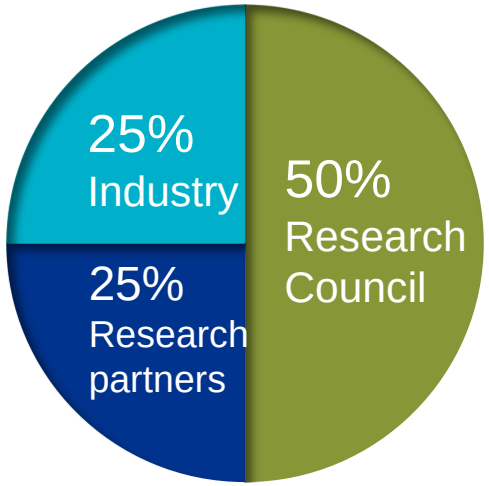
Dr. Amy Brunsvold
NCCS Centre Manager
9th February 2018

Close working relationships generate innovation and high quality

Duration: 8 Years (5+3 years) (2016-2024)

Budget: ~465 MNOK



Ett SINTEF, NTNU CCS satsing

Behov, interesse og innovasjonsvilje i næringslivet

GASSCO, Shell, Oslo Kommune, Quad Geometrics, LarvikShipping, Norcem Heidelbergcement Group, emgs, Total, Krohne, CoorsTek, Ansaldo Energia, Statoil, AkerSolutions, ENGIE, TechnipFMC

Samfunnsinteresse, politisk vilje til satsinger

Klimaendringer, Parisavtalen, EU SET plan, CSLF, Nordisk ministerråd , Klimaforliket, Det Norske Fullskala-prosjektet, TCM

Strategisk prosjektportefølje

Industriprosjekter
SOLVit, DeFacto, COMPLETE, BIGH2, CO2FieldLAB, OXYGT, CO2ITIS, CO2DataShare, Storskala Sentrallager, CEPONG, CapeWaste (BioCCS), INSPIRE, DOPCC, Pd-membran, NAS, AeroSolve, HIPREC

KPN-prosjekter
Porepack, ImpreCCS, uniCQue, Well Integity, HyMemCOPI, SINTERCAP, CAMPS, Caprock Properties, BIGCLC II BIGCLC III, CO2MIX, CO2 Dynamics

EU-prosjekter
CEMCAP, ELEGANCY, CHEERS, PreACT, Align, Gateway, IMPACTS, ECCSEL, ECCO, Dynamis, ENCAP, DECARBIT, EERA, CCS Pilot, CCS Phase, COACH, SUCCESS, European CCS N., HiPerCap

Forskningssenter (FME/SFI)
NCCS, BIGCCS, BIGCO2, CO2SIP, NORDICCS, Negative CO2 (Bio-CLC)

SIP, Blue Sky og forskerprosjekter
CHOICE, NanoDrop, 3D multifluid flow, Inject, DiHI-Tech, Oxy-fun

Forankring i virkemiddelapparatet, tilgang til forsknings-midler

Det Kongelege Olje- og Energidepartement, FME Forskningssenter for miljøvennlig energi, Norges forskningsråd, Forskningsrådet, CLIMIT, GASSNOVA, EERA, Horizon 2020, U.S. Department of Energy

Verdensledende fagkompetanse og infrastruktur, forankring i universitetsmiljøene

ECCSEL, NTNU, SINTEF, University of Zurich, NGI, NIST National Institute of Standards and Technology, TUM, Ruhr Universität Bochum, RUB, TNO innovation for life, BGS British Geological Survey Natural Environment Research Council, MIT, UNIS, UiO: University of Oslo, Lawrence Livermore National Laboratory

SINTEF

Objective

Full-scale CCS chain by 2022

EU energy and climate targets

NCCS will enable fast-track CCS deployment through industry-driven science-based innovation, addressing the major barriers identified within demonstration and industry projects, aiming at becoming a world-leading CCS centre

IEA's two-degree scenario

UN Framework Convention on Climate Change

Deployment Cases - NCCS approach

We want NCCS to:

- Have strong industry ownership
- Overcome critical barriers identified in demo and industry projects
- Align research across disciplines
- Provide targeted research in areas that contribute to large-scale CCS deployment

Deployment Case 1:
CCS for Norwegian industry

Deployment Case 2:
Storing Europe's CO_2 in the North Sea basin

Single-sink CCS chain, few industry CO_2 sources, 1-5 Mt/a.

