**Grant agreement No. 764810**

# Science for Clean Energy

H2020-LCE-2017-RES-CCS-RIA
Competitive low-carbon energy

## D2.1
## Early Project Report on Ethical Conduct

**WP 2 – Ethical Oversight**

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| **Due date of deliverable** | Month 6 – February 2018 |
| **Actual submission date** | 28/02/2018 |
| **Start date of project** | 1st September 2017 |
| **Duration** | 36 months |
| **Lead beneficiary** | IPGP |
| **Last editor** | Natalie Nestorowicz (UCL) |
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| **Dissemination level** | Public (PU) |

*This Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 764810*

# History of the changes

| Version | Date | Released by | Comments |
|---|---|---|---|
| V.1.0 | 20-02-18 | Alberto Striolo | First draft of the report released |
| V.1.1 | 28-02-18 | Natalie Nestorowicz | Final version including feedback of partners |

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## Key word list

Ethical Risks, Ethical Oversight, Risk Mitigation Strategies

## Definitions and acronyms

| | |
|---|---|
| | Carbon capture and storage |
| **CCS** | Life cycle analysis |
| **LCA** | Science 4 Clean Energy |
| **S4CE** | |
| **LCA** | Life cycle analysis |
| **ESAB** | External Science Advisory Board, |
| **EAB** | Ethics Advisory Board |
| **S4CE** | Science 4 Clean Energy |
| **WP** | Work Package |

# 1. Introduction

The consortium Science 4 Clean Energy (S4CE) has the ambition to develop and implement new and unique technologies beyond the state of the art for sensing and monitoring, to assess the environmental footprint of geo-energy sub-surface operations in EU and to extract the added value of a multi-sensor approach in managing sub-surface operations. The innovations that are considered as part of this consortium include new instruments development, implementation of new models, testing of new protocols for characterization of rock samples, etc.

The practical applications that are considered within the consortium include various sub-surface geo-energy applications, which include carbon sequestration, enhanced geothermal energy production, enhanced gas recovery, and unconventional hydrocarbons production. These technologies attract vast public attention, and they present several risks. It is expected that progress in the consortium could both have high impact, and also generate significant public attention.

S4CE has the goal of delivering the unbiased and independent assessment of the environmental footprint related to geo-energy sub-surface operations. As such, S4CE will have as primary impact the assistance to policy making in relation to CCS, EGT and the development of unconventional hydrocarbons. During this project many data will be obtained. To be useful for policy makers, these data will have to be consolidated and made easy to digest. For this purpose, S4CE will develop/implement bespoke risk-assessment protocols.

The European Commission recognizes that public concern regarding sub-surface operations will persist as long as legal uncertainty and a lack of transparency remain, especially regarding unconventional hydrocarbon production [SWD (2014) 21]. S4CE acknowledges that the public, both near and far from sub-surface operation sites, is ultimately affected by geo-energy applications. *S4CE will address public concerns* and will maintain active dialogue with all stakeholders of sub-surface geo-energy operations.

## 1.1 General context

The general goals of the consortium, listed above, stem from the fundamental nature of the proposed research and development plan proposed to the European Commission and supported by Horizon 2020. It is however understood that significant commercial interest is related to the research activities proposed by the S4CE consortium.

As a consequence, it is recognized that there might be a potential conflict of interest between scientific integrity, commercial interest, and public discussions. It is necessary to ensure that the reports, deliverables, public dissemination events and scientific publications from the consortium adhere to the highest ethical standards. To ensure that such ethical standards are upheld, S4CE has designed Work Package 2: Ethical Oversight.

Work Package 2 will provide recommendations to mitigate ethical risks. The main tasks of this Work Package are:

**Task 2.1 – Dual and Misuse Use**
The consortium will develop instruments and deploy them to measure induced micro-seismicity, emissions, and transport of fluids in the sub-surface. This WP will suggest strategies to prevent the use of this information and methods along goals that are not consistent with the consortium's objectives.

