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GETTING INNOVATION, COST REDUCTION AND TAXES ON THE SAME PAGE

This is the last newsletter before the summer break and it's nice to be able to finish the season on a high note.

We just learned that the Danish government has proposed a number of fiscal incentives for further investment in the Danish offshore sector. These are expected to enable a rebuild of the Tyra gas hub infrastructure which again might lead to development of small oil fields relying on this mature infrastructure and increase its lifespan. The proposed fiscal measures still must be approved by the Danish parliament, but it's quite encouraging news for the oil and gas sector in Denmark to see it has government backing.

Tax incentives alone are of course not enough, production costs will also need to be lowered both in the short term and the long term. On the whole it is becoming harder to produce oil and gas, so production methods need to be improved continuously. Technological innovations and more efficient processes have made it possible to remain cost-effective under increasingly challenging conditions in the past and this needs to continue.

A good example of that trend was presented in the recent February talk where automation of production operations in the Maersk operated Culzean HPHT gas field will lead to a significant reduction in offshore staff numbers and related costs. Fiscal incentives by the UK govern-

ment had also contributed to the field's economic development.

Technological innovation is a major part of cost effectiveness improvements, either as a game-changer or through gradual productivity and efficiency advances. An industry opinion survey by Lloyd's Register, who incidentally made an unrelated presentation at the DONG sponsored March event, has shown that the innovation areas being prioritised by the industry are: safety improvements (45%), improving operational efficiency (44%), reducing costs (43%), accessing new reserves (29%) and increasing asset lifespan (27%).

Continued risk aversion in the sector, especially in the deployment of new technologies, is however, a major brake on innovation. Globally only a quarter of oil and gas companies consider themselves to be early adopters. It is therefore inspiring to see that industry and government are collaborating to make innovation happen in Denmark and the UK.

With that said allow me to direct your attention to the final 3 events of the season, described further on in this newsletter, which are lectures sponsored by GEUS on shale gas, by Chevron on value creation plus the Annual General Meeting, and finally the June SPE Summer Party organised in inimitable style by Schlumberger. Looking forward to see you all there!

Hans Horikx
Copenhagen SPE Chairman

FUTURE MEETINGS

FOR MORE INFORMATION REGARDING THE PROGRAMME SEE PAGE 6

SPE

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THE BOARD · 2016-2017 SEASON

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ASSESSING EUROPEAN GAS AND OIL RESOURCES

Karen Lyng Anthonsen (GEUS)

