Project acronym and title:

SECURe – Subsurface Evaluation of Carbon capture and storage and Unconventional risks

SECURE- PROJECT MANAGEMENT PLAN

Authors and affiliation:

Ed Hough, Jan Hennissen, Rhian Kendall, Karen Kirk, Bryony Chambers-Towers

British Geological Survey, Keyworth, Nottingham, NG12 5GG, UK

Email of lead author:
eh@bgs.ac.uk

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Disclaimer

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Verified (WP leader)	E HOUGH	
Approved (EB member)	JM PEARCE	
Approved (Coordinator)	E HOUGH	

Author(s)		
Name	**Organisation**	**E-mail**
E. Hough	UKRI-BGS	eh@bgs.ac.uk
J A. I. Hennissen	UKRI-BGS	janh@bgs.ac.uk
R. Kendall	UKRI-BGS	rhnd1@bgs.ac.uk
K. Kirk	UKRI-BGS	klsh@bgs.ac.uk
B. Chambers-Towers	UKRI-BGS	brycha@bgs.ac.uk

Public introduction

Subsurface Evaluation of CCS and Unconventional Risks (SECURe) is gathering unbiased, impartial scientific evidence for risk mitigation and monitoring for environmental protection to underpin subsurface geoenergy development. The main outputs of SECURe comprise recommendations for best practice for unconventional hydrocarbon production and geological CO_2 storage. The project is funded from June 2018–May 2021.

The project is developing monitoring and mitigation strategies for the full geoenergy project lifecycle; by assessing plausible hazards and monitoring associated environmental risks. This is achieved through a program of experimental research and advanced technology development that includes demonstration at commercial and research facilities to formulate best practice. We will meet stakeholder needs; from the design of monitoring and mitigation strategies relevant to operators and regulators, to developing communication strategies to provide a greater level of understanding of the potential impacts.

The SECURe partnership comprises major research and commercial organisations from countries that host shale gas and CCS industries at different stages of operation (from permitted to closed). We are forming a durable international partnership with non-European groups; providing international access to study sites, creating links between projects and increasing our collective capability through exchange of scientific staff.

Executive report summary

This project management plan gives a detailed description of the technical and management aspects of the SECURe work programme. The organisational structure is outlined along with workflows and project reporting protocols.

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Introduction

This document is a working document of the SECURe project's management. Below, for all tasks in each work package (WP) is detailed:

- Summary description of the technical aspects of the Work Package, Tasks and Sub-tasks;
- Lead organisations, including where appropriate, a named individual lead scientist/technical manager who is responsible from delivery of individual tasks;
- Effort, in person months, for the work package, split by individual beneficiaries working within the work package;
- Timing of delivery of the WP/task/subtask, including a description of dependencies and if there are any known constraints on completion of the activity;
- Critical aspects of the activities that will be monitored by the WP lead to ensure delivery of activities;
- A list of deliverables and milestones that rest within each work package, with lead organisation and named lead scientist/technical manager who is responsible for the submission of deliverables for review by WP colleagues prior to forwarding to the Co-ordinator for approval and submission to EU via participants portal.

As an annex to this project management plan (PMP), a GANTT chart is provided which combines the timing of each task and the delivery dates of deliverables and milestones.

AIMS OF THE SECURE PROJECT

The potential environmental impacts of shale gas and CCS technologies need to be better understood. The recent expansion of the unconventional gas industry in North America and its potential advent in Europe has generated public concern regarding the potential detrimental impacts on air, water and the land. Mitigation of the steep rise of greenhouse gas emissions and the related climate changes will need to include CO_2 storage in deep geological reservoirs. Both activities utilise deep-lying geological formations and may induce similar impacts via similar pathways, including induced seismicity, detrimental fluid migration and displacement of brines.

A key objective of SECURe is to integrate the broad expertise that the consortium maintains in the fields of both CO_2 storage *and* shale gas monitoring across the key spatial and temporal domains relevant to geoenergy project development (Figure 1). The membership of the SECURe partnership is a major asset as it includes several National Geological Surveys and major research organisations from EU member states that host shale gas and CCS projects at different stages of operation (from permitted to closed), as well as companies actively involved in the deployment of CCS and exploitation of unconventional gas.

The SECURe project has the following specific objectives:

1. To produce a risk assessment framework for assessing the hazards and likelihoods of specific risks that relate to the protection of the environment in CO_2 storage and shale gas operations.
2. To demonstrate best practice in establishing baseline conditions for subsurface geoenergy

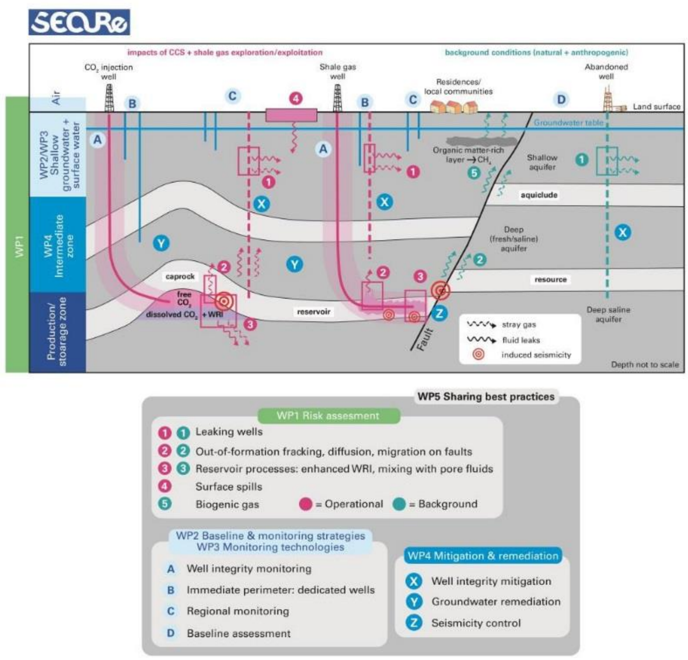

Figure 1 **The SECURe Concept – providing best practice recommendations across these domains for the protection of groundwaters, surface environments and local communities.**

operations by working across a network of both commercial, pilot and research-scale sites in Europe and internationally, underpinned by laboratory measurements and model up-scaling to the field scale.

3. To develop new technologies to improve the detection and monitoring of environmental impacts related to geoenergy projects.
4. To investigate new methods for remediating potential environmental impacts of geoenergy projects specifically to reduce leakage from wells or naturally occurring permeable pathways.
5. To develop best practice guidelines for the shale gas and CO_2 storage industries specifically in environmental baseline assessment and monitoring; the intention is that these will not unduly delay the development of new technologies or innovations.
6. To understand the needs of a range of stakeholders, including local communities, and to engage them through the development of appropriate communication strategies, including participatory monitoring and through the education of early-career researchers.
7. To leverage best practice through collaboration with leading groups in the USA, Canada and Australia.

SECURe will achieve this by:

1. Developing frameworks for quantifying and managing risks including impact assessment (monitoring and characterisation) for developing and implementing effective remedial strategies and to contribute to the evidence base underpinning policy making;
2. Investigating leakage processes and impacts at the laboratory and field-scale using a portfolio of existing European and North American facilities and field sites to better characterise and quantify relevant risk factors;
3. Developing, applying and testing a range of monitoring technologies, systems and strategies to contribute to effective (best practice) risk evaluation, establishment of baseline conditions and monitoring and management of impacts;
4. Explore opportunities of participative monitoring as an aspect of public engagement.
5. Provide a series of recommendations for best practice that can be used as a dataset to inform effective regulation and monitoring strategies for shale gas and CCS sites.

Project technical description & implementation

The project is delivered by 7 work packages (WP). WP7 is the management work package, led by UKRI (BGS)-BGS. Its function is to co-ordinate and administrate the legal and financial aspects of the project, and communicate with the European Commission. WP1 is concerned with Ethics related to the project.

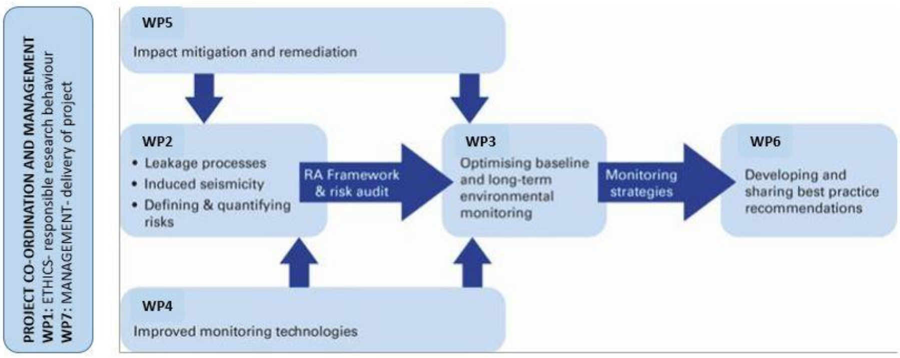

Figure 2: Work packages and their interactions, designed to create an integrated and complementary workflow to ensure outputs are achieved to maximum impact.

The technical components of the project are operated through WP2 – 5 (see panel). These feed into WP6, which has the remit of developing and sharing best practice recommendations, which is the main output of the consortium.

In WP2 well integrity, fractures, fault permeability, induced seismicity and water quality impacts will be evaluated in geological settings typical for CO2 injection and unconventional gas exploitation. In this context, numerical models that predict leakage and induced seismicity threats will be produced. Ultimately, this will result in a set of guidelines that permit conducting transparent and verifiable risk assessments. WP3 will develop multi-scale strategies for environmental baseline assessment and operational to post operational monitoring. Synergies between approaches designed for CCS and unconventional gas operations will be explored. Emphasis will be on cost-effective monitoring of the whole lifecycle of both subsurface energy operations. WP4 will enhance seal and fracture characterisation by developing state-of-the-art sensors to monitor flow leaks and geomechanical stresses. Within the scope of WP4, new technologies will be tested to improve sensor measurement thresholds for toxic quantities that fall below the detection limit of current state-of-the-art sensors. WP5 contributes to the development and implementation of effective remedial and mitigation strategies for subsurface geoenergy operations. The focus in WP5 lies on near well and far-field leakage monitoring and seismicity prediction and mitigation. WP6 ties together the lessons learned in WPs 2–5 and will result in recommendations on best practice for maintaining and re-establishing baseline conditions on surface and in the subsurface. It will also provide models and best practice guidelines for participatory monitoring. WP6 aims to contribute to the development of commercial CCS and the responsible exploitation of shale gas reserves in Europe and the dissemination of information on these geoenergy operations to non-technical audiences such as policymakers and European citizens.

