAH
Project reference number:	GeoE.171.002
Project topic:	GeoEnergy
Project specific topic:	GE1-Fossil energy, energy security and climate action
Lead partner:	GEUS Geological Survey of Denmark and Greenland
Project website:	http://geoera.eu/projects/garah/

☒ Technical review report
☐ Final review report

Period covered	01/07/2018 – 31/12/2019
Review meeting date	05.02.2020, concise 28.02.2020

Contributor:	Role:	Approved on:
Barbara Simić	Monitoring and reporting officer	24.02.2020
Maja Ilić	Monitoring and reporting officer	25.02.2020
Miloš Markič	Scientific reviewer	06.02.2020
Jasna Šinigoj	Scientific reviewer	11.03.2020
Matija Krivic	Scientific reviewer	10.03.2020
Serge van Gessel	Theme coordinator	16.03.2020
Thomas Crafford	Stakeholder Council member	NA
Harikrishnan Tulsidas	Stakeholder Council member	21.04.2020

1 LEVEL 1 – MONITORING OF PROGRESS INDICATORS

In this section the project is monitored "remotely" on the basis of the respective reports. This part is filled in by Monitoring and reporting officer with aim to monitor the effectiveness of implementation of the selected projects with respect to finance, time and administration, based on submited MPPR and FPPR.

	Yes	Partially (comment needed)	No
PROJECT MANAGEMENT			
Has the MPPR / FPPR report been submitted on time?	☒		☐
Have there been any changes in project partnership?	☐		☒
Has the project management been performed as required?	☒		☐
Has the collaboration between partners been effective?	☒		☐
Do you identify evidence of underperforming partners, lack of commitment or change of interest of any partners?	☐ (see comment)		☒
DELIVERABLES and MILESTONES			
Have the planned deliverables for the period been submitted on time according to timeline in Project Agreement?	☐	See comment no.1	☒
Have the planned deliverables for the period been completed (from MPPR / FPPR, sheet 4)	☒		☐
Have any changes to deliverables occurred (type/ dissemination level)? (from MPPR / FPPR, sheet 4 and 5)	☒	See comment no.2	☐
Have planned milestones been achieved for the reporting period? (from MPPR / FPPR, sheet 4)	☒		☐
Have the project partnership identify any difficulties achieving any of the deliverables / milestones?	☐		☒
DEVIATIONS (from MPPR / FPPR, sheet 5)			
Has the project partnership identify any deviations that will not affect projects outputs?	☒		☐
Have any deviations occur on the project, with impact on project outputs?	☐		☒
In case of deviations, have the project adopted corrective measures?	☒		☐
DISSEMINATION, COMMUNICATION			
Has the project adopted its dissemination plan?	☒		☐

Have the planned dissemination activities been completed for the reporting period? (from MPPR / FPPR, sheet 6)	☒		☐
Have the partners' disseminated project results and information adequately?	☒		☐
Is the project following dissemination plan?	☒		☐
Is the project interacting in a satisfactory manner with other GeoERA projects?	☒		☐
Is the project interacting in a satisfactory manner with national/international bodies?	☒		☒

FINANCE			
To the best of your estimate, have the resources used been utilised for achieving the project? (according to MPPR / FPPR, sheet 9)	☒		☐
To the best of your estimate, have the resources used been in a manner consisted with the principle of economy, efficiency and effectiveness? *	☒		☐
Are there any major deviations in the budget consumptions from the financial plan? (zero consumption in M18; deviation from plan exceeding 20% in M36)	☐		☒
Are there any major deviations in the Person - Months consumptions from the plan? (zero consumption in M18; deviation from plan exceeding 20% in M36)	☐		☒
Are any budget modifications for the project needed? (from MPPR / FPPR, sheet 5)	☐		☒

***The principles of economy, efficiency and effectiveness** refers to the standard of "good housekeeping" in spending public money effectively. Economy can be understood as minimizing the costs of resources used for an activity (input), having regard to the appropriate quality and can be linked to efficiency, which is the relationship between the outputs and the resources used to produce them. Effectiveness is concerned with measuring the extent to which the objectives have been achieved and the relationship between the intended impact and the actual impact of an activity. Cost effectiveness means the relationship between project costs and outcomes, expressed as costs per unit of outcome achieved.