Complements and support the plans for a Norwegian full-scale CCS project within 2022

Additional CO_2 sources in Norway and Europe can link up to the Norwegian full-scale project –focus on the next phase

Deployment Case 1

CCS for Norwegian industry

Smeaheia aquifer has a storage capacity large enough to store more of Norway's (and eventually Europe's) captured CO_2 than currently planned.

Build on the Sleipner, Snøhvit, and Boundary Dam projects, align with ROAD, and will seek synergies with TCM.

Norwegian industrial CO_2 sources, in the current full-scale chain and beyond 2022

CO_2 volumes in the order of 100 Mt/a will be considered for transport via safe and flexible pipe-line infrastructure

Capturing CO_2 from power and industry sources from all over Europe

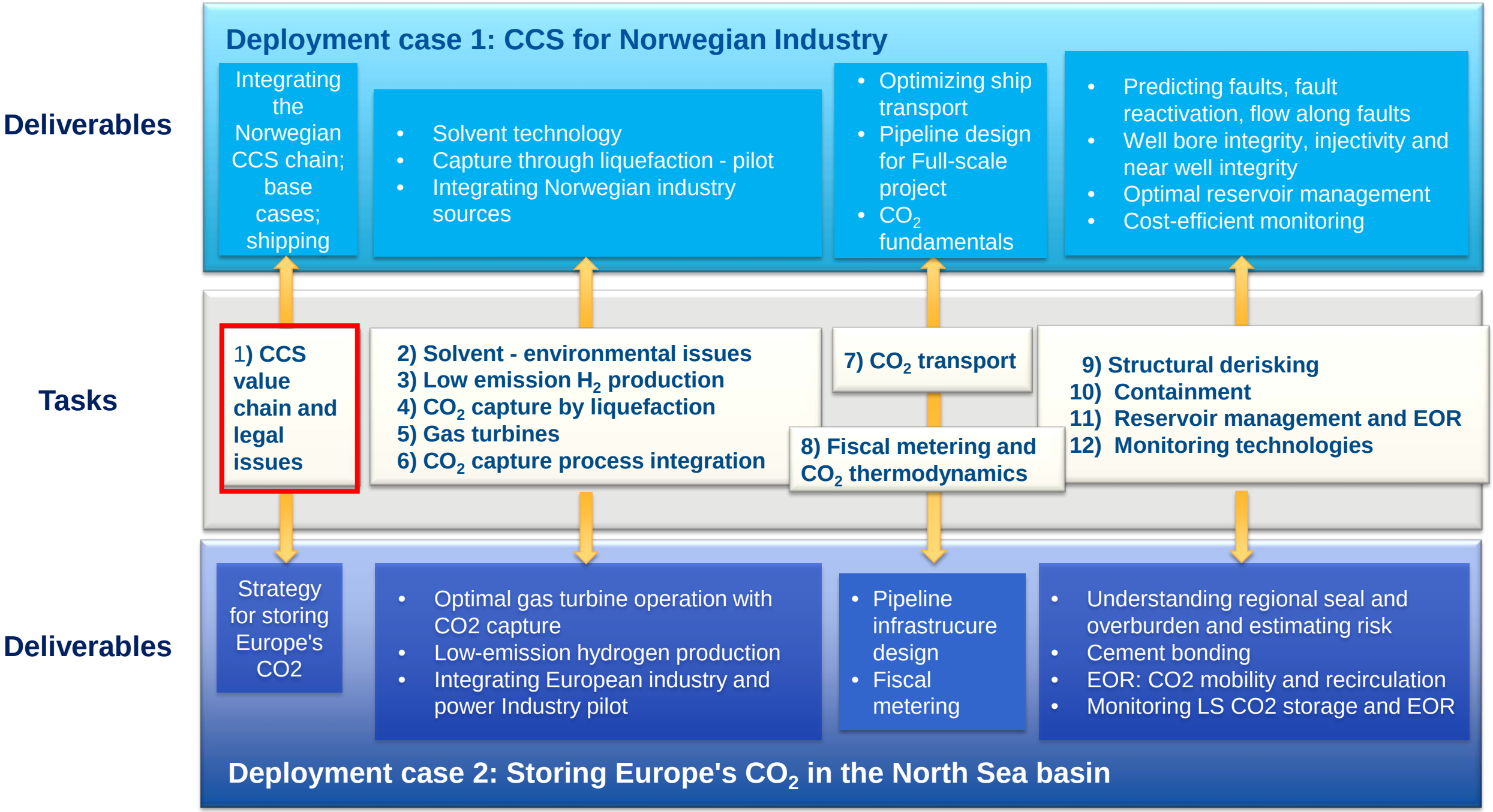
Potential to improve the CCS business case by enabling H_2 production with CO_2 capture from natural gas