Results achieved

At the end of the project, SECURe is anticipated to provide a legacy of:

1. Representative experimental and industrial field sites in the CCS and Shale Gas sectors, for deployment of a comprehensive suite of detection and monitoring methods as a proving ground for cutting edge technologies and to enable technology transfer between sectors;
2. A platform for international cooperation and future projects with focus on US and Canada, facilitating the exchange of scientific knowledge and researchers;
3. A scientifically sound, unbiased and independent, pragmatic, and cost-effective best practice for baselining, monitoring, mitigation and remediation – within a risk-assessment framework and with community engagement;
4. Models and best practice guidelines for engaging different stakeholders including citizens through participatory monitoring
5. A formal continuous training programme for researchers and students [including post-project]
6. Dissemination of results through engagement with the public.

Impact

SECURe will address risks most often associated with the successful development of CO_2 storage and unconventional hydrocarbons production (including the release and impacts of contaminants on groundwater quality, impacts on the atmosphere resulting from fugitive emissions, and impacts on the surface environment. Close links with the M4CE project will ensure enhanced impact of both projects in related areas (e.g., monitoring technologies and policy advice).

Replicability Strategies will be developed by SECURe to support commercial developers, regulators and policy makers and host communities in their planning and joint discussions to allow them to make informed decisions on ways to use best available technologies (BAT) in the project development.

Socio-economics Importantly the resulting 'best practice' in stakeholder engagement will include practical demonstrations of citizen science, through community-based participatory monitoring, as well as results from improved definitions and understanding of ethical and responsible research and innovation issues.

Environment SECURe will contribute significantly to the improved understanding of both natural and engineered pathways for CO_2 and natural gas and related fluids through field- and lab-scale experiments as well as simulations to both upscale experimental results and provide further quantifiable insight into the relative importance and timings of these impacts.

Market Transformation Specific low Technology Readiness Level (TRL) technologies will be targeted in SECURe to improve their application in CO_2 storage and/or unconventional hydrocarbon production. Firstly, we are developing tools that will improve the detectability of stray gases at the surface and in the subsurface, improve capabilities for attributing stray gases to specific subsurface operations, or define detection limits. Secondly, by demonstrating the integration of different portfolios of monitoring technologies in new, innovative ways, SECURe will support industry, policy-makers and regulators with the development of standard protocols for monitoring design, including, *inter alia*, the appropriate spatial and temporal sampling densities, methods of tool selection, data management and reporting.

Policy SECURe will develop pragmatic recommendations that, as a minimum, meet with current legislation. This will be achieved by including policymakers and regulators on the SECURe Advisory Board plus reviews of the relevant legislation in WPs2 and 3. Direct discussions with industrial and other commercial organisations is planned as part WP6, which will feed into the compilation of Best Practice recommendations that are fit-for-purpose and appropriate to the technologies and processes concerned.

MANAGERIAL TEAM, ROLES AND ADVISORY BOARD OF THE SECURE PROJECT

The following individuals constitute the Management Board of SECURe. These were formally incorporated by unanimous vote at the SECURe kick-off meeting, 14 June 2018:

Table 1: The SECURe Management Board comprising Technical WP leads.

Work Package	WP Lead	Organisation	Email
Management WP Lead Co-ordinator WP1/7	Ed Hough	UKRI-BGS	eh@bgs.ac.uk
WP2	Jens Wollenweber	TNO	jens.wollenweber@tno.nl
WP3	Wolfram Kloppmann	BRGM	w.kloppmann@brgm.fr
WP4	Matteo Icardi	UNOTT	matteo.icardi@nottingham.ac.uk
WP5	Pierre Cerasi	SINTEF	pierre.cerasi@sintef.no
WP6	Jonathan Pearce	UKRI-BGS	jmpe@bgs.ac.uk

Ed Hough is supported as Co-Ordinator of SECURe by a team comprising Karen Kirk and Jan Hennissen (technical and logistical issues), Jo Booth and Laura Platt (liaison with EU), Sally Stone (Meetings and Missions) and Sue Stocks (Financial).

Table 2: The Advisory Board of SECURe, formally incorporated by unanimous vote at the SECURe kick-off meeting, 14 June 2018:

Name	Organisation	Email
Kevin Parks	Alberta Energy Regulator	Kevin.Parks@aer.ca
Katherine Romanak	Bureau of Economic Geology, TX	katherine.romanak@beg.utexas.edu
Don Lawton	CMC (Carbon Management Canada Inc)	don.lawton@cmcghg.com
Alwyn Hart	Environment Agency (UK)	alwyn.hart@environment-agency.gov.uk
Patricia Fosselard	European Federation of Bottled Waters	p.fosselard@efbw.org
Gerhard van der Linde	Golder Associates	GvanderLinde@golder.co.za
Steve Thompsett	UKOOG (UK Onshore Oil and Gas)	sthompsett@ukoog.org.uk
Jose Bermudez Menendez	Department of Business, Energy and Industrial Strategy (UK)	Jose.Miguel@beis.gov.uk
Marcella Dean	Shell Global Solutions International BV	marcella.dean@shell.com
Krzystof Lyczko & Andrzej Maksym	PGNiG	krzysztof.lyczko@pgnig.pl andrzej.maksym@pgnig.pl
Luke Warren	CCSA (Carbon Capture and Storage Association, UK)	luke.warren@ccsassociation.org

REPORTING PERIODS AND START DATE

The start date of the SECURe project was set as 1st June 2018 in order to maximise the task durations during the summer months for field work in the WPs (2.1, 2.3, 3.1, 3.2 and 3.3).

There will be two reporting periods for this project, the first from month 1 – month 18 and the second from month 18 – month 36.

SCHEDULE OF MEETINGS

General Assembly

An initial kick-off meeting will be held close to the start date of the project. The consortium will:

- be addressed by the EU assigned project officer who will provide guidance on what is required for the operational aspects of the project.
- will vote on the membership of the Management Board and the Advisory Board.
- hold separate work package meetings chaired by the work package leads allowing beneficiaries to plan how best to proceed

The Advisory Board will also meet to discuss their expectations of what they feel are the important aspects for the project to deliver.

After this there will be an annual General Assembly held (including a final meeting at the end of the project) at which one person from each beneficiary will be required to attend to report on progress of work against the description of work.

Management Board meetings

The Management Board will hold monthly skype/conference calls (or where possible have an in-person meeting at the General Assembly) to review overall progress of the project, address arising issues and discuss emerging ideas or opportunities.

Advisory Board meetings

The Advisory Board will hold biannual skype/conference calls (or where possible have an in-person meeting at the General Assembly) to provide guidance to ensure that the project deliverables are fit-for-purpose and will meet stakeholder needs – they will effectively represent the stakeholder groups. As part of GA, the Advisory Board will be invited to give their views on the project's direction, progress and content of key learnings.

PROGRESS REPORTING

The consortium will be required to provide a report detailing progress within the project, which must be submitted within 60 days of the end of each reporting period. The periodic report consists of the periodic technical and financial reports:

1. **Technical report (in 2 parts)**
   - *Part A structured tables from the grant management system:*
     - cover page
     - publishable summary
     - web-based tables covering issues related to the project implementation (e.g. work packages, deliverables, milestones, etc.)
     - ethical issues, critical implementation risks and mitigation measures
     - dissemination and exploitation of results
     - gender issues
     - answers to the questionnaire about the economic and social impact, especially as measured against the Horizon 2020 key performance indicators and monitoring requirements
   - *Part B the free text, core part of the report that must be uploaded to the grant management tool as a single PDF document with:*

- explanations of the work carried out by all beneficiaries and linked third parties during the reporting period
- updates to exploitation and dissemination, data management and project management plans (if required)
- follow-up of recommendations and comments from previous reviews
- an overview of the progress towards the project objectives, justifying the differences between work expected under Annex I and work actually performed, if any (including tasks not fully implemented, changes in use of resources, unforeseen contracting and unforeseen use of in-kind contributions from third parties)

2. Financial report

Consists of structured forms from the grant management system, including:

- individual financial statements (Annex 4 to the GA) for each beneficiary and third parties
- explanation of the use of resources and the information on subcontracting and in-kind contributions provided by third parties, from each beneficiary for the reporting period concerned. The explanation of resources should follow the eligibility guidance for Horizon2020.
- periodic summary financial statement including the request for interim payment

BGS will review budgets as part of the first period review (month 18), and may transfer budgets between activities/partners if required, with the agreement of partners/project officer where appropriate. Management of budgets will be an iterative process and close scrutiny will be paid throughout the period of funding to ensure targets are met within available resources, with any deviations flagged up at an early stage with the Management Board and project officer.

PROJECT LOGO AND ACRONYM

The acronym of this EC Horizon 2020 project is SECURe. A logo was created (Figure 3 and Figure 4) which along with the Horizon 2020 logo should be used for any dissemination products related to SECURe. A PowerPoint presentation template (Figure 5) and a template for deliverable reporting are provided as well.

Figure 3: SECURe logo.

Figure 4: SECURe logo, reversed colors.

Figure 5: PowerPoint presentation template, with title slide (left) and regular slide (right).

GENDER ANALYSIS

This topic, LCE27 and the potential research outputs and deliverables from SECURe are not considered to be gender relevant, i.e. it is not expected that its findings affect women and men or groups of women and men differently. Neither is the gender dimension explicitly integrated into the call.

The consortium will comply with national and international legislation and guidelines regarding gender equality. All partners are committed to promote equal opportunities in the implementation of the action and to ensure a balanced participation of women and men at all levels in research and innovation teams and in management structures. The consortium includes many highly experienced female scientists (section 4.1), who will lead tasks as appropriate. Contributions by third parties, where specified, also include female scientists. Initial commitments to the Advisory Board include female representation. In addition, the consortium will promote the increase in the number of female colleagues by actively encouraging the employment of female engineers and scientists working on the project, and will strive to ensure a gender balance in participation in the Advisory Board members.

UKRI (BGS), the coordinating organisation, is an equal opportunities employer. The British Geological Survey (BGS), the component centre representing UKRI (BGS) in SECURe, has Athena SWAN accreditation. Athena SWAN (Scientific Women's Academic Network) is a charter established by the British Equality Challenge Unit in 2005 and implemented by the UK Resource Centre that recognises and celebrates good practice towards the advancement of gender equality: representation, progression and success for all. The Athena SWAN charter was established to encourage and recognise commitment to advancing the careers of women in science, technology, engineering, and mathematics (STEM) employment in higher education and research. SWAN awards recognise work undertaken to address gender equality broadly, including good practice in recruiting, retaining and promoting women in STEM subjects. In the coordination and management of this project, BGS will adhere to these principles and promote good practice.

