Collaboration Agreement

regarding the Societal and Industry-oriented Research Centre with the following title:

"National Centre for Sustainable Subsurface Utilization of The Norwegian Continental Shelf"
("NCS2030")

(The Research Council of Norway funded project no. 331644)

This Collaboration Agreement, based upon the contract between the Funding Authority and Universitet i Stavanger, is entered into between:

1 **Universitetet i Stavanger** (Project Owner), org.nr. 971 564 679,

2 **NORCE Norwegian Research Centre AS**, org.nr. 919 408 049,

3 **Institutt for energiteknikk**, org.nr. 959 432 538,

4 **Universitetet i Bergen**, org.nr. 874789542,

5 **Equinor Energy AS**, org.nr. 990 888 213,

6 **Vår Energi ASA**, org.nr. 919 160 675,

7 **Aker BP ASA**, org.nr. 993 250 287,

8 **DNO Norge AS**, org.nr. 913 905 881,

9 **OKEA ASA**, org.nr. 915 419 062,

10 **Wintershall DEA Norge AS**, org.nr. 985 224 323,

11 **Landmark Graphics AS**, org.nr. 971 106 514,

12 **Schlumberger Information Solutions AS**, org.nr. 994 265 873

hereinafter collectively referred to as the “Parties”, or individually as “Party”.

1 Definitions

Affiliated Entity:

a) entity that is directly or indirectly in possession of more than 50 per cent of the share capital or voting rights or in some other way exercises direct or indirect control over one of the Parties (parent company);
b) entity in which one of the Parties is directly or indirectly in possession of more than 50 per cent of the share capital or voting rights or in some other way exercises direct or indirect control (subsidiary company), or an entity in which one of the Parties controls 50 per cent or less of the voting rights, but none the less has determining influence in that entity (operator of oil & gas license);
c) entity for which more than 50 per cent of the share capital or voting rights are directly or indirectly possessed or in some other ways are directly or indirectly controlled by one or more companies that are directly or indirectly in possession of more than 50 per cent of the share capital or voting rights or in some other way exercise direct or indirect control over one of the Parties (associated company).

Background: Material contributions or Intellectual Property Rights, know-how and information that a Party brings to the Project. The Background provided by the individual Party is specified in Appendix 3.

The Board: The supervisory body for the execution of the Project which reports to and is accountable to the General Assembly.

Centre Director: The individual appointed as project manager in the R&D Contract. Oversees the progress and implementation of the Project on behalf of the Project Owner.

Confidential Information: Background or any other information disclosed by one Party to the other Party(ies) under or in connection with this Collaboration Agreement.

Commercial Utilisation: Direct or indirect use of Project Results in the development and/or marketing of products, services or processes, or the transfer and/or licensing of use of Project Results to third parties. Publication through publishing houses is not deemed to be Commercial Utilisation.

Defaulting Party: A Party that the General Assembly has deemed to be in breach of its obligations under the Collaboration Agreement.

Fair and Reasonable Conditions: Appropriate conditions, including possible financial terms or royalty-free conditions, considering the specific circumstances of the request for ownership or access. The conditions shall reflect the value of the Project Results or Background to which access is requested, financial and non-financial contributions, as well as the scope, duration or other characteristics of the exploitation envisaged. The terms of the Collaboration Agreement must ensure that any undertakings taking part in the Project do not receive indirect state aid, as is set out in the EFTA Surveillance Authority's guidelines for state aid for research and development and innovation Section 28, paragraph b), c) or d).

Force Majeure: Unforeseeable and exceptional circumstances which are beyond the control of the Party affected, and which cannot be remedied by the exercise of reasonable diligence, including without limitation acts of God, acts of civil or military authority, governmental orders, war, fire, explosion, labor unrest (except if limited to the Party affected) or epidemic.

Funding Authority: The Research Council of Norway.

General Assembly: The ultimate decision-making body of the Project and shall consist of one representative of each Party.

Governing Body: The Board and the General Assembly of the Research Centre.

Intellectual Property Rights: All rights to technical solutions, methods, processes and procedures, regardless of whether or not these are or may be patented. This also includes all copyrights and other rights to trademarks, design, plant species, databases, integrated circuit layout designs, drawings, specifications, prototypes, company confidential information and the like.

Research Centre: National Centre for Sustainable Subsurface Utilization of The Norwegian Continental Shelf, in short "NCS2030". The terms Research Centre and Project are used interchangeably.

Project: The overall activities covered by the R&D Contract. The terms Project and Research Centre are used interchangeably.

Project Description: Scientific and administrative description of and plan for the implementation of the Project, included as an attachment to the R&D Contract.

Project Owner: The Party designated as Project Owner in the R&D Contract and host institution for the Research Centre.

Project Period: The time span during which the Project is to be performed, as specified in the R&D Contract and Section 2.

Project Results: All results produced or achieved through the work carried out under the Project, including Intellectual Property Rights, regardless of whether or not the results are protected by law.

R&D Contract: Agreement relating to a Project between the Project Owner and the Funding Authority that comprises a written agreement, general terms and conditions for R&D Projects, as well as the Project Description and any supplementary documents, and is included as Appendix 1.

Research Partner: A Norwegian research organisation, defined as such by the Funding Authority, being Party to the Collaboration Agreement.

Subcontractor: An entity, that is not a Party to the Collaboration Agreement or an Affiliated Entity, that supplies goods and/or provides services to the Project on assignment from Parties.

User Partner: Any Party to the Collaboration Agreement from outside the research sector.

Work Plan: Annual plan that specifies obligations and contributions of the Parties within the Project.

2 Project Period

Start date: 01.01.2022
End date: 31.12.2026

Subject to successful mid-term evaluation of the Research Centre a three-year prolongation of the Project will be granted by the Funding Authority:

Prolonged start date: 01.01.2027
Prolonged end date: 31.12.2029

3 The Collaboration Agreement

3.1 The Collaboration Agreement governs the organisation and implementation of the Project, as well as the rights and obligations of the Parties.

3.2 The parameters of the Project, including the terms and conditions for support from the Funding Authority, the scope of the support, the Project's objective, the Project Description, funding plan and reporting requirements are stated in the R&D Contract and any supplementary documents indicated in Appendix 1.

The Collaboration Agreement has the following appendices:

Appendix 1: The R&D Contract, including the requirements and guidelines that applies to Societal and Industry-oriented Research Centres
Appendix 2: Specification of the Project's funding plan
Appendix 3: Background

In the event of a conflict between the R&D Contract and this Collaboration Agreement, the R&D Contract shall take precedence.

Notwithstanding the above, any reference to "Halliburton AS" and "DNO ASA" appendix 1 shall mean "Landmark Graphics AS" and "DNO Norge AS", respectively, in the context of this Collaboration Agreement including appendices. The Project Owner shall be responsible for revising appendix 1 in line with this reservation as soon as possible following the execution of the Collaboration Agreement.

4 Entry into force, duration, and withdrawal

4.1 Entry into force

4.1.1 This Collaboration Agreement enters into force on the date on which it is signed by all the Parties, with effect from the start of the Project Period.

Accession of new Parties to the Collaboration Agreement after the Project has started requires the written consent of the Funding Authority and following decision by the General Assembly. The General Assembly might also decide on specific terms for accession, such as a fee to be paid by the new Party in order to be acceded in Collaboration Agreement. The new Party becomes party to the Collaboration Agreement by signing an accession agreement, and the Parties hereby grant a power of attorney to the Project Owner to sign such an accession agreement on behalf of the Parties. The Project Owner signs the accession agreement on behalf of the Research Centre.

When it is considered to include a new Party to the Collaboration Agreement, the Board shall assess the need for and propose any changes in the appendices to the Collaboration Agreement to the General Assembly. Any such changes will enter into force once the new Party has signed the accession document.

4.2 Duration

4.2.1 The Collaboration Agreement applies between the Parties during the Project Period, until the Project has been completed and the Parties have fulfilled all their obligations under the Collaboration Agreement. After this date, the Collaboration Agreement shall automatically terminate except for provisions that by their nature are intended to survive termination.

4.3 Withdrawal

4.3.1 A Party, except for the Project Owner, may request to withdraw from the Collaboration Agreement, and thus to abdicate its rights and be exempted from its obligations. A request for withdrawal must be submitted with a minimum of six months' notification to the Board. The Board will request the approval of the Funding Authority to continue the Project with a

change in composition of Parties.

4.3.2 The withdrawing Party will still be liable for its share of funding to the Project as specified in Appendix 2 up to the end of the calendar year of the effective date of withdrawal.

5 Governing Bodies

5.1 The Research Centre's Governing Bodies are the General Assembly and the Board.

5.2 General operational procedures for Governing Bodies

5.2.1 Representation in meetings

Any member of a Governing Body (hereinafter referred to as Member) should be present or represented at any meeting of such Governing Body, may appoint a substitute or a proxy to attend and vote at any meeting but is required to keep the chairperson of the respective Governing Body informed of their representatives at any given time.

5.2.2 Convening meetings

The chairperson of a Governing Body is responsible for convening meetings of that Governing Body.

Governing Body	Ordinary meetings	Extraordinary meetings
General Assembly	At least once a year	At any time upon written request of the Board or 1/3 of the member of the General assembly
Board	At least twice a year	At any time upon written request of any member of the Board

5.2.3 Notice of meetings

The chairperson of a Governing Body is responsible for giving notice in writing of a meeting to each Member of that Governing Body as soon as possible and no later than the minimum number of days preceding the meeting as indicated below.

Governing Body	Ordinary meetings	Extraordinary meetings
General Assembly	45 calendar days	14 calendar days
Board	14 calendar days	7 calendar days

5.2.4 Agenda for meetings

The chairperson of a Governing Body is responsible for preparing and sending to each Member of that Governing Body a written agenda no later than the minimum number of days preceding the meeting as indicated below.

Governing Body	Ordinary meeting	Extraordinary meeting
General Assembly	21 calendar days	10 calendar days
Board	7 calendar days	7 calendar days

Any agenda item requiring a decision by the Members of a Governing Body must be identified as such on the agenda.

5.2.5 Adding items to the agenda

Any Member of a Governing Body may add an item to the original agenda by written notification to all the other Members of that Governing Body up to the minimum number of days preceding the meeting as indicated below.

Governing Body	Ordinary meeting	Extraordinary meeting

General Assembly	14 calendar days	7 calendar days
Board	2 calendar days	2 calendar days

During a meeting the Members of a Governing Body present or represented can unanimously agree to add a new item to the original agenda.

5.2.6 **Meetings by video or teleconference**
Meetings of each Governing Body may be conducted by means of video or teleconference.

5.2.7 **Voting rules and quorum**
Each Governing Body shall not deliberate and decide validly unless two-thirds of its Members are present or represented (quorum).

Each Member present or represented in the meeting shall have one vote. A Party shall not vote in decisions regarding its own breach of the Collaboration Agreement and the consequences thereof.

Decisions shall be adopted by two-thirds majority.

5.2.8 **Minutes of meetings**
The chairperson of a Governing Body is responsible for producing written minutes of each meeting which shall be the formal record of all decisions taken. The chairperson shall send the draft minutes to all Members within 10 calendar days of the meeting.

The minutes shall be considered as accepted if, within 14 calendar days from sending, no Member has objected in writing to the chairperson with respect to the accuracy of the draft of the minutes.

A decision becomes valid and binding for the Parties only after the minutes have been approved.

5.3 **The General Assembly**

5.3.1 In addition to the rules described in Section 5.2 the rules in this Section 5.3 applies to the General Assembly.

5.3.2 **Members and chairperson**
All Parties are Members of The General Assembly.

The chairperson of the General Assembly shall be chosen by and among the representatives present at the General Assembly.

The Funding Authority will have observatory status in the General Assembly and shall be invited to all meetings, cf. Appendix 1.

5.3.3 **Decisions**
The General Assembly shall ensure that the Board performs its duties in accordance with this Collaboration Agreement. The General Assembly may instruct the Board accordingly.

The General Assembly is free to act on its own initiative to formulate proposals and take decisions in accordance with the procedures set out in the Collaboration Agreement. In addition, all proposals made by the Board shall be considered and decided upon by the General Assembly.

The following decisions shall be taken by the General Assembly:

• Content of the Collaboration Agreement, finances, and Intellectual Property Rights, including:

- Proposal for suspension of all or part of the Project
- Proposal for termination of the Project as a whole
- Proposals for changes to the R&D Contract to be agreed by the Funding Authority
- Major changes to the Work Plan (including Project budget)
- Addition and withdrawals of Background (Appendix 3)

• Evolution of the Research Centre, including:

- Decide on the accession of a new Party to the Collaboration Agreement and adopt the conditions of the accession of such a new Party, including any Late Fees
- Declaration of a Party to be a Defaulting Party
- Remedies to be performed by a Defaulting Party
- Termination of a Defaulting Party's participation in the Research Centre.

5.3.4 **Voting rules and quorum**

In matters which substantially alter the individual Party's rights and obligations under the Project, the decision must be adopted unanimously. Such decisions require all members of the General Assembly to take part in the vote. Amendment of the Collaboration Agreement and the adoption of annual budgets require the unanimous approval of the Parties.

A Party is not entitled to vote on a matter regarding its own breach of the Collaboration Agreement and the consequences thereof. As for decisions regarding termination of a Defaulting Party's participation in the Research Centre the rules in Section 5.2.7 apply.

5.4 **The Board**

5.4.1 In addition to the rules described in Section 5.2 the rules in this Section 5.4 applies to the Board.

5.4.2 **Members**

The Board shall consist of one representative from each Party to the Collaboration Agreement at the time of its entry into force, cf. Section 4.1.1 first paragraph. .

The Board nominates its chairperson among the Members from the User Partners.

The Funding Authority will have observatory status in the Board and shall be invited to all meetings, cf. Appendix 1.

5.4.3 **Tasks**

The Board shall ensure that the activities described in the Project Description, funding plan, and Work Plans are completed within the defined time frame, hereunder that the In-kind contributions are delivered as specified.

Furthermore, the Board shall:
- Seek a consensus among the Parties
- Prepare meetings, propose decisions and the agenda of the General Assembly.
- Be responsible for the proper implementation of the decisions by the General Assembly.
- Monitor the implementation of the Project as well as the deliverables.
- Agree on the content and timing of press releases and joint publications by the Parties.
- Approve to involvement of Subcontractors.
- Review HSE statistics including incidents, accidents, and near misses.
- Appoint representatives to the Technical Committee, cf. Section 6.1.

6 Advisory committees and Centre Administration

6.1 The Technical Committee

The Technical Committee shall include a sufficient number of representatives from the User Partners to follow up on the Centre's research activities to give technical input to ensure its relevance.

6.2 The Scientific Advisory Committee

The Scientific Advisory Committee (SAC) shall consist of international experts. SAC's main tasks are to advise and evaluate the scientific performance of the Research Centre in relation to the objective and research plans, including PhD projects. Members will be appointed by the Board. In case Confidential Information is to be shared with the members of the SAC the Project Owner shall ensure that a non-disclosure agreement is entered into between the members of the SAC and the Parties.

6.3 The Innovation Committee

The Innovation Committee will be established by the Project Owner and shall include representatives from all Parties. The Innovation Committee's main tasks are identifying and foster innovative solutions from the Project Results and give advice to the Board. The Innovation Committee will be led by a representative from the User Partners.

6.4 The Centre Director

The Centre Director is appointed by the Project Owner. The Centre Director is responsible for the day-to-day activities of the Research Centre and reports to the Board. The Centre Director will be supported by a centre management team consisting of representatives from each of the Research Partners, as well as administrative support from the Project Owner.

7 Responsibilities of the Parties

7.1 Each Party shall perform the R&D activity and/or provide the financial or other type of support pursuant to the Project Description.

7.2 All R&D activities shall be carried out in accordance with commonly accepted research practices. The Parties shall comply with all applicable legislation and regulations, all rules and guidelines of relevance to the implementation of the Project, and rules and guidelines relating to ethical considerations and recognised quality standards and norms. The Parties are responsible for ensuring proper practices relating to health, safety and the environment are in place for R&D activities.

7.3 Research inherently entails uncertainty regarding the results to be achieved, and no Party is therefore liable to the others to achieve a specific result or a specific target that has been

set for the R&D activity, provided that the conditions relating to the performance of the R&D activity as specified above have been met.

7.4 With the approval of the Board, a Party may assign parts of the R&D activity for which it is responsible to an appropriate subcontractor. This does not release a Party from its obligations to the other Parties. A Party may not serve as a subcontractor for another Party to the Collaboration Agreement.

7.5 In the event a Party does not perform according to the Collaboration Agreement, and subject to such Party not rectifying its breach of the Collaboration Agreement within reasonable time of having received written notification of such breach by the Board the Board may decide to transfer responsibility for the work in whole or in part to another Party, based on specified terms and conditions. Such a transfer does not release the Party in question from its other obligations according to this Collaboration Agreement.

7.6 The Parties undertake a commitment to sign any agreements with owners, employees (including individuals with dual employment), partners, subcontractors, and others that are required to fulfil the relevant Party's obligations under this Agreement, including measures to ensure the necessary transfer of Intellectual Property Rights.

7.7 The Parties shall notify the Project Owner of matters relevant to the implementation of the Project.

8 Work Plan and reporting

8.1 The Board shall adopt an annual Work Plan for the Project. The Work Plan shall form the basis for the technical and financial implementation of the Project in line with the Project Description and the funding plan.

8.2 The Project Owner is responsible for coordinating scientific and financial reporting to the Funding Authority. Parties shall without undue delay submit all Project Results, reports, accounting documentation and other documents that the Project Owner requires to fulfil its obligations to the Funding Authority.

9 Payment

9.1 Distribution of funding

9.1.1 The Project Owner receives and manages the financial contributions to the Project from the Funding Authority and the Parties contributing with cash financing to the Research Centre. The Project Owner disburses payments in accordance with the adopted Work Plan, reports approved by the Funding Authority and according to the routines set out in Section 7.4.

9.1.2 Parties are only entitled to receive payment for the work performed and costs incurred in accordance with the adopted Work Plan.

9.1.3 In accordance with its own auditing and management principles, each of the Parties shall be solely responsible for documenting its own Project costs, both towards the Funding Authority and to the other Parties. Documentation shall be provided at the request of either the Project Owner or the Funding Authority.

9.1.4 A Party using less than its allocated share of the project funds will only receive payment for its actual and justified costs, in accordance with the Work Plan. A Party using more than its

allocated share of the Project funding will only receive payment for the actual and justified costs up to the amount equalling that allocated share of Project funding.

9.1.5 Disbursed funding that a Party is unable to document as actual and eligible costs in accordance with the Work Plan shall be repaid. A Defaulting Party shall also cover any direct and immediate loss incurred by the other Parties due to the breach.

9.2 **In-kind contribution**

Parties contributing in-kind to the Project shall report the actual and justified costs associated with such to the Project Owner. Such reporting shall be submitted in accordance with the deadline in Appendix 2, or in accordance with what has been agreed in the Work Plan.

9.3 **Invoicing**

9.3.1 The Project Owner shall invoice the Parties for their financial contributions to the Project as set out in Appendix 2.

9.3.2 The Parties shall invoice the Project Owner every 4 months, in arrears, in accordance with the documented expenditures and in line with the Work Plan, unless otherwise specifically agreed. Unless otherwise agreed, correct invoices as further described in Appendix 2, shall be paid within 30 days of receipt.

9.3.3 In the event of delayed payment, penalty interest on arrears shall be calculated in accordance with the Norwegian Act relating to Interest on Overdue Payments.

9.4 **Withholding payment and recovery of funding**

The Project Owner may withhold any payments due to a Party identified by the General Assembly to be a Defaulting Party. Furthermore, the Project Owner is entitled to recover already disbursed and unused funding to a Defaulting Party.

10 Background

10.1 The Background considered relevant upon entry into the Collaboration Agreement, including any limitations and/or conditions concerning its use, is specified and described in Appendix 3. The Party that brought it into the Project will maintain ownership of that Background.

10.2 Any Party wishing to contribute further Background during the Project Period shall notify the other Parties of this. Any request to modify a Party's Background to the Project shall be approved by the General Assembly, and relevant appendices shall be updated continuously.

10.3 Any results from the Project that do not comprise Background pursuant to Appendix 3 and are not approved by the General Assembly as Background pursuant to Section 10.2, will automatically be assigned the status of Project Results.

10.4 For the duration of the Project Period, the Parties shall have access at no charge to the Background necessary for the implementation of their own work in the Project in accordance with the Work Plan.

10.5 Access to Background necessary for the Commercial Utilisation of another Party's own Project Results, shall be granted on Fair and Reasonable Conditions, and in accordance with

any limitations and/or conditions specified in Appendix 3. Such requests for access may be made up to twelve months after the Project Period.

10.6 Requests for access must be submitted in writing to the relevant Party. The granting of access may be made conditional on the acceptance of specific conditions aimed at ensuring that these rights will be used only for the intended purpose and that appropriate confidentiality obligations are in place.

11 Project Results

11.1 Ownership to Project Results

11.1.1 Each Party will have ownership rights to the Project Results generated by that Party, its employees or suppliers.

11.1.2 If two or more Parties have generated the Project Results collaboratively, and the Project Results cannot be separated, they shall have joint ownership of these. The Parties' undivided share shall correspond to the respective Party's proportionate intellectual contribution to the Project Results in question.

Parties owning Project Results jointly shall, within six months after the Project Results in question were generated, enter into a separate agreement on the utilisation of these Project Results, including any protective measures and the distribution of costs relating to such. The co-ownership agreement should as a minimum include the following items:

- A clear description of the Project Results, including each Party's ownership share.
- Provisions regarding which of the co-owners shall be responsible for protecting and maintaining the Project Result, including relevant authorisations.
- A detailed plan for how the Project Results shall be protected, defended, maintained and used, including a plan for Commercial Utilisation.

11.1.3 Parties shall notify the Board of all Project Results. Project Results shall be treated confidentially for a minimum period of 30 days from such notification to the Board.

11.2 Access rights to Project Results

11.2.1 For the duration of the Project Period, the Parties shall have access at no charge to Project Results that are necessary for implementing their own work in the Project in accordance with the Work Plan.

11.2.2 Access rights to Project Results necessary for the Commercial Utilisation of another Party's own Project Results, shall be granted on Fair and Reasonable Conditions.

11.2.3 Research Partners shall have access at no charge to Project Results that are to be used for their own educational or research purposes.

11.2.4 All requests for access to Project Results must be submitted in writing.

12 Access rights and ownership rights for new Parties and withdrawing Parties

12.1 New Parties

12.1.1 All Project Results produced prior to the time at which a new Party has acceded the Collaboration Agreement will be considered Background in relation to that Party.

12.2 **Defaulting and withdrawing Parties**

12.2.1 Access rights of a Defaulting Party shall cease immediately from the time that party receives the formal notification from the General Assembly that its participation in the Project has been terminated but will still be obligated to give the remaining Parties access rights to its own Background and Project Results in accordance with the Collaboration Agreement. For the sake of clarity, this provision does not affect access rights to Commercial Utilisation already granted by a Party to a Defaulting Party pursuant to Section 11.2.2.

12.2.2 A Party that withdraws from the Project may request access to other Parties' Project Results generated up to the date of withdrawal.

12.2.3 Any Party leaving the Project maintains ownership to Project Results according to Section 11.1, however the Party shall continue to grant access rights to its own Background and Project Results pursuant the Collaboration Agreement as if it had remained a Party for the entire Project Period.

13 Publication

13.1 Project Results shall be published as quickly as possible. Among other things, the dissemination measures and communication plans specified in the R&D Contract shall be implemented.