**Task 2.2 – Non-EU Countries**
The research success of the proposed activities depends on the collaboration with research sites in Iceland, Serbia, Switzerland, USA and Canada. This WP has the task of ensuring that the research practices implemented by our partners in these countries will be consistent with the EU norms and regulations.

**Task 2.3 – Defensive/Offensive Use and Sensational Interpretation**
Because of the significant emphasis on the environmental impact of sub-surface operations, it can be tempting for researchers to achieve short-lived fame by providing sensational interpretation of research results, as well as to pursue fast research results implementing un-ethical methods and procedures. This WP will recommend strategies to prevent such events from happening and for S4CE to maintain a balanced and independent role in recommending policy changes based on the independent assessment of the environmental risks associated with sub-surface geo-energy operations in Europe.

In support of Work Package 2, S4CE has established the Ethics Advisory Board, who will oversee the results and the publications from the S4CE consortium.

## 1.2 Deliverable objectives

The objective of this deliverable is to summarize the possible ethical risks that could be faced by the S4CE consortium, to describe some of the procedures that will be put in place to ensure that the consortium adheres to the highest standards of ethics, and to present the composition of the Ethics Advisory Board.

# 2. Methodological approach

## 2.1 Summary of ethical risks faced by the S4CE consortium

### 2.1.1 DUAL USE

Potential dual use implications of the project. The proposed research is extensive, and starts from the collection of rock samples, their characterisation, and the investigation of the behaviour of fluids confined within the pores in the rocks, and their transport. While the line of research just briefly outlines can find applications, upon appropriate extensions and modifications, in a range of industrial sectors that include the chemicals industry, the design of new materials, cosmetics, and even the implementation of novel drug delivery strategies, the proposed research does not have immediate dual-use implications.

The main applicability of the research is within the energy sector, as well as within the environmental-remediation industrial sector. The successful completion of the proposed research has goal of potentially allowing the exploitation of natural resources, specifically natural gas and unconventional hydrocarbons, carbon sequestration and enhanced geothermal energy, while minimising the environmental impact of sub-surface technologies. As hydrocarbons (both natural gas and higher molecular weight hydrocarbons) constitute the source of fuels for transportation and heating, the potential dual use of the project is connected with the issue of energy security. Hydrocarbons are also used by the chemicals sector for producing a wide range of commodities. So the availability of hydrocarbons at moderate prices is often considered important for securing the economic well being of a nation. However, as hydrocarbons are in general widely available, the risk of unintentional dual use of the project is considered very limited. It is however recognised that, sometimes, geopolitical tensions arise because consolidated routes of access to hydrocarbons are interrupted, intentionally or unintentionally. This social aspect is not considered as part of this project, and of anything the success of the proposed activities could provide access to natural gas and oil within Countries where such resources have been traditionally limited, or are in the process of being consumed. Therefore it is considered that the project does not have dual-use applicability, but instead has the potential of relieving social tensions.

The project will lead to better characterisation of rock samples from various formations. The project is innovative, as the current limits of the experimental capabilities will be pushed towards achieving the best resolution. This will allow us to provide information to computer modelling efforts. The characterisation experiments are per se not of dual use. However, the techniques developed could be in principle applied to a variety of materials. While this project is focused on rock samples and as such no dual use is expected, any new technique could find application in unexpected circumstances.

The project will develop a better understanding of the behaviour of fluids under confinement, via the use of multiple computational techniques. The aspect that might find dual use application from this level of investigation is the ability we expect to develop to describe the transport of ions in complex sub-surface environments. This piece of knowledge is critical for designing materials to prevent the unintended environmental contamination due to, e.g., nuclear waste. It is expected that the level of knowledge developed within this project will help prevent environmental contaminations, and as such will reduce the dual use potential.