A full summary of gender per project partner will be input to the EU participants portal. This will include:

- number of female and male researchers working on the project;
- number of female and male employees (other than researchers) working on the project;

WP1: Ethics requirements

INVOLVED PARTNERS IN WP1

Table 3: WP1 partners

Partner	WP1 Effort
UKRI (BGS)	Effort for this WP is charged from the WP7 allocations

WP1 covers three deliverables due in months 1 and 3 that affirm ethical issues that will be adhered to during the SECURe project. As such, the work package is funded from the WP7 Management budget, and there are no tasks or subtasks.

WP1 OUTPUTS

Table 4: WP1 deliverables

Del. #	Deliverable Title	Org.	Responsible Person	Email	Delivery Date
D1.1	Detailed information on the informed consent procedures that will be implemented in regard to the collection, storage and protection of personal data must be submitted on request.	UKRI (BGS) UEDIN	Ed Hough Simon Shackley	eh@bgs.ac.uk simon.shackley @ed.ac.uk	31/08/2018
D1.2	The applicant must confirm that the ethical standards and guidelines of Horizon2020 will be rigorously applied, regardless of the country in which the research is carried out.	UKRI (BGS) UEDIN	Ed Hough Simon Shackley	eh@bgs.ac.uk simon.shackley @ed.ac.uk	31/08/2018
D1.3	The applicant must provide further information about the possible harm to the environment caused by the research and state the measures that will be taken to mitigate the risks	UKRI (BGS)	Ed Hough	eh@bgs.ac.uk	30/06/2018

Table 5: WP1 milestones

Mil. #	Milestone Title	Org.	Responsible Person	Email	Delivery Date
MS8	Ethics & Integrity Assessment of the SECURe R&D with recommendations	UEDIN	Simon Shackley	simon.shackley @ed.ac.uk	30/06/2020

NECESSARY INPUT FOR WP1 COMPLETION

WP1 is by nature a series of summary reports that detail existing corporate methods and guidance of individual beneficiaries. As such, the deliverables form WP1 are collaborative in nature, with content collated by BGS from all beneficiaries. BGS, however, remain responsible for the completion of these deliverables.

Infringements and issues associated with the ethical requirements will be raised through the SECURe management chain as necessary. Compliance with the ethical requirements of H2020/EU will be monitored closely by WP leads and the lead contacts for individual beneficiaries, and formally reported at monthly Management Board meetings. The ethical issues will also be a standing item at General Assembly meetings.

WP2: Risk assessment for leakage and induced seismicity: methodology and case studies

INVOLVED PARTNERS IN WP2

Table 6: WP2 partners

Partner	WP2 Effort in person months
BRGM	16.00
GEUS	12.00
INIG	73.20
PIG-PIB	12.00
SINTEF AS	9.00
UNOTT	10.00
HWU	34.50
TNO	35.10
RISKTEC	23.00
Total	**224.80**

TASK 2.1: RISK ASSESSMENT FRAMEWORK AND SCENARIO ANALYSIS

Subtask 2.1.1: Assessing impacts of subsurface geochemical reactions resulting from leaking CH_4 and CO_2

This study combines a review, laboratory experiments and field data to investigate the impacts of leakage in terms of subsurface geochemical reactions. Laboratory batch and tank experiments will be performed to assess the short- and long-term environmental effects of leaking CH_4 and CO_2 on water quality as well as the time needed to return to the baseline. The conditions will cover relevant initial redox conditions as well as typical pressures and temperatures of aquifers which will affect the impacts of CO_2 and CH_4.

Subtask 2.1.2: Risk Analysis of long term acid gas sequestration operation at Borzęcin

This study will describe in detail the past and present status of the long-term (> 20 years) sequestration process carried out in the Borzęcin structure including measurements for direct and indirect evidence of the injected gas migration and possible leakage. A comprehensive modelling exercise will be carried out to access the risk factors relevant to the injected gas storage by simulation predictions of reservoir effects and analysis of well completion materials. At this site, a key risk mitigation challenge arises in the complex hydrogeology of the saline aquifer in which the injection takes place.

Subtask 2.1.3: Risk framework and barrier performance indicators

This subtask integrates the outcomes of WP2 into a risk assessment framework, develops guidelines, and provides inputs for the other work packages in terms of indicators for monitoring and communication of risks. An initial set of bowties will be developed in Bowtie XP based on current understanding of risks associated with CO_2 and shale gas reservoirs. These bowties will identify possible leak pathways, the controls (e.g. geology, well integrity, monitoring) that may be expected to be in place and mitigation strategies that may be employed.

TASK 2.2: WELL INTEGRITY

Subtask 2.2.1: Assessment of well integrity threat

This activity is a combination of experimental and numerical work, to improve the understanding of leakage rates and volumes that can escape through defects in wells for CCS and unconventional hydrocarbon extraction. In addition, this subtask will consider the risks of potential damage caused by hydraulic fracturing (intended – during unconventional hydrocarbons development, or unintended – during CO_2 injection) on the cement sheath and the surrounding rock in the near-well area.

Subtask 2.2.2: Field scale numerical models for well integrity threat assessment

The objective of this subtask is to develop a comprehensive, probabilistic framework for modelling well cement integrity and leakage probability throughout the lifetime of a well. A gap exists between well design and as-built performance of cementation jobs. Significant uncertainty exists in the present state of old wells and the state of wells at the end of the operational phase prior to abandonment.

TASK 2.3: ASSESSMENT OF FAULT AND FRACTURE PERMEABILITY

Subtask 2.3.1: Assessment of fault and fracture permeability to CO_2 and brine

This activity will conduct (i) A comprehensive literature survey to compile relevant flux data from lab tests, field pilots or natural systems, (ii) laboratory experiments on a range of seal and reservoir lithologies to assess the permeability of fractures to CO_2 under different conditions of pore pressure and confining stress. Additional experiments such as (iii) outcrops will be mapped in order to obtain a better understanding of fracture networks and network connections.

Subtask 2.3.2: Fault and Fracture Network Permeability: unconventionals

Laboratory experiments will be conducted on a range of seal and reservoir lithologies to assess the permeability of fractures to hydrocarbons, brine and fracturing fluid under different conditions of pore pressure, saturation and confining stress.

Subtask 2.3.3: Data analysis selected field sites

Analyses on formation confinement based on historic results of laboratory geochemical measurements of brine samples for several field sites to assess the presence of relic brine or brine exchange between reservoirs/aquifers will be conducted.

TASK 2.4: SURFACE DEFORMATION AND INDUCED SEISMICITY

Subtask 2.4.1: Fault dynamics, surface deformation and leakage risks

This subtask studies the source mechanics of induced earthquakes to assess the risk of rupturing top-seals leading to unwanted fluid migration and leakage in CO_2 storage and shale gas operations. Specifically, the possibility that small earthquakes would cause fault rupture through the cap-rock, and consequently be jeopardizing the seal and containment integrity will be investigated.

Subtask 2.4.2: Induced seismicity risk models

An evaluation will be conducted on how the standard models used for assessing risks of natural seismicity can be applied to risks of seismicity induced by $_{CO2}$ storage and hydrocarbon exploitation. If they cannot be applied directly, the possibility of adapting and improving the models will be studied. This work will allow a better understanding of the mechanisms of induced earthquakes (or the conditions of no induced earthquakes) to better assess the related impacts.

Subtask 2.4.3: Induced seismicity from pressure changes

Changes in pressure conditions in the subsurface have the capacity to generate induced and/or triggered earthquakes posing a potential hazard to infrastructure and well integrity. Close monitoring of micro seismicity related to pumping activities is essential for establishing guidelines for safe operation.

WP2 OUTPUTS

Table 7: WP2 deliverables

Del. #	Deliverable Title	Org.	Responsible Person	Email	Delivery Date
D2.1	Report on state of the art microseismicity techniques.	BRGM	Thomas Le Guenan	t.leguenan@brgm.fr	31/03/2019
D2.2	Report on effects of long-term sequestration	INIG	Miroslaw Wojnicki	wojnicki@inig.pl	31/05/2020
D2.3	Report on induced seismicity models	BRGM	Thomas Le Guenan	t.leguenan@brgm.fr	31/05/2020
D2.4	Report on geochemical models	GEUS	Rasmus Jakobsen	raj@geus.dk	31/07/2020
D2.5	Report on risk factors in fluid and CO_2 migration	TNO	Jan ter Heege	jan.terheege@tno.nl	30/09/2020
D2.6	Guidelines for risk assessment for leakage and induced seismicity risks	TNO	Jens Wollenweber	jens.wollenweber@tno.nl	31/01/2021

Table 8: WP2 milestones

Mil. #	Milestone Title	Org.	Responsible Person	Email	Delivery Date
MS7	Risk assessment framework agreed	TNO	Jens Wollenweber	jens.wollenweber@tno.nl	31/05/2020

NECESSARY INPUT FOR WP2 COMPLETION

- Field data: Information from Operators on wells and (potential) fluid migration of the sites involved in WP2.
- Results from measuring campaigns (and modelling) in WP3 and WP4 to define risk framework and to perform a comprehensive risk evaluation.
- Results from WP5 on leakage pathways and remediation options as crucial information to provide risk management plans.

WP3: Environmental baseline and monitoring strategies

INVOLVED PARTNERS IN WP3

Table 9: WP3 partners

Partner	WP3 Effort in person months
UKRI (BGS)	56.90
BRGM	104.60
GEUS	3.00
PIG-PIB	107.20
SINTEF AS	1.00
UNOTT	7.00
GFZ	29.00
TOTAL	3.30
Total	**312.00**

TASK 3.1: ENVIRONMENTAL BASELINE ASSESSMENT EBA

Subtask 3.1.1: Basin-scale groundwater/soil/air quality baseline assessment

Based on ongoing EBA activities at SECURe field sites in the UK (Vale of Pickering) and in Canada (Alberta GOWN network), and on worldwide experience, taking into account current regulation and best practices, subtask 3.1.1 will design optimised 3D arrays of observation networks as well as optimised sampling/measurement frequencies.

Subtask 3.1.2: Water/gas baseline assessment in exploration/exploitation/observation wells

Monitoring of drilling operations and post-drilling downhole techniques provide information on lithology, solid and fluid geochemistry, gas flow characteristics, and hydrogeological parameters. New combinations of surface/downhole monitoring techniques of in-situ gas and fluid composition and isotope fingerprints will be developed.

Subtask 3.1.3: Seismic and micro-seismic baseline

Knowledge of the pre-existing stress conditions and possible active faults within the injection zone of influence is critical for further assessment of the seismicity induced or triggered by injection operations; this involves a monitoring seismic network running before the injection operations. A methodology will be built to estimate the sensitivity needed to take into account the possibility of subcritical faults and fault propagation effects. This will help to find a balance needs between the network specifications and the duration and costs of the baseline.