13.2 If a Master's degree or Ph.d. is included in the Project, the purpose is for this work to be published. Subject to the provisions of this Section 13 and Section 14, nothing in this Collaboration Agreement shall be interpreted as preventing the publication of Project Results such Master student or PhD candidate is required to publish in order to qualify for any degree.

13.3 Given that the conditions stipulated in Sections 13.4 and 13.5 have been met, Parties are entitled to publish their own Project Results when such publication does not impair the ability of the other Parties to utilise their own Project Results.

13.4 If Project Results have been generated by an employee in an academic position at a university or university college, the Act relating to universities and university colleges places restrictions on the permanent postponement of publication. The board of the institution (or its authorised representative) shall consent to a postponement of publication when there is a legitimate reason to do so. Permanent restrictions on the right to publish Project Results over and above those laid down in legislation or pursuant to legislation may not be agreed upon or stipulated. Project Results shall however not be published if doing so will unlawfully disclose Confidential Information and/or business secrets.

13.5 Notification of plans for publication of Project Results shall be submitted to all Parties by the Party that has generated the relevant Project Results. Parties have a deadline of 30 days from the date on which the notification was issued to object and request postponement of the publication.

13.5.1 An objection is justified if (a) the protection of the objecting Party's Project Results or Background would be adversely affected, (b) the objecting Party's legitimate interests in relation to the Projects Results or Background would be significantly harmed, or c) the proposed publication includes Confidential Information of the objecting Party. The objection must include a precise request for necessary modifications.

13.5.2 The objecting Party can request a publication delay of not more than 90 calendar days from the time it raises such an objection. After 90 calendar days the publication is permitted, provided that the objections of the objecting Party have been addressed.

14 Confidentiality

14.1 During the Project Period, and for a subsequent period of three years, the Parties are under obligation to keep confidential any Confidential Information disclosed to them in connection with the Project and store this information in a secure manner. Confidential Information shall only be used to perform Project tasks and to utilise Project Results, or as agreed with or presupposed by the disclosing Party.

14.2 The Parties shall ensure that all employees and third parties, contractors and Subcontractors, who are given access to Confidential Information, complies with the above confidentiality obligation.

14.3 The following information is not considered to be Confidential Information:

a) information already known to the Party in question at the time it was received;
b) information that is or becomes generally known in a manner other than through breach of confidentiality under this Collaboration Agreement;
c) information received from a third party with no known confidentiality obligations;
d) information developed by a Party without the use of Confidential Information.

14.4 The above confidentiality obligation shall not prevent the publication of Project Results in line with the provisions of Section 13. Neither does the confidentiality obligation preclude the disclosure of Confidential Information to the Funding Authority or the legally mandated disclosure to the courts and other public authorities, and disclosure pursuant to the Freedom of Information Act. The disclosing Party shall be notified upon such disclosure.

15 Breach

15.1 If the General Assembly identifies a Party to be in breach of its obligations under the Collaboration Agreement, the Project Owner or, if the Project Owner is in breach of its obligations, a Party appointed by the General Assembly, will give formal notice to the Party with a reasonable deadline to remedy the breach.

15.2 If the breach is not remedied within the set deadline or is not capable of remedy the General Assembly may decide to deem the Party to be a Defaulting Party and, in consultation with the Funding Authority, determine the consequences thereof. The decision of the General Assembly may imply transferring the designated tasks of the Defaulting Party to another Party or cancelling the Collaboration Agreement with the Defaulting Party, however in the latter case of cancelling the Collaboration Agreement only subject to the breach in question being of a material nature.

15.3 Defaulting Parties for which the Collaboration Agreement is cancelled shall ensure that conditions are in place for the other Parties to continue the Project, without any right to compensation for such assistance.

16 Liability

16.1 No warranties

16.1.1 In respect of any information or materials, including Project Results, Background and Confidential Information supplied by one Party to another under the Project, no warranty or representation of any kind is made, given, or implied as to the sufficiency or fitness for

purpose nor as to the absence of any infringement of any proprietary rights of third parties. Therefore, the recipient Party shall in all cases be entirely and solely liable for the use to which it puts such information and materials, and no Party granting Access Rights shall be liable in case of infringement of proprietary rights of a third party resulting from any other Party exercising its access Rights.

16.2 **Limitation of contractual liability**

16.2.1 No Party shall be responsible to any other Party for any indirect or consequential loss or similar damage such as, but not limited to, loss of profit, loss of revenue or loss of contracts, provided such damage was not caused by a wilful act.

A Party's aggregate liability towards the other Parties collectively shall be limited to the Party's share of the total costs of the Project provided such damage was not caused by a wilful act.

16.2.2 The terms of this Collaboration Agreement shall not be construed to amend or limit any Party's statutory mandatory liability.

16.3 **Damages**

16.3.1 Each Party shall be solely liable for any loss, damage or injury to third parties resulting from the performance of the said Party's obligations by it or on its behalf under this Collaboration Agreement or from its use of Project Results or Background.

16.4 **Force Majeure**

16.4.1 None of the Parties shall be held liable for breach of obligations under the Collaboration Agreement due to Force Majeure. The Parties shall notify the Centre Director forthwith if a situation of Force Majeure arises. If the obstacles have lasted, or are expected to last, more than six weeks, or will have serious ramifications for the ability of the other Parties to carry out the project, the General Assembly may decide to redistribute the Project tasks.

17 Ethics, conflict of interest and anti-corruption

17.1 Each Party is committed to maintain the highest ethical standards in its work for the Project. Each Party shall ensure that all of its employees and Subcontractors undertake the same commitment.

17.2 Each of the Parties shall avoid conflicts of interest in its contact with organisations and/or persons performing tasks associated with the Project.

17.3 Each of the Parties shall carry out the Project in a manner designed to counter any corruption, misappropriation of funding and improprieties. The Parties shall, without undue delay, inform the Board if there are indications of corruption and misappropriation of funding of which the Party becomes aware during the implementation of the Project. Furthermore, the Parties agree, in the performance of the activities under the Collaboration Agreement, not to accept or offer any form of gift, offer, payment or other type of advantage that entails unlawful or corrupt practice.

18 Personal data

The Parties shall comply with all applicable requirements of the EU Data Protection Legislation and, if necessary, enter into a separate legal agreement in respect of the submission and/or the processing of personal data subject to EU Data Protection Legislation.

19 Health, safety and environment

19.1 Each of the Parties carrying out tasks under the Project shall plan and perform the work in a manner ensuring that no lives will be lost, and that there shall be no damage to health, facilities and equipment, nor pollution and emissions, and that no production and/or processes shall cease to function.

19.2 The Parties are expected to have implemented internal HSE guidelines and a management system based on HSE legislation.

19.3 The Parties shall without undue delay report incidents, accidents and near-misses associated with the Project to the Project Owner.

19.4 The Project Owner shall without undue delay report incidents, accidents and near-misses to the Board.

19.5 A Party performing work at a facility or installation belonging to another Party is obliged to follow the existing applicable rules and guidelines of the owner of the facility.

20 Human Rights

20.1 Each of the Parties shall take reasonable and effective measures to ensure that its performance of the Collaboration Agreement respect Human Rights consistent with the United Nations Guiding Principles on Business and Human Rights (2011). To this effect, each of the Parties, in connection with performance of the Collaboration Agreement, shall:

a) take all reasonable steps to avoid, or otherwise appropriately address or remedy, including through the establishment of appropriate grievance mechanisms, adverse impacts on Human Rights which it or any of its affiliates (the parent company of such Party or any subsidiary of such Party or subsidiary of the parent company of such Party), or any officer, director, agent, representative or employee of such Party or such affiliates may cause or contribute to;
b) take reasonable steps to seek to prevent or mitigate adverse human rights impacts to which such Party's or any of its affiliates' operations, products or services are directly linked through a business relationship; and
c) take all reasonable measures in order to ensure that no officer, director, agent, representative or employee of such Party or affiliates take part in or support, whether through acts or omissions, Modern Slavery pursuant to the UK Modern Slavery Act 2015 if applicable to the Party or any other bodies of law on human rights protection applicable to a Party.

20.2 In the event a Party fails to comply with the obligations set out in the section above, such Party shall on its own initiative or upon the General Assembly's request, promptly identify and implement the actions necessary to cure such breach.
If a breach of any of the above sections is not cured by such Party within reasonable time or repeated breaches of these obligations occur, this shall be regarded as a substantial breach of the Collaboration Agreement.

20.3 For the purpose of this section 19, the following definitions shall apply: "Human Rights" means all internationally recognised human rights including those set out in the Universal Declaration of Human Rights (1948), the International Covenant on Civil and Political Rights (1966) and the International Covenant on Economic, Social and Cultural Rights (1966) (collectively the International Bill of Human Rights), the International Labour Organisation (ILO) Declaration on Fundamental Principles and Rights at Work, applicable standards of international humanitarian law, and the Voluntary Principles on Security and Human Rights. "Modern Slavery" means all forms of slavery, human trafficking, servitude or forced labour

as defined in article 4 of the European Convention for the Protection of Human Rights and Fundamental Freedoms (1950).

21 Audit

21.1 During the Project Period, and for 12 months after the end of the calendar year in which the Project is completed or terminated, each of the Parties has the right to audit the Project accounts, documents, etc., including information relating to HSE. Such audit shall be carried out within normal working hours on the premises of the Project Owner. The Project Owner agrees to give the auditors access to all the systems and data necessary to perform the audit and shall otherwise ensure that the audit will be carried out effectively and without unnecessary delay. All costs relating to an audit shall be borne by the auditing Party(-ies). Written notification of an audit shall be sent to the Project Owner, with a copy to the other Parties, at least 30 days prior to the planned commencement of the audit.

21.2 If multiple Parties wish to carry out an audit, the audit shall take place concurrently, or, as the case may be, by a joint auditing group. The audit shall be carried out in a manner that causes the least inconvenience.

21.3 Pursuant to the R&D Contract, the Funding Authority and the Office of the Auditor General have the right at any time to verify that the allocated funds are being spent in accordance with the R&D Contract. The Parties agree to produce, upon request from the Funding Authority and/or the Office of the Auditor General, the receipts, time sheets, calculations and other relevant underlying material that are requested in order to carry out such verification.

21.4 Any documented deviations presented during an audit and justified by reference to the Collaboration Agreement shall be corrected by the Party within a reasonable time.

22 Export Control

22.1 An exporting Party agrees to comply with applicable rules for export control. If a Party performs work, including the export of products, technology and software requiring an export licence, said Party shall apply well in advance for the required licences and ensure that the other Parties have access to copies with the Export Control Classification Number (ECCN) at the time of application submission. A Party shall indemnify the other Parties for all fines, costs and any and all liabilities that may arise as a result of said Party's violation of this provision.

23 No representation or partnership

23.1 The Parties may not commit the other Parties in the Project financially or legally or represent themselves as acting on their behalf. Neither this Collaboration Agreement nor the participation in the Project shall be deemed to constitute any form of formal partnership or joint business activity.

24 Governing law and dispute resolution

24.1 This Collaboration Agreement is subject to Norwegian law. Attempts shall be made to resolve any disputes between the Parties by negotiation or voluntary mediation. In the event such attempts fail, the dispute may be brought before the Stavanger District Court (Stavanger tingrett).

25 Signatures

The authorised signatories of each Party have signed the Collaboration Agreement.

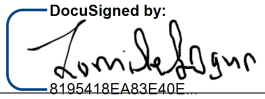
On behalf of:	Universitetet i Stavanger
Name:	Øystein Lund Bø
Title:	Dean, Faculty of Science and Technology
Signature:	
Place: Stavanger	Date: 01.07.2022

On behalf of:	**NORCE Norwegian Research Centre AS**
Name:	KRISTIN WALLEVIK
Title:	CEO
Signature:	Kristin Wallevik
Place: Kristiansand	**Date:** 26/7-2022

On behalf of:	**INSTITUTT FOR ENERGITEKNIKK**
Name:	Martin Smedstad Foss
Title:	Vice President
Signature:	
Place: Lillestrøm	**Date:** 11.07.2022

On behalf of:	**UNIVERSITETET I BERGEN**
Name:	CHRISTEN LORENTZ SOLEIM
Title:	FUNG. UNIVERSITETSDIREKTØR
Signature:	
Place:	BERGEN **Date:** 08.07.2022

Grete K. Ersland

On behalf of:	**LANDMARK GRAPHICS AS**
Name: Tomide Togun	
Title: Area Manager	
Signature:	DocuSigned by:  8195418EA83E40E...
Place: Stavanger Norway	**Date: July 26, 2022**

Approved Legal
JJT 07-26-22

On behalf of:	**SCHLUMBERGER INFORMATION SOLUTIONS AS**		
Name:	Yenny Jaimes		
Title:	D&I SCA Digital Manager		
Signature:	DocuSigned by: ADB468A61184451...		
Place:	Stavanger	**Date:**	14 July 2022

On behalf of:	**EQUINOR ENERGY AS**		
Name:	Sylvi Marilyn Gjertsen		
Title:	Principal contract consultant		
Signature:	Sylvi M. Gjertsen		
Place:	Trondheim,	**Date:**	18/07/22

Invoice address:

Invoices in English

Static data on invoices from Contractor shall be in the English language. Static data is defined as all fixed/permanent text in an invoice document, regardless of the invoice content. As an example the invoice shall state “invoice” instead of “faktura”.

Invoice submission

Contractor registered as a Norwegian entity shall submit invoice and credit note in the electronic format “Elektronisk handelsformat” (EHF), unless otherwise instructed by Company.
The EHF-format shall fulfil the requirements in “Krav til referanser på EHF Faktura”, which may be changed from time to time, located here:
http://www.equinor.com/no/OurOperations/Procurement/Invoicing/Pages/eInvoice.aspx

The E-mail with the PDF-file may only contain one file and be related to one invoice. No text may be written in the e-mail body. No paper invoice shall be sent.

Contractor shall carry its own cost related to submitting invoices and credit notes.

Invoice reference:

Purchase Order: 4504114572

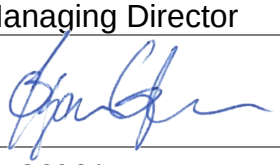
On behalf of:	**VÅR ENERGI ASA**
Name:	GJERTRUD HALSET
Title:	R&D Manager Vår Energi AS
Signature:	DocuSigned by: DB1DC46AD28445A...
Place:	Stavanger **Date:** 07-07-22

Invoice address:

Vår Energi ASA, P.O.Box 101, 4068 Stavanger - invoice@varenergi.no

Invoice reference:

R&D project P521

On behalf of:	**DNO Norge AS**
Name:	Ørjan Gjerde
Title:	Managing Director
Signature:	
Place: Stavanger	**Date:** 28 July 2022

Invoice address:

Invoice reference:

On behalf of:	OKEA ASA
Name:	THOMAS LERDAHL
Title:	VP RESERVOIR & PRODUCTION TECHNOLOGY
Signature:	
Place: TRONDHEIM	**Date:** 01. 07. 2022

Invoice address:

Delivery Address: OKEA ASA

Kongens gate 8
7011 Trondheim
NORWAY
Contact Person: Thomas Lerdahl
Invoice E-mail: faktura@okea.no

PO Description: NCS2030

Incoterms: DDP - Delivered Duty Paid
Pay Terms Days: 30
Order Priority: Normal
Invoice E-mail: faktura@okea.no

Instructions:
Okea contact person: Thomas Lerdahl
Vendor contact: Alejandro Escalona
E-mail: alejandro.escalona@uis.no
Ref Collaboration Agreement - NCS2030
PO start/end: 01.08.2022/01.08.2026
OKEA requests our suppliers to use the EHF – Electronic Trading Format for electronic invoicing.
EHF-invoice to the correct entity/organizational number: 915 419 062
OKEA VAT code: 915419062MVA
Goods/Services to be used on the Norwegian Continental Shelf. Invoice to be marked no VAT.
Reference to
Norwegian VAT regulations (MVA-forskriften §6-32)
Please read the complete terms and conditions at http://okea.no/contacts/supplier-info/
Vendor Code: 213568

Invoice reference:

PO Number: 100-50008394
Ref Collaboration Agreement - NCS2030

On behalf of:	**AKER BP ASA**
Name:	Thomas Bognø
Title:	Vice President Concept Development & Technology
Signature:	DocuSigned by: Thomas Bognø 2CA8E2054EDE414...
Place:	**Date:** 07.07.2022 | 12:10 CEST

Aker BP specific invoice instructions:

- Hard copy invoices are not accepted
- EHF is the preferred format for all invoices
- Alternative format for invoicing is PDF format by e-mail
- Invoices in PDF format to be sent to invoice@akerbp.com
- Invoice and attachments must be merged into one PDF file
- Value Added Tax (VAT) if applicable shall be stipulated as a separate item on invoices.

Invoice address:

Aker BP - Accounts Payable
Postboks 480 Sentrum
4020 Stavanger

Invoice reference:

- Invoice must contain the PO number and the Contract number
- The invoiced amount shall not exceed the corresponding amount on the PO
- Host Institution VAT and/ or organization number(s).
    - The invoice should be issued from the same organisational number as listed in the PO.
    - If the invoices are to be paid to a factoring company, or another company within the same Group, this must be clearly stated at the invoice.
- PO number: TBC (a PO will be issued after contract signing)

Failure by Host institution to adhere to any of the aforesaid may result in invoices being returned to sender and/or considerable delay in payment. In any such event Sponsor will not be held accountable for any loss of interest.

Further information on Aker BP's requirements for invoicing is located at:
Suppliers - Aker BP

On behalf of:	**WINTERSHALL DEA NORGE AS**		
Name:	Torgeir Norstad		
Title:	Head of Reservoir Management		
Signature:	DocuSigned by: Torgeir Norstad 2FB618CF5A7F4C7...		
Place:	Stavanger	**Date:**	08 July 2022 | 08:43:49 CEST

Invoice address:

Invoice reference:

Appendix 1: The R&D Contract, including the requirements and guidelines that applies to Societal and Industry-oriented Research Centres

R&D Project Agreement Document

Article 1: Contracting parties

Between

The Research Council of Norway

Enterprise number: 970141669

(hereafter also referred to as the **Research Council**)

and

UNIVERSITETET I STAVANGER

Enterprise number: 971564679

(hereafter referred to as the **Project Owner**)

a contract has been signed for the following project, described below (hereafter referred to as the **project**).

The following project partners /collaborating partners will participate in the project:

Organizationno.	Project partner	From date	To date	Role in the project
874789542	UNIVERSITETET I BERGEN	01.01.2022		Collaborating partner
959432538	INSTITUTT FOR ENERGITEKNIKK	01.01.2022		Collaborating partner
923609016	EQUINOR ASA	01.01.2022		Collaborating partner
919160675	VÅR ENERGI ASA	01.01.2022		Collaborating partner
993250287	AKER BP ASA AVD STAVANGER	01.01.2022		Collaborating partner
994265873	SCHLUMBERGER OFFSHORE SERVICES LIMITED, SCHLUMBERGER OFFSHORE SERVICES LIMITED	01.01.2022		Collaborating partner
968967983	HALLIBURTON AS	01.01.2022		Collaborating partner
985224323	WINTERSHALL DEA NORGE AS	01.01.2022		Collaborating partner
921526121	DNO ASA	01.01.2022		Collaborating partner
915419062	OKEA ASA	01.01.2022		Collaborating partner
919408049	NORCE Teknologi/Energi ROGALAND, NORCE NORWEGIAN RESEARCH CENTRE AS	01.01.2022		Collaborating partner

The Project Owner is under obligation to draw up a collaboration agreement with the partners with reference to Section 5 of the Requirements and guidelines for Societal and Industry-oriented Research Centre and Section 3 of the General Terms and Conditions for R&D Projects.

Article 2: The project

2.1 Project title: National Centre for Sustainable Subsurface Utilization of The Norwegian Continental Shelf

2.2 Project no.: 331644

Please specify the project number in connection with all enquiries directed to the Research Council, including on payment documents.

2.3 Objective of the project

The primary objective of NCS2030 is to fill knowledge gaps and provide solutions for maximizing value creation of subsurface resources to reach the Net Zero Emission (NZE) goals on the Norwegian Continental Shelf (NCS).
The secondary objectives are to:
- Build integrated near field subsurface holistic models for increasing reserve base and evaluate the potential of geological CO2 and H2 storage;
- Develop new IOR solutions for improved and accelerated HC production at low environmental footprint;
- Develop data-driven and machine learning approaches to integrate subsurface characterization, uncertainty quantification and management workflows;
- Recommend field cases with high potential for NZE production;
- Create awareness and acceptance of NCS2030 activities;
- Establish an innovation platform for technology development with industry;
- Attract and train future scientists and skilled professionals for the energy transition and disseminate results.

2.4 Project description and project summary

The project description for project no. 331644 is provided in the document dated 18.03.2022.

Changes in the project description must be approved by the Research Council. Requests for changes must be submitted to the Research Council via “My RCN Web” > “Projects/Reports” > “View / Change project”.

The following project summary may be published by the Research Council:

The vision of the NCS2030 centre is to facilitate an energy-efficient, multi-purpose utilization of the subsurface into a “Sustainable Subsurface Value Chain” to reach the Net-Zero-Emissions goals on the Norwegian Continental Shelf. Four main research areas are identified, namely Subsurface energy systems, Net-zero emission production, Digitalization and Society. The research activities are organized into eight work packages (WP): six WPs in research, one WP in education and outreach and one WP in management.

The Centre will:
- Develop new and improved knowledge of geological plays for both hydrocarbon and renewable resources, including storage of CO2 and H2, and geothermal energy near field areas;
- Recommend more effective hydrocarbon production solutions with minimized energy and reduced carbon footprint by integrating renewable energy sources and CCS;
- Develop the next generation of digital tools and methods for improved subsurface characterization, with multiple scenarios, uncertainty, decision analysis for highly nonlinear problems, large models and big data;
- Extend the experience of ensemble-based workflows for emission reduction, energy efficiency and supporting utilization of reservoirs for storage of energy and waste.

Education of professionals with new competencies that will drive the transition is an important priority. NCS2030 will enable collaboration between policy makers, field operators, service companies, technology providers and academic groups, and will complement established research initiatives to create new solutions through an innovation program.

The Centre consists of 4 main academic and research partners (UiS, NORCE, IFE, UiB), 3 national (UiT, UiO, NFiP) and 13 international academic collaborators, support from at least 6 major energy operators on the NCS, 2 major service companies and 8 innovation/technology companies and associations who will ensure high relevance, impact and dissemination.

Article 3: Contract documents and rules of interpretation

The contract includes this signed agreement document and as a minimum the following documents:

- **The General Terms and Conditions for R&D Projects** (attached)
- **Project description** (see reference in Article 2.4)

This project will be carried out in collaboration with partners, and a copy of the signed collaboration agreement(s) must be attached to this agreement document.

In the event that the provisions of the various contract documents conflict with one another, they shall apply in the order of precedence listed above.

Amendments agreed between the parties in writing subsequent to the signing of the contract are also part of the contract and will take precedence over other contract documents.

Article 4: Project management – administrative and scientific

The Project Owner has appointed the following project management:

Project administrator
Name: Merete Vadla Madland
Title: Prorector for research

Project manager
Name: Alejandro Escalona Varela
Title: Head of department, Professor

Any change of project administrator shall be immediately reported to the Research Council. Notification must be submitted to the Research Council via "My RCN Web" > "Projects/Reports" > "Change of role".

Changes of the project manager must be approved by the Research Council. Requests for changes must be submitted to the Research Council via "My RCN Web" > "Projects/Reports" > "Change of role" and must include the CV of the desired project manager as well as the desired date of commencement of duties.