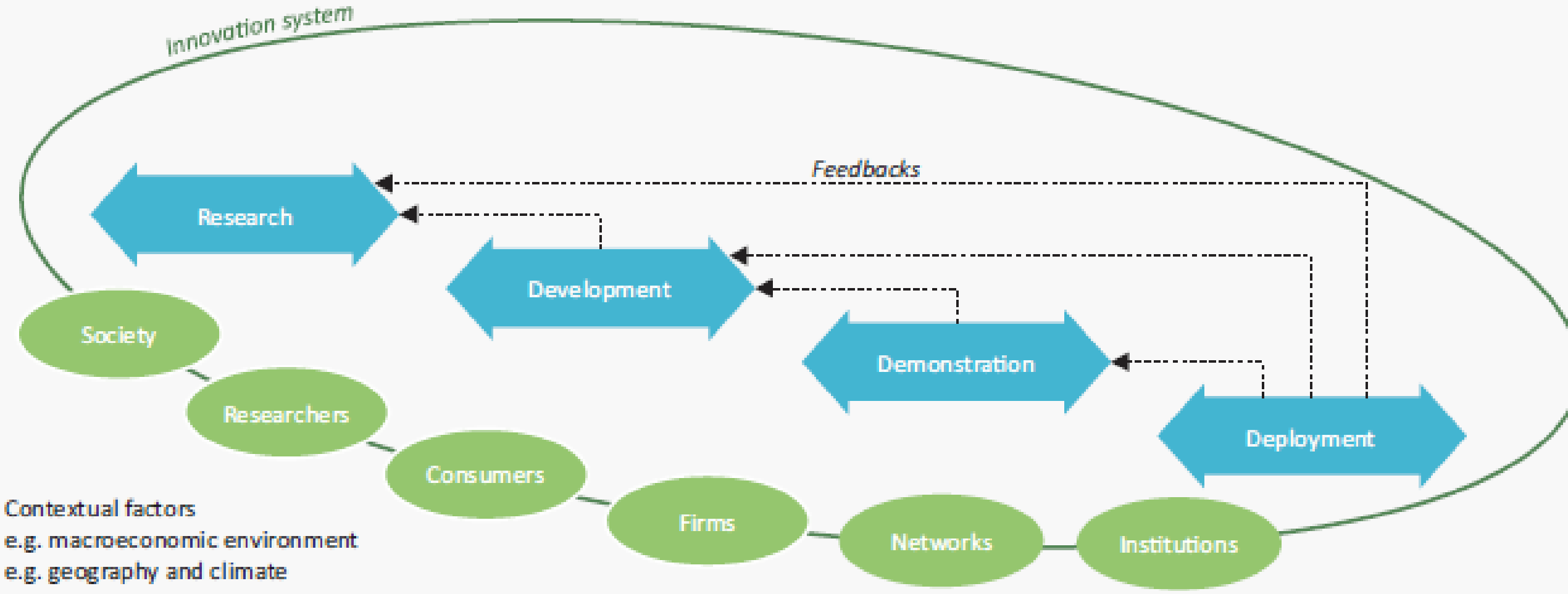
Deployment Case 2

Storing Europe's CO_2 in the North Sea basin

Enabling development of commercial-scale CO_2-EOR

Cross-border CCS infrastructure, terms and need for change under international and EU/EEA-law


Deployment case 1: CCS for Norwegian Industry
Deliverables
Integrating the Norwegian CCS chain; base cases; shipping
Solvent technology
Capture through liquefaction - pilot
Integrating Norwegian industry sources
Optimizing ship transport
Pipeline design for Full-scale project
CO_2 fundamentals
Predicting faults, fault reactivation, flow along faults
Well bore integrity, injectivity and near well integrity
Optimal reservoir management
Cost-efficient monitoring
Tasks
1) CCS value chain and legal issues
2) Solvent - environmental issues
3) Low emission H_2 production
4) CO_2 capture by liquefaction
5) Gas turbines
6) CO_2 capture process integration
7) CO_2 transport
8) Fiscal metering and CO_2 thermodynamics
9) Structural derisking
10) Containment
11) Reservoir management and EOR
12) Monitoring technologies
Deliverables
Strategy for storing Europe's CO2
Optimal gas turbine operation with CO2 capture
Low-emission hydrogen production
Integrating European industry and power Industry pilot
Pipeline infrastrucure design
Fiscal metering
Understanding regional seal and overburden and estimating risk
Cement bonding
EOR: CO2 mobility and recirculation
Monitoring LS CO2 storage and EOR
Deployment case 2: Storing Europe's CO_2 in the North Sea basin



Sources: GEA (2012), *Global Energy Assessment: Toward a Sustainable Future*, Cambridge University Press, Cambridge, United Kingdom and New York; th International Institute for Applied Systems Analysis, Laxenburg, Austria.