Subtask 3.1.4: Baseline and impact monitoring

During the Wensyssel-1 drilling GEUS carried out baseline monitoring of micro seismicity within 10 km of the drilling site for a period of two years. A temporary network of six Broad Band seismographs transmitted data in real-time to a server at GEUS 24-7, where processing of the data took place. The detection threshold for events was estimated to magnitude 0.1 or smaller. A similar baseline monitoring is not directly possible at active sites. Instead microseismic monitoring around an active site will be combined with baseline measurements in a comparable geological setting at a distance.

TASK 3.2: MULTI-TRACER IDENTIFICATION OF GAS AND FLUID CONTAMINATION SOURCES

Subtask 3.2.1: Gas monitoring and fingerprinting

This subtask will demonstrate continuous gas monitoring (CO_2, CH_4, O_2) for identification of leakage through gas ratio methods. It will extend existing field-based protocols for free and dissolved gases in soil and groundwater that will enable an operator or regulator to attribute the source of leaking gas, once detected. Special focus will be on mobile, high-frequency, on-site measurements (laser spectrometry: CRDS) allowing for monitoring of drilling operations and for regional vehicle-based survey of air quality and gas sources.

Subtask 3.2.2: Fluid migration monitoring

This subtask aims to carry out chemical and multi-isotopic characterisation (fingerprinting) of injected and flowback waters, of key importance for detecting leakage of such fluids, but also for assessing reservoir processes in the deep subsurface (fracture propagation, mixing with pore waters, water-rock interaction intensity). It makes use of advanced tracers (e.g. B, Li, U isotopes). It will also address the identification of brine displacement related to CO_2 injection in CCS reservoirs and water-rock interaction (WRI) triggered by CO_2 leaks.

TASK 3.3: OPERATION TO POST CLOSURE LONG-TERM MONITORING

Subtask 3.3.1: Long-term monitoring of CCS sites

The work will include (1) assessment and simulation of CO_2 impacts on the reservoir geochemistry; (2) uncertainty assessment of the geochemical database for modelling (CO_2-driven reactions and highly saline fluids; (3) leakage detection accuracy through above-zone pressure and geochemical monitoring; (4) identification of meaningful parameters for integrated monitoring; (5) recommendations for optimal baseline surveys and return-to-baseline measures.

Subtask 3.3.2: Long-term monitoring of shale gas plays

The Polish SECURe sites (Lublin and Pomerania regions) provide the unique opportunity for investigating abandoned fractured shale gas exploration wells and for planning and testing environmental measurement methods and strategies with regard to long-term impacts of deep wellbore infrastructure and downhole activities.

Subtask 3.3.3: Statistical approaches for detecting and quantifying deviations from the expected behaviour

An approach will be developed for rigorously discriminating unexpected behaviour from normal behaviour during CCS/ shale gas operations. Unexpected behaviour can be divided into two categories: 1) operations leading to impacts that should not have occurred (e.g. leakages in the shallow subsurface); 2) operations leading to subsurface modifications that were expected to occur, but are different from predictions (e.g. higher pore overpressure during CO_2 injection). In terms of decision-making, these two categories need to be handled differently.

TASK 3.4: DATA MANAGEMENT AND INTEGRATED PROPERTIES CALIBRATION

This task will provide a framework for data aggregation from multisource sensors and monitoring to allow the quick and efficient integration of sensor data into model calibration. Parametric uncertainty stems from the difficulties in estimating the input parameters (in a broad sense) of models/analysis due to the limited, poorly represented (caused by time, space and financial limitations) and imprecise data. Such parameters within CCS/shale gas modelling include fracture flow properties, the size of the grid mesh and the choices of boundary conditions.

TASK 3.5: BEST PRACTICES FOR CCS/NON-CONVENTIONAL HYDROCARBON BASELINE ASSESSMENT AND MONITORING

Task 3.5.1: Establishing a reliable baseline for active sites

Establishing a reliable baseline takes several years and has to be carried out while the subsurface is still undisturbed. This is not always practically possible, especially not at already active sites. It is therefore necessary to establish a best practice for assessing a baseline under these conditions. While a small network of seismographs monitors an active site, another set of instruments will be placed at various distances, up to 100 km to find the optimal configuration for establishing a baseline, post disturbance.

NECESSARY INPUT FOR WP3 COMPLETION

To be completed by month 4 (September 31st 2018) during the WP meeting.

WP3 OUTPUTS

Table 10: WP3 deliverables

Del. #	Deliverable Title	Org.	Responsible Person	Email	Delivery Date
D3.1	Report on methods on baseline methods	GEUS	Carsten Nielsen	cmn@geus.dk	31/07/2019
D3.2	Report focusing on best practice methods to establish baseline levels post-operational activity	GEUS	Carsten Nielsen	cmn@geus.dk	31/08/2019
D3.3	Report on synergies of environmental baseline strategies for CCS and shale gas plays	UKRI (BGS)	Pauline Smedley	pls@bgs.ac.uk	31/05/2020
D3.4	Report on downhole monitoring as part of environmental baseline assessment for carbon storage and shale gas development	BRGM	Wolfram Kloppman	w.kloppmann @brgm.fr	30/11/2020
D3.5	Report on state of the art and new developments for defining the seismic baseline for gas storage and exploitations	BRGM	Wolfram Kloppman	w.kloppmann @brgm.fr	30/11/2020
D3.6	Report on integrated multi-tracer finger printing of gas and fluid migration upon CCS and hydraulic fracturing	UKRI (BGS)	Pauline Smedley	pls@bgs.ac.uk	30/11/2020
D3.7	Guidelines for common strategies in gas storage and exploitation baseline assessment and monitoring	GFZ	Cornelia Schmidt-Hattenberger	conny@gfz-potsdam.de	31/01/2021
D3.8	Report on long-term post-operational monitoring of Ketzin (CCS) and Polish (shale gas) sites	PIG-PIB	Monika Konieczyńska	mkon@pgi.gov .pl	31/03/2021
D3.9	Integrated data platform for multisource multiscale sensor data	UNOT T	Matteo Icardi	Matteo.icardi @nottingham. ac.uk	31/05/2021

Table 11: WP3 milestones

Mil. #	Milestone Title	Org.	Responsible Person	Email	Delivery Date
MS2	Collaboration with Third parties initiated (joint with WP6)	UKRI (BGS)	Pauline Smedley	pls@bgs.ac.uk	31/05/2019
MS4	Criteria for baseline monitoring defined	BRGM	Wolfram Kloppman	w.kloppmann@ brgm.fr	30/11/2019

WP4: Advanced monitoring and sensor technologies

INVOLVED PARTNERS IN WP4

Table 12: WP4 partners

Partner	WP4 Effort in person months
UKRI (BGS)	37.80
GEUS	10.00
INIG	13.00
SINTEF AS	12.00
UNOTT	26.00
IFPEN	17.00
TNO	8.40
GFZ	3.00
TOTAL	3.40
Total	**130.60**

TASK 4.1: IMPROVING MONITORING AND MEASUREMENT THRESHOLDS

Subtask 4.1.1: UAV technology for large scale monitoring

This subtask will develop large-scale monitoring and remote sensing strategies of shale gas and CCS sites providing a combined approach to gas monitoring to produce a multi-layered flexible portfolio of survey/monitoring techniques. Initially UAVs will provide qualitative survey tools to direct/focus ground based techniques but our intention is to develop more complex models that can take raw UAV data directly, combine this with wind speed/direction data, and produce extended quantitative conclusions about gas emission rates with confidence.

Subtask 4.1.2: Determination of geochemical element mobilization

This subtask will be conducting laboratory experiments to assess the impact of changes in chemical parameters of fluids on fluid-rock interaction (pH, temperature, oxidant level, fluid/rock ratio, salinity, etc), and thus on the elemental concentrations in fluids. Geochemical reactions will be evaluated. Shale samples will be characterised mineralogically and chemically. Fluids from fluid-rock interaction experiments will be chemically characterised (by inductively coupled plasma mass spectrometry and ion chromatography for changes in heavy metal and other element concentrations) at multiple stages during on-going experiments.

Subtask 4.1.3: Noble gas downhole sampling for enhanced thresholds

The downhole sampler (patented by IFPEN and developed with an industrial partner) dedicated specifically to the identification of noble gas content (in gas and/or dissolved form) will be deployed. The tool recovers samples representative of prevailing conditions in a reservoir or aquifer and can therefore be used as an early warning system for leak detection. Mass balances can also be calculated with these natural inert chemical tracers. In addition, a specific software package has been developed to determine the content of the noble gases of a gas/brine mixture according to physical/thermodynamic parameters such as pressure and temperature.

Subtask 4.1.4: Efficient measurement and monitoring of induced and triggered seismicity

Different vault-style seismic network configurations will be tested at an operational site (Stenlille) in order to determine the optimal practice based on both cost and quality. High quality seismic sensors from European and North American manufacturers will be tested at various distances around the operational area. Various control parameters and their correlations will be investigated with respect to risk of damaging earthquakes.

TASK 4.2: SURFACE-SUBSURFACE MONITORING DEVELOPMENT

Subtask 4.2.1: Efficient subsurface fracture-flow risk prediction

To quantify the risks associated with natural or engineered fractures the flow properties of the fracture pathways must be well characterised and modelling tools must be available that integrate the hydrogeochemical- geomechanical processes governing flow rates. Cutting edge model reduction techniques will be developed by UNOTT to reduce the dimension of the systems from several thousand to merely a few dozens. This will be achieved by offline computation as a pre-processing step and by utilising model reduction techniques an efficient lower dimensional computational space will be defined.

Subtask 4.2.2: Seismic and geoelectric thresholding technologies

Here we will further develop the state of the art in terms of seismic imaging as a monitoring and sensing tool. UKRI (BGS) have developed a prototype software tool for establishing leakage detection thresholds from 3D timelapse seismic. The tool uses a discrete wavelet transformation to decompose time-slices from seismic difference cubes into components which each represent the repeatability noise level at different spatial scales. This subtask will test the suitability of the tool at onshore storage sites (e.g. FRS in Canada) and between standard and high resolution 3D seismic data.

Subtask 4.2.3: Local-to-global geomechanical characterization

This subtask will develop an integrated diagnostic and predictive workflow combining high-resolution reservoir and geomechanical modelling. UNOTT will use the results of this modelling as a benchmark for later numerical modelling (to be completed outside of this project) and will link to parallel studies that consider the risk of induced seismicity. Geomechanical models will be developed and tested to assess their effects on recovery and injection over time, as well as their link to near-wellbore mechanics where catastrophic failure may occur (INIG-PIB).