Research performance site at the Project Owner:
UNIVERSITETET I STAVANGER, Organization number: 971564679

Article 5: Project period and progress plan

The project period is five years:

From the starting date: 01.01.2022 To the date: 31.12.2026

The Research Council of Norway will decide if the project period shall be extended with three years (with reference to Section 6 of Requirements and guidelines for Societal and Industry-oriented Research Centre). On the condition of a positive decision on a prolongation of the centre after five years, the project period will be extended:

From the date: 01.01.2027 To the date of completion: 31.12.2029

The Project Owner is under obligation to carry out the activities listed in the progress plan:

Main activity / milestone	From year	Quarter	To year	Quarter
WP1 - Near Field resource evaluation	2022	1	2029	4
M1a Methodologies for quantitative prediction	2023	2	2024	4
M1b Reservoir potential and integrity	2025	1	2026	4
M1c Established models for primary migration	2025	1	2028	4
M1d M2d Reservoirs for geothermal	2024	1	2029	4
WP2 - Reservoir for energy transition	2022	1	2029	4
M2a Solutions for combine CO2 EOR	2023	1	2025	4
M2b parameters to enhance storage CO2 H2	2024	1	2025	4
M2c Modelling tools for CO2 andH2 plume	2028	1	2029	4
WP3 - Net Zero Emission production	2022	1	2029	4
M3a EOR methods with low emission potentia	2022	1	2028	4
M3b IOR Solutions for tight reservoirs	2023	1	2028	4
M3c M4b Improved near-well modelling	2024	1	2028	4
WP4 - Efficient water management	2022	1	2029	4
M4a Water conformance control method cases	2023	1	2025	4
M4c IORSim upgrade	2024	1	2024	4
M4d Field methods demonstration	2028	1	2029	4
WP5 - Digital subsurface for decisions	2022	1	2029	4
M5a Subsurface Knowledge Cloud	2023	1	2024	4
M5b Methodologies for MF uncertainty	2024	1	2025	4
M5c ML proxy models tested	2025	1	2025	4
M5d Hybrid ML-Ensemble methods	2023	1	2027	4
M5e ML/MF calculation of BME	2024	1	2026	4
WP6 - Energy policy, economy and society	2022	1	2029	4
M6a Impact into the business climate	2025	1	2029	4
M6b policy impact of emissions	2023	1	2026	4
M6c Criteria for supporting policy makers	2025	1	2029	4
WP7 - Education and Outreach	2022	1	2029	4
PhDs 9, Postdocs 2	2022	1	2026	4
PhDs 7, Postdocs 3	2026	1	2029	4
15 Scientific workshops	2022	1	2026	4
9 Scientific workshops	2027	1	2029	4
75 Scientific publications	2022	1	2026	4
75 Scientific publications	2027	1	2029	4
5 Energy Conference	2022	1	2026	4
3 Energy Conference	2027	1	2029	4
WP8 - Management and reporting	2022	1	2029	4
M8a NCS2030 start, all contracts in	2022	1	2022	3
M8a Kick-off workshop	2022	1	2022	2
M8b NCS2030 website up and running	2022	1	2022	2
M8c Midway evaluation by RCN	2026	2	2026	4
M8dFinal center ending event.	2029	2	2029	4

Article 6: Project budgets and funding

6.1 Cost plan

6.1.1 Distribution of project costs by cost category (amounts in NOK 1 000)

The project is to be implemented in accordance with the following cost plan:

	2022	2023	2024	2025	2026	2027
Payroll and indirect expenses	21.687	31.860	37.086	42.080	38.320	34.235
Procurement of R&D services	0	0	0	0	0	0
Equipment	587	957	965	972	981	989
Other operating expenses	2.753	2.753	2.753	2.753	2.753	2.753
Total amount	**25.027**	**35.570**	**40.804**	**45.805**	**42.054**	**37.977**

	2028	2029	Amount
Payroll and indirect expenses	32.219	28.480	265.967
Procurement of R&D services	0	0	0
Equipment	998	704	7.153
Other operating expenses	2.753	2.753	22.024
Total amount	**35.970**	**31.937**	**295.144**

Changes in the cost plan must be approved by the Research Council. Requests for changes must be submitted to the Research Council via “My RCN Web” > “Projects/Reports” > “View / Change project”.

6.1.2 Distribution of project costs by cost code (in NOK 1 000)

Project costs are to be distributed by cost code as follows:

	2022	2023	2024	2025	2026	2027
Trade and industry	3.201	3.202	3.202	3.200	3.202	3.201
Research institutes	16.045	16.551	16.763	16.982	17.207	17.439
Universities and university colleges	5.781	15.817	20.839	25.623	21.645	17.337
Other sectors	0	0	0	0	0	0
Abroad	0	0	0	0	0	0
Total amount	**25.027**	**35.570**	**40.804**	**45.805**	**42.054**	**37.977**

	2028	2029	Sum
Trade and industry	3.201	3.201	25.610
Research institutes	17.678	16.534	135.199
Universities and university colleges	15.091	12.202	134.335
Other sectors	0	0	0
Abroad	0	0	0
Total amount	**35.970**	**31.937**	**295.144**

Changes in the distribution between cost codes must be approved by the Research Council. Requests for changes must be submitted to the Research Council via My RCN Web> Projects/Reports > View/Change project.

6.1.3 Distribution of project costs per partner per main activity (in NOK 1 000)

The distribution of project costs per partner per main activity is to be as follows:

Partner / Activity	01	06	10	14	18	24
UNIVERSITETET I STAVANGER	18.218	6.592	8.471	14.112	20.472	4.985
INSTITUTT FOR ENERGITEKNIKK	9.800	11.111	9.800	9.800	9.800	1.625
UNIVERSITETET I BERGEN	0	11.523	11.817	551	1.653	276
HALLIBURTON AS	1.000	1.500	1.500	1.000	4.000	0
NORCE Teknologi/Energi ROGALAND	4.200	20.975	15.505	11.800	23.200	4.850
SCHLUMBERGER OFFSHORE SERVICES LIMITED	1.000	1.500	1.500	1.000	4.000	0
Total amount	**34.218**	**53.201**	**48.593**	**38.263**	**63.125**	**11.736**

Partner / Activity	28	37	Sum
UNIVERSITETET I STAVANGER	6.903	25.533	105.286
INSTITUTT FOR ENERGITEKNIKK	200	3.500	55.636
UNIVERSITETET I BERGEN	836	836	27.492
HALLIBURTON AS	0	1.000	10.000
NORCE Teknologi/Energi ROGALAND	400	5.800	86.730
SCHLUMBERGER OFFSHORE SERVICES LIMITED	0	1.000	10.000
Total amount	**8.339**	**37.669**	**295.144**

Changes in the distribution of project costs between the various partners or main activities must be approved by the Research Council. Requests for changes must be submitted to the Research Council via “My RCN Web > Projects/Reports > “View / Change project”.

6.1.4 Distribution of project costs by partners defined as funding recipients (in NOK 1 000)

The distribution of project costs between partners defined as funding recipients is to be as follows:

Partner / Activity	01	06	10	14	18	24
UNIVERSITETET I STAVANGER	18.218	6.592	8.471	14.112	20.472	4.985
UNIVERSITETET I BERGEN	0	11.523	11.817	551	1.653	276
SCHLUMBERGER OFFSHORE SERVICES LIMITED	1.000	1.500	1.500	1.000	4.000	0
INSTITUTT FOR ENERGITEKNIKK	9.800	11.111	9.800	9.800	9.800	1.625
NORCE Teknologi/Energi ROGALAND	4.200	20.975	15.505	11.800	23.200	4.850
HALLIBURTON AS	1.000	1.500	1.500	1.000	4.000	0
Total amount	**34.218**	**53.201**	**48.593**	**38.263**	**63.125**	**11.736**

Partner / Activity	28	37	Amount
UNIVERSITETET I STAVANGER	6.903	25.533	105.286
UNIVERSITETET I BERGEN	836	836	27.492
SCHLUMBERGER OFFSHORE SERVICES LIMITED	0	1.000	10.000
INSTITUTT FOR ENERGITEKNIKK	200	3.500	55.636
NORCE Teknologi/Energi ROGALAND	400	5.800	86.730
HALLIBURTON AS	0	1.000	10.000
Total amount	**8.339**	**37.669**	**295.144**

Changes in the distribution of the various project costs between partners must be approved by the Research Council. Requests for changes must be submitted to the Research Council via “My RCN Web > Projects/Reports > “View / Change project”.

6.2 Funding plan (amounts in NOK 1000)

The project is to be implemented in accordance with the following funding plan:

	2022	**2023**	**2024**	**2025**	**2026**	**2027**
The Research Council	8.153	9.229	10.067	11.355	10.820	10.083
Own financing	4.228	10.073	12.708	15.790	12.301	8.685
Public funding	0	0	0	0	0	0
Private funding	12.646	16.268	18.029	18.660	18.933	19.209
International funding	0	0	0	0	0	0
Total amount	**25.027**	**35.570**	**40.804**	**45.805**	**42.054**	**37.977**

	2028	**2029**	**Amount**
The Research Council	10.125	10.168	80.000
Own financing	6.278	5.081	75.144
Public funding	0	0	0
Private funding	19.567	16.688	140.000
International funding	0	0	0
Total amount	**35.970**	**31.937**	**295.144**

Changes in the funding plan may be approved in writing by the Research Council and is treated as a contractual amendment, ref. General Terms and Conditions for R&D Projects, item 15. Requests for changes must be submitted to the Research Council via My RCN Web > Projects/Reports > View > Change project.

6.3 Specification of the Research Council’s allocations for 2022 and pledges for upcoming years

Year	**Up to NOK**	**Limited to persent of approved actual costs**
2022	8.153.000	32.6 %
2023	9.229.000	25.9 %
2024	10.067.000	24.7 %
2025	11.355.000	24.8 %
2026	10.820.000	25.7 %
2027	10.083.000	26.6 %
2028	10.125.000	28.1 %
2029	10.168.000	31.8 %

6.4 Disbursement

The Research Council’s allocation for the first year and any pledges for subsequent years will be disbursed in accordance with the conditions set out in this agreement and the General Terms and Conditions for R&D Projects.

The Research Council will initiate automatic disbursement subsequent to the approval of the first project account report.

Once the first project account report has been approved, funds will be disbursed automatically at four-month intervals during the first and second interims in the calendar year provided that the project is in compliance with the progress and funding plans set out in the contract. Disbursement for the third interim will be subject to approval of the project accounts report.

Article 7: Reports

The following reports shall be submitted to the Research Council:

7.1 Project account reports

The Project Owner is to submit project account reports for each calendar year. The reports are to show the total project costs in relation to the total project funding.

The following cost categories are to be used in the Project Owner's accounts:

- Payroll and indirect expenses
- Equipment
- Other operating expenses

Societal and Industry-oriented Research Centre does not use the cost category Procurement of R&D services.

The first project account report is to be delivered at the end of the first full four-month interval after project start-up, if possible, and at the latest by the end of the first year of the allocation. For subsequent years, the project account report for each year shall be submitted at the latest by **20 January** of the following year.

Forms to be used: Project Account Report available on My RCN web.

7.2 Progress reports

The Project Owner is to submit progress report annually .

Deadline: **1 December**

The progress report is to be submitted electronically via “My RCN Web”.

Otherwise, please see Section 6 of the General Terms and Conditions for R&D Projects.

7.3 Final report

Deadline: **3 months after the conclusion of the project period.**

The Project Owner is to submit the final report electronically via “My RCN Web”.

Otherwise, please see Section 6 of the General Terms and Conditions for R&D Projects.

7.4 Other reports

The Project Owner is to submit an annual work plan to the Research Council with updated plans for the forthcoming year. Deadline: **1 December**

The Project Owner is to submit an annual report for the previous year. Deadline: **1 April**

Reports and publications that are not compulsory that have been drawn up on the initiative of project management shall not be submitted to the Research Council, unless specifically agreed upon. The Project Owner is required to store all technical reports and publications for at least 10 years after conclusion of the project period. The Project Owner shall assign an ISBN/ISSN number to the reports and/or publications, where so required, and ensure that these are sent to the National Library in Mo i Rana.

Article 8: Other special terms of contract and deviations from the General Terms and Conditions for R&D Projects

The following special conditions shall apply to this project:

1. The centre shall comply with Requirements and guidelines for Societal and Industry-oriented Research Centre.

2. Special stipulations:

The centre board should consider to carry out a techno-economical preproject of the work package 2.3 "Geothermal Heat Mining from HPHT Reservoirs" to confirm that the work package is appropriate, before the activity is started.

The centre must coordinate the activity with ongoing centres in PETROSENTER or other large projects, such as a Norwegian Centre of Excellence (SFF), Centre for Research-based Innovation (SFI) or Centre for Environment-friendly Energy Research (FME).

3. The centre must have three or more partners that are not research organisations and that provide funding to the project (user partners). Funding from the Research Council may be a maximum of two times that of funding from user partners. Both cash contributions and the user partners' work effort (in-kind contributions) can be included. The requirement to collaboration agreement is described in Requirements and guidelines for Societal and Industry-oriented Research Centre and General Terms and Conditions for R&D projects. The Project Owner is required to ensure that the collaboration agreement reflects the terms and conditions of the contract, including that the partners are bound by the same obligations as the Project Owner in so far as this is relevant for the partner's role in the project, and that the partners at all times are informed about the contract. The collaboration agreement shall specify the financial contribution of each collaboration partner, and at all times reflect the funding plan in the contract with the Research Council. The innovation program shall be organized as a separate project, and is not a part of the contract and the collaboration agreement

4. State aid will not be granted through the research centre. Undertakings may not receive funding to cover project costs. Funding awarded to a research organisation is only to go to the organisation's non-economic activity. The Research Council requires a clear separation of accounts for the organisation's economic and non-economic activities. Ownership of project results must be regulated to ensure that undertakings participating in the centre do not receive indirect state aid from participating research partners. The regulation of ownership must therefore be in compliance with paragraph 28 of the EFTA Surveillance Authority's guidelines for state aid for research and development and innovation. This means that ownership of IPR from the project must be allocated to the different project partners in a way that satisfactorily reflects their work packages, contributions and respective interests. The centre activities are to be implemented by means of effective collaboration as defined in the state aid rules (see definition in General Terms and Conditions for R&D projects). More detail is given in Requirements and guidelines for Societal and Industry-oriented Research Centre.

5. The Research Council will carry out a midterm evaluation of the centre as described in Requirements and guidelines for Societal and Industry-oriented Research Centre.

6. A representative from the Research Council may take part in the centre board meetings with the status of observer. The Research Council should receive meeting documents.

7. The project owner should work out a Dissemination plan for the centre. Acknowledgement is to be made of PETROSENTER and the Research Council of Norway as the funding source in any external information issued about the project. The project number must be specified. Publication information must be obtained from CRIStin. Those who do not have the opportunity to use CRIStin must register the scientific publications manually. The project number must be registered in CRIStin.

The following persons are engaged in this project:

Amount	Grant/Position
16	Doctoral research fellowship
5	Post-doctoral research fellowship

Name	Grant/Position	Start date	End date	Country
NN Navn ikke registrert	Doctoral research fellowship	01.01.2026	31.12.2028	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.08.2024	31.07.2027	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2026	31.12.2028	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2023	31.12.2025	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2023	31.12.2025	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.08.2022	31.07.2025	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2025	31.12.2027	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2024	31.12.2026	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.08.2022	31.07.2025	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2027	31.12.2029	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2023	31.12.2025	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2026	31.12.2028	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2027	31.12.2029	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.08.2022	31.07.2025	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2025	31.12.2027	Norway
NN Navn ikke registrert	Doctoral research fellowship	01.01.2023	31.12.2025	Norway
NN Navn ikke registrert	Post-doctoral research fellowship	01.01.2024	31.12.2025	Norway
NN Navn ikke registrert	Post-doctoral research fellowship	01.01.2023	31.12.2024	Norway
NN Navn ikke registrert	Post-doctoral research fellowship	01.01.2025	31.12.2026	Norway
NN Navn ikke registrert	Post-doctoral research fellowship	01.01.2025	31.12.2026	Norway
NN Navn ikke registrert	Post-doctoral research fellowship	01.01.2025	31.12.2026	Norway

For research fellowship positions in the project:
When a research fellow is hired, the Project Owner shall submit confirmation of employment with full name, person security number and date of commencement of employment to the Research Council, either by progress reporting or by creating a request for changes via My RCN Web. Employment must commence during the agreed fiscal year, unless otherwise agreed in writing with the Research Council.

The Research Council's funding per research fellow will be commensurate with standard rates, and will be awarded as a lump-sum allocation per year for the duration of the employment period. The parameters for the project will not be upwardly adjusted during the project period.

The Project Owner or, if relevant, a partner has employer responsibility for the research fellow and must comply with the rules and guidelines that apply to employers. The Research Council must be notified immediately of any changes of significance to the implementation of the project.

Should the Research Council find a fellowship-holder's progress to be less than satisfactory, the issue must be raised with the Project Owner, who is required to implement feasible, reasonable measures as dictated by the Research Council. In the event the Project Owner finds grounds indicating that the fellowship should be discontinued or terminated, the Research Council must be notified immediately. Discontinuation or termination of the fellowship may not take place without the prior written consent of the Research Council.

For doctoral fellowships:

The Research Council's allocation is granted on the condition that the applicant is accepted into a doctoral programme prior to commencement of the fellowship.

The organised researcher education that the Research Council funds is stipulated as three man-years.

Mandatory duties, if any, will be funded by and are at the disposal of the Project Owner.

For post-doctoral grant:

In the case of a post-doctoral grant, employment may not commence until the individual's doctoral thesis has been defended successfully.

Please be advised that the "Regulations concerning terms and conditions of employment for the posts of post-doctoral research fellow, research fellow, research assistant and resident" do not give permission to extend the post-doctoral fellowship period by more than six months beyond what is stipulated in the contract of employment. If an employer expects the extension of the fellowship period to exceed six months as a result of an overseas research stay and subsequent extension, stipulations allowing for this must be included in the post-doctoral candidate's original contract of employment.

Requirements relating to professional development plans for post-doctoral fellowships:
The Research Council's allocation is granted on the condition that the doctoral thesis has been successfully defended and approved. The fellowship is granted for a period of 2 - 4 years. A candidate may not receive funding for more than one post-doctoral fellowship period. The Project Owner or the research institution where the post-doctoral research fellow is employed is required to draw up a professional development plan for the full duration of the post-doctoral period. The plan must be submitted to the Research Council at the latest three months after the post-doctoral research fellow has been formally employed, and must be signed by the post-doctoral research fellow and the project administrator. The scheme applies to all post-doctoral research fellows that have been awarded funding under a call for proposals with a deadline after 1 January 2017.

Required submission of data management plans for projects that generate research data
Starting in 2018, all projects that have applied for and been granted research funding will, as a general rule, be required to submit a data management plan if the project collects or in some other way produces research data. The Project Owner is to use its own internal guidelines for data management to assess whether the project requires a data management plan.

Information about the archives and/or data infrastructure(s) where the data are to be stored is to be provided in the data management plan and in the final project report.

In the case of projects that generate research data but have not drawn up a data management plan, information regarding the archives and/or data infrastructure(s) where the data are to be stored must be provided in the final project report.

Archiving of research-generated data
The Project Owner is responsible for ensuring that research-generated data/result data generated in connection with projects, and all the necessary documentation for reuse of the data (metadata) are stored in secure archives. The data are to be transferred for storage at the earliest possible stage, and no later than three years after completion of the project.

Projects that involve animal experimentation
In projects that involve experimentation on live animals, all participants in the project are required to ensure that the experiment activities are planned and carried out in accordance with the laws, regulations and guidelines governing such tests that are in force at least one EU-/EEA member country. This obligation applies regardless of where the animal experimentation is carried out and independent of the country in which the performing party is domiciled. The Project Owner is responsible for ensuring that all parties involved in the project comply with this requirement.

Requirements relating to medical and health-related clinical trials involving human subjects
Starting in 2020, the Research Council stipulates special requirements that apply to all calls for proposals for medical and health-related trials involving human subjects. This encompasses clinical intervention studies, observational studies and preventive and health-promoting intervention studies. These requirements apply to projects that require pre-approval by the Norwegian Regional Committees for Medical and Health Research Ethics (REK), and that are funded wholly or partially by the Research Council.

The clinical trials are to be registered in one of the following registries: ClinicalTrials.gov or another registry approved by the International Committee of Medical Journal Editors (ICMJE). The trial must be registered before the initial intervention has been administered to the first patient/trial subject, or as soon as possible afterwards. Information about the selected registry, trial registration number and registration date is to be sent to the Research Council via “My RCN Web” as soon as possible after the trial has been registered. This requirement also applies to trials that have commenced prior to receiving funding from the Research Council. Trials that are already initiated but have not been registered are to be registered at the earliest possible date. All relevant fields in the selected registry are to be assessed and updated on an ongoing basis (at least once a year) until the trial is concluded and the results have been published or made publically accessible. If the trial is terminated before the planned completion date, the registry must be updated to indicate the new date of termination and the number of participants involved in the trial at that time.

Information that the trial is funded by the Research Council, with reference to the project number, must be included in the registration information.

All clinical trials that plan to include patients/trial subjects in Norway must in addition be registered in the list of clinical trials published on Helsenorge, the national health website: https://helsenorge.no/kliniske-studier.

The trial’s registration number is to be included in all publications resulting from the study and in the article’s summary/abstract.

See the Research Council’s webpages for more detailed guidelines as well as recommendations regarding registry information, costs related to registration and reporting, and the monitoring activities of the Research Council.

Projects of relevance for Svalbard:

The Project Owner is required to register and update project information in the **Research in Svalbard** (RiS) database. Enquiries about the database may be sent to the secretariat of the **Svalbard Science Forum** at *ssf@rcn.no*.

Attachments:

- Requirements and guidelines for Societal and Industry-oriented Research Centre
- General Terms and Conditions for R&D Projects (valid at date of received application: 15.09.2021)
- Project description
- Copy of signed collaboration agreement

This contract has been approved and expedited electronically.

For the Research Council of Norway
Oslo, 04.05.2022

Siri Helle Friedemann

Director

For the Project Owner:

Merete Vadla Madland
Prorector for research

Forskningsrådet

Societal and Industry-oriented Research Centre

Requirements and guidelines

Societal and Industry-oriented Research Centre is an application type variant for focused and long-term initiatives at a high international level that strengthen research and innovation with a view to value creation and benefits to society. The research centres are intended to help increase capacity and expertise through long-term research and/or innovation. Effective collaboration is required between research groups and actors outside the research sector, e.g. in business and industry, public sector bodies or non-profit organisations.

A research centre is established for a set period and is affiliated to a Norwegian research organisation, approved by the Research Council, which is responsible for the centre's activities. Societal and Industry-oriented Research Centre status is normally awarded for a project period of five years, with an option to extend for a further three years.

In this document, a societal and industry-oriented research centre will be referred to as a research centre or centre.

This document describes the requirements and guidelines that apply to this application type. This document forms an important part of the basis for calls for this type of application and is included as part of the contract between the Research Council and the individual Project Owner awarded funding.

1. Key terms

1.1. Terms apply as they are defined in the General Terms and Conditions for R&D Projects.

1.2. *Research partner:* A research organisation that is a centre partner. The Research Council's definition and delimitation of 'research organisation' will be applied. Norwegian research organisations must be approved by the Research Council.

1.3. *Company partner:* Company participating as a centre partner.

1.4. *User partner:* Collective term for partners from outside the research sector. This includes companies, public sector bodies and non-profit organisations.

1.5. *Undertaking:* An entity that carries out economic activity consisting of offering goods or services on a given market.