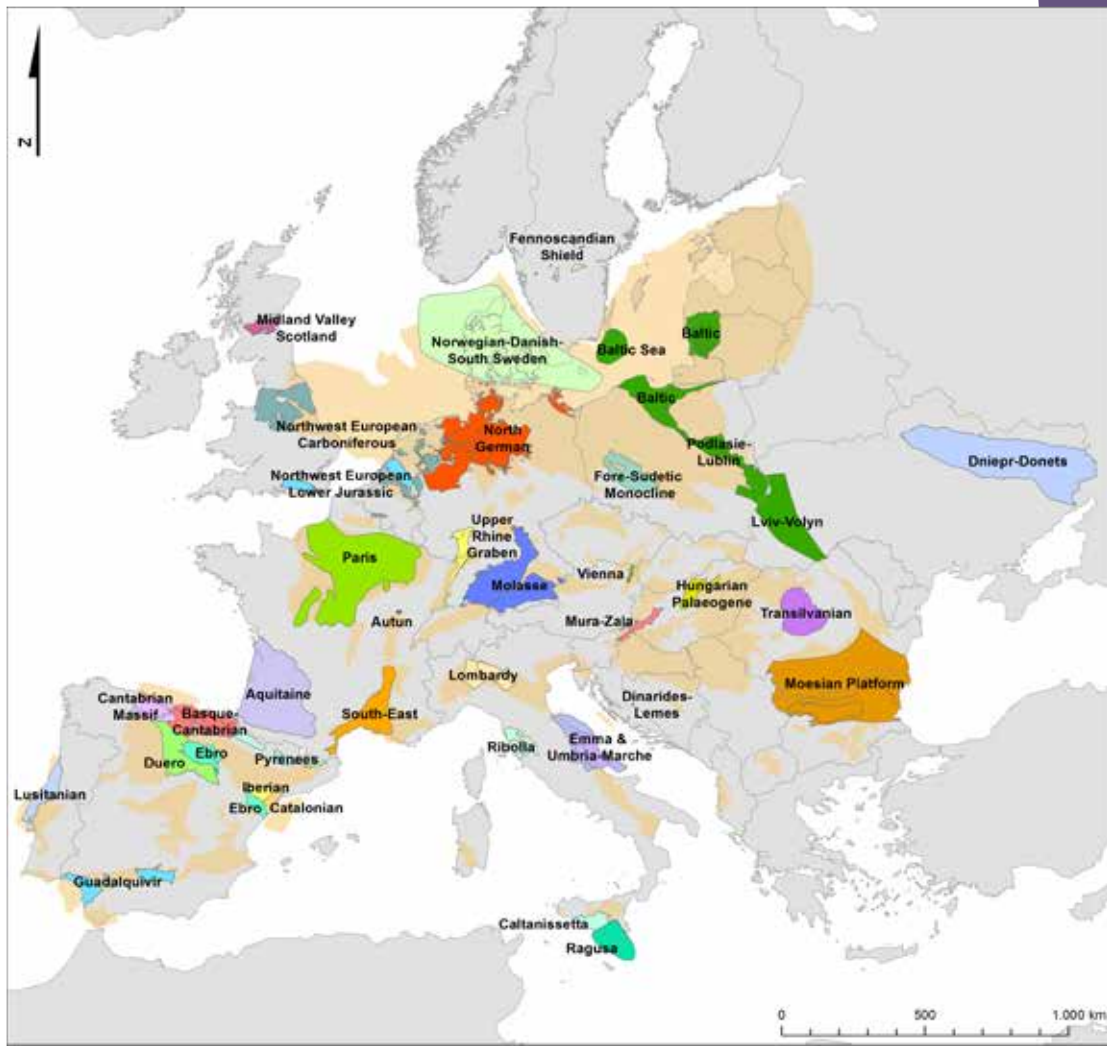
The Geological Survey of Denmark and Greenland (GEUS) has mapped the European shale gas and oil resources. The mapping was initiated in 2015 on behalf of the EU Commission's Joint Research Centre, Institute for Energy and Transport (JRC-IET) and done in collaboration with TNO and 18 other European National Geological Surveys (NGS'). The project, termed "European Unconventional oil and gas assessment project (EUOGA)", provides an inventory of existing published knowledge on shale oil and gas resources in Europe as well as new analysis on the resources. The project has compiled data from European countries who are members of EuroGeoSurveys (EGS) and the European Union, including Ukraine. The main results apart from the mapping have been to assess the European shale hydrocarbon resources based on a common pan-European methodology.

The project management and database development has been in the hands of GEUS, whereas TNO has coordinated and developed a common European assessment methodology for shale hydrocarbon and calculated shale gas and oil resources for the European basins and for each individual country. The NGS' have provided national published information on shale formations and have been the key to the success of the project as the NGS' possesses the crucial knowledge. The NGS' provided information on basin outlines, shale distribution and the critical parameters needed for estimating the shale gas and oil resources such as frequency distribution of the TOC, porosity distributions, mineralogy and geochemical proxies for organic matter type and maturity. The assessment steps started with a description of the shale, followed by subdivision into assessment units, ranking based on a set of screening criteria and finally estimation of GIIP and/or OIIP. A total of 82 shales within 38 basins were identified (36 thermogenic and 2 biogenic) and an analysis of the critical shale parameters were compared with US shale analogies.

The geology of Europe is complex and in order to make the best possible geological interpretation, the European shale hydrocarbon assessment has been carried out basin by basin. This approach has provided the basis for a uniform and consistent European geological knowledge framework and has ensured transnational correlations. Maps and information on individual basins and shales in many cases already existed in different formats at the NGS'. This information was gathered and compiled into a uniform pan-European geodatabase. The final geodatabase will be available at the European Commission's new European Unconventional Hydrocarbon web-portal Open ECHO, which possibly will be launched in June 2017, and it is the aim to include the geodatabase in the EGS' European Geological Data Infrastructure (EDGI) web-platform as well.