TASK 4.3: ADVANCED SENSORS FOR CHALLENGING MONITORING SCENARIOS

Subtask 4.3.1: Gas source based monitoring sensors

This subtask will develop and extend existing field-based protocols for specialised characterisation that will enable an operator or regulator to attribute the source of leaking gas. Carbon and hydrogen isotopes have proved useful in characterising CO_2 and CH_4 sources. We propose to apply process-based monitoring techniques that will determine the sources of CO_2 and CH_4 in the shallow subsurface, whether local production (respiration, oxidation, dissolution) or leakage from the deep subsurface. This will include characterisation of CH_4, higher hydrocarbons, O_2 and N_2 concentrations.

Subtask 4.3.2: Microbial based monitoring sensors

Molecular microbial methods will be used for monitoring shale gas (methane) leakage via groundwater. Different versions of the methane-monooxygenase (MMO) gene appears to be present in all methanotrophes, i.e. micro-organisms oxidizing methane using oxygen as the oxidant. There are two versions of the gene (and probably in-betweens), one version is used when there are high concentrations of methane another at low concentrations. So, by monitoring the quantities of the two different MMO genes by qPCR, the ratio between them could be combined with other parameters such as the $\delta^{13}C$ and methane/(ethane+propane) ratio as well as changes in inorganic chemistry related to the methane oxidation to give a sensitive multidimensional indicator of leakage.

Subtask 4.3.3: Wellbore based mechanical sensors

Knowledge of the pre-existing stress conditions and possible active faults within the injection zone of influence is critical for further computations of the seismicity induced by injection operations; this involves a monitoring seismic network running before the injection operations. A methodology shall be built to estimate the sensitivity needed to take into account the possibility of subcritical faults and fault propagation effects near the drilling site.

NECESSARY INPUT FOR WP4 COMPLETION

WP4 OUTPUTS

Table 13: WP4 Deliverables

Del. #	Deliverable Title	Org.	Responsible Person	Email	Delivery Date
D4.1	Report on applicability of UAV technology for monitoring design of large sites and the impact of remote sensing on monitoring design. The effectiveness of hyperspectral monitoring in CCS/Shale gas.	UKRI (BGS)	Colm Jordan	cjj@bgs.ac.uk	31/05/2020
D4.2	Best practice report on methods for monitoring of induced and triggered seismicity	GEUS	Trine Dahl Jensen	tdj@geus.dk	31/05/2020
D4.3	Report on the potential for exploiting methane oxidiser genes for monitoring stray CH4 intruding into aquifers and assessment of the area that can be monitored	GEUS	Tina Bech Bundgaard	tib@geus.dk	31/08/2020
D4.4	Report on modelling and simulation	UNOTT	Matteo Icardi	Matteo.icardi @nottingham. ac.uk	30/09/2020
D4.5	Report on integrated local-global geomechanics	SINTEF AS	Amir Ghaderi	Amir.Ghaderi @sintef.no	31/12/2020
D4.6	Report on the effectiveness of gas and microbial sensors	TNO	Tanya Goldberg	tanya.goldberg @tno.nl	31/12/2020
D4.7	Guidelines for next generation measurement and monitoring of Shale Gas/CCS	GEUS, IFPEN, UKRI (BGS)	Jakobsen Rasmus	raj@geus.dk	31/12/2020
D4.8	Report on noble gases sampling and analyses	IFPEN	Bruno Garcia	bruno.garcia@ ifpen.fr	31/12/2020

Table 14: WP4 milestones

Mil. #	Milestone Title	Org.	Responsible Person	Email	Delivery Date
MS9	Advanced tool development plans (joint with WP7)	UKRI (BGS)	Colm Jordan	cjj@bgs.ac.uk	31/08/2020

WP5: Impact Mitigation and Remediation

INVOLVED PARTNERS IN WP5

Table 15: WP5 partners

Partner	WP5 Effort in person months
GEUS	8.50
SINTEF AS	23.65
UNOTT	15.30
TNO	18.27
Total	**65.72**

TASK 5.1: NEAR-WELL LEAKAGE EVOLUTION AND CONTROL

Subtask 5.1.1: Geochemical remediation through engineered precipitation

Laboratory testing using a range of host rocks, groundwater chemistry, fracture surfaces etc. will be performed to explore the factors that influence the location and rate of chemical precipitation. CO_2 column experiments will be pursued in porous and fractured media, where CO_2 bubbles migrate upwards at a semi constant flux, driven by a constant bottom pressure (BGS). Once the flux is established, an alkaline $CaCl_2$ solution will be injected. After a period of precipitation, the flux is determined, giving a direct measure of the efficiency of the sealing. After the experiment the column material will be cut up and analysed chemically and visually (microscopy). Information will be gained from industrial analogues of Ca-rich, alkaline fluids reacting with CO_2 where large-scale precipitation of carbonate minerals can be demonstrated. Similar experiments will be run where a constant pressure driven flux of CH_4 is established, and instead of a $CaCl_2$ solution, solutions containing nutrients as well as electron acceptors in the form of nitrate are injected and the resulting CH_4 flux, lowered by the bio-clogging is determined (GEUS). Again, the material can be analysed after the experimentation phase has finished.

Subtask 5.1.2: Remediation of leakage using silicate gels

Inorganic silicate gels are a proven remediation product which have the ability to reduce permeability. Silicate gels were identified by BRGM as promising as a gel that could be engineered to respond to the presence of CO_2 in order to control implementation. Silicate gels were also highlighted due to their potential deep penetration into the rock, good thermal and chemical stability, environmental friendliness and low cost, though BRGM did note that the implementation of silicate gels needs testing in the acidic environment presented by CO_2 dissolved in water. Laboratory tests at SINTEF will examine if silicate gels are suitable for remediation of unwanted migration or leakage. Foams and other types of chemicals to plug leakage paths will also be investigated. This activity will build on this study and consider how it could be expanded to include the unconventional hydrocarbon industry

Subtask 5.1.3: Combatting casing and tubing integrity

This activity will determine how downhole pipes are affected by rough well operations in CCS and unconventional hydrocarbon wells via laboratory experiments. Well tubulars will be exposed to high temperatures/pressures, acidic flow and erosion caused by flow including proppants/sand. The integrity of the tubulars will be monitored using light optical and electron microscopes. How, when, where and why tubular integrity is at risk in CCS/unconventional wells will be determined based on the experimental results (SINTEF).

TASK 5.2: SEISMICITY PREDICTION AND MITIGATION

Subtask 5.2.1: Optimisation of injection and hydraulic stimulation strategies

Predictive models that forecast induced seismicity will be used to address the consequences of injection activities, such as the (rate of) change in the pressure field. It will be used with proper fault and rock parameters to calculate the (rate of) stress changes on faults and subsequently the risk of fault reactivation and related seismic activity. The models will derive a quantifiable measure of fault reactivation potential (e.g. Coulomb stress change on faults) which can be used to further quantify the seismic hazard (or in case of cap rock integrity leakage hazard). The model chain will assess injection volumes and distribution of reservoir pressure as a function of time and place as well as the consequences of pressure changes for fault reactivation and induced seismicity (TNO).

Subtask 5.2.2: Laboratory-based investigation of micro-seismicity mitigation

Hydraulic fracturing and fracture reactivation tests will be carried out to develop understanding of acoustic mechanisms related to injection or production of fluids, with the aim of devising guidelines to limit seismicity by regulating injection or production procedures. The tests will make use of advanced wave-train recording using state-of-the-art acoustic emission set-up and software. The recorded data will be analysed, taking into account attenuation and rock anisotropy. The localisation of source events will be compared to industrial computerized tomography (CT) imaging. Scale effects will be investigated through the use of increasing sample size, from 5 cm up to 40 cm diameter, using the new True Triaxial cell at SINTEF.

TASK 5.3: FAR-FIELD LEAKAGE REMEDIATION

Subtask 5.3.1: Remediation of far-field leakage by subsurface injection

Laboratory experiments will involve the development of novel effective chemical solutions that can be injected in fault zones and/or where precipitation is catalysed by exposure to CO_2. Such methods will be tested on fractured core samples, whereby kinetic reaction rates are evaluated and the injectivity of chemicals in the fault zone will be tested.

Subtask 5.3.2: Natural attenuation in the saturated zone

In terms of groundwater pollution with CO_2, one possible option is to stop the leak and to allow sufficient time for the system to re-equilibrate and mitigate the impact of leaked CO_2. This activity will assess the ability for the natural groundwater system to equilibrate and remediate the impacts of leaked CO_2 using the UK GTB site as a case study. Advanced simulation techniques using high-resolution (multi-million cell) reservoir simulation tools, such as Schlumberger’s INTERSECT, will reduce technological risk associated with long term remediation of CO_2 injection sites and for unconventional geothermal reservoir engineering (BGS/UNOTT).

Subtask 5.3.3: Mitigating impact of hydraulic fracturing on well integrity

Hydraulic fracturing can damage the cement sheath and the surrounding rock in the near-well area. It can thereby introduce unforeseen flow paths/escape routes for CO_2 and formation fluids. Predicting damage development will aid in designing fracturing for shale gas and CO_2 injection schedules so as to minimize the risk of their adverse effects on well integrity. A coupled 3D numerical model of hydraulic fracturing based on SPR's codes MDEM (fracturing software) and MRST (open-source reservoir simulation toolbox) will be used to create a predictive tool for well integrity analysis for hydraulic fracturing and CO_2 injection

NECESSARY INPUT FOR WP5 COMPLETION

- Remediation fluids should be where possible shared between the partners so as to make bench-top and pressurised larger scale experiments on the same chemistries
- Coordination with WP2 is highly desirable in order to optimise experimental effort (generate leakage paths and remediate the same geometry wherever possible)
- Choice of rock and cement samples has to be made in collaboration with field sites to ensure representativity.