2. Delimitations and clarifications

2.1. A Societal and Industry-oriented Research Centre is not a separate legal entity.

2.2. State aid will not be granted through this application type. All projects carried out by a Societal and Industry-oriented Research Centre must be carried out in effective collaboration with the partners participating in the project.

2.3. The research can be of a basic and/or applied nature, and benefits broad segments of society. Research results are to be made accessible through sharing and publication in line with the Research Council's Policy on Open Science (applicable from 2020).[1]

2.4. Each centre must have at least three user partners unless another minimum requirement is specified in the call. The user partners must be engaged in considerable innovation activities of their own and/or have the ability to utilise research results in the development of their own organisation.

2.5. The role of each individual centre partner must be clearly defined.

2.6. Any subcontractors must be an external source for the client, who is either the Project Owner or a centre partner. This means that the subcontractor cannot be part of the same group of companies as the client.

3. Organisation and responsibility

3.1. The centre is to be a part of the Project Owner's administrative organisation, but must be managed by its own board. The centre's organisation must enable it to effectively achieve the objectives specified in the project description, its organisation and management form must ensure that the centre is well adapted to the Project Owner's organisation and it must establish procedures that ensure good interaction between all partners.

The centre's board

3.2 The Project Owner is responsible for ensuring that a board is appointed for the centre. The centre's board must comprise representatives of the Project Owner, user partners and research partners. The centre should have a strong and consistent user focus. Unless otherwise specified in the call, the user partners are to have the majority on the board and the chair of the board should be a representative of one of the user partners.

3.3. The board's main responsibility is to ensure that the intentions and plans that form the basis for the contract with the Research Council are fulfilled, and particularly that the activities set out in the project description are realised within the adopted budget and time frame. The board is to ensure good cooperation between the Project Owner and the partners.

3.4. Clear guidelines must be drawn up for the centre's activities in terms of responsibility and authority, including what the board is authorised to do, the rules that apply to board

[1] ISBN 978-82-12-03822-6 (PDF)

representation etc. The board's mandate must, among other things, ensure that the board does not make decisions that interfere with the Project Owner's area of responsibility.

Advisory committees

3.2 Unless otherwise specified in the agreement document with the Research Council, the centre must have a Scientific Advisory Committee comprising independent international top researchers. The committee must be involved in discussions about the centre's scientific strategy and scientific challenges throughout the project period. The committee can also give advice on other issues.

3.6 The centre can also have other advisory committees such as technical committees comprising representatives of the user partners.

Centre management

3.5. The centre must have joint day-to-day management and one overall research plan that corresponds with the project description. It must also have an effective plan for communication and exchange of personnel between the different parts of the centre.

3.6. The Project Owner must ensure that the centre has a strong management that, within the framework of the project description and the funding and cost plan, enjoys great scientific and administrative autonomy. The Project Owner must ensure that the centre has a good administrative support system in place.

3.7. The centre will be managed by a centre director or by a centre director supported by a management team. The centre director will act as the project manager in accordance with the contract between the Research Council and the Project Owner. The director must be able to act with autonomy in the scientific context and in connection with recruitment of staff for the centre. The director and, if relevant, the members of the management team will be appointed by the Project Owner in consultation with the partners. A description must be available of the centre director's authorisations.

Staffing and personnel responsibility

3.8. The centre is to be developed around researchers who have already proven to have the potential to work at a high scientific level. The Project Owner and the partners must themselves determine how employer responsibility for the centre staff should be organised, but the centre cannot have employer responsibility.

3.9. When recruiting staff, the centre must take gender equality into account and actively work to attract outstanding researchers. The centre must facilitate staff exchanges between partners.

Researcher education

3.10. The centre must encourage and contribute to researcher education in areas where recruitment is important for renewal and value creation. The centre must take steps to ensure that students and research fellows can carry out parts of their work with one of the user partners. The centre must also ensure that user partner staff participate in the supervision of students and research fellows. The Project Owner and relevant partners are responsible for the staff when the centre closes down and must especially ensure that master's and doctoral degree students can complete their studies according to plan.

4. Costs and funding

4.1. The contract between the Research Council and the Project Owner applies for five years with an option to extend for a further three years.

Cost plan

4.2. The Research Council only approves actual costs directly related to carrying out centre activities in accordance with the contract. The Research Council's rules for calculating payroll and indirect expenses to be included in the budget must be used. Rules have been adopted for the following groups: The university and university college sector, the institute sector, companies and public sector bodies. Partners' payroll expenses must be budgeted pursuant to the rules that apply to the group the partner is affiliated to. All partners must use the stipulated research fellow rates for all years the application covers.

4.3 The Research Council's grant cannot be used to cover any of the centre undertaking's[2] project costs. This means that they cannot receive state aid through the Research Council's grant, but must cover their own costs.

4.4. Nor must the undertakings participating in the research centre receive indirect state aid through favourable conditions for their collaboration with the research organisations participating in the research centre.

Funding plan

4.5. The societal and industry-oriented research centre scheme requires the long-term commitment of the user partners. The call for proposals stipulates the minimum requirement for funding from the user partners. The Project Owner and other centre research partners can also contribute funding to highlight their engagement and the centre's strategic foundation. Any requirements for own funding on the part of the Project Owner and research partners will be stated in the call.

4.6. The board must work to secure funding and necessary expertise for the centre if any partners leave the centre. The Research Council can reduce its grants to the centre if the minimum requirement for user funding is not met after a user partner leaves the centre. If the change in partners means that important assumptions that formed the basis for the establishment of the centre lapse or are significantly changed, the Research Council may terminate its contract with the Project Owner.

5. Collaboration agreement

5.1. The Project Owner is obliged to enter into a joint collaboration agreement with all center partners in the research center. The collaboration agreement must be drawn up in accordance with the Research Council's agreement document, the Requirements and Guidelines for Societal and Industry-oriented Research Centre and the General Terms and Conditions

[2] When research organisations engage in research and development in effective collaboration with others, this activity constitutes non-economic activity. The EFTA Surveillance Authority considers that R&D carried out by a research organisation in effective collaboration with others is part of the organisation's independent R&D activity, as defined in the state aid rules. The research organisation is not considered an undertaking in the context of this activity.

for R&D Projects. The Research Council's knowledge of the collaboration agreement does not mean that it approves any deviations from the contract between the Project Owner and the Research Council.

5.2. The collaboration agreement should contain provisions setting out the Project Owner's and partners' obligation to contribute resources in accordance with the centre's activity and funding plan, rules regarding the right to join and leave the centre, rules regarding employer responsibility, and provisions on property rights, utilisation rights, licensing, publication of project results and confidentiality. A period of notice of at least six months must be given before a partner can leave the centre.

5.3. The Research Council's General Terms and Conditions for R&D Projects regarding property rights, utilisation rights, licensing, publication of project results and confidentiality must be used as a basis. The collaboration agreement's terms and conditions regarding these issues must be worded in a manner that ensures that the undertakings participating in the centre do not receive indirect state aid, as described in the EFTA Surveillance Authority's guidelines on state aid for research and development and innovation Section 28 letters b), c) or d).

6. Scientific and administrative follow-up

6.1. The scientific and administrative follow-up described here comes in addition to the reporting procedures specified in the Research Council's agreement document.

6.2. The Project Owner must create a website for the centre to be actively used in external and internal communication.

6.2. The Project Owner must ensure that a communication plan is prepared for the centre.

6.4 In principle, research data should be openly available. The Project Owner must ensure that a data management plan is prepared in line with the Research Council's Policy for Open Access to Research Data.

Reporting to the Research Council

6.4. By 1 April each year, the Project Owner must draw up an annual report for the previous year. The annual report must be written in English, sent to the Research Council and published on the centre's website.

6.5. By 1 December each year, the Project Owner must prepare and send a work plan to the Research Council with updated plans for the forthcoming year.

6.6. The Project Owner must send a final report no later than three months after the end of the project period.

Site visit

6.7. In consultation with the Project Owner, the Research Council must, at appropriate intervals, organise a site visit to the centre to review developments, the centre's work and plans going forward. Representatives of the centre's board, the centre management, the

centre participants and the Research Council are obliged to be present. The first site visit must take place no later than two years after start-up.

Midterm evaluation

6.8. The Research Council will carry out a midterm evaluation of each centre within four years of start-up of the centre. The elements that will be given particular weight in this evaluation are described in the list of key success criteria for a Societal and Industry-oriented Research Centre, which is enclosed with this document. The evaluation will also entail an assessment of how the centre will contribute to achieving any thematic objectives and priorities described in the call and how, if relevant, the stipulations for allocation have been followed up. The evaluation will particularly compare the results achieved by the centre with the original project description. The evaluation will also give an assessment of the plans for the centre's activities during a potential three-year extension of the contract. The centres must be given an opportunity to comment on the midterm evaluation. In addition to this evaluation, the Research Council will evaluate the administrative situation at each centre.

6.9. The midterm evaluation, any comments from the centres and the evaluation of the administrative situation form the basis for the Research Council's decision to either extend operation of the centre for a total of eight years after start-up or to close it down five years after start-up.

Success criteria for Societal and Industry-oriented Research Centre

In addition to complying with formal requirements, a successful Societal and Industry-oriented Research Centre is characterised by the following:

The research

- The centre is engaged in long-term research at a high international level that is relevant to industry and/or benefits society in the field described in the project description.
- The centre has a clear research profile and has and has been successful in achieving recognition at the international level.
- The centre incorporates interdisciplinary perspectives in its research.
- Researchers from both the Project Owner's and the partners' organisations actively participate in the centre's research.
- The centre's user partners have increased their research commitments both through participation in the centre's activities and their own R&D activities on topics of relevance to the centre.

Innovation, value creation and benefits to society

- The centre's research has generated or is expected to generate opportunities for innovation and/or increased competitiveness among user partners, as well as expectations of social ripple effects in society beyond the partners directly participating in the centre's activities.
- The centre can document that its research results have helped to address challenges and exploit opportunities in the centre's thematic areas.
- There is expedient mutual staff mobility between the centre's research partners and user partners.
- The centre encourages innovation and defines, maps and follows up research results with innovation potential.
- The centre has implemented measures to ensure that the expertise and results achieved through its research can be used effectively by the partners.
- The centre has taken steps to ensure that results, including results that fall outside the user partners' core areas, can be commercialised through user partners, research-based business start-ups or in other ways.

Internationalisation

- Through the centre collaboration, the partners work actively to become involved and promote their activities in international research arenas, including the EU's framework programme.
- The centre is engaged in active collaboration with international research groups and has also contributed to the internationalisation of Norwegian research and industry in other ways.
- There is mutual mobility between the centre and outstanding foreign research groups.
- The centre attracts outstanding foreign researchers.

Researcher education and recruitment

- If relevant, the centre offers high-quality researcher education.
- The centre helps to strengthen recruitment, also at master's level, to the centre's field of research and, if relevant, contributes to research-based teaching.
- The centre contributes to gender balance and diversity in researcher education and recruitment.
- The centre's research contributes to higher quality of education in the centre's thematic areas and disciplines.

Partners and funding

- The Project Owner and the partners have a long-term commitment to the centre. The company partners have increased their funding above the minimum requirement.
- Active and targeted endeavours are made to strengthen the composition of centre partners.
- The centre's participants succeed in winning competitions for national and international R&D funds.

Organisation

- The centre has a high profile and clear identity and enjoys successful collaboration with its partners.
- The centre's board and management contribute to the follow-up of the intentions and plans that formed the basis for the centre's establishment.
- The centre has succeeded in creating added value as a centre where synergies are secured between different work packages to achieve common goals.

Forskningsrådet

General Terms and Conditions for R&D Projects

The General Terms and Conditions for R&D Projects constitute an integral part of all R&D project contracts with the Research Council of Norway and apply unless otherwise agreed in writing.

The following general terms and conditions apply as from 1 January 2021.

1 Key terms

Project administrator: The individual who is authorised to represent and assume obligations on behalf of the Project Owner in respect of the Research Council. If the Project Owner has designated a specific contract administrator, then this individual will assume the role of the project administrator with regard to authorisation to accept and/or amend the agreement documents for all R&D projects which the Project Owner has established with the Research Council of Norway.

Agreement document: The document that is signed by the parties and that contains the agreed-upon specifications and stipulations for the project.

Allocation: The Research Council's approved funding of a project, which is binding for one budget year at a time.

Direct costs: Costs that are directly attributable to the implementation of the project.

Effective collaboration: Collaboration between at least two independent parties to exchange knowledge or technology, or to achieve a common objective based on the division of labour, where the parties jointly define the scope of the collaborative project, contribute to its implementation and share its risks, as well as its results. One or several parties may bear the full costs relating to the project and thus relieve other parties of its financial risks. Contract research and provision of research services are not considered forms of collaboration.

Funding plan: A plan indicating how the project costs will be financed throughout the project period.

Force majeure: Unforeseeable or exceptional circumstances beyond a party's control.

Research-generated data: Registered records, notes and reported information in the form of numbers, text, visual and audio files that are generated by or emerge in the course of the research project.

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Research infrastructure: Facilities, resources and related services that are used by the scientific community to conduct research in their respective fields and covers scientific equipment or sets of instruments, knowledge-based resources such as collections, archives or structured scientific information, enabling information and communication technology-based infrastructures such as grids, computing, software and communication, or any other entity of a unique nature essential to conduct research.

Such infrastructures may be 'single-sited' or distributed' (an organised network of resources).

R&D: Research and development

R&D provider: An entity that, pursuant to the agreement document, will deliver R&D work on assignment for the Project Owner and/or any partners.

Progress plan: Plan for the performance of the project's activities, including secondary objectives and milestones.

Intellectual property rights: Patents and all other rights to technical solutions, methods, processes, procedures, drawings, prototypes, specifications, design, circuit layout drawings and trade secrets, regardless of whether or not these are or may be patented or registered as well as all copyrights, database rights and other similar rights, rights to trademarks, domains, and other distinguishing business identification marks, and rights protected under the Act relating to the control of marketing and contract terms and conditions, etc. (Marketing Control Act), regardless of whether these are or may be registered.

Indirect costs: Costs that are associated with the project's proportional use of resources that are not directly attributable to the implementation of the project.

Commercial utilisation: Direct or indirect use of project results in the development and/or marketing of products, services or processes, or the transfer and/or licensing of use of project results to third parties. Publication through publishing houses is not defined as commercial utilisation.

Contract: The R&D Project Agreement Document, the project description and the General Terms and Conditions for R&D Projects, as well as any specified supplementary documents.

Contract administrator: A designated individual who is authorised to accept and/or amend the agreement document for all R&D projects which the Project Owner has established with the Research Council.

Cost plan: A list of the overall budgeted project costs for the project period distributed by cost category.

Party/Parties: The Project Owner and the Research Council, individually or together.

Project: The overall activities covered by the contract.

Project Owner: The entity that is responsible vis-à-vis the Research Council for ensuring that the project is carried out in accordance with the contract, receives the Research Council's allocation on behalf of itself or any partners, and that is otherwise obligated under the contract.

Background: The knowledge, including intellectual property rights, that the Project Owner and partners bring into the project.

Project description: Scientific and administrative description of and plan for the implementation of the project.

Project funding: Resources that are made available to cover the project costs.

Project costs: Direct and indirect costs associated with the implementation of a project.

Project manager: The individual who is in charge of the progress and performance of the project on behalf of the Project Owner.

Project partner: Project Owner, partner and R&D provider.

Project period: The time span during which the project is to be performed, as specified in the agreement document.

Project accounts: Accounts detailing the project costs and project funding.

Project results: All results produced or achieved in connection with the project, including intellectual property rights, regardless of whether or not the results are protected by law.

Project summary: Short scientific description of the project that may be made available to the public.

Collaboration agreement: Agreement regulating among other things the approach, distribution of tasks and rights and obligations between the Project Owner and the partners.

Partners: The entities that, in accordance with the agreement document, are to perform the project in effective collaboration with the Project Owner and, if relevant, other partners.

Sign/signing: Electronic acceptance of the contract on ‘My RCN Web’ in the Research Council’s online application administration system and/or the physical signature on the agreement document.

Pledge: A conditional promise of funding from the Research Council to the project.

Sub-contractor: An actor who supplies goods and/or provides services to the project on assignment from the Project Owner and/or any partners, and who is not a partner or an R&D provider.

2 The project

2.1 Project implementation

The project shall be carried out in accordance with the contract.

In cases where the Research Council has approved the grant application without requiring any special agreement document, the project shall be implemented in accordance with the grant application and the General Terms and Conditions for R&D Projects issued by the Research Council.

The Project Owner is required to comply with the applicable statutory framework and other public regulations, ethical guidelines as well as recognised quality standards and norms for good research practice.

2.2 R&D providers

The Project Owner and/or partners can enter into agreements with R&D providers in accordance with the framework that follows from the contract.

The use of R&D providers does not exempt the Project Owner from its obligations and liability pursuant to the contract.

The Project Owner is required to ensure that R&D providers comply with the rights and obligations that follow from the contract.

Any changes in the composition of R&D providers as outlined in the agreement document will require the prior written approval of the Research Council.

The Project Owner is obliged to ensure that the R&D providers deliver their services on terms and conditions that ensure that the Project Owner and partners do not receive indirect state aid from the R&D provider, in accordance with the EFTA Surveillance Authority's guidelines on state aid for research and development and innovation.

2.3 Subcontractors

The Project Owner and/or any partners can enter into agreements with subcontractors in accordance with the framework that follows from the contract.

The use of R&D providers does not exempt the Project Owner from its obligations and liability pursuant to the contract.

Subcontractors may not be granted any rights to project results.

The Project Owner is required to ensure that subcontractors comply with the rights and obligations that follow from the contract.

3 Projects in collaboration with partners

In projects carried out in collaboration with partners, the Project Owner shall represent the partners vis-à-vis the Research Council.

The Project Owner is required to sign a collaboration agreement with the partners. Unless otherwise agreed in writing, the collaboration agreement is to be completed within three months after the Research Council has sent the contract to the Project Owner, and must have been received before the Research Council will disburse any funds.

The collaboration agreement is to govern the reciprocal rights and obligations of the Project Owner and respective partners, including distribution of project costs, ownership of research infrastructure and rights, etc., pertaining to research results, cf. Section 8.3.

The Project Owner is required to ensure that the collaboration agreement reflects the terms and conditions of the contract, including that the partners are bound by the same obligations as the Project Owner in so far as this is relevant for the partner's role in the project, and that the partners at all times are informed about relevant elements of the contract. The Project Owner must, among other things, ensure that the allocation is used in accordance with the contract, and that the partners that receive funding keep and submit cost accounts to the Project Owner as a basis for the preparation of project accounts that meet the requirements set out in the contract, cf. Section 6.

Collaboration shall take place on terms and conditions that ensure that neither the Project Owner nor the partners receive indirect state aid, in accordance with the EFTA Surveillance Authority's guidelines on state aid for research and development and innovation.

The Research Council may stipulate special requirements pertaining to collaboration between partners.

The signing of the collaboration agreement in no way changes the Project Owner's responsibility pursuant to the contract.

The collaboration agreement shall establish the right of the Research Council to exercise the rights of the Project Owner pursuant to the collaboration agreement in so far as this is necessary in order for the Research Council to exercise its rights under the contract (including provisions on duty of secrecy, verification and auditing, etc.).

Any changes in the composition of the partners as outlined in the agreement document will require the prior written approval of the Research Council.

4 Disbursement, transfers and reservations

4.1 Disbursement

Funding will not be disbursed until the contract has been signed by both parties and received by the Research Council along with copies of any collaboration agreements, and information about the Project Owner's bank account number has been conveyed to the Research Council in the manner specified. Funding will be paid into the bank account number that has been provided.

Unless otherwise agreed in writing, funds will be disbursed automatically at four-month intervals based on the agreed funding plan and the Research Council's allocation, as set out in the agreement document.

The Research Council will not disburse the final payment until the final report and/or annual accounting report has been submitted and approved, cf. Section 7.3

4.2 Termination of disbursement

The Research Council can stop any further payments if the Research Council finds that the implementation of the project deviates from the contract, or if other circumstances so indicate, cf. Section 4.7.

4.3 Transfer of unused funds from a fiscal year

On the basis of a request from the Project Owner citing reasons why it is justified, the Research Council may consent to the carrying forward of unused funding from one fiscal year to the next. The Project Owner must submit its request to the Research Council at the latest by the end of calendar year to which the grant applies.

In the event consent is not given for the unused funding to be carried forward, this amount will be deducted from the total allocated sum. If the funding has already been disbursed, the Research Council may reduce the following year's disbursement by a corresponding amount or require reimbursement of the unused funds.

4.4 Reduced payment and reimbursement of unused funds due to lower project costs

If the project costs are lower than the amounts indicated in the cost plan, then any remaining undisbursed funds will not be paid out. Disbursed funding in excess of the Research Council's agreed proportion of the project costs shall be repaid to the Research Council in the manner that it specifies.

4.5 Reimbursement as a result of incorrect disbursement

If the Research Council has disbursed a higher amount than what follows from the allocation, the Project Owner shall repay the difference immediately. Unless the incorrect disbursement is due to conditions on the part of the Research Council, interest accrues in accordance with the Act relating to Interest on Overdue Payments etc. (LOV-1976-12-17-100) from the date on which the Project Owner received the funds.

4.6 Offsetting

The Research Council may recover overpayment of funding by offsetting the amount against remaining payments or other claims that the Project Owner may have vis-à-vis the Research Council, including undisbursed funding in other projects. This applies regardless of the date on which the claim arose or fell due.

4.7 Reservations

Allocations are made for one fiscal year at a time. Any pledges for subsequent years are not binding on the Research Council unless specifically stated in the agreement document.

Disbursement of the grant for Year 1 and honouring of any pledges for subsequent years are contingent on there being no changes in public regulations (rules, standards, legislation, etc.), and that no other unforeseen circumstances have arisen that will have a major impact on the implementation of the project, or the Research Council's ability to contribute to it.

The Research Council will honour its pledge for subsequent years contingent on the following stipulations, among others:

- That no deviations from the contract and/or breach of contract have occurred
- The Research Council approves the progress report for the project and any requests to change the approved project framework, cf. Section 7.2.

In the event one or more of these conditions is not satisfied, the Research Council may stop or change any future allocations or pledges. Furthermore, the Research Council may require repayment of all or part of the disbursed allocation, or decide to cancel the contract pursuant to Section 18, if this is warranted under the circumstances.

5 Eligible project costs

Only direct and indirect costs that are necessary to the implementation of the project and that are included in the cost plan may be charged to the project.

6 Accounting

The Project Owner is to keep a separate project account specifying project funding and project costs.

Project funding and project costs must appear in the Project Owner's formal accounts. The accounts shall be kept current. Under all circumstances, information of significance to the preparation of compulsory reports stipulated in the contract must be recorded within the deadlines that apply to such reporting. Project accounts must satisfy the requirements set out by the Research Council in its relevant guidelines, and must be in accordance with good accounting practice and commonly accepted accounting principles.

7 Reports

7.1 In general

The Project Owner is required to prepare and submit reports within the stipulated deadlines, in the manner and format specified by the Research Council. The information shall be up-to-date and meet the Research Council's guidelines applicable at all times.

All changes and deviations to the project and the contract shall be reported to the Research Council unsolicited and without undue delay in the format specified by the Research Council.

The Project Owner shall store the final report and project data in a safe and secure manner for at least 10 years after the conclusion of the contract period.

7.2 Progress reports and notifications of changes to the project framework

In the progress report, the Project Owner is to provide information regarding the project results achieved.

The progress report and any notifications of changes to the project framework must be approved by the Research Council before the allocation can be disbursed and/or funding pledges will be honoured, cf. Section 4.7.