Joining the geological scientific expertise, sharing and exchanging knowledge between the Geological Surveys in Europe have been very rewarding and EUOGA has demonstrated this type of cooperation project have the ability to produce excellent outcomes for the benefit of all countries. ◀

EUROPEAN SHALE RESOURCES



Overview of the basin areas reported to have a potential shale gas and shale oil resource by the National Geological Surveys. Not all basin areas on this map can be assessed due to lack of sufficient geological information (e.g. the Aquitaine and South-East basins in France).

European Unconventional Oil and Gas Assessment (EUOGA) basins 2016

- | | | |
|-------------------------------|-------------------|-----------------------------------|
| Norwegian-Danish-South Sweden | Ribolla | Guadalquivir |
| Baltic | Emma | Lusitanian |
| Fore-Sudetic Monocline | Umbria-Marche | Aquitaine |
| Dniepr-Donets | Ragusa | South East |
| Transilvanian | Caltanissetta | Autun |
| Moesian Platform | Cantabrian Massif | Paris |
| Dinarides-Lemes | Basque-Cantabrian | Upper Rhine Graben |
| Hungarian Paleogene | Pyrenees | North German |
| Mura-Zala | Duero | Northwest European Lower Jurassic |
| Vienna | Ebro basin | Northwest European Carboniferous |
| Molasse | Iberian | Midland Vally Scotland |
| Lombardy | Catalanian | Sedimentary basins |



ABSTRACT

EVALUATION OF THE ALUM SHALE PLAY IN SCANDINAVIA

European shale gas exploration is still in its early phase. In many countries the oil and gas industry has focused on thick organic rich Palaeozoic shales known as important source rocks for conventional oil and gas fields. In Denmark the potential unconventional resources in the Lower Palaeozoic occur along the margin of the Norwegian-Danish Basin where the Palaeozoic shales are buried between 1.5-7 km. The onshore prospective area for Palaeozoic shales has been assessed by the USGS in 2013 to hold between 0-4.8 TCF gas. Within the Lower Palaeozoic sequence the primary target formation is the Cambro-Ordovician Alum Shale which is unusually rich in organic matter, typically 5-10% and locally up to 20% (in central Sweden immature Alum Shale even contains 25% TOC). The formation is up to 180 m thick offshore Denmark.

The Lower Palaeozoic shales in Denmark were buried and matured to gas stage within a Caledonian fore-land basin during the late Silurian-early Devonian. In the Carboniferous and early Permian the Palaeozoic succession was faulted, tilted and subjected to intensive erosion.

The first exploration well for shale gas was drilled in 2015 in northern Denmark. This well confirmed previous results obtained by Shell from their exploration campaign in southernmost Sweden (2008-2012) that the succession only contains gas in uneconomical quantities. This is in contrast to the equivalent shale formations in northern Poland where exploration has shown that the gas content is comparable to what is present in core areas of North American shale gas producing formations.



Exploration activities in south central Sweden in the Alum Shale. Shallow buried oil mature Alum Shale is a target for biogenic gas. Photo N.H. Schovsbo.



The Alum Shale exposure in the Andrarum quarry, Scania. The Alum Shale is here about 80-90 m thick, gas mature has an average TOC content of 9%. Similar type has been target for thermogenic gas in Denmark, Sweden and Poland. "Drilling behind outcrop campaigns" have provided low cost data for reservoir characterisation. Photo A.T Nielsen.

Because of the complicated burial history with Carboniferous and Permian faulting, uplift and erosion it is likely that significant amounts of gas leaked out since it formed more than 400 million years ago. Hence, gas retention in the shale poses a major risk factor for the play in Scandinavia. In contrast to the thermogenic gas play in Denmark and southernmost Sweden, shallow buried (< 150 m) immature to marginally mature Alum Shale has been known for decades to contain gas in south central Sweden and is currently under exploration. The biogenic gas was generated after the Pleistocene glaciation, as modern meteoric water infiltrated the shale and created the right conditions for bacterial activities.