Comments (highlighting the project progress) / deviations / recommendations:

Comment no.1: In the first reporting period 7 deliverables were due:
5 deliverables were submitted in time
1 deliverable was submitted with eligible delay (amendment 1)
1 deliverable is postponed to period 2
Comment no.2: Changes to deliverables:
D2.1: postponed from M9 → M10
D1.4: postponed from M18 → M19
The changes have no impact on the project outputs.

Project GARAH deals with the identification of new potential areas for hydrocarbon exploration with the aim to give further information regarding basin development and evolution, and the HC resources assessment. It will be used by planning and policy makers, commercial exploration strategies and to highlight remaining knowledge gaps, which may inform about further academic research or programs of exploration sponsored by member states. The project builds knowledge on finalized project EUOGA, among others.
In the first reporting period GARAH completed all planned deliverables, 2 deliverables that were postponed were submitted with only one-month delay from the original plan. The original project plan is well established, the partnership recognized the challenges well in advance and is following the project proposal well.
Dissemination plan has been adopted and followed in the first reporting period, the project is cooperating with other GeoERA projects, mainly with GIP-P and 3DGEO-EU. The recommendation from the Monitoring team is to try to keep track of the communication and dissemination activities and try to count or estimate the number of people reached with these activities.
Overall financial consumption at the end of first reporting period is 40 %, which is a bit low. According to the project plan, the majority of activities will be done in the second reporting period, consequently the financial consumption will increase.

No challenges regarding achieving the project outcomes are recognized, project lead provides good support to partners with implementation of project activities.

Overall assessment of the project:

☐ 5 - **Overachiever** (the project has achieved all objectives and goals for the period and has even exceeded expectations)

☒ 4 - **Excellent progress** (the project has fully achieved its objectives and goals for the period)

☐ 3 - **Good progress** (the project has achieved most of its objectives and goals for the period with relatively minor deviations)

☐ 2 - **Acceptable progress** (the project has achieved some of its objectives; however corrective action will be required)

☐ 1 - **Unsatisfactory progress** (the project has failed to achieve critical objectives and/or is not at all on schedule)

Summary of dissemination activities (detailed activities are annexed to this report):

Activity	Target audience	Number of people reached
Publications	Scientific community	
Events	Scientific community	250
Meetings	EU institution	200
Meetings	Scientific community	215
Media	General public	
		665

Are the dissemination activities adequate? (link to GeoERA WP5)

☐ 5 - **Overachieved** (the projects dissemination activities have exceeded expectations)

☐ 4 - **Excellent** (the projects dissemination activities have fully achieved its expectations)

☒ 3 - **Good** (the projects dissemination activities are adequate; however some additional activities are needed)

☐ 2 - **Acceptable** (the projects dissemination activities need corrective actions; additional activities are needed)

☐ 1 - **Unsatisfactory** (the project has failed to disseminate)

Cummulative financial statement:

	Person months	Total eligible costs	Reimbursement rate	GeoERA contribution	In-kind contribution
Plan	118,64	1.076.731	22%	233.361	843,370
1st period consumption	49,34	406.518	22%	89.434	317.084
2nd period consumtion					

2 LEVEL 2 – SCIENTIFIC REVIEW

In this section the project is reviewed ”remotely” on the basis of the respective reports. This part is filled in by reviewer with aim to review the quality of the deliverables and review of achieving scientific and professional goals. Scientific review is based on submitted deliverables and reported Impact statement in MPPR/FPPR.

