
U N I V E R S I T Y O F B E R G E N
Department of Physics and Technology

Applications of CO₂ as CCUS

Efficient, Cost Saving and More Sustainable Petroleum Production

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CCUS (carbon capture, **use** & storage)

Huge Opportunity for the Petroleum Industry

- Produce more from mature fields
- Reduce carbon footprint
- Social license to operate
- Enable vast additional energy resources
- Attracts new generation energy engineers

Advantages with CO₂
compared with water/ HC gas



Effective oil mixing	Decrease oil viscosity
Increase oil flow	Associated CO₂ storage

Challenges with CO₂ Injection



Low viscosity	Availability
Recycling	Corrosion

OG 21 New Strategy Reservoir Physics Strategy

1. Maximize resource utilization

Enhance recovery in mature areas

2. Minimize environmental impact

Produce oil by injection of CO₂

3. Improve productivity and reduce costs

Reduce injected gas volumes and production of water

4. Develop innovative technologies

UiB patented industrial solutions CO₂ for Oil/Gas production

5. Attract, develop and retain the best talents

Petroleum Research School of Norway, international collaboration, student participation in industry projects



Dept. of Physics and Technology



32 professors

24 Postdoc/researchers

25 technical/administrative

10-15 PhD/year

50-60 MSc/year

170 MNOK turnover



Space Physics

Theory, energy and process technology

Optics and atomic physics

Petroleum upstream research since mid 1980s

Subatomic Physics

Acoustics

Nanoscale physics and electronics

Petroleum and Process Technology



Petroleum and Process Technology



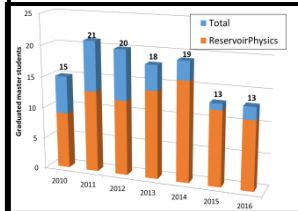
Nasjonal forskerskole i petroleumsfag
 Chairman of the Board Prof. Arne Graue
 Coordinator Martin Fernø



NorTex Petroleum Cluster

Chairman of the Board Prof. Arne Graue
 Secretary function Martin Fernø

- Lead Master program in Petroleum Technology
- Interdisciplinary collaboration with Haukeland University Hospital
- Operate MRI laboratory at Statoil Sandsli
- Strong International Collaboration focus on USA



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Faculty

Prof. Arne Graue
 Prof. Bjørn Kvamme
 Prof. Tatyana Kuznetsova
 Assoc. Prof. Geir Erslund
 Prof. Martin Fernø

12

PhD

31

master

7

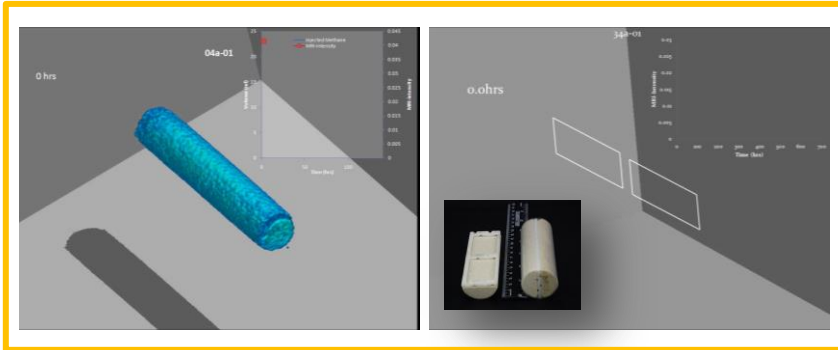
Laboratories

Energy for the Future

Gas Production WITH CO₂ Storage in Hydrates

Energy bound in hydrates is more than combined energy in conventional oil, gas and coal reserves

UiB Laboratory Verification of Technology



What are Methane Hydrates?

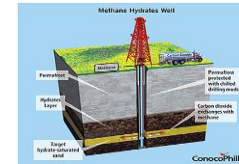
Methane hydrates are ice-like structures with natural gas trapped inside, and are found both onshore and offshore along nearly every continental shelf in the world.

< 10 year
US \$30 mill

Field Verification of UiB Technology

"While this is just the beginning, this research could potentially yield significant new supplies of natural gas."