7.3 Final reports

Unless otherwise agreed in writing, the Project Owner is to submit the final report to the Research Council by at the latest one month after the conclusion of the project period.

The Project Owner is to provide the name of the archives or data infrastructure to be used for storing the research data/output data generated in connection with the project that may be relevant for reuse, and all the necessary documentation for reuse of the data (metadata).

Projects that have submitted a data management plan must append the latest version of this plan to the final report.

The final report must be approved by the Research Council.

7.4 Other reports

Within reason, the Research Council is entitled to request additional reports covering shorter periods of time or specific parts of a project.

For certain types of projects, the Research Council requires the submission of an annual project account report. This will in such case be specified in the agreement document.

Upon the request of the Research Council, and to the degree possible, the Project Owner and partners are required to contribute at no charge to the Research Council’s evaluation of the project and measurement of results. This evaluation includes an assessment of the scientific and economic significance of the project’s results. Unless otherwise agreed in writing, the Project Owner will be under obligation to contribute in this way for a period of up to 10 years from submission of the final report.

The Project Owner is also required to submit account information and any other statistical data relating to the project to the national research statistics authorities.

8 Employer responsibility

The Project Owner has employer responsibility for all its own staff members who are affiliated with the project.

9 Right of ownership, utilisation rights and licensing

9.1 Research infrastructure

The Project Owner has ownership of research infrastructure purchased with project funds in projects without partners. In projects involving collaboration with partners, the ownership of the research infrastructure shall be regulated in the collaboration agreement, cf. Sections 3 and 9.3.

The Project Owner and, if relevant, any partners with ownership rights to the infrastructure, is required to ensure that the research infrastructure is adequately insured and kept operational and in good working order during the contract period.

9.2 Project results

Rights
The Project Owner and any partners must obtain the rights to commercial utilisation of the project results, and are required when necessary to sign agreements with owners, employees (including individuals with multiple employers), subcontractors and others to achieve this.

The obtainment of such rights is not intended to limit the protection accorded the rights holder's moral rights pursuant to the Norwegian Copyright Act, nor does it preclude agreements regarding remuneration schemes for rights holders corresponding to those that apply to employees' patentable inventions pursuant to the Act respecting the right to employees' inventions.

The Project Owner shall ensure open access to scientific publications relating to the project results, including that the Project Owner, partners and/or authors shall retain sufficient intellectual property rights to meet the open access requirements, which are described in more detail in Section 10. Among other things, this means that the Project Owner, partners and/or authors shall retain the unconditional right to make the final version of a manuscript following a peer review (AAM) and/or the publisher's published version (VoR) of a scientific article available under an open licence through an open archive, immediately on publication by the publisher.

Protection
The Project Owner and any partners must assess the need to protect project results that may have commercial value and, when so indicated, take suitable protective action. Where legislation requires that rights must be registered to obtain protection, such registration shall be carried out.

Utilisation
The project results must be utilised within a reasonable period of time, given the characteristics of the particular industry or market, the specific field of research, and the relevant product's development time-frame, useful economic life and utilisation opportunities. If the party holding the rights to the project results does not achieve such utilisation, the persons who have produced the project results may demand that the rights are transferred to them, unless a different agreement is in place between the Project Owner and those same persons, or between the various parties involved in projects in collaboration with partners, cf. Sections 3 and 9.3. This does not apply, however, in cases where:

- measures to achieve utilisation have been launched and are underway; or
- the rights holder's lack of utilisation of a project result is of commercial significance for the utilisation of the rights holder's other project results

Transfer of project results to a foreign legal entity
The transfer of ownership and/or licensing of exclusive rights to project results to a third party who is not a partner, and who is in a country outside the European Economic Area, may not take place without the written approval of the Research Council. The Research Council may refuse to allow transfers/licensing agreements if they are in conflict with national economic interests, ethical principles or considerations relating to the safety of the realm. Alternatively, the Research Council

may stipulate conditions for the proposed transfers/licensing agreements. A request may be considered approved if the Research Council has not responded within four weeks of receipt of written notification. This provision applies for the duration of the project period and for three years after the project has been concluded.

Changes in ownership – foreign owners
The Research Council shall be notified immediately and in writing if a person or an undertaking outside the European Economic Area assumes a controlling interest in the Project Owner through the acquisition of a stake in the enterprise (shares, etc.), by agreement or by other means. The Project Owner is also required to notify the Research Council immediately and in writing if a person or an undertaking outside the European Economic Area assumes a controlling interest over any of the partners after a contract has been signed.

If the changes in ownership entail that the project results may be used in conflict with national economic interests, ethical principles or considerations relating to the safety of the realm, the Research Council is entitled to impose conditions on the project and project results, including that the Project Owner shall wholly or partially transfer the project results exclusively to the Research Council. The Research Council may also cancel the agreement document and require reimbursement for disbursed allocations pursuant to Section 17 and 18. This provision applies for the duration of the project period and for three years after the project has been concluded.

9.3 Supplementary provisions for projects in collaboration with partners

The collaboration agreement between the parties, cf. Section 3, is to regulate ownership of infrastructure, and the rights to, protection of and use of project results, as well as use of, and any compensation for, the background and any research infrastructure brought into the project.

The following principles are to be adhered to:

- For the duration of the project period, the Project Owner and partners must have the right to use, at no charge, all project results that are necessary for implementing their own work in the project.
- The Project Owner and partners must have the right to use project results and background brought in according to the agreed-upon terms, when this is necessary for commercial utilisation of the project results to which they themselves have rights under the project.

10 Publication and archiving

10.1 Publication of project results

Unless otherwise stipulated below, the Project Owner is required to make the project results public as quickly as possible. This includes ensuring that the dissemination measures and plans specified in the contract are implemented.

If publication of project results will interfere with the protection or commercial utilisation of the project results, the publication may be temporarily postponed until such protection or commercial utilisation has been achieved.

In special cases, the Research Council may give its written consent to the imposition of permanent secrecy on the project results. This does not apply to projects with participants from the university and university college sector, as it is in contravention of the Act relating to universities and university colleges.

Research-generated data must be made publicly available after the conclusion of the project, unless special circumstances indicate otherwise, or unless this is prevented by the terms and conditions of the contract or other public rules.

The Project Owner shall ensure that all scientific publications about or based on project results that are written by authors affiliated to the Project Owner or the partners, are published in accordance with the Research Council's requirements for such publications at all times, available at https://www.forskningsradet.no/en/Adviser-research-policy/open-science/apen-tilgang-til-publikasjoner/. Among other things, this means that scientific articles shall be made immediately available online with open access under a Creative Commons Navngivelse CC BY 4.0 licence unless otherwise agreed with the Research Council.

10.2 Archiving of project results

The Project Owner shall ensure that all research- generated data, including all data that forms the basis for publications, is stored in a secure digital archive. Such archiving is to be carried out as soon as possible and at the latest two years following the conclusion of the project period. The Research Council may require that all such data, including the necessary documentation for reuse of data (metadata), is stored in designated, secure national or international archives.

The Project Owner is under obligation to ensure that a copy of peer-reviewed scientific publications based on research that is wholly or partially funded by the Research Council is stored in appropriate, open-access archives immediately on publication by the publisher. The archived version shall be the last version of the manuscript following peer review (AAM) and/or the publisher's published version (VoR).

10.3 Publication of project information

The Project Owner and any partners are required to make reference to the Research Council's support in any external information issued about the project.

The Research Council has the right to publish the name of the Project Owner and project manager, the project title, the duration of the project, the project summary, the popular science presentation and the amount of its allocation.

The Research Council may publish project results that are reported in connection with the progress and final reports unless the information has been designated as confidential.

Within reason, the Research Council is entitled to require that the Project Owner establishes a website for the project and takes part in relevant seminars, conferences and other dissemination and networking measures.

11 Confidentiality

The Research Council is required to comply with the Freedom of Information Act of 19 May 2006 No. 16 and the provisions relating to duty of secrecy under the Public Administration Act of 10 February 1967.

12 Transfer

The Project Owner may not transfer, mortgage or in any other way convey the use of the contract, or portions of the contract, including allocations and pledges from the Research Council, without the prior written consent of the Research Council.

13 Indemnification and discharge of liability

The Project Owner bears liability for ensuring that the performance of the project does not violate the rights of any third parties, including the third party's copyrights and other intellectual property rights, or can in any other way lead to claims from a third party.

The Project Owner shall indemnify the Research Council against any claims resulting from the Project Owner's performance of the project, including claims related to infringements of intellectual property rights.

The Research Council bears no legal or financial liability for injuries or losses ensuing from e.g. defects in or non-proficient use of equipment, methods or programmes associated with the project.

14 Force majeure

Either party shall notify the other party without undue delay should a situation of force majeure prevent that party from fulfilling its obligations under the contract.

None of the parties is to be held liable for a breach of contract if the inability to fulfil its obligations is due to force majeure.

Should force majeure entail a risk that the project cannot be performed in accordance with the contract, the parties shall meet to negotiate any contract adjustments that might be required. Should the parties fail to agree on such adjustments, the Research Council is entitled to stop payment of the allocation until the situation of force majeure is resolved.

If the situation of force majeure is expected to last, or has lasted, for more than 90 days, each of the parties may terminate the contract with one month's notice.

15 Amendments

The Research Council may introduce amendments as set out in the contract.

Each of the parties may propose amendments to the contract. Amendments may apply to the project's objectives, scope, or other conditions

Amendments to the contract require the prior written consent of the Research Council.

16 Verification, auditing and disclosure requirement

The Research Council, the Office of the Auditor General or a third party appointed by the Research Council are entitled at any time to verify that the funds are being applied in accordance with the contract.

Upon a request from the Research Council or Office of the Auditor General, the Project Owner shall produce receipts, time sheets, calculations and any other relevant documentary evidence and information requested by the Research Council and/or the Office of the Auditor General in order to carry out such verification.

The Research Council and the Office of the Auditor General may require the Project Owner to disclose all information that is necessary to verify compliance with the rules pertaining to public support.

17 Repayment

Regardless of what follows from Section 4, the Research Council may demand repayment of the disbursed allocations, in whole or in part, in case of deviations from and/or breach of contract, including that the project has received other project funding than assumed at the time the contract was signed, or if the Research Council has disbursed funds that will constitute unlawful state aid.

18 Cancellation

18.1 The Research Council's right of cancellation

The Research Council may cancel the contract in the event of a material breach on the part of the Project Owner.

Such a material breach includes among other things situations in which:

- there are significant deviations in relation to the progress plan or other factors regulated in the contract;
- the Project Owner has not fulfilled its obligations relating to reporting and archiving, including that the reporting provides an incorrect picture of the actual situation, cf. Sections 7 and 10, respectively;
- the disbursed funds have not been applied in accordance with the contract;
- research infrastructure has not been adequately insured and kept operational and in good working order during the contract period, cf. Section 9.1;
- the Project Owner is engaged in activities which are not compatible with the current legislation or with the Research Council's objectives and guidelines;
- the Project Owner is unwilling or unable to complete the project.

The Research Council may furthermore cancel the contract in the event that:

- a person or undertaking outside the EEA assumes control of the Project Owner, and the terms set out under Section 9.2, final clause are met;
- there is notification of a declaration of bankruptcy, or a petition for compulsory winding up or the opening of composition proceedings on the part of the Project Owner, or there is other compelling reason to believe that the Project Owner is insolvent;
- a decision has been taken to close down the Project Owner's activities or there is other compelling reason to believe that grounds exist for forced dissolution of the company;
- key prerequisites underlying the contractual relationship are not fulfilled, such as the Research Council receives less funding than expected, or there are changes in public regulations or other unforeseen circumstances arise that will have a major impact on the implementation of the project or the Research Council's ability to contribute to it, cf. Section 4.7.

18.2 Procedure for cancellation

The Project Owner is to be notified before the Research Council decides to cancel the contract.

Notification of cancellation shall be submitted in writing with specification of the reasons for cancellation.

18.3 Reimbursement claims in the event of termination

If the Research Council cancels the contract pursuant to Section 18.1, the Research Council may demand repayment of the disbursed allocations, in whole or in part, including interest on the amount from the date of the breach, in accordance with the Act relating to interest on overdue payments, etc. (LOV-1976-12-17-100).

The Project Owner is to be notified before the Research Council decides to claim reimbursement of allocations.

18.4 Transfer of rights to project results in the event of cancellation

In lieu of such reimbursement, the Research Council may demand transfer of the rights to project results. The claim for such transfer shall be submitted in writing, and the Project Owner shall surrender the rights without undue delay, and cover any costs in connection with the transfer. Upon surrender, the right of ownership will be passed from the Project Owner to the Research Council or to a relevant third party.

19 Duration and discharge of the contract

19.1 In general

The contract will enter into force from the date on which it has been signed by both parties and one copy along with any signed collaboration agreements have been received by the Research Council. The contract will be discharged without notice upon conclusion of the project and submission and approval of the final report.

Discharge of the contract does not imply cessation of contract provisions that are not, by their nature, limited to the contract period. This applies, for example, to the provisions pertaining to accounts, reports, the transfer of project results, publication, etc.

19.2 Termination of the contract by agreement

The parties may agree in writing to terminate the contract before the conclusion of the project period.

20 Choice of law/venue

This agreement is governed by and shall be interpreted in accordance with Norwegian law.

Any disputes shall be settled in the ordinary courts. Oslo District Court shall serve as the court of venue. In the event that the Project Owner is a public institution, disputes shall be submitted to the Ministry of Education and Research, which will decide how these shall be solved.

National Center for Sustainable Subsurface Utilization of The Norwegian Continental Shelf (NCS2030)

Relevance to the call

The Intergovernmental Panel on Climate Change (IPCC) 6th report[1] emphasizes that the globe is warming, and rapid action is needed to mitigate climate change. In order to reach the Paris agreement target, the International Energy Agency (IEA), in its last report[2], proposes a scenario where none of the new oil reserves will be developed. The Norwegian petroleum industry is preparing its future paths toward Net-Zero Emissions (NZE) by 2050, while continuing to supply the world with energy (Equinor[3]). An energy mix, with the right combination of fossil and renewable energy sources, together with CO_2 capture and storage (CCS) is a viable option. Norway is one of the most important providers of energy to Europe and has major opportunities to become a frontrunner in the sustainable energy transition to renewable energy and NZE hydrocarbon (HC) production. To transform the Norwegian Continental Shelf (NCS) into sustainable utilization, a new way of thinking across disciplines and societal acceptance are required. Therefore, it is important to integrate research, education, and innovation to build knowledge and develop technologies towards the optimal utilization of the NCS.

The vision of the NCS2030 center is to facilitate an energy-efficient, multi-purpose utilization of the NCS subsurface in the transition to a "***Sustainable Subsurface Value Chain***" (Figure 1). This includes both cost- and energy-efficient NZE oil and gas production, utilization of reservoirs for renewable energy production and storage of CO_2 and other waste disposal in near field areas. Reutilization of existing infrastructure in an optimal manner (circular economy) and connection to other value chains, e.g. CO_2 transport and storage, Blue H_2 produciton, offshore wind and geothermal energy, are paramount. This vision directly addresses the scope, priorities, and objectives of the Research Center for Petroleum call, and comply with the plan for the Petroleum research portfolio as specified by the Research Council of Norway (RCN)[4].

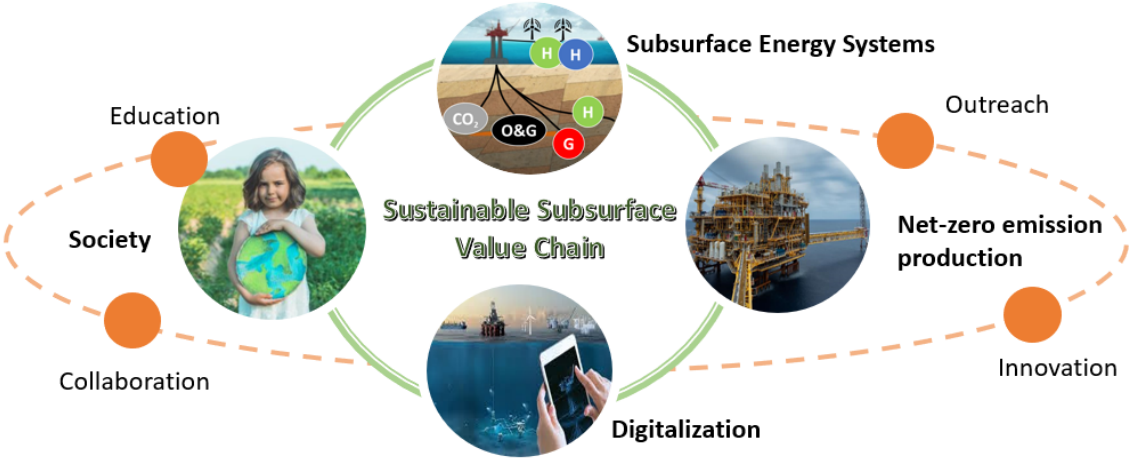

Figure 1 – NCS2030 to establish The Sustainable Subsurface Value Chain

We consider four important research areas (Figure 1), namely ***i) Subsurface energy systems, ii) Net-zero emission production, iii) Digitalization*** *and* ***iv) Society***, that integrate multi-disciplinary research activities for the Sustainable Subsurface Value Chain. In addition, ***Education*** of professionals with new competencies, and ensuring equality and gender balance are an important priority. NCS2030 will enable ***collaboration*** between policy makers, field operators, technology providers and academic groups. Furthermore, it will complement and benefit established research initiatives and networks to create new solutions through a dedicated ***Innovation*** program. With this large network, NCS2030 will be a significant national and international arena for ***outreach*** to the scientific community, stakeholders, and society.

[1] Climate Change 2021 The Physical Science Basis, IPCC, 2021
[2] Net Zero by 2050, A Roadmap for the Global Energy Sector, Flagship report — May 2021 IEA
[3] Equinor's Energy Perspectives 2021 (www.equinor.com)
[4] Portfolio plan for Petroleum (https://www.forskningsradet.no/om-forskningsradet/portefoljer/petroleum/).

Excellence

1.1 Knowledge needs, objectives and state of the art

Societal and industrial needs: Transitioning to a sustainable energy mix is required to comply with the Norwegian Government's strategy and the Paris agreement, while contributing to the UN's Sustainable Development Goals. There is an urgent need for integration of new knowledge and technology to ensure the transition to NZE energy production in the coming years and decades. The petroleum industry is the largest and most profitable Norwegian industry, with high technological competence that contributes to energy security and job creation. Greenhouse gas (GHG) emissions from the petroleum industry, mostly CO_2, represent 25% of the total national emissions. Norway plans to continue production of its HC resources to meet market demand and has ambitions to reduce its emissions by at least 40% by 2030 and achieve NZE by 2050 (KonKraft[5]). Small-size discoveries, declining production from mature fields, increasing water production, CO_2-emissions taxation, volatile oil prices, policy changes and public perception, are some of the critical challenges facing the industry. This requires policy makers to set strategies based on qualified data and information from science and research. Advanced technologies, highly skilled work forces and reutilization of existing infrastructure are the foundation for generating new business opportunities to maintain the NCS' competitive position and license to operate.

Scientific needs: The Norwegian petroleum industry and academia have developed advanced technologies and competence for HC exploration and production leading to some of the highest recovery rates (~46% for oil, and ~70% for gas) in the world and lowest GHG emissions (8 g/barrel). Norway also has extensive experience in decarbonisation of oil and gas production (e.g. Sleipner and Snøhvit CCS projects; Ringrose, 2020). Nevertheless, about 50% of the HC resources will be left behind with a large amount in poor quality reservoirs – the so called "Challenging Barrel" (Norwegian Petroleum Directorate; NPD, 2020), which will require existing and new disruptive improved/enhanced oil recovery (IOR/EOR) methods. The development of other offshore energy resources is progressing, but still in its infancy. NZE HC production, blue H_2, subsurface utilization for other energy resources (e.g. geothermal), as well as for storage of both energy (e.g. H_2) and waste (e.g. CO_2) introduces new challenges. Therefore, the competence should be expanded to manage resources and reservoir usage for future energy production and storage (Heinemann et al., 2018). In addition, mature or depleted fields and saline aquifers may be considered as potential storage sites for large quantities of CO_2 (Ringrose, 2020; Halland et al., 2014), making use of existing infrastructure (Eide et al., 2019).

The primary objective of NCS2030 is to fill knowledge gaps and provide solutions for maximizing value creation of subsurface resources to reach the Net-Zero Emissions goals on the NCS. This ambitious goal will be reached by following seven **secondary objectives** (**SO,** Table 1) that we believe are well aligned with the call, focusing on future sustainable subsurface utilization, which positions NCS2030 to meet the scientific, technological and societal needs.

Table 1. Secondary objectives, relevant research, work packages (WP) and deliverables

	Secondary objectives	Research domains / WPs	Main deliverables / Key Performance Indicator
SO1	Build integrated near field subsurface holistic models for increasing reserve base and evaluating the potential of geological CO_2 and H_2 storage, and renewable energy production	***Subsurface energy systems:*** WPs 1-2-5	Surface hub models, workflows, and methodologies; geological scenarios to reduce uncertainty
SO2	Develop new IOR solutions for improved and accelerated HC production at low environmental footprint to help reach 50% emission reduction by 2030	***NZE production, Society*:** WPs 3-4-5-6	Proposed new solutions with large increased reserve and reduced emissions by 50%.
SO3	Develop data-driven and machine learning approaches to integrate subsurface characterization, uncertainty quantification and management workflows for better decisions	**Digitalization:** WPs 1-2-3-4-5	New digitalization workflows with improved functionalities and computational efficiencies.
SO4	Recommend field cases on the NCS with high potential for NZE production based on renewable energy and the Sustainable Subsurface Value Chain	***Subsurface energy systems:*** WPs 1-3-5-6	At least 5 potential cases in collaboration with center's industry partners.

[5] Konkraft Report 2021: The energy industry of tomorrow on the Norwegian Continental Shelf (https://www.norskoljeoggass.no/

SO5	Strengthen the business climate, create awareness and establish acceptance of NCS2030 activities and NCS exploitation	***Society***: WPs 1-2-3-4-5-6	White papers to policy makers, society, stake holders. News articles in national media.
SO6	Establish an innovation platform as catalyst for new technology development in collaboration with industrial players on the NCS.	***Innovation***, **collaboration**: WP7	10-15 innovation projects for new technology development and field implementation.
SO7	Attract and train the next generation of scientists and skilled professionals for the energy transition, together with user partners and disseminate results of high quality and impact	***Education, Outreach***, All WPs	27 PhDs/Postdocs, 40 master theses, workshops, conferences, > 200+ peer-reviewed publications

State of the art

Subsurface Energy Systems: Over the last years, research on the interplay between tectonics and sedimentation in rift systems (Tillmans et al., 2021; Zhong and Escalona, 2020), salt tectonics (Tvedt et al., 2016; Rojo et al., 2020), pre-Jurassic petroleum systems (Ohm et al., 2012 - PaBas consortium), and the subsurface geology of the high north (Birtchall et al., 2020 - ArCEX; Marin et al., 2019 - LoCRA) have contributed to highlight new petroleum exploration play concepts on the NCS. Recent discoveries are small, most of them near existing infrastructure and many plays are still poorly understood. Traditionally, exploration and exploitation of NCS reservoirs have been limited to HC production (Halland et al., 2014; Quirk and Archer, 2020; NPD, 2020). Therefore, a holistic resource evaluation of the subsurface as a comprehensive energy system, given its large potential for renewable energy supply and storage, will add value, provide energy security, and contribute to achieving NZE. For example, non-traditional reservoirs such as salt caverns (Caglayan et al., 2020) for hydrogen storage and high-pressure high-temperature (HPHT) reservoirs for geothermal energy production (Cui et al., 2016) are key and should be further studied.