Impact statement (from MPPR / FPPR, sheet 8):

The GARAH project idea will result in the identification of new potential areas for hydrocarbon exploration, directly addressing the requirement for identifying secure energy HC sources. This will give further information regarding basin development and evolution, and the HC resources will be systematically assessed. Outcomes will therefore feed into planning and policy (licensing of areas for exploration) by Member States, commercial exploration strategies and highlight remaining knowledge gaps, which may inform about further academic research or programs of exploration sponsored by member states. The generated catalogue of the multiple-use (or sequential-use) potential and impacts of hydrocarbon reservoirs will enable the European community to improve efficient, sustainable, and foster climate friendly use of the subsurface. A consistent estimation of hydrocarbon resource will be a first step in assessing and quantifying the hydrocarbon reserves in the main hydrocarbon basin in Europe. Our mission is to generate a catalogue of the multiple-use, enabling synergies between various uses and securing a sustainable development, whilst reducing overall climate impact of fossil fuel use. The identification of potential hydrate resources in the European margins and provide a unified database and maps detailing potential distribution of gas hydrates (energy source), potential geohazard areas. In addition, we will aim to identify zones could be used to store CO2 as a hydrate (subsurface CO2 storage resource) within the European offshore and onshore areas. The results will foster the development of new HC technologies in Europe and will feed into planning, policy (licensing of areas for exploration) by Member States, and commercial exploration strategies. The outcomes of this project idea will inform EU Member States of potential frontier plays in a pan-EU perspective, allowing for the currently poorly understood offshore methane hydrate and shale gas/oil resource to be acknowledged in developing legislation and regulation.

Expected impact (from Project Agreement):

A variety of different evaluation methods have been employed to assess the hydrocarbon resource in different areas of the EU. Consistent evaluation methods and data processing on newly released and legacy data will help rationalize the resource estimates across the EU, allowing for improved planning for the exploration, development and closure of hydrocarbon reservoirs. Technology improvements may

result in resources previously considered uneconomic (e.g., shale gas and methane hydrates) to be considered viable exploration targets in areas with little exploration history. The identification of these areas and quantification of resource will contribute to the development of planning strategies for member states in terms of licensing and policy development. A consistent estimation of hydrocarbon resource will be a first step in assessing and quantifying the hydrocarbon reserves in the main hydrocarbon basin in Europe. The GARAH project idea will result in the identification of new potential areas for hydrocarbon exploration, directly addressing the requirement for identifying secure energy HC sources. This will give further information regarding basin development and evolution, and the HC resources will be systematically assessed. Outcomes will therefore feed into planning and policy (licensing of areas for exploration) by Member States, commercial exploration strategies and also highlight remaining knowledge gaps which may inform about further academic research or programmes of exploration sponsored by member states. The datasets generated will also highlight areas of potential risks associated with exploitation of fossil fuels and the closure of mature fields. Areas with the potential for multiple uses of the subsurface that may require the development of appropriate legislation or guidance will also be identified, therefore partially mitigating delays in bringing energy to market that are related to those issues. The generated catalogue of the multiple-use (or sequential-use) potential and impacts of hydrocarbon reservoirs will enable the European community to improve efficient, sustainable, and foster climate friendly use of the subsurface.

Our mission is to generate a catalogue of the multiple use, enabling synergies between various uses and securing a sustainable development, whilst reducing overall climate impact of fossil fuel use. For example, utilizing the infra structure and the potential of associated geothermal-shale and or depleted reservoir schemes could enable the possibility of a climate neutral HC production. The identification of potential hydrate resources in the European margins and provide a unified database and maps detailing potential distribution of gas hydrates (energy source), potential geohazard areas. In addition, we will aim to identify zones could be used to store CO2 as a hydrate (subsurface CO2 storage resource) within the European offshore and onshore areas. The results will foster the development of new HC technologies in Europe and will feed into planning, policy (licensing of areas for exploration) by Member States, and commercial exploration strategies. By mapping zones of interest, there will be a contribution to marine spatial planning, including possible conflicts between deep hydrocarbon resources; gas storage (i.e. CO2, Hydrogen) positioning and impacts of deep-sea infrastructure; fishing activities and deep-sea habitats; national security issues. The GARAH project will contribute to the development of appropriate legislation and guidance (e.g., storage vs. production, preservation). The outcomes of this project idea will inform EU Member States of potential frontier plays in a pan-EU perspective, allowing for the currently poorly understood offshore methane hydrate and shale gas/oil resource to be acknowledged in developing legislation and regulation.