The project will also investigate the likelihood of stimulating micro-seismicity events using the technology of hydraulic fracturing. While the scope of the project is to identify procedures to minimize the likelihood of such events as well as to identify procedures to mitigate the consequences of accidents, better understanding how to avoid micro-seismicity inevitably leads to better understanding how to promote micro-seismicity. Any dual use of such knowledge will require drilling, which is not part of the proposed activities. A lot is known already regarding ways to promote earth tremors, so our studies will not have a significant impact on this aspect of dual use implications.
Other aspects of the proposed research include the comparative analysis of legislation within different Countries (EU, USA, Canada, maybe others) regarding the rights of sub-surface minerals; (d) the identification of best practices for the minimization of risks; and (e) the analysis within a life cycle assessment and a multi-risk perspective of the environmental impacts, both in terms of greenhouse gas emissions and fresh water utilisation, related to the extraction of hydrocarbons from either conventional or unconventional formations. These research directions do not have immediate dual-use applications. The comparative analysis of legislation among various Countries has the potential of identifying differences, which could be addressed by the decision-making bodies in the various Countries. This research direction has the potential of reducing differences among different locations. Additionally, the identification of best practices will lead to a safer exploitation of hydrocarbons. The identification of best practices to reduce risk and improve safety has the potential of improving national security, hence reducing dual use potential. The life cycle analysis, LCA, is becoming a routine line of research for identifying the true environmental impact of any technology or human activity. Applied to the present project, the LCA method has the potential to identify the part of the technology (e.g., hydraulic fracturing vs. drilling) that has the highest impact on the environment (hot spot analysis). As such the LCA approach could guide future research into limiting the environmental impact by focusing on the technologies that are the most promising. No dual use is identified for this research direction.

**Risk mitigation strategies**

While the research planned within the S4CE consortium has very limited dual use potential, as just described, procedures have been established to minimise the correspondent risks.
The most important measure we will implement is the public dissemination of the results in their entirety, via appropriate channels and with care not to divulge inaccurate information. We have planned open presentations at each of our annual meetings, and we have also organised public forums to discuss the progress in our research. All results will be published in peer-reviewed journal articles and/or presented at international conferences. Summaries will be placed on our website.
To ensure an independent assessment of the possible dual use of our research results we have established an External Science Advisory Board, ESAB. Members of the ESAB have been selected from EU, USA and Canada. These members are highly respected researchers well known in their field of expertise. The ESAB will convene at each of our annual meetings, will be given an overview of the research results, and will be asked to comment on potential dual use aspects of the research activities. Should the ESAB identify research directions with potential dual use implications, the Project Management Team will contact the European

Commission to identify the best course of action. The most likely scenario is that the specific research direction will be modified to ensure that dual use applications will not be achieved during the course of the present project.
The recommendations and the comments from the ESAB will be made available to interested third party researchers to ensure the transparency of our research.

### 2.1.2. NON-EU COUNTRIES.

It is anticipated that S4CE researchers will travel outside the EU for reporting the findings of this research at international conferences, or for soliciting collaborations with potential industrial partners. These activities will consist of travels, conferences, presentations and discussions. As such, it is not anticipated that concrete risks will be encountered. To minimise potential risks, travels in unstable Countries will be restricted.

Possible ethical issues could arise because non-EU Countries (Iceland, Serbia and Switzerland) will be involved in the proposed research. In particular, rock samples could be exchanged between non-EU and EU Countries to complete the research activities described within the present proposal.
Access to non-EU rock samples will allow S4CE to accomplish the research activities proposed within the proposal.
Ethical standards and guidelines as provided by Horizon 2020 will be rigorously applied regardless of the country in which the rock samples will be attained and tested. Please note that the research activities will be focused primarily on rock samples from European formations. A library of rock samples from North American shale formations has already been acquired. While its use within the present proposal requires a formal agreement with British Gas Group, the rightful owner, we guarantee that the samples will not be used unless the ethical standards of Horizon 2020 were implemented when these rocks were acquired.
It is possible that rock samples from the EU Countries will be transported to research laboratories in non-EU Countries (most likely North America) when the experimental facilities in our laboratories will not be sufficient to provide complete characterization using state-of-the-art capabilities. Should this be the case, the consortium will ensure that the Horizon 2020 ethical guidelines will be implemented while the characterization experiments will be conducted within the laboratories in non-EU Countries. The sample rocks will be returned to the EU once the characterization has been completed, to prevent breaches to the ethical guidelines in the future.