Key point *Interactions across the entire innovation system will enable actors to develop necessary incremental improvements and breakthroughs in technologies needed to meet climate goals.*

Scientific and technical research in NCCS

Coupling to social science

Public policy and instruments

- Legal aspects are addressed in *CCS Value Chain and Legal Aspects*
- Legal barriers towards large scale transport and storage will be studied

Business development, innovation and dissemination of technologies

- Strong focus on being an industry-driven Centre
- Special activities related to promotion of innovations, innovative research and innovative solutions
- Knowledge sharing and dissemination → always the goal!

Society and behavior

- Active in the public debate, newspapers, social media
- Currently no activity related to public interviews, surveys, etc.

Sustainability and resource efficiency

- Ambition of NCCS is to contribute to environmentally friendly energy solutions
- Technical focus is on *reducing the cost* and *de-risking* the chain
- *Scenario development* and studies of *market-based instruments* are proven to be the most efficient way to tackle environmental problems – both to be studied in NCCS

Market and energy system

- CCS Value Chain investigates market and system analysis; PhD and Post – doc positions at NTNU, with strong links to Censes
- Innovation task investigates the potential impact and value creation from innovations in accomplished research results and potentials from foreseen innovations or research in NCCS.

Educational activities related to social science

Advisor: Prof. Catherine Banet (UiO)

- PostDoc (2018): "Long-term liability for CO_2 storage activities"
- PhD (2019): "Developing the North Sea CCS network"

UiO : University of Oslo

NCCS

SINTEF

Co-advisor: Task 1 Leader, Simon Roussanaly

Educational activities related to social science

Advisor: Prof. Asgeir Tomasgård (NTNU/CENSES)

Dr. Ozgu Torgut (PostDoc)

"The Role of CCS when reducing emissions in the European energy system and industry"

Vegard S. Bjerketvedt (PhD cand.)

''Optimal design and operation of CCS value chains with focus on the transport system"

PhD candidate (2021)

"Reducing the cost of CCS through techno-economic optimization of CCS processes"

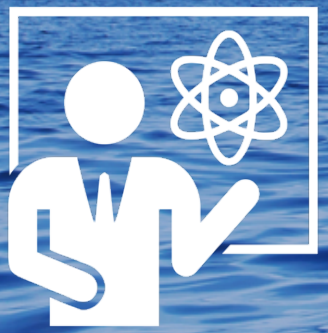
Co-advisor: Task 1 Leader, Simon Roussanaly

Five roles to facilitate

Innovation

Reminder

Identifier



Facilitator

Supporter

Communicator

Acknowledgement

This publication has been produced with support from the NCCS Centre, performed under the Norwegian research program Centres for Environment-friendly Energy Research (FME).

The authors acknowledge the following partners for their contributions: Aker Solutions, ANSALDO Energia, CoorsTek Membrane Sciences, Gassco, KROHNE, Larvik Shipping, Norcem, Norwegian Oil and Gas, Quad Geometrics, Shell, Statoil, TOTAL, and the Research Council of Norway (257579/E20).

Ideas for workshop discussion

- Difficult to find a systematic description about social sciences as a whole.
- Defining what are to count within the social sciences is unclear,
  - No clear or extensive official checklists of what subject count as social sciences
    - a perplexing gap we could address?

- Including social science research tightly with STEM research in CCS could help us separate what is *possible* in the world from what *should be done* in the world?

"My problem with this laser focus on the hard sciences and on medicine is that it pretends that people's quality of life simply depends on physical phenomena—how fast computers are or how much their knee hurts and so on. That's simply not true. Much of people's happiness—indeed, including whether they have access to computers or can endure a physical malady—depends on social phenomena"

http://www.edwardrcarr.com/opentheechochamber/2013/02/06/why-science-and-technology-need-the-social-sciences-and-humanities/


NCCS
NORWEGIAN CCS RESEARCH CENTRE
Industry-driven innovation for fast-track CCS deployment

Thank You!