WP5 OUTPUTS

Table 16: WP5 deliverables

Del. #	Deliverable Title	Org.	Responsible Person	Email	Delivery Date
D5.1	Report on remediation strategies for tubings and cement sheaths	SINTEF AS	Pierre Cerasi	pierre.cerasi@sintef.no	31/07/2019
D5.2	Report on the experiment-based knowledge on acoustic emission characteristics of CCS and shale gas operations and suggestions on how to mitigate seismicity for both operations	SINTEF AS	Pierre Cerasi	pierre.cerasi@sintef.no	30/09/2019
D5.3	Report on remediation strategies for tubing and casings	GEUS	Rasmus Jakobsen	raj@geus.dk	30/09/2019
D5.4	Guideline with ranking of various squeeze sealant materials with respect to ease of placement	SINTEF AS	Pierre Cerasi	pierre.cerasi@sintef.no	31/05/2020
D5.5	Report on the small scale processes occurring during engineered precipitation and models to assist in the upscaling	SINTEF AS	Pierre Cerasi	pierre.cerasi@sintef.no	30/09/2020
D5.6	Report on application of the optimisation workflow to a field case with available seismicity data	TNO	Jan terHeege	jan.terheege@tno.nl	30/11/2020
D5.7	Recommendations on how to minimize damage to cement sheath and surrounding rock during hydraulic fracturing and CO2 injection	SINTEF AS	Pierre Cerasi	pierre.cerasi@sintef.no	30/11/2020
D5.8	Report on kinetics of enhanced cementation reactions for CO2 leakage remediation and fault healing processes	UNOTT	Veerle Vandeginste	Veerle.Vandeginste@nottingham.ac.uk	30/11/2020

Table 17: WP5 milestones

Mil. #	Milestone Title	Org.	Responsible Person	Email	Delivery Date
MS5	Best available well-remediation technologies defined	SINTEF AS	Pierre Cerasi	pierre.cerasi@sintef.no	30/11/2019

WP6: Development and Exchange of Best Practice to ensure SECURe impact

INVOLVED PARTNERS IN WP6

Table 18: WP6 partners

Partner	WP4 Effort in person months
UKRI (BGS)	17.20
BRGM	3.50
GEUS	4.50
PIG-PIB	10.00
SINTEF AS	3.50
UNOTT	10.00
AMU	35.50
UEDIN	25.90
TNO	14.30
EUR	7.50
GFZ	4.00
Total	**135.90**

TASK 6.1: SHARING OF BEST PRACTICE GUIDELINES

Subtask 6.1.1: Best practice development

We will develop best practice guidance on establishing baseline monitoring by combining the experience gained in SECURE with that from other projects. It will integrate the scientifically-robust evidence developed in SECURe with proven best practice to produce two targeted sets of recommendations: one for CO_2 Storage (D6.8) and one for Shale gas (D6.9). A further summary document (D6.7) will summarise general recommendations for other geoenergy and related sectors (e.g. geothermal, gas storage, coal-bed methane). Although these best practice recommendations will be independently produced to guarantee their impartiality and robustness, it is considered necessary to ensure recommendations can be practically implemented. To achieve this, discussions (via workshops and meetings) will be held with representatives of both sectors: commercial developers, policy makers, regulators, ENGOs, at national and international levels (WP6.2 will focus on local engagement). The SECURe Advisory Board will advise on the scope and context of these recommendations. D6.7, D6.8 and D6.9 will take the form of 'multilevel' reports allowing readers to receive key messages, summary recommendations or gain detailed insights into scientific basis for the recommendations. Summary recommendations will be translated into all project languages.

Subtask 6.1.2: Consensus-building

In Year 1 national workshops will identify user requirements, define knowledge gaps and determine the scope for best practice recommendations. In year 3, follow-up workshops will be held to seek feedback on draft recommendations. A series of national workshops will be hosted by partner(s) and a Brussels-based meeting will be organised by the SECURe management board. Workshops will be held in Denmark, Netherlands, Poland, Brussels and the UK – countries where interest in shale gas production and/or CO_2 storage is known. Invitees will be targeted stakeholder representatives from regulators, policy makers, operators and commercial developers. Public concerns are often quite different from expert ones, so these points of view, identified in WP6.2, will feed into these workshops.

TASK 6.2: ETHICAL PUBLIC ENGAGEMENT IN SUBSURFACE GEOENERGY MONITORING

Subtask 6.2.1: Overview of Ethical and Social Issues Associated with CCS

We will survey the ethical issues associated with CO_2 storage with a focus on the onshore (D6.1). CCS raises two distinct ethical issues. Firstly, CCS enables continued use of (substantially) decarbonised fossil fuels (FFs) for energy production. There are external costs arising from the extraction, transportation and use of FFs apart from carbon emissions, yet CCS may be perceived as justifying continued FF extraction. Even the prospect of CCS could be used to justify further carbon lock-in (as in: 'it's OK to build this coal or gas-fired power-plant because we'll aim to install CCS onto the equipment in a few years' time). Secondly, the costs of CCS are perceived locally, while the benefits are global. This imbalance could make local communities unwilling to accept local costs without recognition or measures such as compensation.

Subtask 6.2.2: Overview of Ethical and Social Issues Associated with Shale Gas Research

Shale gas extraction raises multiple ethical issues. Firstly, shale gas development is feared by large parts of societies due to their perceptions of potential local impact on water and seismicity, as well as human health. Secondly, shale gas is a fossil fuel, and its extraction associated with fugitive methane emissions, and as such leaves a greenhouse gas footprint on the climate. Some actors reject shale gas development on the basis that this is not the best alternative for moving to a low-carbon economy, to develop any kind of fossil fuels is unethical and every effort, be it research or investment, should be directed into developing renewable energy sources; furthermore, they argue that the risks to health and water pollution are unacceptably large. Other actors argue that demand for gas for, e.g., heating, will not decline anytime soon, and that shale gas may be used as a back-up fuel to stabilise electricity production from renewable energy sources, such as wind and solar. Thirdly, shale gas development has been radically rejected by many communities which raises questions about how decisions over development of local energy sources should be taken in democratic societies and who has what rights. In this context compensation (from governments and/or industry) provided to communities willing to develop shale gas in their vicinity may be perceived by some actors as bribery rather than compensating strategy.

Subtask 6.2.3: Responsible Research and Innovation applied to SECURe

A set of criteria for defining RRI will be created through review of the literature and discussions with the SECURe team (D6.3). It is vital to get project-wide buy-in to the meaning and application of RRI to ensure high-quality engagement (including data, discussion, reflection, etc.). A project workshop will be held during the SECURe Project launch in order to discuss and achieve consensus on the criteria which can be used to define RRI. Some components of SECURe will then be selected for exploration using the RRI criteria agreed-upon, a process managed by the social science team. The selected topics need to have clear potential socio-economic or policy impact and real-world case-studies will help to make the issues more tangible.

Subtask 6.2.4: Ethics and Integrity (E&I) Assessment of Research Process

As a way of ensuring our proposal has received E&I appraisal, we submitted an E&I assessment to the School of GeoSciences, University of Edinburgh, outlining some of the research we intend to undertake. It is not possible to include all the intended research in an ethics appraisal at this stage because sufficient detail is necessary prior to E&I assessment, so a more detailed E&I form will be submitted prior to the research being carried out and assessed according to the ethics procedures of all the institutions involved (M8).

TASK 6.3: PARTICIPATORY MONITORING

The aim of Task 6.3 is to apply a generic approach to participatory monitoring to four cases in Poland, the UK, Germany and the Netherlands and to co-develop best practices for participatory monitoring and stakeholder engagement through practical experience and joint research (action research). This task builds on a general approach for participatory monitoring and stakeholder engagement regarding the development and implementation of a large scale low cost monitoring network, which has been developed by TNO in 2015, taking into consideration the complex interactions between subsurface, technology and society.

TASK 6.4: INTERNATIONAL COLLABORATION PLATFORM

Subtask 6.4.1: International platform for environmental monitoring

This task will establish an international platform for environmental monitoring (IPEM) that will bring together internationally-leading research groups in scientific, operational and social science aspects of CO2 storage and shale gas. The platform will comprise two components; (i) a data-sharing infrastructure that will extend the existing system currently used for the UK's national CCS R&D programme (UKCCSRC Data portal, operated by UKRI (BGS)) and (ii) a network of research groups (see Table 3.3b) and other stakeholders that will organise and host a joint conference in Year 3 to facilitate knowledge exchange between sectors. Although primarily focussed on CO2 storage and shale gas, as nascent technologies in Europe, representatives of other new subsurface energy technologies, such as compressed air storage and geothermal energy will also be invited. The conference will be organised by three joint programmes of the European Energy Research Alliance: CCS, Shale Gas and Geothermal, which will access over 20 research groups with an interest in these subsurface technologies. The conference will be the launch of the international platform (Milestone 10). A data-sharing portal will be established by the SECURe team to enable datasets to be collaboratively used by research groups globally (Milestone 10).

Subtask 6.4.2: Education and training for the European research community

The goal is to develop a coordinated assessment of future CCS and shale gas skills in Europe. These training resources will be developed and used within SECURe (Task 6.3) and will be made available for future use through the SECURe website and hosted by UNOTT. We will train young scientists through one-week workshops and address future skills shortages in Europe, with regards to CCS and shale gas. We will seek accreditation for these training courses to allow practitioners to include the training in their Continuous Professional Development towards professional certification. We will reinforce this by organising education for the broader community; through the development of e-learning resources.

Subtask 6.4.3: Education for the media and key non-expert stakeholders

SECURe will continue the action initiated by CGS Europe to develop interaction with the media in the form of educational events for science journalists. Direct exchange with media professionals and press releases are not always the most effective method for dissemination of complex scientific knowledge, such as the multidisciplinary research areas like CCS and shale gas. Participation of science journalists (D6.10) at events such as the annual CO2GeoNet Open Forum, where the latest research developments are presented are an excellent opportunity to provide an understanding of the technology that goes substantially beyond what can be achieved through internet resources.

Subtask 6.4.4: Outreach and online teaching e-resources

Science, Technology, Engineering and Mathematics (STEM) are subjects that the EU has identified as being absolutely critical to its future prosperity and global competitiveness. Whilst STEM are all studied at school, many pupils have misconceptions regarding engineering that can extend to complex topics in which engineers play a key role, e.g. CCS and shale gas. SECURe will develop a range of new outreach events designed to inspire school children (aged 11-17) to consider studying engineering at University (D6.12).