Evaluation of deliverables

Deliverables list status			
No.	Title	Status (Approve/ Reject)	Comments
D1.1	Dissemination and Exploitation plan	Approved	Well done
D1.2	Project data management plan	Approved	See below
This deliverable provides a first version of the GARAH Data Management Plan. It is structured according to the guidelines of the Overall GEOERA Data Management following Horizon 2020 FAIR Data and Management Plan. Since GIP-P did not yet provide recommendations and EGDI will furtherly develop, this report could be updated in the future.			
D1.3	Annual progress report 2018	Approved	Well done
D1.4	Midterm Project Progress Report	Approved	Presented at the telemeeting on 5th February
D2.1	Data base & harmonization report	Approved	Well done
D3.1	Collection data report on available Hydrates data	Approved	Well done
D4.1	Preliminary data selection, IP guidelines, QA procedures	Approved	Well done

Has the quality as a whole been achieved according the objectives? Has the project as a whole been making satisfactory progress?

☐ 5 - **Overachiever** (the project has achieved all objectives and goals for the period and has even exceeded expectations)

☒ 4 - **Excellent progress** (the project has fully achieved its objectives and goals for the period)

☐ 3 - **Good progress** (the project has achieved most of its objectives and goals for the period with relatively minor deviations)

☐ 2 - **Acceptable progress** (the project has achieved some of its objectives; however corrective action will be required)

☐ 1 - **Unsatisfactory progress** (the project has failed to achieve critical objectives and/or is not at all on schedule)

Comments (highlighting the project progress) / deviations / recommendations:

The GARAH project is well in accordance to basic EU strategy: being sustainably supplied with energy and being at the same time sustainable environmentally. A proclaimed target of the EU Energy Policy is to become a “Carbon-Zero” society in a “short” time. However, there is an awareness among a great part of well credible professionals that in a mid-period of some decades, maybe even considerably longer, fossil energy resources will still play an important role, technologically and economically. Nowadays fossil fuels cover more than 80 % of primary energy

consumption in the World (both developed and developing) and are economically acceptable, positive. The greatest issue of fossil fuels is environmental, now seen as a major contributor to the green-house gasses, especially CO2. But, among fossil fuels there are great differences. Coal ("dirty" or "clean") is an environmental enemy number 1. More acceptable are oil (still almost inevitable in transports and many organo-chemical products), and natural gas with a wide spectrum of uses, and "producing" only ca. 60 % CO2 per unit of energy in comparison to coal. Among fossil fuels, therefore, natural gas, geologically known or still unknown (?), conventional and unconventional, in its variety of natural occurrences plays a number 1 role.

In the 1970-ies natural gas and oil found, explored and started to be exploited in the North Sea stopped an oil crisis due to increasing OPEC prices of oil. Not only lowering HC prices but also replacing coal by gas in W European countries was the result of this time.

Nowadays Europe is quite highly dependent on the gas import. Without new HC plans, exploration, resources/reserves evaluations, exploitation with best available techniques, and environmental managing, Europe can come in suffering position regarding economically acceptable energy supply.

From all above briefly cited aspects it is very reasonable for Europe that in knows what and how much potential and realistic energy resources and reserves it has. Europe has ca 150 years history of intensive HC exploration and production in the areas that are now mostly known as fields of conventional HCs. Many of conventional HC-bearing strata/formations are nowadays in EU already depleted or in declining production. But because their reservoir characteristics are mostly very well-known such formations represent ideal plays e.g. for CO2 and/or e.g imported natural gas storage.

Besides conventional CH fields, unconventional HC-bearing formations become more and more attractive also in EU, among them especially shale gas, tight gas and gas hydrates, their resources are considered as enormous. In this project particularly the Northern European Permian Basin is dealt with, with a welcome ambition to extend the procedures of HC resources/reserves assessments also in the whole Pan-European area.

From all above aspects it is concluded that a complex impact of the GARAH project in the GeoERA programme will be undoubtedly highly positive.

Conclusions:

1) It is very positive, that the project aims to consider all geosources of an area (not only HCs) - in this context my recomendation is to more point out also great aquifers which are often in more or less "critical" vicinity to HC-bearing formations.