Today's development towards understanding the subsurface as an integrated complex multi-dimensional system is driven by **digitalization** to maximize data utilization and extract more information. This new knowledge can be utilized not only for HC exploration and production, but also for CO_2 and H_2 storage and geothermal energy extraction. However, there is still a lack of quantitative data-driven understanding of various key risk factors and proper integration of data for extening reservoir utilization, de-risking prospects, and properly analyzing seal integrity and reservoir storage capacity (Van Schaack and Tillmans, 2021). This may also increase the current pre-drill probability of success (10-15%) of exploration wells in the NCS with less than half of the discoveries being commercial (NPD, 2020). The current understanding of hydrocarbon charging of the reservoirs is the main uncertainty, reflecting our limited capability in mapping the distribution of source rocks and fluid migration (NPD, 2020). In this context, aquifer behaviour and connectivity play an important role and is critical for storage capacity of energy and waste. Improved understanding of the migration and distribution of fluids will open undiscovered potential in near-field areas not only for HC but also for other fluids and will improve well placement.

The **energy mix scenario** is based on clean H_2 production combined with large-scale CCS and underground H_2 storage. Several pilots and small-scale industrial projects have substantially increased confidence in underground CO_2 and H_2 storage reliability. However, gigaton scale CO_2 injection has not been implemented on the NCS, and many challenges remain, e.g. large injection rates could bring significant geomechanical effects (Elenius et al., 2018; Wangen et al., 2016). CO_2 mixed from multiple sources raises a question of CO_2 quality and the effect of impurities on the reservoir flow and seal integrity. Existing reservoir simulation tools are struggling to provide reasonable predictions for CO_2 flow (Räss et al., 2014; Verdon et al., 2013). Attempts have been made to history-match observations at the Sleipner field using conventional reservoir simulations. However, these have failed to capture the first-order observations, such as facile vertical flow of CO_2 through low permeable shale layers, the formation of focused fluid flow channels or chimneys, and rapid lateral spread underneath the seal rock (Boait et al., 2012). Furthermore, the underground capacity for H_2 storage in salt caverns, and porous reservoirs such as saline aquifers or depleted gas reservoirs is still in its infancy. Technical feasibility, efficiency, and safety of H_2 storage are impacted by fluid-rock interactions meaning that a coupled hydro-chemo-mechanical approach is required to assess the short- and long-term impact of cyclical H_2 injection. The effect of fluid-rock interactions on storage integrity or capacity is currently unknown and needs an interdisciplinary approach of experimental investigations, numerical simulations, geological

characterization and assessment of operational procedures. On the other hand, the potential for geothermal energy is large in areas with low-temperature gradients, but there are currently few sites in operation globally (IGA, 2014). Latest advances in drilling technologies bring new opportunities for developing geothermal energy in Norway. However, these technologies are still under development, and further research is needed.

NZE production: Many existing fields on the NCS are in decline and are producing at a high water-cut, which increases energy-demand, costs and emissions per barrel. EOR methods to improve reservoir sweep and to minimize water/gas-cut may have large potential to accelerate production and reduce energy requirements and emissions. Recent findings have established fundamental knowledge of the NCS reservoirs and their improved recovery potentials. IOR/EOR methods such as low salinity (Smart Water), alone or in combination with polymers, HC gas and CO_2 miscible gas or water alternating gas (WAG) injection have been identified with high technical and economic potential (Smalley et al., 2020). Comprehensive research, largely at the National IOR Center of Norway (NIORC) and by its partners, forms a solid foundation for the future NZE production. These include understanding effects of pore fluid chemistry and temperature on wetting and geomechanical properties of reservoir rocks (Voake et al., 2019; Minde et al. 2018, Mamonov et al. 2019); improved oil-water mobility ratio by combining Smart Water and polymer (Piñerez et al., 2018) and by wettability alteration (Lake et al., 2014); CO_2-WAG and CO_2-foam for mobility control combined with CO_2 storage (Alcorn et al., 2020; Rognmo et al., 2019); accelerated and incremental oil recovery from sandstone and carbonate reservoirs with Smart Water (Puntervold et al., 2015; Aghaeifar et al., 2018); carbonated water to improve water flooding performance while storing CO_2 (Fjelde and Guo, 2019); reservoir monitoring with partitioning tracers (Silva et al., 2020); environmental risk assessment for EOR (Vora et al., 2021); CO_2 EOR for tight reservoirs (Berawala et. al, 2020); modelling tool IORSim for EOR processes (Hiorth et al., 2017); better prediction of IOR potential (Minde et al., 2020); and Open Porous Media (OPM) for reservoir management and decision making (Rasmussen, 2021).

EOR as a tertiary recovery method often requires additional equipment and chemicals that are energy- and cost-demanding, leading to added emissions. Methods that accelerate production and store CO_2 at the same time (when used as injectant, or combined with late field life CO_2 storage), will be prioritized by NCS2030. Methods for accounting the reduced emissions and energy invested in the complete EOR life cycle must be developed (Metidji, 2021; Farajzadeh et al., 2021). Most earlier research has been conducted at nano- to core-scale and rely on models to predict field scale potential. Recent large-scale testing at NIORC (Åsen et al., 2019; Stavland et al., 2020) and field testing for foam-based CO_2 injection (Alcorn, et al., 2020) have demonstrated the need for more large- and pilot-scale testing to upscale EOR methods for offshore fields.

Digitalization: Substantial amount of subsurface data on the NCS has been and is increasingly collected. Data acquisition, sharing and fast access have been important contributions to the success of the petroleum industry in Norway. Complex and large models for multiple scenarios (*here defined as distinct alternatives, which may contain many uncertain quantities, from political to model uncertainties*) and utilizing Big Data, digital twins and machne learning (ML) will require high performance computing. Improved input to models using conventional methods or assisted with ML require underlying data and training datasets from accessible and exchangeable sources. The industry is evolving fast with new solutions in cloud computing technology and standardization such as the OSDU community[6] for subsurface data sharing, DELFI[7], etc. Large scale applied data science will shift from computing and analysis at a single site to the new paradigm of federated computing that transfer computation to data, rather than the opposite[8]. This technological revolution offers a great opportunity to improve the current modelling workflows and computing performance. In addition, the new generation of communication technologies enabling automated federated data service for accessing multiple data sources, sufficient computing power for handling of intensive computations for model development and testing with realistic field cases, is offering a major step towards data utilization and effectivization (Yue et al., 2021).

[6] Open Subsurface Data Universe: An Open Source standards-based, technology-agnostic data platform https://osduforum.org/

[7] Schlumberger's Cognitive E&P Environment

[8] EU patents MySoMe, PCT/EP2018/050125; and TOTEM, PCT/EP2020/079649

Reliable flow forecasts are instrumental for decision support in reservoir management. Ensemble-based data assimilation (DA) (Evensen, 2021; Chen and Oliver, 2017) has led to a paradigm shift in petroleum reservoir management through its ability to include uncertainty quantification in subsurface characterization and flow forecasts, and is now the industry standard in the petroleum sector. DA still has important methodological challenges to be resolved and has not been extensively applied to other subsurface flow problems, such as CO_2 and H_2 injection and storage. Most importantly, standard application of DA quantifies uncertainty for a given scenario (geological setting, petrophysical model, etc.); But in reality, multiple scenarios are usually viable, posing both methodological (Höge et al., 2020) and significant computational (Sinsbeck et al., 2021) challenges. NCS2030 will extend current DA workflows to allow for multi-scenarios, better uncertainty quantification and to include CO_2 and H_2 storage. Appropriate multifidelity (MF) (Peherstorfer et al., 2018) and ML (Luo et al., 2021) proxy models will be developed and applied to resolve computational challenges as well as large simultaneous (e.g., seismic) datasets (Nezhadali et al., 2021).

Society: Future sustainable subsurface solutions will require human and financial resources. The petroleum industry and Norway will have to compete for these resources against other sectors and countries. The broad business climate of the industry and country, the policies for reaching NZE goals, and societal acceptance are key to mobilizing the necessary resources. Therefore, critical aspects for research are risk analysis, the tax system, access to long-term financial capital, factor mobility across sectors and societal acceptance. Research shows that petroleum investments are sensitive to the business climate, which again is formed by political risk, institutions, and taxes, among other factors (Bohn and Deacon, 2000; Cust and Harding, 2020; Arezki et al., 2019). Research by Ahlvik and Harding (in progress) suggests that financial constraints for oil companies on the NCS already exist. These are only likely to be more severe going forward given the current sentiment towards the petroleum sector in financial markets. More research is required to understand how climate-aware investors and stricter environmental policies will affect investments in physical and human capital in the petroleum sector. Regarding mitigation policies, there has recently been an emerging interest for supply side-oriented measures, but the literature is still dominated by theoretical studies (e.g., Harstad, 2012) and simulations (e.g., Fæhn et al., 2017). There is a need for bringing in analysis of real-world data to understand the effects of such policies in practice.

The Sustainable Subsurface Value Chain requires collaborative and cross-disciplinary research and technology development, and gives opportunities for new solutions by involving students, researchers, technology developers and end users. NCS2030 will expand knowledge and results from other established centers and projects (Table 2) that have built competence in subsurface, digitalization, decision-making, CO_2 value chain and sustainable offshore energy production.

Table 2. Building bridges between established national research initiatives and NCS2030

Centers/Initiatives	Scope and field of research	NCS2030 complementary research
NIORC - The National IOR Centre of Norway - Petrosenter, 2012-2021, UiS	Basic understanding of fluid flow in reservoirs, laboratory experimental studies, EOR and reservoir characterization on field scale	Optimization of IOR methods at pore, core and field scale, rock and fluid interactions and modelling tools for field application
ArCEX - Arctic Petroleum Exploration - Petrosenter, 2012-2021, UiT	Contribute to the understanding of the geology and resource potential of the high north	Learnings and methodologies on subsurface characterization will be implemented in NCS2030.
Low Emission Center Petrosenter, 2019-2026, SINTEF	Develop new technology and concepts for offshore energy systems and integration with renewable power production technologies	Close cooperation on the storage part of the CCS value chain together with NCCS
NCCS - Norwegian CCS Research Centre, FME, 2016-2024, SINTEF	Fast-track CCS by working closely with the industry on research that addresses major barriers in making CCS happen.	Close cooperation on the storage part of the CCS value chain, with synergies in EOR methods and storage capacity
BRU21 - Better Resource Utilization in the 21st century, cluster, 2018-, NTNU	Research program in digital and automation solutions for the petroleum industry	Synergies within the area of digitalization and ML in reservoir characterization.
SIRIUS - Centre for scalable data access, SFI 2015 – 2023, UiO	Addresses the scalable data access with interdisciplinary research leading digitalization in petroleum industry.	Close collaboration on competence and knowledge transfer within digitalization methodology, knowledge, and information.

DigiWells (2020 – 2028) Digital Well Center for Value Creation, NORCE	Center for value creation, competitiveness and minimum environmental footprint within digital drilling and well-technology	Synergies on well completion for IOR and CO_2 storage, also well reporpusing for renewable energy production and storage.
SWIPA - Centre for Well Plug & Abandonment, SFI, 2020 - , SINTEF	Scientific understanding of permanent well barriers and improve the methods for well plugging.	Synergies on knowledge and technology for well reporpusing and P&A for CO_2 storage and energy production.
COREC - Centre for Oil Recovery, industry research program, 2003-2021, NORCE	Increase oil recovery from tight chalk reservoirs, build competence and education as leading IOR center in an international network.	Mutual benefit for technology implementation.
CGER - Norwegian Centre for geothermal energy Research, cluster, 2009- , NORCE	Build a platform for strengthening national cooperation in research and technology within geothermal energy	Synergies in the area of geothermal characterization in sedimentary basins
SUCCESS - Subsurface CO_2 storage, FME 2008-2017, NORCE (previous CMR)	CO_2 storage in the subsurface within storage performance, seal properties, injectivity, monitoring and risk for the environment.	Synergies in the area of subsurface storage, seal capacity and monitoring, which can also be used for the hydrogen value chain
Ongoing consortia: e.g **SAFARI**, **PABAS**; **Syn-Rift Systems**	Subsurface understanding of various geological settings in the NCS led by NORCE, UiS, and UiB	Learning and methodologies will be implemented in NCS2030
Climate Futures, SFI 2020-2028, NORCE	Cross-sectoral center to co-develop better methods and practices for climate risk management.	Synergies in developing forecast methods with uncertainty. Climate change predictions important for NCS2030 risk assessments.
Release Wells initiative 2024, Norwegian Oil and Gas Association	Release of around 700,000 sample database systematically photographed and analyzed using XRF	Utilize the database using digitalization tools for improving subsurface understanding

1.2 Research questions and hypotheses, theoretical approach and methodology

The main research areas of the Sustainable Subsurface Value Chain are organized in eight cross-disciplinary and interconnected work packages (WPs). Researchers will focus on the scientific methodologies within each WP, and the results will be applied in other relevant WPs (Figure 2). Due to their technological nature, WPs 1-6 are described in this section, whereas WPs 7-8 are described in sections 2.2, 3.4 and 3.2.

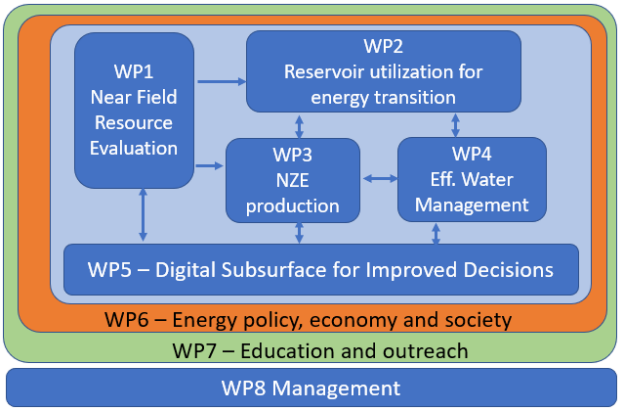

Figure 2 – NCS2030 – Work packages and their relations

WP1. Near Field Resource Evaluation

The growth in energy demand combined with climate change requires the use of new, integrated strategies and multi-disciplinary methods for the long-term sustainable exploitation of subsurface energy resources and storage capacity to reach the NZE goals by 2050 (**SO1, SO4, SO7**). Specific targets of WP1 are:

- Produce an integrated geological holistic model and workflows for a selection of nearby existing infrastructure (hubs; ca 50km radius) to provide energy and storage opportunities.
- Unlock yet-to-find reserves in mature, near-field areas and provide new energy opportunities to extend the life of existing infrastructure.
- Map fluid migration pathways and model basin-scale fluid dynamics to identify locations of best reservoir facies, reduce failure in exploration drilling, and to reduce environmental impact caused by leakage from storage sites.

Research questions:

Q1.1 How can we maximize data usage for building an integrated model of near-field areas and build predictive models for reservoir quality and distribution?

Q1.2 What is the most efficient strategy to identify HC or geothermal reserves, and identify storage sites for H_2 and CO_2 to extend the life of infrastructure for long-term sustainable energy production?

Q1.3 How can we improve the understanding of fluid migration to increase the success of exploration, and reduce uncertainties and risks related to leakage when injecting wastewater, CO_2 and H_2?

Task 1.1 | Reservoir and seal integrity for NZE energy production and storage

A main activity is to evaluate reservoirs for HC production and their potential for long-term storage of H_2, CO_2 and wastewater. In addition, this task will categorize reservoir suitability as a source for geothermal

energy (e.g. HPHT). In the case of H_2, caverns in salt domes are of interest. Detailed characterization of reservoirs for H_2, CO_2 and geothermal energy will be performed in **WP2**. Another activity is to map the basin-scale fluid connectivity from reservoirs to the surface through the overburden and to de-risk charge by correlating the geochemical signature of surface seeps to fluid sources at depth. Therefore, mapping and characterizing structural and stratigraphic traps, as well as carrier beds, faults, gas clouds and chimney structures in the overburden as potential migration pathways will be performed. Processes controlling transport of fluids (HC and brines) from reservoirs to the surface using numerical simulators will also be conducted. To achieve these goals, it is necessary to optimize the use of quantitative geophysical analyses (forward modelling, ensemble methods) in combination with ML (physics informed and Big Data; **WP5**) to improve the search for yet-to-find resources and storage sites. The starting point is to revisit the near field database and integrate different techniques and experiences such as subsurface data interpretation, outcrop analogues, structural analyses, and forward modelling for creating quantitative models with various geological scenarios for reducing uncertainty.

Task 1.2 | Source rocks and primary migration

This task focuses on the fluid dynamics related to aquifer behaviour, petroleum generation and expulsion in the source rocks, followed by fluid migration to charge traps or leakage to the surface. This task proposes to map the distribution of source rock properties and estimate the quantity of petroleum in a petroleum-brine solution that is expelled from the source rocks, a mechanism that is often overlooked. This work involves the development and use of models beyond Darcy flow and linear poroelasticity by including the processes of primary migration and expulsion of HC and water on multiple length scales.

WP2. Reservoir Utilization For Energy Transition

Achieving the NZE target by 2050 requires further development of CO_2 sequestration sites and exploration of alternative energy, such as H_2 and heat. Therefore, developing methods and tools that can enhance the capacity of geological sites for storage (CO_2 and H_2), and production of geothermal energy on the NCS is of importance (**SO1, SO4, SO7**). Specific targets of WP2 are:

- Improve the reservoir energy production strategy with carbon capture and storage.
- Describe and understand H_2 storage and retrieval mechanisms in different geological formations.
- Provide tracer monitoring, leakage remediation and mitigation strategies for waste and energy storage.
- Model reactive flow transport in deformable porous rocks for reliable assessment of storage sites.
- Investigate if HPHT reservoirs can be utilized as geothermal heat mining sites.

Research questions:

Q2.1 What is the reliability and capacity of CO_2 and H_2 storage sites on the NCS?
Q2.2 How can HPHT gas and condensate reservoirs be converted for geothermal heat production in the NCS?
Q2.3 What is the best strategy to prevent leakages during injection and long-term storage?
Q2.4 What is the impact of reactive flow in deformable porous rocks on the performance and safety?

Task 2.1 | CO_2 Utilization and Storage Enhancement

Reaching NZE requires the contribution of CCS technology. The capacity for CO_2 utilization and storage must be increased from 1 Mt/year to Gts/year. This task will evaluate the potential of CO_2 utilization combined with carbon storage in mature and depleted fields on the NCS (improved sweep efficiency in **WP3**). Understanding fluid-rock interactions during CO_2/H_2 injection to enhance storage capacity will be investigated. Improved modelling of CO_2 plume migration in porous media based on reactive flow transport will be performed. Finally, the task will develop strategies for optimized injection operation and remediation of geological formations with support from the modelling and DA tools developed in **WP5**. This includes analysis of multiple scenarios (for modeling of CO_2 plume) and ML/MF based proxy modelling (for optimization of injection operation).

Task 2.2 | Underground H_2 Storage Site Reliability Improvement

H_2 is a key energy source for the decarbonization of the industry. However, intermittency and seasonal availability of renewable sources often do not correspond with energy demands at different times and locations, thus require a mid- to long-term storage solution. Fuel cell batteries are not capable of storing significant amounts of energy. Therefore, the underground storage of H_2 produced from renewable energy during times of over-production is one attractive option (**WP1**). However, integrity and loss of H_2 in subsurface geological sites are still questionable. This task will evaluate the potential of H_2 storage in salt

caverns in the NCS based on geomechanical and geochemical properties (**WP3, 4**). Similarly, improved modelling of H_2 migration in porous media based on reactive flow transport will be performed. It is also of interest to evaluate chemical processes for low-energy H_2 storage and/or incremental capacity for it. Using the same modelling tools as in Task 2.1, we will propose methods for leakage prevention, detection and mitigation to protect the environment.

Task 2.3 | Geothermal Heat Mining from HPHT Reservoirs

Geothermal energy is a promising replacement for fossil fuels and can contribute to overcome the drawbacks in supply, which is characteristic of other renewable resources. With the advance of new technology for heat extraction and energy conversion, even medium temperature sedimentary basins can be utilized as a heat source. However, heat extraction from these basins is not easy and many challenges such as fracture design, scale (salt and calcite) formation, induced seismicity and wastewater management need to be tackled for an efficient heat extraction strategy. The focus of this task is to develop subsurface knowledge for converting HPHT gas reservoirs (**WP1**) to geothermal heat extraction sites for electricity generation. This includes characterizing natural heat-flow and evaluating heat exchange with the subsurface.

WP3. NZE Production

HC production is energy intensive and emits large amounts of CO_2. There is an urgent need to develop concepts and implement new energy-efficient solutions to produce HC resources at the lowest possible emissions (**SO2, SO4, SO6, SO7**). Specific aims of WP3 are:

- Develop IOR concepts for improved, accelerated, profitable and sustainable HC production at low environmental footprint, to reach 50% emission reduction by 2030 and NZE by 2050.
- Propose new sustainable field development strategies integrated with renewable energy sources offered by the upcoming green offshore industries.

Research questions:

Q3.1 How to improve production for both conventional and tight reservoirs using CO_2, polymer, smart water, and mobility control foam to save energy and significantly reduce the overall CO_2 emissions?

Q3.2 What is the late life IOR potential combined with CO_2 storage, and what is the optimal timing?

Q3.3 How can smart wells and advanced stimulation technologies contribute to improved production, in combination with remaining oil saturation measurements using partitioning tracers near wellbore?

Task 3.1 | Maximizing value creation on NCS

Approximately half of the reserves on the NCS will be left in place by the end of field lifetime; with about half in tight reservoirs (< 1 mD for oil, < 0.1 mD for gas fields defined by NPD's 2020). By implementing additional IOR/EOR methods beyond the current seawater and gas/WAG flooding, it is possible to increase production while simultaneously reducing the CO_2 emissions per barrel. This task will further mature the most relevant methods for the NCS and prioritize methods such as smart water, green polymer and CO_2 EOR combined with CO_2 storage (**SO2, WP2**), and foam for CO_2 mobility control. The whole value chain will be evaluated, both for its IOR potential as well as its environmental footprint, emission reduction and energy saving. For example, polymer IOR will include its production, transport, injection, back production, reinjection and discharge; or the time for stimulation and 'slow' HC production from tight reservoirs, combined with CO_2 storage at late field-life to maximize value creation. Partitioning tracers will be further evaluated for in-situ determination of remaining oil (SOR) and wettability, combined with deep well stimulation (Bjørnseth et al., 2019), to directly quantify IOR effects. Modelling tools must be improved to be able to handle the whole value chain (scenarios in **WP5**). It is also important to improve input to the models (**WP5**) by including large scale lab data, information from time-lapse geophysical monitoring and new data from well fibre optics, etc..

Task 3.2 | Real field applications for NZE production

Field production in the coming decades must comply with and support the NZE ambition. At the same time, it is our obligation to maximize value creation from existing fields and infrastructure. New methodology and processes will be developed to evaluate feasible IOR/EOR concepts according to the future regulatory frameworks, including reduced CO_2 emissions, saved taxation and classification of HC products. In this respect, best practice of the life cycle analysis (LCA) will be used to quantify the overall value creation and its implications (**WP6**). Forecasting emission reduction, saved cost and energy for existing and new infrastructure will be based on the DA workflows further developed in **WP5**.

WP4. Efficient Water Management for NZE

The amount of water injected, produced and discharged to sea in aging fields on the NCS is increasing. Water handling is energy-intensive and costly, thus efficient water management is crucial for field economics and effective management will help to protect the environment (**SO2, SO5, SO6, SO7**). Specific aims for WP4 are:

- To investigate solutions for improved macroscopic sweep of reservoirs.
- To minimize injection water recirculation with reduced energy needs, thus reducing CO_2 emissions.