WP6 OUTPUTS

Table 19: WP6 deliverables

Del. #	Deliverable Title	Org.	Responsible Person	Email	Delivery Date
D6.1	Overview report of ethical issues associated with CCS and with Shale Gas R&D	UEDIN	Simon Shackley	simon.shackley@ed.ac.uk	30/11/2018
D6.2	Workshop on co-designing tailor made strategies for participatory monitoring including training on working with stakeholders	TNO			31/05/2019

D6.3	Best practice recommendations for implementing responsible research and innovation for CCS and shale gas R&D	UEDIN	Simon Shackley	simon.shackley@ed.ac.uk	31/05/2020
D6.4	Online e-resources for online training and school children in STEM, on environmental monitoring for shale gas and CO_2 storage	UNOTT	Bagus Muljadi	Bagus.Muljadi@nottingham.ac.uk	31/05/2020
D6.5	Training software and dataset	GEUS	TBD	TBD	31/05/2020
D6.6	Best practice recommendations on participatory monitoring of the impacts of CCS and shale gas development projects in four selected sites	TNO	TBD	TBD	30/11/2020
D6.7	Summary of recommendations for environmental monitoring for geoenergy operations in Europe.	TNO	TBD	TBD	31/05/2021
D6.8	Best practice recommendations for the environmental monitoring of CO_2 storage operations in Europe	UKRI (BGS)	Jonathan Pearce	jmpe@bgs.ac.uk	31/05/2021
D6.9	Best practice recommendations for the environmental monitoring of shale gas operations in Europe	UKRI (BGS)	Jonathan Pearce	jmpe@bgs.ac.uk	31/05/2021
D6.10	Targeted educational talks with science journalists and non-expert stake holders at all levels including the general public	UEDIN	Simon Shackley	simon.shackley@ed.ac.uk	31/05/2021

Table 20: WP6 milestones

Mil. #	Milestone Title	Org.	Responsible Person	Email	Delivery Date
MS1	Metrics for Ethical and Responsible Research and Innovation	UKRI (BGS)	Jonathan Pearce	jmpe@bgs.ac.uk	30/11/2018
MS2	Collaboration with Third parties initiated (joint with WP3)	UKRI (BGS)	Jonathan Pearce	jmpe@bgs.ac.uk	31/05/2019
MS3	Defined strategies for participatory monitoring	TNO	TBD	TBD	31/05/2019
MS8	Ethics & Integrity Assessment of the SECURe R&D with recommendations	UEDIN	Simon Shackley	simon.shackley@ed.ac.uk	31/05/2020
MS10	Launch of International Platform of Environmental Monitoring for Geoenergy Projects	UKRI (BGS)	Jonathan Pearce	jmpe@bgs.ac.uk	31/08/2020

WP7: Management and co-ordination

INVOLVED PARTNERS IN WP7

Table : WP7 partners

Partner	WP1 Effort
1 – UKRI (BGS)	31.15
Total	**31.15**

TASK 7.1: COMMUNICATION WITH THE EC AND CONTRACTUAL REPORTING

This task comprises the high level management activities including:

- Liaison with the EC and the consortium participants for all contractual, legal, financial and administrative issues.
- Technical and financial reporting to the EC
- Submission of deliverables to the EC on time: report deliverables to be approved by task lead, WP lead then co-ordinator prior to upload. To ensure timely completion and to give time for reviews and to address comments from reviewers, it is recommended that deliverables are completed approximately 6 weeks prior to the upload deadline.
- Supporting Partners in issues with H2020 framework.

TASK 7.2: PROJECT COORDINATION

This task comprises the overall coordination of the project and consortium. Main duties and responsibilities are:

- Implementation of the Grant Agreement
- Drafting and implementation of the Consortium Agreement
- Administration of funding contributions
- Administration of and internal reviewing/approval of (technical) deliverables
- Organisation of annual General Assembly meetings and Advisory Board

TASK 7.3: TECHNICAL PROJECT MANAGEMENT BY THE MANAGEMENT BOARD

This task comprises the overall and day to day scientific project management, including WP liaison and integration, project planning and review, WP reporting and collation. It will include:

- Management Board meetings every month (mainly telephone conferences with in-person meetings to be held at the General Assembly meetings) to review overall progress of the project, address arising issues and discuss emerging ideas or opportunities. A continuous evaluation of the ethical issues of the project (mitigation of potential environmental harm; adhere to the ethical standards and guidelines of Horizon2020; adhere to informed consent procedures where applicable) will be undertaken and reviewed at each Management Board meeting.
- Monitoring the progress of SECURe
- Organisation of the annual General Assembly meetings:
    - Kick-off meeting 14th/15th June 2018
    - 1st GA w/c 10th June 2019
    - 2nd GA w/c 8th June 2020
    - Final GA March 2021

Consultation with the Advisory Board to help guide decisions with meetings to be held biannually. In-person meetings will be held at the General Assembly detailed above with additional meetings being carried out via skype/telephone conference call.

TASK 7.4: INNOVATION MANAGEMENT

To support beneficiaries in their post-SECURe future development and exploitation, the coordinator has identified an Innovation Manager that will be responsible for identifying, supporting, coordinating and collating future innovation opportunities for technologies being improved by partners. The Innovation Manager will work closely with partners to help identify markets and opportunities, potential commercial partners and develop their plans for routes to market. It is anticipated that the Innovation Manager will meet with all WP leads by the end of month 6 to establish some of the likely candidates for the development of innovative opportunities within SECURe.

TASK 7.5: DATA MANAGEMENT

SECURe is committed to open data access, long-term archiving and availability after the funding period of the project has finished. The project is participating in the Pilot on Open Research Data in Horizon 2020, which aims to improve and maximise access to, and re-use of, research data generated by projects.

Partners are required to

1. deposit the data in a recognised research data repository.
2. as far as practicable, take measures to enable third parties to access, mine, exploit, reproduce and disseminate this research data.

Open data is data that is free to access, reuse, repurpose, and redistribute. The Open Research Data Pilot aims to make the research data generated by Horizon 2020 projects accessible with as few restrictions as possible, while at the same time protecting sensitive data from inappropriate access. This Data Management Plan (DMP) defines certain datasets to remain closed according to the principle "as open as possible, as closed as necessary".

As part of making data findable, accessible, interoperable and re-usable (FAIR), this Data Management Plan includes information on:

- the handling of research data during and after the end of the project
- what data will be collected, processed and/or generated
- which methodology and standards will be applied
- whether data will be shared/made open access
- how data will be curated and preserved (including after the end of the project)

Overall data management for the project will be undertaken by UKRI (BGS) as the project co-ordinator with co-ordination of data generated by individual work packages resting with individual work package lead organisations. UKRI (BGS) has appointed a data manager for SECURe who has responsibility for coordinating and managing the collation and archiving of SECURe’s data to ensure long-term data management complies with current best practice to allow continued data availability.

This Data Management Plan is an active document and will be updated over the course of the project as required. The data management plan will be discussed annually at General Assembly meetings, following which it will be revised as necessary to ensure it remains representative of the data management strategy for the project. The data manager may also attend work package meetings and Project Management Board meetings as necessary to discuss data management requirements with partners.

For data management support and assistance with archiving data, contact the SECURe data manager, Mary Mowat secure.data@bgs.ac.uk.

The SECURe data management plan (DMP), D7.8 (Table 21), details how data are stored and made accessible to the stakeholders. The data collected/generated by SECURe will be varied, with a range of data types and formats. These will include field and analytical data (including geochemical, geophysical and biological), data produced via computer simulations and data on participants in citizen science projects as part of SECURe’s participatory monitoring.

Data management is imbedded within each work package. A Data Management Questionnaire (DMQ), will be sent to WP leaders to gather more information on the data outputs. WP leaders can also forward to task and sub-task leaders as required. The DMQ is a data management planning tool to help identify data of long-term interest and also assists with data management requirements (e.g. expected high volume datasets). This should be completed with details of the expected data sets, formats, etc. The status of data should also be flagged as open access or confidential with any restrictions specified.

NECESSARY INPUT FOR WP7 COMPLETION

WP7 OUTPUTS

Table 21: WP7 deliverables

Del. #	Deliverable Title	Org.	Responsible Person	Email	Delivery Date
D7.1	Minutes of the SECURe launch meeting for the Management Board, General Assembly and Advisory Board; data management plan	UKRI (BGS)	Karen Kirk	klsh@bgs.ac.uk	31/07/2018
D7.2	Minutes of Management Board, General Assembly and Advisory Board meetings from the 1st annual meeting	UKRI (BGS)	Karen Kirk	klsh@bgs.ac.uk	31/05/2019
D7.3	First period reports to the EC	UKRI (BGS)	Ed Hough	eh@bgs.ac.uk	31/12/2019
D7.4	Minutes of Management Board, General Assembly and Advisory Board meetings from the 2nd annual meeting	UKRI (BGS)	Karen Kirk	klsh@bgs.ac.uk	31/05/2020
D7.5	Minutes of Management Board, General Assembly and Advisory Board meetings from the final annual meeting	UKRI (BGS)	Karen Kirk	klsh@bgs.ac.uk	31/03/2021
D7.6	Final period reports to the EC	UKRI (BGS)	Ed Hough	eh@bgs.ac.uk	31/05/2021
D7.7	Project Management Plan	UKRI (BGS)	Ed Hough Jan Hennissen	eh@bgs.ac.uk janh@bgs.ac.uk	31/08/2018
D7.8	Data Management Plan	UKRI (BGS)	Mary Mowat	mmow@bgs.ac.uk	31/07/2018

Table 22: WP7 Milestones

Mil. #	Milestone Title	Org.	Responsible Person	Email	Delivery Date
MS6	Stage gate for SECURe continuation	UKRI (BGS)	Ed Hough	eh@bgs.ac.uk	30/11/2019
MS9	Advanced tool development plans (joint with WP4)	UKRI (BGS)	Rhian Kendall		31/05/2020
MS11	Review of scientific outputs	UKRI (BGS)	All WP leads with final signoff by Ed Hough	eh@bgs.ac.uk	31/05/2020

Technology exploitation and innovation

Both the unconventional hydrocarbons and CCS industries are at an early stage of large-scale uptake by Member States of the EU. This gives significant potential for the development of innovative technologies, and a joined-up approach to best practice for some common aspects of CCS and unconventional hydrocarbons technologies.

SECURe will allow the progression of moderately advanced technologies (Table 23) through to system development, proving concepts with field studies. It will also foster the development of novel technologies from research concepts through to feasibility studies and early-stage technology development.

A UKRI (BGS) Innovation Manager has been appointed to facilitate by undertaking the following tasks:

- Through consultation with the subtask leaders, identify and collate information on potential innovative technologies both identified to at proposal stage (Table 23) and any new ideas which may evolve through the course of the project.
- Following each Work Package meeting, obtain progress update from the Work Package leaders in order to monitor progress and identify any risks to completion. This information will be compiled and be made available for the Management Board Meetings.
- Following discussion about innovation at Management Board meetings, evaluate any comments and advice and feed back to Work Package leaders.
- Identify potential partnerships across the consortium and facilitate their development.
- Identify potential uses and markets for new technologies, though consultation with the Work Package Leaders.
- Identify any potential IPR issues and work with the SECURe IPR expert and Work Package leaders to resolve these.
- Consult with UKRI (BGS) Innovation Panel for guidance where necessary.
- Undertake detailed analysis of evolving markets for CCS and shale gas.
- Assist partner's plans for commercialisation and exploitation.
- Provide information on innovative technologies to the SECURe communications team for use in their products and public engagement activities.
- Provide SECURe communications team with assistance in understanding and interpreting the innovative technologies if necessary.