2) Do maybe mention that results of your project could be also valuable for studying locations for (imported) natural gas storage (not only CO2 sequestration – CCS).

3) Gas hydrates (GHy): you have an overview map of GHy in the ocean and the seas – what about inland permafrost?

5) When you are speaking about unconventional HCs systems do maybe mention more outstandingly that there are inland and off-shore systems /areas (though geologically speaking there is no strict difference between inland and off-shore – the differences are more technical / economical /ecological).

6) in Chapters Impact statement and Expected impact you have a sentence: *"The identification of potential hydrate resources in the European margins* ***and provide a unified database and maps detailing potential distribution of gas hydrates (energy source), potential geohazard areas****"*. I suggest writing this sentence more clearly – maybe in two sentences …

3 LEVEL 3 – REVIEW OF THE THEME PROGRESS

In this section the project is reviewed ”remotely” on the basis of the respective reports. This part is filled in by Theme coordinator with aim to review the achieved scientific goals in accordance with theme objectives, on the basis of Sheet 3 in MPPR / FPPR – Project contribution to GeoERA project.

Project contribution to GeoERA project (from MPPR / FPPR, sheet 3):

WP2 (North Sea Petroleum Systems) will define the range of petroleum systems in the North Sea and populate a harmonized database detailing the oil and gas resource present in the UK, Dutch, German, Danish and Norwegian sectors. The work package will give a harmonized assessment of the conventional and unconventional using the methodology developed in the EUOGA project. The WP2 will also demonstrate the advantages of 3D model assessment in a pilot study area. WP3 (Addressing knowledge gaps in the hydrate assessment in the European continental) will develop a harmonized model for a pan-European gas hydrate data infrastructure. A GIS-database will be developed that includes key gas hydrate observations. This will feed into an assessment of hazard associated with effective closure of mature fields, including multiple and alternative use of assets and infrastructure.

Theme objectives:

Theme objectives: compliant

- Potential subsurface contributions with regards to energy resources and storage capacities;
    - Main project objective, results presented at midterm are compliant to this
- Potential risks and environmental impacts associated with subsurface use for energy applications;
    - Part of project objective, not presented as concrete result in mid term yet
- Risks of competition and interference between different uses of subsurface space, including interactions with surface infrastructures, and rewards of synergies.
    - Part of project objective, not presented as concrete result in mid term yet

Theme scope: compliant

- Hydrocarbons including conventional/unconventional oil and gas, gas hydrates;
    - Main project scope, results and progress presented

- Energy derived from solid resources such as coal (including coal bed methane (CBM) and underground coal gasification), lignite, peat, uranium;
    - Not in project scope
- Geothermal energy from hydrothermal and petro-thermal resources, both shallow and deep;
    - Not in project scope
- Capacities for temporary storage of energy carriers (natural gas, hydrogen, compressed air and heat);
    - Part of project scope. Re-use / multi-use of gas fields to be investigated in 2nd phase
- Capacities for permanently storage of CO2 and other energy effluents.
    - Part of project scope. Re-use / multi-use of gas fields to be investigated in 2nd phase
- Identification and analyses of overlap and interactions between geo-energy resources and areas prone to seismic activity;
    - Not in project scope
- Determination and analysis of potential connections to groundwater and surface water systems;
    - Not in project scope
- Identification and analysis of potential interferences as well as synergies/pooling between various geo-energy resources and subsurface uses.
    - Part of project scope. Re-use / multi-use of gas fields to be investigated in 2nd phase

Theme approach and methods: compliant

- Deliverables proposed by geo-energy theme projects should be compatible with a common spatial geological framework defined by the extent, depth, thickness, as well as essential properties of geological intervals containing relevant geo-energy resources and storage capacities.
    - The project follows/incorporates frameworks from earlier EU projects (EUOGA)
- Common state-of-the-art methodologies will be developed and applied with the aim to assess and quantify technically recoverable resources.
    - Common resource assessment methodologies (conform industry standards) are used (presented as result/progress)
- Development and demonstration of advanced 3D modelling and assessment activities may be proposed for complex geological configurations typical for specific cross-border regions under the condition that these methodologies have generic value and can be linked to the future objectives of a common spatial-assessment framework.