Research questions:

Q4.1 How can water production and recirculation be minimized by conformance control technologies?

Q4.2 How can produced water re-injection (PWRI) become an opportunity for improved recovery and can it be combined with CO_2 applications, such as CO_2/WAG?

Q4.3 How can tracers be used to measure reservoir thief zones for water-shutoff operations?

Task 4.1 | Improved water-management for energy-efficient production

Water conformance control methods for both near-well water shut-off and deep-reservoir water diversion for high water-cut wells will be designed for field implementation. Novel methods utilizing CO_2 (**WP2**) and produced water as injection fluids will be studied for its added value of emission reduction. Tracer techniques (**WP3**) for determining recirculated water volume and thief zone size will be evaluated for real field data to optimize water shut-off operations. Subsurface challenges and opportunities related to in-well water separation and PWRI into another well interval (e.g. thief zone blocking by oil-in-water emulsion; Alahmed et al., 2020) will be evaluated. In addition, injected fluids, chemicals and particles may change rock mineralogical composition, wettability, permeability and geomechanical properties, which may be beneficial or detrimental for efficient reservoir drainage. Experimental and analytical methods will be used to improve the understanding of how the reservoir will respond to these effects in order to improve well treatment operations. Other techniques such as smart well completions and advanced well stimulation will also be studied to accelerate oil production at lower water cut (**WP3**).

Task 4.2 | Near-well modelling tools improvement

Better near-well modelling tools are necessary to improve description of the complex chemical reactions and injectivity in near-well regions during injection, well stimulation and smart well completions. Simulation models, IORSim and OPM, both developed in NIORC, will be further extended to incorporate water and gas injection with blocking gel for conformance control, carbonated water, CO_2/WAG, tracers (passive and partitioning, micro PITT tracer tests), smart well completions with ICD/AICD, and stimulation processes. These tools are critical to design water management operations, estimate cost benefit and emission reduction (**SO2**), and will also reduce uncertainties in the moddels for the digitalization workflows (**WP5**).

Task 4.3 | Real field applications for no water discharge to sea

Validation of real field applications is a critical step to guarantee successful deployment of solutions for water management. Proposed activities include to develop and demonstrate methods on field cases, including first verification on synthetic cases and benchmarking on available field cases, utilizing the digital tools of **WP5**.

WP5. Digital Subsurface For Improved Decisions

Large amounts of subsurface data are available, but current workflows and programs for subsurface understanding are not optimal, resulting in inadequate utilization of datasets. To build a Sustainable Subsurface Value Chain and make more informed decisions, digitalization and ML are necessary to integrate the knowledge and competence building from different WPs (**SO3, SO7**). A digital infrastructure, ***Subsurface Knowledge Cloud (SKC),*** will be established to provide readily usable data and high-performance computing power and visualization tools. Specific targets of WP5 are:

- More robust model forecasts with feasible computational cost and better accessibility of big datasets.
- More comprehensive and reliable uncertainty quantification for multi-purpose reservoir usage.
- Develop data-driven approaches to integrate ML into subsurface-characterization, uncertainty quantification, and the decision-making process.
- **Research questions:**

Q5.1 How can we effectively utilize all available data from available data sources across multiple sites?

Q5.2 How can we develop automated workflows allowing for more robust forecasts from subsurface models with feasible computational cost?

Q5.3 How can important uncertainties be accounted for quantifying uncertainties in model forecasts?

Q5.4 How can ML extract relevant information for decision-making and quantifying data value?

Task 5.1 | Data Assembly, Theory-guided Data science and Multi-fidelity Modeling

Current ensemble-based subsurface-characterization and optimization workflows use computationally expensive physics-based simulators with large input data sets. With increasing model complexities, and with focus on reliable uncertainty quantification, there is a need for increased ensemble sizes to make the uncertainty quantification statistically more robust. Therefore, this task will focus on developing computationally efficient physics-informed ML and MF models for subsurface-characterization and optimization workflows. Accurate ML methods require large data sets for training and validation. Many subsurface data sources are currently available, but without proper metadata labelling and often with unknown quality, thus not ready to be applied. To access and use available data from multiple sources, this task will make tools for automated labelling, quality checking, stamping and preparation of available datasets for effective model input and ML. This will potentially lead to automated workflows through the NCS2030 digital platform SKC based on the computing power and UiS' *Data-centered and Secure Computing Cloud Hub,* which is also connected with cluster-nodes at the Green Mountain data centers (https://greenmountain.no/). Existing data sources and external computing centers can be managed by automated smart contracts agreed in the data federation with OSDU standard.

Task 5.2 | Uncertainty quantification with multiple scenarios

For realistic subsurface flow problems, multiple scenarios including geological setting and process modeling are usually viable. Unwarranted selection of a single scenario for further investigation can lead to large errors in flow forecasts that are not reflected when the corresponding uncertainty is quantified. For realistic uncertainty quantification, it is therefore required that the workflow takes multiple scenarios into account in a statistically correct manner. Published methodologies with this aim typically rely on calculation of the Bayesian model evidence (BME), which is computationally challenging for realistic reservoir model sizes. This task will develop methods for multiple scenarios uncertainty quantification and utilize ML- and MF-enhanced reservoir flow simulations (task 5.1) for calculation of BME, at realistic reservoir model sizes.

Task 5.3 | Improved workflow for decision making

To increase the potential of data science, subsurface characterization through DA, uncertainty quantification, and the decision-making process must be aligned. Therefore, the use of hybrid ML and ensemble-based DA algorithms for improved reservoir management will be implemented. In addition, ML for unbiased uncertainty quantification, decision support, and multi-objective decision-making including the assessment of value-of information and value-of-flexibility will be used. Finally, this task will work on development of new methods for dimensionality reduction to handle complex models and big datasets.

WP6. Energy Policy, Economy and Society

The role of the NCS in the future energy system depends on the national and international business regulations, societal acceptance and licence to operate. The targets of WP6 are to (**SO4, SO5, SO7**):

- Address the competitiveness of the NCS in national and international contexts.
- Contribute to sound climate mitigation policies.
- Understand and explain the risk and uncertainty of investments related to **WP1-WP5**

Research questions:

Q6.1 Does the Norwegian tax and subsidy system ensure the right balance between investment in profitable projects and allowing the petroleum sector as a vehicle for green industries vs avoiding stranded assets and expensive pilot projects?

Q6.2 What are the viable measures to curb emissions in the NCS, e.g., production taxes and electrification?

Q6.3 What are the effects of increasing risk premiums, political scrutiny and competition in the petroleum sector and how to improve handling and communication of uncertainty in businesses and policymaking?

Task 6.1 | Business climate

This task will investigate the role of the business climate (e.g., licenses, taxes, infrastructure, and human capital) for the operations on the NCS as described in **WP1-4**. We will evaluate how the state and the petroleum sector are to balance investing in profitable projects and avoiding stranded assets and expensive failures to gain public support. One of the issues to consider is to identify the increasing discrepancies in the interests of the petroleum sector, the state and society, and the high stakes in petroleum extraction, and climate mitigation. The market may also have decreasing appetite on HC investments, resulting in increasing

risk premiums and fiercer competition in attracting investments. Simultaneously, we will investigate how the complementarities between petroleum and new technologies such as CCS and H_2, can facilitate the transition towards the new energy system. The NCS is in a particularly strong position for taking advantage of these complementarities, but we need to make sure that the business climate is prepared for laying the ground for a successful symbiosis. NCS2030 sees the petroleum sector as the vehicle towards new technologies, but regulatory tools and policies need to be in place for the business climate to adapt seamlessly.

Task 6.2 | Emissions

Supply side policy induced reductions of exploration and production can increase oil prices and reduce CO_2 emissions. There is an emerging interest in this internationally and several countries have implemented such measures. However, given the possibility that other countries can replace production cuts on the NCS, international coordination is likely to be key to making supply side policies effective and to limit the costs of such emission reductions. By using observed variations in actual supply side restrictions across countries, such as production taxes or bans on licencing, and associated investments and production data, this task will bring knowledge on the costs and benefits of cutting emissions through supply side restrictions.

Task 6.3 | Acceptance evaluation

This task will employ and develop risk principles and methods for evaluating the quality of subsurface solutions, including the use of multi-criteria decision-making approaches and prioritization of measures. The increasing scrutiny facing oil producers in politics, in the legal system and in financial markets contribute to a less predictable business climate. How to communicate risk and uncertainty will further be an important part of this task.

1.3 Novelty and ambition

Transitioning the NCS into the future Sustainable Subsurface Value Chain requires a new way of thinking across disciplines and also integration of new offshore industries. The transition time is short; therefore, it is crucial to integrate research, education, collaboration and innovation in order to transfer research results into timely applications. Core and critical elements for achieving a sustainable NCS future are defined by the NCS2030. The focus is on the long-term multi-purpose utilization of the NCS subsurface, including both energy-efficient HC production and the transition to renewable energy resources by utilizing the reservoirs for heat extraction and energy and waste storage. NCS2030 will provide the fundamentals and the framework to transform the NCS into a sustainable energy provider, ensuring energy security and contributing to reaching NZE, and if possible, negative emissions. The main ambitions are classified in the following areas:

Subsurface energy systems: Sustainable development of the NCS requires a more inclusive and dynamic multiphase flow migration model that can be applied not only to explore oil and gas, but also to characterize the geological storage sites for other types of utilization. This model will be applicable for the exploration of oil and gas, storage of CO_2 and H_2, and production of geothermal energy. In parallel, a portfolio of plays near infrastructure for multipurpose utilization within the sustainable subsurface value chain builds the basis for new business opportunities and increases the competitiveness of the NCS in the future. In addition to the ongoing efforts toward commercial CO_2 storage in the subsurface (e.g. Northern lights), H_2 storage and geothermal heat are areas where cutting edge research and rapid implementation are necessary. Subsurface knowledge for blue and green H_2 production and storage of GHG for energy security during unstable supply of other renewable energy sources on the surface is a main keystone. Geothermal energy is among the most climate friendly and renewable sources of energy. The understanding of its potential in sedimentary basins will contribute to power generation for field operations. We expect to develop fundamental knowledge about rock-fluid interactions and fluid flow processes during CO_2 and H_2 storage using laboratory experiments and mathematical models. We will evaluate the role of impurities and fluid chemistry on trapping mechanisms, storage capacity, injectivity, leakage risk, and sweep efficiency.

NZE production: On the NCS it is critical that CO_2 emissions are significantly reduced and HC are energy-efficiently produced at lower water-cut. Many EOR methods are environmentally unfriendly and energy intensive, thus methods that improve reservoir sweep, accelerate oil production and reduce water handling (both for injection and discharge) will be developed for achieving NZE. Possibilities of combining Smart Water/Low salinity water with low concentration polymers will be further investigated. Utilization of CO_2 in

oil recovery processes will be studied, and innovative experimental methods will be used to expand existing knowledge of CO_2 foam flow in porous media. A particular focus will be to establish a link between new observations at the pore- and core-scale to field-scale displacement mechanisms. Efforts will target implications for co-optimizing CO_2 EOR and CO_2 storage when using CO_2 foams for mobility control. Methods with focus on energy-efficiency and new promising chemicals for water shut-off such as thermo-associative polymers (TAP) will be developed. This fundamental research will lead to improved understanding of the mechanisms involved in better HC recovery with less water. The generated results will supply input data in simulation models for decreasing the modelling uncertainty. New tracer deployment methods for determining in-situ wettability and SOR will be developed. For evaluating the success of applying a method, existing in-house modelling tools will be further improved to handle near-well geochemical and physical processes.

Digitalization: Digitalization and ML are becoming the processes and tools that can lead the transformation into an efficient and sustainable industry. MF modeling is a rapidly growing area in many science disciplines, but it has not been extensively applied for subsurface. Since porous-media properties vary with fluid types and scales, and while it is unclear how these will influence modelling results, porous-media flow for multi-purpose reservoir usage seems a natural habitat for MF modeling. We expect developments of new theoretical and methodological advancements within MF modeling for application to reservoir modeling. Multi-scenario uncertainty quantification for large-scale reservoir models is a daunting computational task, and it will not be possible without significant scientific progress regarding computation of the BME. Development of techniques and workflows that permit constructive predictive and quantitative models with integrated data sources of analogues and large subsurface datasets, assisted with ML and fast forward models, will be a continuous process with arising target towards the sustainable transition. The data and tool accessibility barrier will be removed by the planned SKC which can be effectively used as a testbed, and as an innovation and education platform for modelling and ML tools.

Society: After 50 years of successful operations, the NCS is experiencing mixed signals from policy makers and society. The markets are in the short run positive, with a rising oil price at the wake of the pandemic and a likely investment deficit globally to replace declining supply. In the longer run, climate mitigation actions are likely to reduce demand and hence the price for oil and gas. This is likely to increase the competition for investments in oil and gas. Many countries may be able to compete with the NCS in terms of production costs and may have large potential for stimulating their oil sectors by reducing investment-distorting taxes. The project will investigate the role of the business climate for the continued operations on the NCS. The project will lead to tangible results on economic costs and benefits as well as on risk analysis. In turn, these will help policy makers and the sector with balancing the challenge investing in profitable projects, avoiding stranded assets and contributing to lower GHG emissions.

2 Impact

2.1 Potential impact of the proposed research

NCS2030 contributes to several **UN Sustainable Development Goals (SDG)** including **SDG 7** (affordable and clean energy) by building new competence and research solutions for the Sustainable Subsurface Value Chain, **SDG 13** (climate action) by providing solutions for a NZE society by 2050; **SDG 4** (education) by educating the new generation of professionals for the energy transition; and also **SDG 8** (decent work and economic growth); **SDG 9** (industry, innovation, and infrastructure) by building competence for new business opportunities; **SDG 12** (responsible consumption and production) by providing solutions for low-emission and effective utilization of the subsurface; **SDG 14** (Life below water) by safe subsurface storage of CO_2/H_2 and reduced water discharge to sea; and **SDG 5** (gender equality) by setting the ambitious goal that at least 40% of center staff will be female.

Nationally, NCS2030 will play an important role as the national subsurface competence center in educating a new generation workforce for the transformation of the NCS into the Sustainable Subsurface Value Chain to achieve the Norwegian national emission reduction goals. This transformation will require new technologies and solutions as well as competences and skilled human resources. The proposed research

topics in NCS2030 will address this broad need while ensuring energy security and contributing to building new industries. **Internationally**, NCS2030 will promote Norway as an attractive technology and knowledge provider worldwide for the sustainable offshore energy sector and will reinforce Norway's leadership in sustainability.

Advances in science and technology within NCS2030 will have its greatest impact on the **energy industry** by facilitating its green transition and supplying skilled professionals. The results and deliverables include a holistic understanding and utilization of subsurface, next-generation modelling tools and methodologies, solutions with new technologies or by integrating state-of-the art technologies, and well-trained research and work forces. More specifically, we will develop new and improved knowledge of geological plays for both new HC resources and for renewable energy combined with CO_2/H_2 storage. We will recommend more energy-effective HC production solutions with minimized carbon footprint by integrating renewable energy sources and a CCS value chain. We will develop effective digitalization tools and methods for subsurface characterization with multiple scenarios, quantification of uncertainties for better decision, extend the experience of ensemble-based workflows for emission reduction, energy efficiency, utilization of reservoirs for storage of energy and waste, and effective use of multiple data sources to improve interoperability. The new tools and methods will lead to better decisions, increased value creation, reduced risk and improved safety. Furthermore, the research results will also guide the role of policy, regulatory framework, and support energy companies, investors and decision makers in assessing risks and profitability for the future NCS.

The planned Innovation Program will form a platform for the **industrial partners** to quickly adopt new technologies and methods to their operations and develop new services and products both for the NCS and for export. This will contribute to value creation for the companies in the transition period and contribute to economic growth, job security and social welfare.

The impact for **academia** includes the opportunity of conducting high-level industry-relevant research of benefit for the industry and society, and to directly contribute to the transformation of the NCS toward a Sustainable Subsurface Value Chain. Research dissemination of the PhDs', Postdocs' and master students' work using open access channels and international conferences will attract more students to study subsurface topics. Additionally, it will encourage closer collaboration with the existing academic programs and current development of continued education for professionals at the Department of Energy Resources at UiS within the fields of digitalization and energy transition of the subsurface. A plan for the young researchers and students to work in close collaboration with experts from the industrial partners will be established (e.g., company placement). PhD and Postdocs will have access to The Petroleum Research School of Norway (NFIP; https://nfip.no/) where relevant courses and workshops will be implemented. High quality publications will increase the chance for Norway to attract funding from international programs such as EU Horizon 2020 (Societal Challenges) and Horizon Europe (Climate, Energy and Mobility).

2.2 Measures for communication and exploitation (WP7)

An active webpage and data portal will be established as the Center starts.To impact and reach out to the scientific community, NCS2030 scientific results will be published in open access, high-impact science and technology journals, and in journals for other sectors for cross-pollination. We anticipate publishing a minimum of 150 high-impact papers in scientific peer-reviewed journals during the eight-year lifetime of the Center, as well as 20-30 conference presentations per year to disseminate research results. At the same time, the petroleum industry needs skilled human resources for many years to come, but there is a lack of interest for studying subjects related to petroleum which will lead to lack of competence in the long-term. Therefore, we will work together with stakeholders, such as the Norwegian Oil and Gas Association (https://www.norskoljeoggass.no/en/) to communicate the national importance and career opportunities by providing seminars to young people at secondary and high schools, social media, and newspapers. We will use our research to change the negative public perception of petroleum production. Therefore, NCS2030 will offer an opportunity to the next generation of professionals to transform the energy industry. A main dissemination arena is the annual **Energy Norway Conference (ENC)** (to replace the IOR Norway Conference 2015-2021) as the meeting place for subsurface professionals in Norway and international communities,

policy makers, regulatory bodies and students. The NFIP is another instrument to divulgate competence via courses, workshops and summer schools. Furthermore, close collaboration between researchers, students and industry partners will be prioritized through frequent workshops to exchange research results

NCS2030 will act as a catalyst to expand project activities to EU initiatives and will collaborate with other research and innovation centers (Table 1). The goal is to fill knowledge gaps for complete solutions for the sustainable transformation of the energy sector. An additional way to facilitate fast-track innovation of the research results from the Center is through the planned **Innovation Program** under the NCS2030 umbrella. This will contribute to accelerate implementation of new solutions to meet the NZE goals. An Innovation committee (described in 3.2), assisted by the Technology Transfer Office (TTO) (Validé, https://valide.no/), will continuously scout and create new projects for innovative solutions (**SO6**). The Center's consortium agreement will manage the use of the research results and intellectual property rights (IPR). A separate agreement between the Innovation Program and Center's sponsors will regulate the background IPR.

Data Management Strategy (DMS) will be largely based on planned SKC (WP5) making the Center's output findable, accessible, interoperable and reusable (FAIR). The practicial DMS will be implemented according to the main partners' data management practice in line with the research data management requirements.

3 Implementation

NCS2030 consists of four main academic and research partners with cutting edge competence in subsurface understanding, petroleum and energy resources: University of Stavanger (**UiS**; Center host), Norwegian Research Centre AS (**NORCE**), Institute for Energy Technology (**IFE**), and University of Bergen (**UiB**). In addition, The University of Tromsø (**UiT**), Department of Geosciences will be an associated academic collaborator providing knowledge and PhD co-supervision in WPs 1, 2 and 6. University of Oslo (**UiO**) will be involved in WP5 through SIRUIS, and potentially in WP1,2 for PhD co-supervision. The partners have been collaborating in NIORC (2013-2021) with joint research activities and educating more than 40 PhD/postdoc candidates and also participating in other research centers and larger research projects. NCS2030 will benefit from this collaborative foundation by building on expertise and networks to achieve the Center's goals.

3.1 Center director and project group

Center Director: The Center's director, Professor ***Alejandro Escalona*** is currently Head of the Department of Energy Resources at the University of Stavanger (UiS) until May 2022. Prof. Escalona has more than 25 years of both industry and academic experience, where he, for the last 16 years, has been leading industry projects with focus on the subsurface, together with academic and research institutions both nationally and internationally, with participation of more than 30 industry partners, and total budget over 100MNOK.

Management team and allocated resources: The **Assistant Center Director** is ***Ying Guo,*** PhD, Special Advisor and Senior Business developer at NORCE, and since 2019 Director of NIORC. She has 30+ years' experience within both research, software development (DISKOS), and work experience in an oil and gas company as well as extensive research project management experience. **Christian Dye,** Cand. Scient. is Research Director for Environmental Technology at IFE and will be appointed as **Research and Innovation Director.** Associate professor **Dora Marin** at the Department of Energy Resources at UiS will be appointed as the **Academic Director**. UiS-employed **Administrative and Communication Coordinators** will assist the Center Management with resource planning, supporting outreach and communication as well as PhD/PostDoc students. The Center Director and Assistant Director will fill ca. one full position, whereas the rest of the management will be covered by ca. one full-time position, in addition to administrative support from UiS.

UiS has a long track-record and worldwide recognition in both education and research in the field of petroleum engineering and has been fundamental for the development of the petroleum industry in Norway and the Stavanger region with management of large industry- and RCN-sponsored projects. A major strength of UiS is the multidisciplinary integration between geosciences, reservoir engineering, reservoir chemistry, EOR/IOR, modelling and decision making, together with computer science, economy, risk analysis and social sciences. UiS is also well-equipped with experimental laboratories and digital infrastructure. NCS2030 is aligned with the university's 10-year strategy focusing on the transition to green energy. The specific

competence available at the Department of Energy Resources within subsurface together with the Department of Safety, Economic and Planning, the Business School and the Department of Electrical Engineering and Computer Science fits with the skills needed for NCS2030. All researchers have excellent publication records and impact within the key areas of expertise for the Center's activities.

NORCE is one of Norway's largest independent and multidisciplinary research institutes. NCS2030 goals are well aligned with the NORCE strategy within Sustainable Energy Production. NORCE has long and broad experience in hosting large and complex research centers and has a large portfolio of CCUS and hydrogen related projects funded by national and EU research programs. Relevant groups of highly competent researchers in subsurface digitalization, computational geosciences, computational modelling, geochemistry, geomechanics, well completion and P&A, IOR, CO_2 leakage monitoring and risk mitigation, etc. will be directly involved in NCS2030. NORCE competence in environmental, climate and social science will assist the NCS2030 research.

IFE has since 1948 been a frontrunner in international energy research. IFE contributes to new solutions in renewable energy and petroleum industry, more energy-efficient industrial processes, zero-emission transport solutions and future-oriented energy systems. IFE has extensive infrastructure and full-scale laboratories where theoretical models are transformed into commercial activities. Relevant competence of IFE in NCS2030 is advanced reservoir technology which includes laboratories for tracer technology and fluid migration studies, research groups working with basin modelling, simulation, multiphase modelling (e.g. Olga) and artificial intelligence.

UiB and the Department of Physics and Technology has a record of producing high-quality research related to NCS2030. The Reservoir Physics Group has developed technologies for mitigating climate change and securing energy supply. Research focuses on multiphase flow in heterogeneous and fractured reservoirs, hydrate technology, *in-situ* fluid saturation imaging, integrated EOR (IEOR), CCUS, CO_2 EOR and CO_2 storage, and foam in CO_2 mobility control.

Workplan: Eight work packages (WPs) with defined tasks will be used to manage the research activities. WP leaders have been selected based on their research and management skills. Specific targets, short and long-term goals and milestones within each WP are shown in Table 3. These will be defined in more detail jointly with stakeholders throughout the management governance.

Table 3. Work Packages, leaders, research partners and milestones. All WPs start in 2022 and end in 2029.