The talk presents the latest drilling results and summarizes previous models and concepts for the Alum Shale play. ◀

BIOGRAPHY



Niels Schovsbo, Senior Reservoir Geologist /Geo-chemist, GEUS Copenhagen

Niels Schovsbo is GEUS Coordinator for shale gas investigations. He is a scientific partner on the Gas Shales in Europe (GASH) research project and an EAGE Shale gas student lecture. He has more than 10 years' experience with low permeable shale and chalk reservoirs, 9 of which he has been with GEUS. Current research interests include thermal maturity indices, chemostratigraphy and reconstruction of the black shale and chalk depositional environment and reservoir properties of shale and chalk reservoirs. He received his Ph.D. (2001) and M.Sc. (1995) degrees in geochemistry from the University of Copenhagen. ◀

Co-author Arne Thorshøj Nielsen, Associate professor, dr.scient, University of Copenhagen

Arne T. Nielsen has been working on the Lower Palaeozoic of Baltoscandia and elsewhere for more than 25 yrs, focussing on sea-level changes, sequence stratigraphy, biostratigraphy, palaeoecology and reconstruction of the depositional environment. The Alum Shale of Scandinavia has been in focus for more than 10 yrs. Current research interests include sequence stratigraphy and sea level reconstruction in the later part of the Cambrian. He received his M.Sc. in 1985 and his D.Sc. in 1995 from the University of Copenhagen. ◀



PROGRAMME

17:00 - 18:00
DRINKS

18:00 - 19:00
PRESENTATION AND SPE NEWS

19:00 - 21:00
DINNER

LOCATION

GEUS
Østervoldgade 10
1350 København K

SPEAKER

Niels Schovsbo, GEUS

TOPIC

Shale Gas Evaluation

ENTRANCE FEE

None

REGISTRATION

Please indicate your attendance by Thursday 20 April by signing up on the internet www.spe-cph.dk

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SPE MEETING SCHEDULE

2016-2017

September 22		MAIN SPEAKER	AFTER DINNER
TOPIC	Brent Decommissioning - Next steps		
SPEAKER	Duncan Manning, Shell		
LOCATION	Charlottehaven		
SPONSOR	Shell		
October 26		MAIN SPEAKER	AFTER DINNER
TOPIC	Human Factors in Barrier Thinking		Optimized well design for shallow reservoirs. <i>Speaker: Johnny Bårdsen, Welltec</i>
SPEAKER	Ronald McLeod (SPE DL)		
LOCATION	Welltec		
SPONSOR	Welltec		
November 23		MAIN SPEAKER	AFTER DINNER
TOPIC	Particles in Pores: Enemies and Friends Mineral Precipitation from Brines What Makes Chalk Stick Together		My Experience in Enhanced Oil Recovery Research: A Third of a Century Retold in a Third of an Hour. <i>Speaker: Erling H. Stenby, Head of the Chemistry Department at DTU</i>
SPEAKER	Alexander A. Shapiro, Associate Professor at CERE Kaj Thomsen, Associate Professor at CERE Ida L. Fabricius, Associate Professor at CERE		
LOCATION	DTU		
SPONSOR	DTU		
January 25		MAIN SPEAKER	AFTER DINNER
TOPIC	How can Microfracturing Improve Reservoir Management?		South Arne – Ocean Bottom Seismic. <i>Speakers: Christian Rau Schiott, Hess Marianne Rosengreen, Hess</i>
SPEAKER	Mayank Malik (SPE DL)		
LOCATION	Moltkes Palæ		
SPONSOR	Hess		
February 23		MAIN SPEAKER	AFTER DINNER
TOPIC	Culzean: Technology Enabling People		Improved Wellbore Stability through Shale-Fluid Compatibility Optimization <i>Speaker: Jędrzej Bryla, Maersk Oil</i>
SPEAKER	Peter Hepburn, Maersk		
LOCATION	Maersk		
SPONSOR	Maersk		
March 14		MAIN SPEAKER	AFTER DINNER
TOPIC	A Successful Hejre Drilling Campaign – How to plan your Luck & Improve – as a Habit		How Can Computational Fluid Dynamics Improve Reservoir Simulations and Completion Strategies? <i>Speakers: Kenny Krogh Nielsen, Lloyd's Register, and Casper Schytte Hemmingsen, DTU</i>
SPEAKER	Peter V. Balslev, Dong		
LOCATION	DONG		
SPONSOR	DONG		
April 25		MAIN SPEAKER	AFTER DINNER
TOPIC	Shale Gas Evaluation		
SPEAKER	Niels Schovsbo, GEUS		
LOCATION	GEUS		
SPONSOR	GEUS		
May 23		MAIN SPEAKER	AFTER DINNER
TOPIC	Creating Value from Uncertainty and Flexibility		AGM
SPEAKER	Reidar B. Bratvold (SPE DL)		
LOCATION	Charlottehaven		
SPONSOR	Chevron		
June 16		MAIN SPEAKER	AFTER DINNER
TOPIC	SPE Summer party		
SPEAKER			
LOCATION	Spisehuset 56°, Nyhavn (see invitation on last page)		
SPONSOR	Schlumberger		