Table 23: Summary of monitoring technologies that will be developed in SECURe (extract from the SECURe project proposal document).

Del. #	Technology	TRL Start	TRL End	Description	Who	Pathway to innovation
D3.3	Synergies of environmental baseline strategies (UK & Canada sites)	6	8	Integration of techniques to provide baseline methodologies. Individually the techniques used are probably at currently at TRL 9 but if integrated they are currently at TRL 6	BRGM, UKRI (BGS), PGI, U. Calgary	Analysis of results from, and development of, integrated testing and monitoring tasks
D3.6	Integrated multi-tracer fingerprinting of gas and fluid migration	6	7	Isotope methods applied to gas storage and exploration monitoring	UKRI (BGS), BRGM, U. Calgary	Field testing of a method and lab validation
D3.6	Methodology optimisation for methane and higher hydrocarbons concentrations/isotopic ratio measurements in groundwater and soil gas	5	8	Optimization of sampling and analytical approach to CO_2/methane and higher hydrocarbons concentrations/isotopic ratio measurements in groundwater and soil gas	PGI- NRI	Field testing of a method and lab validation
D4.6	UAV-based CO2 sensor	3	5	CH4-based platform to be extended to CO2. UAV will be test at the GTB, UK.	UKRI (BGS), UNOTT, GEUS, BRGM	Field testing of prototype
D4.4	Gas source based monitoring sensors	2	5	Use the MMO genes of high and low affinity methane oxidizing bacteria collected from wells and possibly streams to monitor the occurrence of stray methane	GEUS, UKRI (BGS) & UNOTT	Field testing of a method and lab validation
D4.5	A tool for the detection of potential leakage (rate) of high heavy metal concentrations	2	4	Development and quantitative framework for detection of soil contamination related to exploitation of unconventional resources	SINTEF	Software optimization and method development

D4.5	Fracture leak rate prediction to validate flow sensors	2	4	Fracture flow prediction to inform about spatial and temporal propagation	SINTEF	Field testing of a method
D4.6	Noble gas downhole sensor	6	8/9	Samples taken under representative downhole conditions allowing calculation of natural chemical inert tracer mass balances	TNO, IFPEN	Field testing of a prototype
D5.1	Study possible failures of well cement	1	4	Mitigate and remediate poor cement completions during CO_2 storage or extraction of unconventional hydrocarbons	SINTEF	Lab validation
D5.2	Remediation of leakage using silicate gels	3	4	Testing and ranking of various squeeze sealant materials with respect to ease of placement	SINTEF	Lab validation
D5.3	Materials to optimize injectivity	1	4	Identify material to help avoid pressure build-up in the well and near-well region	GEUS	Lab validation

IPR Management Plan- SECURe

PURPOSE AND SCOPE

This IPR management plan “the Plan” is intended to supplement the provisions already agreed upon in the SECURe Consortium Agreement “the CA” and Grant Agreement “the GA”. If there is any conflict between the Plan and the CA or the GA, the terms of that agreement will prevail over this plan.

The Plan may be updated throughout the Project if it is deemed that further management is needed for specific IPR issues, or new issues are identified. The Project Management plan which incorporates this Plan will be revised in November 2019.

This Plan aims to summarise existing IPR obligations and provide suggestions for management of data in relation to key areas where it can be anticipated that IPR issues may arise.

DEFINITIONS:

Access rights: ‘means rights to use Results or Background under the terms and conditions laid down in this Agreement’

Background: ‘data, know-how or information held before accession to the CA or added as Background during the Project by way of written request (see 4), which is needed to implement the action or exploit the Results’

Needed: ‘means:

For the implementation of the Project:

Access Rights are Needed if, without the grant of such Access Rights, carrying out the tasks assigned to the recipient Party would be technically or legally impossible, significantly delayed, or require significant additional financial or human resources.

For Exploitation of own Results:

Access Rights are Needed if, without the grant of such Access Rights, the Exploitation of own Results would be technically or legally impossible.’

Party/Parties: The parties to the SECURe Grant Agreement and Consortium Agreement.

Results: ‘means any (tangible or intangible) output of the action such as data, knowledge or information — whatever its form or nature, whether it can be protected or not — that is generated in the action, as well as any rights attached to it, including intellectual property rights.’

The GA: The SECURe Grant agreement number 764531.

The CA: The Consortium Agreement agreed between the beneficiaries of the SECURe project.

AGREED PROVISIONS IN THE GRANT AGREEMENT AND CONSORTIUM AGREEMENT

Section 3 of the GA sets out the rights and obligations related to Background and Results. This is then built upon by section 8 and 9 of the CA, which set out further obligations, time frames and detail.

Under Article 8.1 of the CA, each Party will remain the owner and will retain control of its own Background, and Results are owned by the Party that generates them. This provision will apply in cases where the Results are solely owned or generated by one Party. Where Results are jointly generated by two or more Parties, they will be jointly owned and the Parties must reach agreement separately with regard to the allocation of ownership between the joint owners and exploitation conditions for these Results.

Due to the collaborative nature of this project it is envisaged that such agreements will be needed in order to protect and exploit IP in cases where more than one Party or third Parties have claim to the IP in Results.

Obligations to protect and exploit

Articles 27 and 28 of the GA oblige Parties to both protect and exploit the Results of the project. Article 27 states that Parties must adequately protect Results—for an appropriate period and with appropriate territorial coverage- if:

a) the Results can reasonably be expected to be commercially or industrially exploited and
b) protecting them is possible, reasonable and justified

Article 28 states that Parties "must take measures aiming to ensure 'exploitation' of its Results (either directly or indirectly, in particular through transfer or licencing …) by:

a) using them in further research activities;

b) developing, creating or marketing a product or process;

c) creating and providing a service, or

d) using them in standardisation activities

- Parties' management of IP should therefore ensure that Results are not only protected, but available in a way which allows exploitation of such Results, in order to comply with the GA.
- Ownership and sharing of IP in Results must be clear, as well as the rights of Parties and third parties to use/exploit the Results, and the associated sharing of revenue. This may be achieved by specific IP arrangements on a case by case basis.
- Parties are responsible for identifying and protecting their own IP. Jointly owned IP will be governed by specific IP arrangements as agreed separately between the relevant Parties.

Specific IP arrangements

- Partners must identify and protect IP with specific arrangements in order to comply with the CA and GA.
- Specific IP arrangements are foreseen by the GA and CA and are endorsed in the following provisions in the CA:
    - **8.2** Joint ownership of Results
    - **9.3.1** Access rights to Results
    - **9.3.1** Access Rights to Background if Needed for Exploitation of a Party's own Results
    - **9.6** Additional Access Rights: Grant of Access Rights not covered by the Grant Agreement or this Consortium Agreement
- As stated in the SECURe work plan in the proposal annexed to the GA, it is anticipated that the provisions of both the GA and the CA will be implemented by specific IP arrangements agreed throughout the project, between specific partners, as appropriate.
- Individual, specific agreements covering allocation of ownership and exploitation of jointly generated Results will be necessary due to the range of Results and outputs anticipated, with varying levels of commercial and academic value.

ACCESS RIGHTS TO BACKGROUND

- Parties have outlined, by way of a positive list, their Background which is to be the object of Access Right obligations, and any limitations upon their implementation and exploitation.

- Where Parties have specified no Background at the time of the consortium agreement, and during the project the Background of one Party is Needed by another, a request for Access Rights can be made in writing. If a Party at any point wishes to grant Access Rights to Background, the Article 9.2.1 applies.

  9.1.2 *Any Party may add further own Background to Attachment 1 during the Project by written notice to the other Parties. However, approval of the General Assembly is needed should a Party wish to modify or withdraw its Background in Attachment 1.*

MANAGEMENT OF SPECIFIC IPR ISSUES

Restrictions on Background- Third party rights

- If it is necessary for a Party to use third party data for which they have a prior licence or privileged access, their use of this data must follow any agreement in place between the third party and the Party, permitting use of the third party data on this project.
- Article 9.2.1 of the CA states that each Party bears responsibility for ensuring that its acts within the Project do not knowingly infringe third party property rights.
- When requesting to list new background which is the subject of third party rights, this should be noted as a restriction when adding the background to the listing.

Joint ownership within the consortium.

- During the project, parties may claim joint ownership of IPR in results. For example, it may be necessary for Parties to use the facilities of other Parties to process data, materials or tools, or for Parties to work collaboratively on interpreting data in order to generate Results.
- To avoid any doubt as to how the IPR in the Results of this work will be shared, an agreement must be made to ensure clarity.
- This “joint ownership agreement” should follow the provisions in the GA (Article 26.2) and Article 8.2 of the CA**.**
- Any such agreement should contain provisions relating to allocation of ownership between the joint owners and sharing of revenue from future exploitation of the Results of this work.

Third party sharing of results

- Third Parties may claim rights to Results under the project- for example if a Party uses a third party facility to process data or materials.
- Parties should follow Article 26.3 of the GA, which sets out the Parties’ obligations in a situation where third Parties may claim rights to the Results: “A Party must obtain all necessary rights, whether by way of transfer, licences or other agreement in order for it to be able to respect its obligations as if those Results were generated by the Party itself”.
- Under Article 30 of the GA, if a party grants a licence over its Results to a third party, this must not impede access under Article 31.
- Article 31 of the GA states that Parties must be able to access Results for implementing and exploiting their own Results.
- Exclusive licences of Results to third Parties should not be granted unless all other Parties waive their Access Rights.

Access to third party data during the project

- Parties may need to access third party data during the project in order to produce Results.
- The terms of access to this data should be in line with the provisions of the CA and GA- any licence or agreement with the third party for the use of their data should not hinder the protection and exploitation of or access to the Results of the work- Article 31 GA.
- This third party data will also become part of a Party’s Background, the guidance relating to listing new background will apply. When requesting to list new background which is the subject of third party rights, this should be noted as a restriction when adding the background to the listing.

Additional Access Rights

- Article 9.6 of the CA provides a solution for any IP issue which falls outside of the scope of the situations envisaged by the CA or the GA:

  Article 9.6: For the avoidance of doubt any grant of Access Rights not covered by the Grant Agreement or this Consortium Agreement shall be at the absolute discretion of the owning

Party and subject to such terms and conditions as may be agreed between the owning and receiving Parties.

- In any case where a Party wishes to deal with IP in Background or Results in a way which is out of the scope of either the CA or the GA, this Article 9.6 will apply.

This Plan is not intended to be legally binding, if Parties are not able to reach an agreement on any of the issues contained within this Plan, this should be raised with the work package lead at first instance.