Work Packages /Tasks	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
WP1 - Near Field resource evaluation (Lead: IFE – **S. Polteau**; UiS – D. Marin; NORCE – T. Bhakta)								
Task 1.1 - Reservoir and seal integrity for net-zero energy		M1a	M1a,b	M1b	M1b		M1d	M1d
Task 1.2 - Source rocks and primary migration				M1c			M1c	
WP2 - Reservoir utilization for energy transition (Lead: IFE – **V. Yarushina**; UiS – R. Gholami; NORCE – I. Fjelde; UiB – Z. Alcorn)								
Task 2.1 - CO_2 utilization and storage enhancement		M2a		M2a				
Task 2.2 - Underground hydrogen storage site reliability improvement			M2b	M2b			M2c	M2c
Task 2.3 - Geothermal heat mining from HPHT reservoirs			M2d			M2d	M2d	
WP3 – Net Zero Emission (NZE) production (Lead: UiS - **Tina Puntervold**; NORCE – S. Åsen; IFE – S. Viig; UiB – A. Graue)								
Task 3.1 - Maximizing value creation on NCS	M3a	M3b	M3a,b		M3a,b		M3a,b	
Task 3.2 - Real field applications			M3c		M3c	M3c	M3c	
WP4 - Efficient water management for NZE (Lead: NORCE- **Randi Valestrand**; UiS – P. Andersen; IFE-S. Hassfjell)								
Task 4.1 - Improved water-management for energy-efficient prod.		M4a		M4a				
Task 4.2 - Near-well modelling tools			M4c		M4b	M4b		
Task 4.3 - Real field applications for no water discharge to sea							M4d	M4d
WP5 - Digital subsurface for improved decisions (Lead: NORCE **Geir Evensen**; UiS – C. Rong; IFE – T. Nordlander)								
Task 5.1 – Data Assembly, Theory-guided Data science & MF Modelling		M5a	M5a, b	M5b, c				
Task 5.2 - Uncertainty quantification with multiple viable scenarios			M5e		M5e			
Task 5.3 - Improved workflow for decision analysis		M5d	M5d			M5d		
WP6 - Energy policy, economy and society (Lead: UiS – **Torfinn Harding**; NORCE – A. Blomgren; IFE – K.T. Espegren)								
Task 6.1 - Business climate on NCS				M6a				M6a
Task 6.2 - Emissions		M6b			M6b			

Task 6.3 - Acceptance evaluation				M6c				M6c
WP7 – Education and Outreach (Lead: UiS – **Dora Marin**; Participants: NORCE, IFE, UiB)								
Annual Energy Norway conference (ENC)	1	1	1	1	1	1	1	1
N° of PhD / PostDoc (start) - 21 candidates in total	3/0	4/1	2/1	2/3	3/0	2/0	3/0	0
N° of innovation (spin-off projects)	0	2	2	2	2	2	2	3
N° of Scientific workshops	3	3	3	3	3	3	3	3
N° of Scientific publications	10	10	10	20	20	25	25	30
WP8 - Management and reporting (Lead: UiS – **Alejandro Escalona**; Participants: NORCE, IFE, UiB)								
Management and communication	M8a,b				M8c			M8d
Reporting (annual and bi-annual reports)	2	2	2	2	2	2	2	2

M1a Methodologies for quantitative prediction of reservoir established. **M1b** Mapped and updates of the Reservoir potential and integrity for HC, CO_2, H_2 and waster in near field areas; **M1c** Established models for primary migration and expulsion of HC and water, and connectivity into the reservoirs; **M1d** Categorization of suitability reservoirs as a source for geothermal energy; **M2a** Solutions for combine CO_2 EOR with Carbon Storage. **M2b** Identified and updates of the most important parameters to enhance storage capacity of CO_2 and H_2; **M2c** Modelling tools for CO_2 and H_2 plume migration based and monitoring input; **M2d** Potential of geothermal energy in the NCS estimated. **M3a** EOR methods with low emission potential proposed; **M3b** IOR Solutions for tight reservoirs proposed for new innovation projects; **M3c** Improved near-well modelling capabilities ready for use; **M4a** Water conformance control method cases recommended for field implementation; **M4b** Near-well modelling tools; **M4c** IORSim upgrade including chemical reactions- **M4d** Field methods demonstration and suitable field cases identified. **M5a** Subsurface Knowledge Cloud up and running; **M5b** Methodologies for MF uncertainty quantification integrated workflow ready; **M5c** ML proxy models tested; **M5d** Hybrid ML-Ensemble methods for improved reservoir management showcase ready; **M5e** ML/MF calculation of BME; **M6a** Impact of the NCS2030 solutions into the business climate analysed; **M6b**: Achieved understanding of the policy impact of emissions; **M6c** Criteria for supporting policy makers established. **M8a**: NCS2030 start, all contracts in place, kick-off workshop; **M8b** NCS2030 website up and running; **M8c** Midway evaluation by RCN, **M8d** Final center ending event.

3.2 Organization and management structure (WP8)

The management structure (Figure 3) facilitates the industry's active involvement and is fundamental for the Center's success. The **Center Management** (**CM**) will be responsible for the daily research activities and will coordinate across WPs in regard to education, industry contacts, innovation and outreach. The **General Assembly** consists of representatives from all research and industry partners and elects the **Board.** RCN and other stakeholders will have observer status. The Board provides overall directions and goals, and monitors operations according to the Consortium Agreement. For effective collaboration and dissemination, a **Technical Committee (TC)** will consist of representatives from the industrial partners to follow research activities and give technical input to ensure its relevance. The **WP leaders** will be responsible for scientific research and deliverables. Researchers, students and user partners will work closely through frequent meetings and seminars.

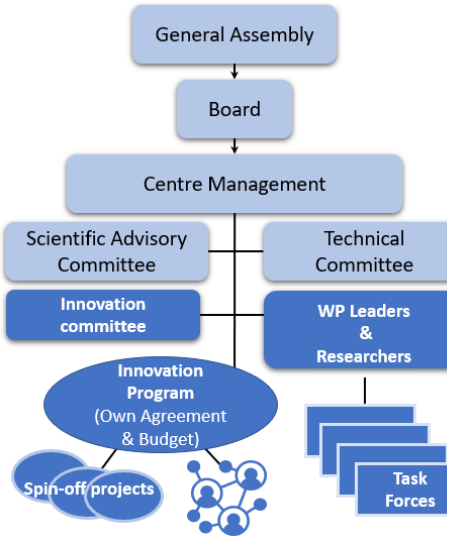

Figure 3 - The management structure

Task Forces (TF) will be established on an as-needed basis and consist of technical experts and users from industry and researchers across WPs. TF will collaborate with the Innovation Program to create new spin-off projects. Further, a **Scientific Advisory Committee (SAC)** will consist of international experts to provide advice and ensure scientific quality at the international level. The Board, TC, TF and SAC will work closely with CM according to the Center's governance.

An **Innovation committee** (proposed to be lead by industry) will be established by CM with the purpose of identifying and foster innovative solutions from the Center's research results. The Innovation committee will work closely with CM, WP leaders, Board and TC with its TFs to monitor research results, by investigating further potential for field demonstration, implementation or commercial products. This activity will be part of the NCS2030 Innovation Program outside of the NCS2030 scope. A PhD/Postdoc representative will be invited to be part of the committee. The goal of the Innovation Program is to establish dedicated projects and processes for technology development, demonstration, or commercialisation with separate private or public funding to accelerate implementation.

User partners represent petroleum companies on the NCS and technology providers, all in the transition to sustainable energy companies and many involved in CCS. They will contribute to the Center via Board, TC, Task Forces and Innovation committee making critical decisions, defining challenges and research goals, providing field cases and critical datasets, exchanging information, participating in Center workshops, hosting and co-supervising students and PhD/Postdocs and facilitating the Innovation Program. At the same time, they will benefit from the Center by exchanging competence and knowledge. Large service companies such as Schlumberger and Halliburton will actively participate in the Center's research and innovation activities with their know-how, digital infrastructure and technology. More details are provided in their letters of intent.

Research infrastructure: The research partners together possess necessary research infrastructure. This includes laboratories of top national ranking, from the microscopic- to core-scale for studies on chemical-CO_2-EOR, CCUS, geomechanics, large-scale porous flow at realistic reservoir temperatures, pressures and flow rates. In addition, the Center's capabilities include unique and world-leading corrosion laboratory for CO_2 and H_2, tracer laboratories to test and prepare tracers for field operations and laboratories for Special Core Analysis (SCAL). The partners also operate, jointly or separately, national infrastructure such as the Ullrigg well center, and the P&A Lab for new technology testing and qualification. The partners have the necessary computer capacity to handle large subsurface data sets and models to perform advanced modelling and simulations, including in-house developed tools, own computing clusters and cluster-nodes at Green Mountain. In addition, NCS2030 will benefit from other national research infrastructures such as the CO_2-lab In Svalbard and Breivik and UNINETT/Sigma2 for supercomputing. We will also identify advanced equipment and computing power/data sources from our international academic and industrial and partners, e.g. wide ranges of micro CT rock scanners at partners sites for special studies, data storage, tools from DISKOS and other relevant data sources from industrial partners and technology providers.

Risks: The identified main risks, their likelihood of occurrence and mitigations are summarized in Table 4.

Table 4. Main risk assessment and mitigations

	Likelihood	Measure for mitigation	Continuous risk analysis
The public/society acceptance for petroleum industry	Medium to high	Outreach activities (WP7) promoting the importance of the subsurface and petroleum competence for the energy transition	Monitoring the perception of the public via newspapers and other media
Change of policy, market, regulatory framework	Medium to high	Discuss with RCN, academic and industry partners and collaborators alternative activities	Periodically revise policies and regulatory framework
Difficult recruitment of skilled personnel	Medium	Promote positions to research partners and collaborators. Advertise in relevant channels	Active scouting of qualified candidates; maintain communication with partners and collaborators
Delays in access or limitation to lab facilities	Low	Planning of activities in due time and alternative options if facilities cannot be used	Maintain overview of planned lab activities and timeline
Critical personnel leaving / sick	Low to Medium	Have regular personnel dialogue to capture any possible leave or health situation. Find qualified replacement personnel when needed	Continuous dialogue and good follow up with personnel, training of personnel with wider skills.
Limited subsurface data access	Low to medium	Discuss with industry, data providers and NPD for sharing data.	Evaluate data replacement, limitations of vintage vs new data

3.3 International cooperation

The NCS2030 key research collaborators have high international recognition and are strategically positioned. In addition, the planned annual ENC conference will be an arena to attract other relevant international collaborators to stimulate new ideas, facilitate innovation and explore technology export opportunities. PhDs and postdocs will spend parts of their studies at selected collaborators' locations to participate in large international R&D programs. Collaborators include: **The University of Texas at Austin (USA)** in petroleum engineering and CO_2 storage research. **University of Basilicata (Italy)** with support with field analogues and detailed sedimentological studies. **University of Aberdeen (UK)** with expertise in CCUS and digital rock. **UFRJ and UNICAMP (Brazil)** are two universities already in close collaboration with NIORC and CCUS subjects; **Imperial College (UK)** and **Edith Cowan University (Australia)** with knowledge in H_2 storage; **Danish Technical University/The Danish Hydrocarbon Research Centre (Denmark)** addressing similar challenges in the Danish

North Sea; **University of New South Wales (Australia)** in geothermal energy; **Stanford University (USA)** on decision analysis, uncertainty and value of data; **Virginia Tech (USA)** on ML and DA. **RWTH Aachen University (Germany)** on MF modelling; **Memorial University** (**Canada)** has long-lasting collaboration on their offshore petroleum industry challenges; and exchanges with the **Oil and Gas Technology Centre in UK** which supports technology for the transition.

3.4 Researcher training and recruitment (WP7)

The Sustainable Subsurface Value Chain requires developing a new generation of skilled workforce (WP7). The needed solutions must be developed in collaboration between experienced researchers and the younger generation. However, the number of students in petroleum-related topics at universities in Norway has dramatically declined and the supply of people with subsurface competence is approaching a critical low level. NCS2030 will be an instrument to show tangible solutions for the energy transition and climate change mitigation and has plans to educate at least 21 PhD/Postdocs and at least 40 MSc students within all research areas. Part of their training will be spent at our international partner locations and UiS will provide support via the research strategy program for guiding them in their carreer path. They will also participate in the activities at NFIP, interact with academic and industrial partners in meetings and research visits, present their research at the annual ENC and Center workshops. UiS also offers study programs in relevant areas such as subsurface, energy, risk, decision analysis, economy, etc., where the Center's results will be part of the research-based education. Also, UiS is planning to establish the "**National Subsurface Academy**", an initiative to secure subsurface competence through mapping competence needs, continuous update of study programs and the re-education of professionals in the areas of digitalization and energy transition.

3.5 Gender equality

NCS2030 has an official goal to have no less than 40% women or men among staff (following the success of the NIORC). The proposed CM (incl. WP leaders) fulfills this ambitious goal with 50-50% female-male balance (section 3.2). The number of female PhD-students is still much lower than that of male PhD-students within petroleum and energy related topics. The Center aims to educate at least 40% female PhDs/Postdocs, therefore we expect to attract more female candidates and promote them to choose subsurface related studies. In accordance with UiS policy, females will be particularly encouraged to apply for the positions. NCS2030 will encourage external committee and board members to include female representatives. Likewise, NCS2030 will encourage international partners to preferentially include female researchers.

3.6 Overall budget outline

The budget and funding are provided in Table 5a and 5b. The Innovation Program funding is not included and will have separate funding by in-kind and cash from the Center partners.

Table 5a. Overall budget per partner for each WP (KNOK)

Work Package	UiS	NORCE	IFE	UiB	Halliburton	Schlumberger	Total
WP1	18,218	4,200	9,800	-	1,000	1,000	**34,218**
WP2	6,592	20,975	11,111	11,523	1,500	1,500	**53,200**
WP3	8,471	15,505	9,800	11,817	1,500	1,500	**48,594**
WP4	14,112	11,800	9,800	551	1,000	1,000	**38,263**
WP5	20,472	23,200	9,800	1,653	4,000	4,000	**63,125**
WP6	4,985	4,850	1,625	276	-	-	**11,735**
WP7	6,904	400	200	836	-	-	**8,340**
WP8 - Mngt	25,533	5,800	3,500	836	1,000	1,000	**37,669**
Sum	**105,286**	**86,730**	**55,636**	**27,493**	**10,000**	**10,000**	**295,144**

Table 5b. Funding per partner for each WP (KNOK)

Year	NRF Funding	UiS	NORCE	IFE	UiB	6 Companies cash	2 companies in-kind	TOTAL
WP1	18,779	3,932	-	-	-	9,506	2,000	**34,218**
WP2	16,059	4,001	-	3,636	3,636	22,869	3,000	**53,200**
WP3	12,387	6,464	3,530	-	3,857	19,356	3,000	**48,594**
WP4	9,824	3,759	-	-	-	22,680	2,000	**38,263**
WP5	14,465	3,767	-	-	-	36,893	8,000	**63,125**
WP6	1,513	3,819	-	-	-	6,404	-	**11,735**
WP7	934	6,904	-	-	-	502	-	**8,340**
WP8 - Mngt	6,039	22,640	3,200	2,000	-	1,790	2,000	**37,669**
Sum	**80,000**	**55,286**	**6,730**	**5,636**	**7,493**	**120,000**	**20,000**	**295,144**

Table 5b specification: UiS funding will cover 7 PhD/Postdoc candidates and part of centre management, NORCE and IFE will cover 1 PhD each and part of centre management, and UiB will have 2 in-kind PhDs. The cash contribution of 6 companies and the in-kind contribution from 2 companies will be distributed evenly within each work package.

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Appendix 2: Specification of the Project's funding plan

Below follows a supplementary description of the individual Party's obligations, and a specified orientation of contribution and cost per party. This is based on, and in accordance with information in Appendix 1. The cost plan for each Party is based on information of costs provided by the Party.

Funding plan for each Party (in NOK 1 000)

UiS	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding	924	2 226	2 263	3 598	3 118	**12 130**	**15 %**
Cash contribution	701	3 150	4 483	4 597	4 718	**17 649**	**22 %**
In-kind	5 792	10 576	10 818	13 883	9 981	**51 050**	**63 %**
Sum	**7 418**	**15 952**	**17 564**	**22 078**	**17 816**	**80 828**	**100 %**

NORCE	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding	4 000	4 000	4 000	4 000	4 000	**20 000**	**37 %**
Cash contribution	5 320	5 744	5 871	6 002	6 137	**29 074**	**53 %**
In-kind	400	1 542	1 576	1 612	400	**5 530**	**10 %**
Sum	**9 720**	**11 286**	**11 447**	**11 614**	**10 537**	**54 603**	**100 %**

IFE	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding	2 500	2 500	2 500	2 500	2 500	**12 500**	**35 %**
Cash contribution	3 575	3 658	3 742	3 830	3 920	**18 725**	**52 %**
In-kind	250	250	1 426	1 462	1 498	**4 886**	**14 %**
Sum	**6 325**	**6 408**	**7 669**	**7 792**	**7 918**	**36 111**	**100 %**

UiB	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding	150	500	1 300	1 250	1 200	**4 400**	**27 %**
Cash contribution	550	1 250	1 450	1 750	1 750	**6 750**	**42 %**
In-kind			1 176	1 212	2 496	**4 883**	**30 %**
Sum	**700**	**1 750**	**3 926**	**4 212**	**5 446**	**16 033**	**100 %**

Landmark Graphics	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding							**0 %**
Cash contribution							**0 %**
In-kind	1 250	1 250	1 250	1 250	1 250	**6 250**	**100 %**
Sum	**1 250**	**1 250**	**1 250**	**1 250**	**1 250**	**6 250**	**100 %**

Schlumberger	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding							**0 %**
Cash contribution							**0 %**
In-kind	1 250	1 250	1 250	1 250	1 250	**6 250**	**100 %**
Sum	**1 250**	**1 250**	**1 250**	**1 250**	**1 250**	**6 250**	**100 %**

Equinor	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding							**0 %**
Cash contribution	2 500	2 500	2 500	2 500	2 500	**12 500**	**100 %**
In-kind							**0 %**
Sum	**2 500**	**2 500**	**2 500**	**2 500**	**2 500**	**12 500**	**100 %**

Vår Energi	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding							**0 %**
Cash contribution	2 500	2 500	2 500	2 500	2 500	**12 500**	**100 %**
In-kind							**0 %**
Sum	**2 500**	**2 500**	**2 500**	**2 500**	**2 500**	**12 500**	**100 %**

DNO	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding							**0 %**
Cash contribution	2 500	2 500	2 500	2 500	2 500	**12 500**	**100 %**
In-kind							**0 %**
Sum	**2 500**	**2 500**	**2 500**	**2 500**	**2 500**	**12 500**	**100 %**

OKEA	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding							**0 %**
Cash contribution	2 500	2 500	2 500	2 500	2 500	**12 500**	**100 %**
In-kind							**0 %**
Sum	**2 500**	**2 500**	**2 500**	**2 500**	**2 500**	**12 500**	**100 %**

Aker BP	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding							**0 %**
Cash contribution	2 500	2 500	2 500	2 500	2 500	**12 500**	**100 %**
In-kind							**0 %**
Sum	**2 500**	**2 500**	**2 500**	**2 500**	**2 500**	**12 500**	**100 %**

Wintershall DEA Norge AS	**2022**	**2023**	**2024**	**2025**	**2026**	**Sum**	**%**
NFR Funding							**0 %**
Cash contribution	2 500	2 500	2 500	2 500	2 500	**12 500**	**100 %**
In-kind							**0 %**
Sum	**2 500**	**2 500**	**2 500**	**2 500**	**2 500**	**12 500**	**100 %**

Funding and reporting

It is expected that the Parties keeps within the budget and cost limit. Each Party keeps its own Project accounts of Project financing and Project costs. Project financing and Project costs must be stated in each Party's official accounting.

Each Party shall submit a yearly report on activities and progress by 1 November.

The Project Owner must submit a complete financial report to the Funding Authority for the calendar year by 20 January. Therefore, each Party must submit a financial report including total costs for the

previous calendar year to the Project Owner, hereunder in-kind contribution and the costs funded by the Funding Authority, by 10 January.

The Project Owner will distribute funding following the Funding Authority's approval of the annual financial report according to received invoices from the Parties to the Project Owner.

The invoice must be marked with: UiSPG NCS2030 Petrosenteret

University of Stavanger - invoice address:
Org.no: 971 564 679
Invoice address for EHF-invoices: 971564679

International invoices should be sent by email as a PDF to: faktura@uis.no

Bank information:
Sparebank 1 SMN, Søndre gate 4, 7011 Trondheim, Norway
Account no for payment to UiS: 4209 01 01743
IBAN: NO0442090101743
Swift: SPTRNO22

Appendix 3: Background

As to **UNIVERSITETET I STAVANGER**, it is agreed between the Parties that, to the best of their knowledge, no Background is needed by another Party for implementation of the Project or utilisation of that other Party's Results.

As to **NORCE**, it is agreed between the Parties that, to the best of their knowledge no Background is needed by another Party for implementation of the Project or utilisation of that other Party's Results.

As to **INSTITUTT FOR ENERGITEKNIKK**, it is agreed between the Parties that, to the best of their knowledge no Background is needed by another Party for implementation of the Project or utilisation of that other Party's Results.

As to **UNIVERSITETET I BERGEN**, UiB is the sole owner of previously developed and granted Background Patents governing the use of CO2 for production of methane from Hydrates and for Foam EOR with associated CO2 storage.

As to **LANDMARK GRAPHICS**, Landmark Graphics maintains and retains full ownership of its Background and makes no contribution, license, or non-assertion right to a Project or Parties of the Collaboration Agreement, unless explicitly agreed for a particular Project in a signed R&D Contract. Nothing in this Collaboration Agreement limits Landmark Graphics' activities alone or with others regarding developing technology related to the scopes of the Work Plans. If Landmark Graphics' in-kind contribution is in the form of software solutions, applicable terms for academic/research use will apply and be provided at the time of distribution/access.

As to **SCHLUMBERGER**, it is agreed between the Parties that, to the best of their knowledge**:** The following Background is hereby identified for the Project. Specific limitations and/or conditions shall be as mentioned:

Describe Background	*Specific limitations and/or conditions for implementation*	*Specific limitations and/or conditions for Commercial Utilisation*
DELFI Cloud-based solutions, Including the Petrotechnical Suite (Petrel, Techlog, Eclipse, etc.)	*User rights for the purpose of implementation of the Project is subjected to IP, licensing, and copyrights*	*Project Results obtained through Schlumberger's solutions are for research purposes as per project's description*

As to **EQUNIOR**, it is agreed between the Parties that, to the best of their knowledge, no Background is needed by another Party for implementation of the Project or utilisation of that other Party's Results.

As to **VÅR ENERGI**, it is agreed between the Parties that, to the best of their knowledge, no Background is needed by another Party for implementation of the Project or utilisation of that other Party's Results.

As to **DNO**, it is agreed between the Parties that, to the best of their knowledge, no Background is needed by another Party for implementation of the Project or utilisation of that other Party's Results.

As to **OKEA**, it is agreed between the Parties that, to the best of their knowledge, no Background is needed by another Party for implementation of the Project or utilisation of that other Party's Results.

As to **AKER BP**, it is agreed between the Parties that, to the best of their knowledge, no Background is needed by another Party for implementation of the Project or utilisation of that other Party's Results.

As to **WINTERSHALL DEA NORGE AS**, it is agreed between the Parties that, to the best of their knowledge, no Background is needed by another Party for implementation of the Project or utilisation of that other Party's Results.