- The project includes a trans-national 3D pilot area for advanced HC assessment and modelling (presented as result/progress)

- The joint call will either ask for final deliverables and methodologies consistent on a transnational to pan European level, or for the demonstration and development in cross-border regions of methodologies that have generic value for future pan-European assessments.
    - The project considers the offshore on a pan-European and/or transnational level. Results presented
- Correlation schemes of cross-border geo-energy resources;
    - Correlation schemes are part of the assessment
- Compatible and interoperable model scales/resolutions and geometries;
    - A regional/national scale is used as basis for the assessments
- Commonly agreed modelling and assessment methodologies.
    - Methodologies are generally in compliance with industry standards

Beyond state of art: compliant

- Advanced mapping and 3D modelling strategies that allow for regional to pan-European cross-border consistency and integration;
    - Project uses 3D modelling and basin history techniques at transnational scale which is quite advanced in this field of research. Results/progress presented
    - Pan-European assessment of Gas Hydrates is advanced
- Advanced and harmonized resource estimation workflows addressing uncertainty and sensitivity;
    - The application of offshore unconventional resource assessments at transnational scale techniques is advanced in this field of research. Results/progress presented
- State-of-the-art assessment workflows for analysis of potential geologically related surficial and subsurface effects induced by resource exploitation (e.g. subsidence, tremors, etc.);
    - Not in project scope
- Methodologies to objectively weigh interacting or mutually exclusive potential uses of space within the geoenergy theme and across the other themes on groundwater and minerals.
    - Part of project scope. Re-use / multi-use of gas fields to be investigated in 2nd phase

Project-2-Project:

GARAH exchanges model data with the 3DGEU-EU project (in GeoEnergy)

Has the project as a whole achieved the objectives and expected impact of the theme?

☐ 5 - **Overachiever** (the project has achieved greater impact on project theme and/or other themes than expected)

☐ 4 - **Excellent progress** (the project has fully achieved its objectives and goals towards the theme as expected)

☒ 3 - **Good progress** (the project has achieved most of its impact towards the theme for the period with relatively minor deviations)

☐ 2 - **Acceptable progress** (the project has minor impact; corrective action will be required)

☐ 1 - **Unsatisfactory progress** (the project has failed to achieve critical objectives and/or is not at all on schedule and/or has no impact on the theme; corrective actions are required)

Comments / deviations / recommendations:

GARAH progresses in line with the project objectives and thereby follows the theme scope/objectives and GeoERA principles in general as mentioned in the call description.

Additionally the review analyses how the project performs beyond the project scope and raises the overall profile of the Energy Theme and GeoERA as a whole, i.e.:

- Developing and actively implementing standards and methods for panEU harmonization in the GSO community that are of value to the Energy Theme and/or GeoERA in general (i.e. beyond the project scope)
- Successfully introducing and implementing innovative and novel methods and standards in stakeholder/science communities leading to wider recognition of the Energy Theme and/or GeoERA
- Stimulating synergies between projects and themes
- Raising the overall impact and recognition of the Energy theme and/or GeoERA though active engagement of stakeholder and science communities
- Opening opportunities for future research and spin-offs including EP-GSE (i.e. possibilities for sustained development of results after project lifetime)

The GARAH project is rated as 'good' for the following reasons:

1) The project actively implements and extends standards and tools for HC assessment (e.g. building on the former EUOGA project) and correlating source formations in offshore regions. The project has a direct exchange with the 3DGEO-EU project to demonstrate the added value of novel harmonized 3D models.
2) Although the project has synergies and interactions with other GeoERA projects (in particular 3DGEO-EU), the current activities are still mostly focused on the project internally. It is recommended to increase external stakeholder

engagement and involvement. Stimulate further external recognition of GARAH activities (e.g. adoption of results in industry and resource management) and thereby demonstrate the added value and benefits of performing these activities in the context of the Energy Theme and GeoERA in general.