U.S. Energy Secretary Steven Chu, May 2nd 2012

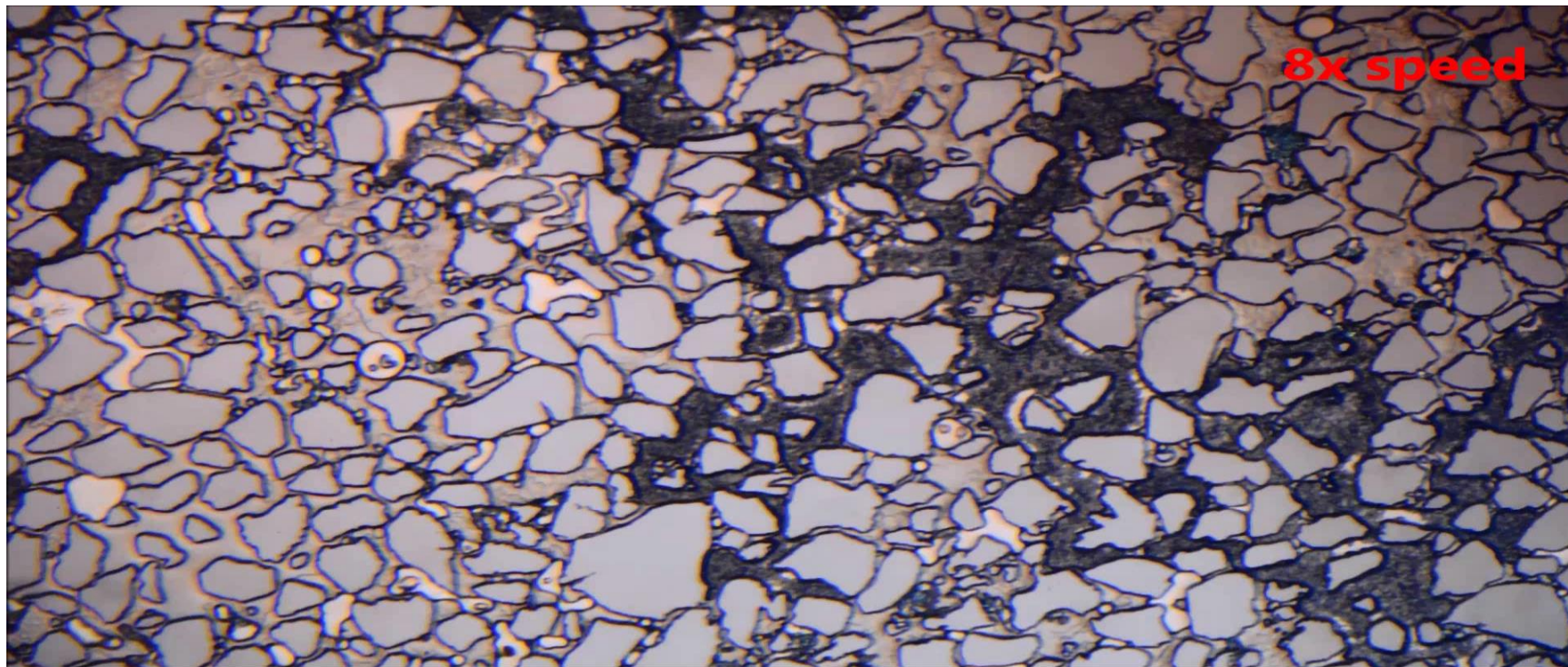


DOE, ConocoPhillips and JOGMEC at the Ignik Sikumi test site, Alaska

Excerpt from U.S. Energy Secretary Steven Chu's statement

...to conduct a test of natural gas extraction from methane hydrate **using a unique production technology, developed through laboratory collaboration between the University of Bergen, Norway...** [D]emonstrated that this mixture could **promote the production of natural gas.** Ongoing analyses of the extensive datasets acquired at the field site will be needed to determine the **efficiency of simultaneous CO₂ storage in the reservoirs.**

PORE-SCALE DISSOCIATION OF METHANE HYDRATE



Lab to Field: CO₂ foam field pilot project

OBJECTIVE

Cost-effective “Roadmap for Success” for CO₂ EOR implementation on Norwegian Continental Shelf through onshore field trials in Texas

WHY TEXAS?