**Risk mitigation strategies**

The consortium has established formal procedures to ensure that the highest standard of ethics requirements are upheld in all aspects of the research conducted within the auspices of the European Commission.
The most important measure we will implement is the public dissemination of the results in their entirety, and of the sources of the rock samples used in our experiments. We have planned open presentations at each of our annual meetings, and we have also organised public forums to discuss the progress in our research. All results will be published in peer-

reviewed journal articles and/or presented at international conferences. Summaries will be placed on our website.
To ensure an independent assessment of the ethical procedures implemented in harvesting the rock samples used in our experiments we have established an External Science Advisory Board, ESAB. Members of the ESAB have been selected from EU, USA and Canada. These members are highly respected researchers well known in their field of expertise. The ESAB will convene at each of our annual meetings, will be given an overview of the research results, including the sources of the rock samples used in our experiments, and will be asked to comment on all ethical aspects connected with our research. Should the ESAB identify shortcomings in terms of ethics, in particular during the acquisition and/or handling of rock samples whether in EU or outside of the EU, the Project Management Team will inform immediately the European Commission to identify the best course of action. The most likely scenario is that we will stop using the rock samples that have been acquired using questionable practices and we will report such practices to the competent authorities.
The recommendations and the comments from the ESAB will be made available to interested third party researchers to ensure the transparency of our research. The ESAB will also comment on the authorizations obtained before rock samples are transferred among EU states, as well imported/exported from the EU.
While the project expects no other ethical issues to arise in the conduct of its work, the consortium has established a process within the management structure to enable partners to raise any ethical issues or concerns to the coordinator, who will be obliged to raise such issues with the General Assembly.

### 2.1.3. MISUSE

The goal of the proposed research is to develop an accurate environmental assessment of sub-surface geo-energy operations in Europe. As such, the deliverables will include theoretical models, calculations, and experimental data sets. The results will be made publicly available in the literature via papers in scientific journals and via presentations at conferences and workshops.
It is possible that new experimental protocols for the characterization of rock samples will be proposed, as well as innovations in the technology for characterizing rock samples, and in software for describing fracture propagation and fluid transport through rock samples. We expect that best practices will be identified to reduce the risks associated with the production of hydrocarbons from either conventional or unconventional formations, microseismicity, and also on the identification of the most appropriate technologies (in terms of economy and of environmental impact) for the various operations. We also expect to identify the parts of the technology that are most likely to have large environmental impacts, so that focused future research could lead to significant environmental benefits.
These products of our research will potentially lead to commercial products (e.g., commercial software, etc.), which will enhance the impact of our project, as described in the proposal narrative. We do not predict immediate malevolent/criminal/terrorist abuse of the research findings expected from our research. On the contrary, we expect that our research will yield recommendations for best practice to reduce the likelihood of environmental consequences, hence decreasing the risk of malevolent/criminal/terrorist actions related to