3) GARAH is compliant to the GeoERA scope. However, since the preparations of GeoERA, the position of hydrocarbons (and fossil fuels in general) is rapidly changing with regards to the European and national energy research agendas. Although fossil is not in the scope of the EU Green Deal, the project results may still contribute to important energy security climate goals (e.g. re-use as CO2 storage or even energy storage, domestic fuels with lower carbon foot print compared to imported gas, managing hazards of gas hydrates, implementation of data and research methods developed and acquired by the industry). It is recommended that the project addresses how the results may enable such spin-offs and prove their relevance for policy makers and science communities (e.g. via stakeholder engagement).

4 LEVEL 4 – GEOERA PROGRESS EVALUATION

In this section the project is reviewed on the Review meetings, where projects present their overall progress and achievements. This section relates to particular project, broader impact of GeoERA as a whole on policies will be covered at the Final Review meeting with questionnaire and interview with Evaluator.

Based on technical review summaries provided by Sections 1 – 3 of this report, and project presentation on the (Final) Review meeting:

Has the project as a whole been making satisfactory progress according to your own understanding and expectations of the GeoERA project?

☐ 5 - **Overachiever** (the project has exceeded expectations)
☒ 4 - **Excellent progress** (as expected)
☐ 3 - **Good progress** (minor recommendations given below)
☐ 2 - **Acceptable progress** (below expectations; minor corrective action will be required)
☐ 1 - **Unsatisfactory progress** (the project has failed; corrective actions are required)

Overall comments for the project (overall recommendations, modifications, corrective actions, or re-tuning the objectives to optimize the impact or keep up with the State of the Art, re-focusing, or a simple praise)

The project aims for a harmonized analysis of conventional and unconventional resources of Europe with emphasis on (i) North Sea potential and (ii) the hydrate potential of the European continental margins. The objectives included support for a transition to a low-carbon future.

North Sea potential: The project faced challenges in synthesizing data which were maintained under different standards such as PRMS, local standards and UNFC etc. The project also looked into the availability of the potential for CCUS, which is essential for the transition to a low-carbon future.

Recommendation: The project has performed well in providing all the deliverables in time and overcoming the challenges of data availability in a uniform standard. As supporting the transition to a low-carbon future is one of the main objectives of the project, a question may be asked on how this project can contribute to the same. It may have to keep in mind that a low-carbon or a carbon-neutral project need not mean the use of hydrocarbons. It may be that a net-zero future could be envisaged with hydrocarbon use couple with CCUS. The integrated used hydrocarbons and renewable energy such as off-shore wind and marine energy such as wave and tidal energy could be necessary for the future. In such a scenario, the increased use of

hydrocarbons could be possible as long as a net-zero carbon model could be maintained. The project is recommended to consider these issues, and it may also be widely communicated to all stakeholders.

Marine Hydrate Potential: This source presents an economic opportunity, while also potentially mitigating huge climate risk. Even though workable solutions are not very obvious, this area will have to be given more attention in the future as ocean temperatures and acidity etc. increases. A careful assessment and availability of useful baseline data are necessary for thinking about possible innovative solutions.

Recommendations: As with other conventional and unconventional resources, the utilization of hydrates could be possible through an integrated net-zero approach. Therefore, the data and information generated by the project should be in a format that could facilitate assimilation across energy potential of the continental shelf od Europe such as conventional and unconventional hydrocarbons, renewable energies such as off-shore wind, tidal, wave energy etc., and the hydrate potential. This approach also could highlight the integration of deep-sea mining, which is also is an essential element in sourcing critical raw materials required for the green transition.

Overall recommendations: Current industry standards in use for the assessment of resources may not be suitable for an integrated framework, where a synthesis, as suggested above, may be easily achieved. Hence, the project may look into these aspects and provide insights on how legacy systems could be improved. UNFC is being updated to address these aspects and inputs from the GARAH project will help in creating a future-proof system.

During the project review, some of the challenges in communicating the results of this project was raised. In the face of the rapid energy transition, the role of net-zero carbon frameworks are essential, wherein the role of hydrocarbons are central to the equation. Communication strategy of the project may be rethought in this direction.