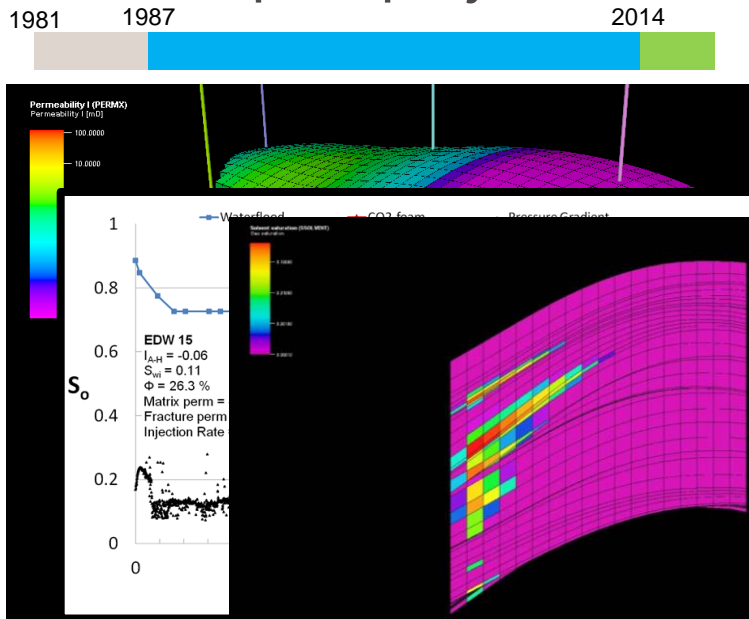
- CO₂ is commercially available
- Up-scaling; major challenge in oil recovery
- Fraction of costs of off-shore field tests
- Fast results: short inter-well distances
- 30 years experience in Texas on CO₂ EOR

COLLABORATORS

U. of Bergen	Total	Stanford U.
U. of Bordeaux	Rice U.	National IOR centre
U. of Houston	TU Delft	Schlumberger
Statoil	UT Austin	Shell

FUNDING 15MNOK

Norwegian Research Council, CLIMIT program
Oil Industry (Shell, Total, Schlumberger, Statoil)
+ local independent operators



Laboratory Results

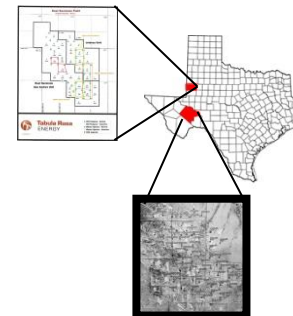
MORE Oil produced:
CO₂ Foam EOR produces 10-30% additional oil after waterflooding

FASTER Production
Operational times reduced up to 90%.

Laboratory Team

Sunniva Fredriksen (PhD)
Arthur Uno Rognmo (PhD)
Michael Jian (PhD)
Connie Wergeland (MSc)
Anders Frøland (MSc)
Andreas G. Polden (MSc)

East Seminole Well Location Map



Ft. Stockton Well Location Map

Simulation Results

EFFICIENT Oil Production:
CO₂ Foam EOR increase sweep efficiency

MORE CO₂ stored:
Displace water to increase CO₂ storage volume

Simulation Team

Zachary Alcorn (PhD)
Mohan Sharma (PhD)
Lars Petter Grønsvigh (MSc)
Anna Bang (MSc)
Max Castro (MSc)
Stine Kristiansen (MSc)



Recruitment

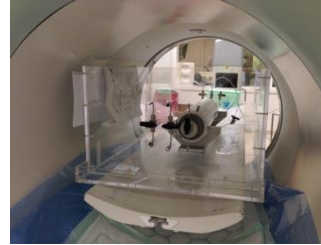
international collaboration with
reputational academic institutions

strong student participation in
industry projects

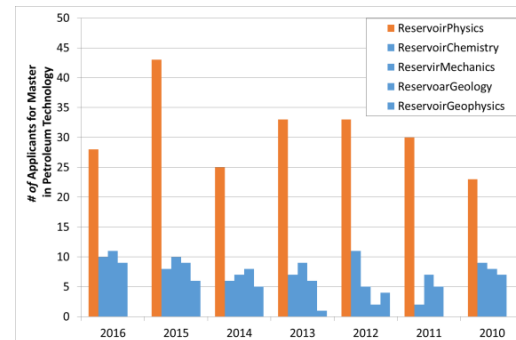
Petroleum Research School of
Norway

STEP (short term exchange program)

Focus on oil and gas solutions for
the future



Reservoir physics students
PET center @ HUS



Summary

Status

Use of CO₂ as a commodity:

Business Case for CO₂ Storage

- CO₂ EOR
- Integrated EOR (IEOR) with foam
- Exploitation of Hydrate Energy

Way Forward

Norwegian technology ready for industrial scale implementation

Ongoing onshore in USA

Looking for opportunities on NCS, Europe and offshore Asia