industrial operations related to the production of conventional and unconventional oil & gas resources.
The most likely malevolent/criminal/terrorist abuse of the research findings is due to mis-representation of the results and faulty communications (e.g., taking the results out of context). To prevent this possibility our consortium has established a number of public venues for reporting the results to the wide community, including web sites, open forums, conferences, and scientific publications.
The S4CE consortium has established formal procedures to minimise the risk of malevolent/criminal/terrorist abuse of the research findings obtained within this project.
As the highest risk has been identified with the mis-representation of the results, the most important mitigation measure we will implement is the public dissemination of the results in their entirety, using language that is accessible to the public. We have planned open presentations at each of our annual meetings, and we have also organised public forums to discuss the progress in our research. All results will be published in peer-reviewed journal articles and/or presented at international conferences. Accessible summaries, and if possible video explanations will be placed on our website.
To ensure an independent assessment of the possible malevolent/criminal/terrorist abuse of our research findings ethic we have established an External Science Advisory Board, ESAB. Members of the ESAB have been selected from EU, USA and Canada. These members are highly respected researchers well known in their field of expertise. The ESAB will convene at each of our annual meetings, will be given an overview of the research results, including our existing communication channels with the public, and will be asked to comment on any possible malevolent/criminal/terrorist abuse of the research findings the ESAB perceives. Should the ESAB identify possible unanticipated malevolent/criminal/terrorist abuse of our research findings, the Project Management Team will inform immediately the European Commission to identify the best course of action. The ESAB will be asked to propose corrective measures, these will be openly discussed among the General Assembly, and the resultant actions communicated to the European Commission. Should it be necessary, the competent authorities will be informed of any perceived risk, so that strategies can be timely implemented to avoid unintended consequences.

## 2.2. Additional Procedures in Place to Minimise Risks

In addition to the mitigation measures discussed above, the S4CE consortium has put in place a process for approving each and all publications. Each publication (entire manuscript for peer-reviewed journal publications or abstract for conference presentations) is shared among the General Assembly members. Comments and recommendations are shared and incorporated in the revised publication before it is submitted externally. This is intended to minimise the risks associated with:

1. Possible exaggeration of the implications of the results, which could grab public attention but also miss-inform the public;
2. Use of proprietary data that are not ready for public dissemination;
3. Defective interpretation of data;
4. Selective interpretation of scientific data.

The Ethics Advisory Board will review the scientific and engineering progress achieved by the S4CE consortium at least once a year, and recommend additional procedures, if necessary.

# 3. Summary of activities and research findings

An Ethics Advisory Board has been set up to ensure that the activities conduced within the consortium adhere to the highest level of standards. The Ethics Advisory Board will assist the tasks described in WP2. In particular, S4CE is a consortium that includes many nations, within the EU but also beyond. It is essential that the EU standards of ethical conduct are upheld both within the EU, and outside when the research results will be employed by S4CE. Sub-surface geo-energy operations are critical for maintaining and expanding the standards of living in the modern western society. As such, much is at stake and depends on the independent assessment of the environmental impact of the various technologies, which will be enabled by S4CE. The Ethics Advisory Board has the task to provide recommendation to ensure these important outcomes are achieved, to ensure that the results are transparent, and also that the innovations are deployed correctly and that the outcomes of the research are correctly interpreted and communicated to all stakeholders. The composition of the Ethics Advisory Board is reported in the Table below. Note that Mr Mark Kaczmarek who is a Councillor in the region where the field site on the Cornwall operations intend to deploy enhanced geothermal energy, and an ex-miner. At the time of this writing he has not yet replied to our invitation. The Chairperson of the Ethics Advisory Board is Dr Ian Davey, of the UK Environment Agency. Dr Helga Bardadottir is from Iceland, where the CarbFix site is located. She is the Head of Division at the Department of Oceans, Water and Climate at the Ministry for the Environment and Natural Resources in Iceland. Both Dr Bardadottir and Dr Davey confirmed their commitment to the S4CE consortium.

**EAB – Ethics Advisory Board**

**Chairperson:** Dr Ian Davey, UK Environment Agency

**Composition**:

| Name | Email |
|---|---|
| Davey, Ian | ian.davey@environment-agency.gov.uk |
| Mark Kaczmarek (Cornwall) | tbc |
| Helga Bardadottir (Iceland) | helga.bardadottir@uar.is |

# 4. Conclusions and future steps

A preliminary risk assessment has been performed with respect to ethical oversight of the research and development activities proposed within the S4CE consortium. Mitigation strategies have been put in place, an Ethics Advisory Board has been established, and a procedure to vet all publications from the consortium has been put in place.
As the project progresses, the Ethics Advisory Board will provide recommendations on how to improve the procedures described in this deliverable, should it be necessary.