I congratulate the Project team for the excellent achievements highlighted in the mid-term review. I hope the project will continue to deliver well in the remaining phase.

Stakeholder Mr Thomas Crafford participated at the review meeting and provided recommendations for the projects. Due to personal reasons, he wishes not to participate further in the GeoERA monitoring and evaluation process. The “date of approval” of this document is therefore NA.

Annex 1: Review meeting list of participants

Name	Role	Organisation
Tessa Witteman	GeoERA coordinator	Netherlands Organisation for Applied Scientific Research
Barbara Simić	Monitoring and Reporting Officer	Geological Survey of Slovenia
Jasna Šinigoj	Scientific Reviewer	Geological Survey of Slovenia
Miloš Markič	Scientific Reviewer	Geological Survey of Slovenia
Matija Krivic	Scientific Reviewer	Geological Survey of Slovenia
Serge van Gessel	GeoEnergy Theme coordinator	Netherlands Organisation for Applied Scientific Research
Tom Crafford	Stakeholder council member	US Geological Survey
Peter Britze	GARAH Project manager	Geological Survey of Denmark and Greenland
Stefan Ladage	GARAH Project member	Geological Survey of Denmark and Greenland
Susanne S. Nelskamp	GARAH Project member	British Geological Survey
Margaret Stewart	GARAH Project member	British Geological Survey
Ricardo León	GARAH Project member	Geological Survey of Spain
Concise Review meeting 28.02.2020		
Harikrishnan Tulsidas	Stakeholder council member	UN Economic Commission for Europe

Annex 2: Communication and dissemination activities

Please select activity	Subcategory	Date	Target audience	Number of people reached	Short name of project participant	Author(s)	Link (if applicable)	Title
PUBLICATIONS	SCIENTIFIC PUBLICATION	17.06.2019	SCIENTIFIC COMMUNITY		npa	Niels H. Schovsbo and Finn Jakobsen	GEUS Bulletin Vol 43	Review of hydrocarbon potential in East Denmark following 30 years of exploration activities
MEETINGS	Meeting with international body	03.07.2018	EU INSTITUTION	200	many			
MEETINGS	Meeting with other GeoERA projects	01.09.2018	SCIENTIFIC COMMUNITY	15	TNO, BGR,GEUS,PGI			
MEETINGS	Meeting with other GeoERA projects	01.03.2019	SCIENTIFIC COMMUNITY	75	many			
MEETINGS	Meeting with other GeoERA projects	01.09.2019	SCIENTIFIC COMMUNITY	15	TNO, BGR,GEUS,PGI			
MEETINGS	Internal project meeting	oct-2018	SCIENTIFIC COMMUNITY	20	TNO, IGME, BRGM, BGR, BGS, GEOINFORM, GEUS			
MEETINGS	Internal project meeting	oct-2019	SCIENTIFIC COMMUNITY	20	TNO, IGME, BRGM, BGR, BGS, GEOINFORM, GEUS			
MEDIA	ONLINE MEDIA		GENERAL PUBLIC		many			
EVENTS	CONGRESS	sep.19	SCIENTIFIC COMMUNITY	100+	BGR, TNO, GEUS	Arfai, Jashar; Lutz, Rüdiger; den Dulk, Maryke; Jakobsen, Finn-Christian; Nelskamp,		3D basin and petroleum system modelling in the North Sea Central Graben: a cross-border Dutch,

						Susanne; Ladage, Stefan; Britze, Peter		German and Danish pilot study
MEETINGS	Meeting with international body	nov.18	SCIENTIFIC COMMUNITY	50	MIGRATE COST	R. León		
MEETINGS	Meeting with international body	29.01.2019	SCIENTIFIC COMMUNITY	20	MIGRATE COST	R. León		
EVENTS	WORKSHOP	sep.19	SCIENTIFIC COMMUNITY	50	GDR Hydrates , Brest	A. Burnol		
EVENTS	**CONGRESS**	sep.19	SCIENTIFIC COMMUNITY	100	IAS 2019, Rome	R. León		