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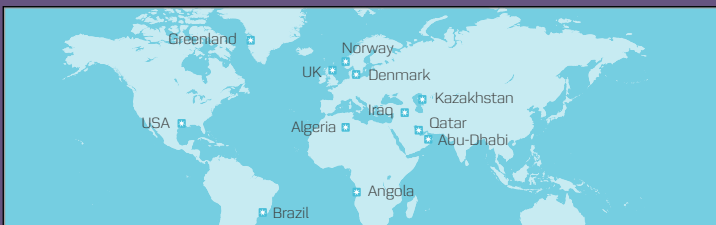
DENMARK FACTS
\$1 Billion INVESTED TO EXTEND PRODUCTIVE LIFE OF THE SOUTH ARNE FIELD
14,000 (BOE/D) NET PRODUCTION
5th LARGEST PRODUCER IN DENMARK
7% OF DENMARK'S PRODUCTION

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Annual General Meeting 2016-2107 Season

Prior to the Chevron SPE presentation we will hold the AGM.

We are always looking for new energy, ideas and input and if you think we could do anything better then we would welcome your presence on the board. If you would like to join the board of the SPE Copenhagen Section then please contact Hans Horikx before the AGM.

AGENDA:

1. 2016-2017 Season Look Back
2. Financial Statement Approval
3. 2017-2018 Copenhagen Board Proposal
4. 2017-2018 Copenhagen Board Approval
5. AOB

SUBSEA INNOVATION UNLOCKS ALDER'

Chevron is celebrating more than just bringing on-line a new energy stream. The milestone represents the successful culmination of a decades-long quest to conquer Alder's technical challenges.

Discovered in 1975, the field lies nearly 2.75 miles (14,500 feet/4.4 km) beneath the seabed and has a design capacity of around 14,000 barrels of condensate and 110 million cubic feet of natural gas per day. With first gas now achieved, how did we unlock Alder's potential?

Innovating in Technology

Alder is a high-pressure/high-temperature (HP/HT) gas condensate (a type of very light oil) development. Pressure here is six tons per square inch – some 400 times that of a typical car tire – and temperatures are around 300°F (150°C), extreme for the North Sea basin. Until recently, the subsea technology did not exist to make developments like Alder technically viable.

Chevron's operations in the North Sea have a proven track record of innovation, and the U.K. has been at the forefront of subsea and HP/HT developments for many years. Now, the legacy continues with Alder combining both areas of expertise, the ingenuity of our people and the wider U.K. supply chain, to deploy an array of technological "firsts" that have enabled us to overcome the technical challenges of Alder and deliver our first subsea HP/HT development.

Finding the Perfect Host

When Alder was discovered, the U.K. oil and gas industry was still in its infancy and focused on developing "elephant" discoveries such as Ninian, Forties and Brent. Fields like Alder were not prioritized, as neither the technology nor infrastructure existed to develop them. It wasn't until 2009 that advances in subsea innovation and the availability of throughput at the host platform, Britannia, made Alder possible.

The most cost effective development solution was to tie the field back to Britannia, in which Chevron holds a 32.38 percent non-operated working interest, via an advanced 17-mile (28 km) subsea pipeline. To successfully receive and process the gas, Britannia required significant modification including the installation of a new processing module. Weight was limited, so lighter, specialty steels had to be used to build the new 850 metric ton module. The "brownfield" scope for the existing platform was as challenging as the module design itself, involving extensive offshore work on a producing platform. The Alder tieback not only brings a new stream of production to the company's portfolio but also helps extend the field life of Britannia.

Collaborating Across the U.K. Supply Chain

The subsea system used on Alder is a showcase for the U.K.'s world-leading subsea manufacturing and engineering skills. Chevron Upstream Europe (CUE) has placed more than 70 percent of Alder's key contracts with U.K. companies. As the business unit's managing director Greta Lydecker explained: "When competitive,



Visit <https://www.youtube.com/watch?v=qGUxKzixfkQ> or scan the code

ATION S POTENTIAL

Chevron uses local suppliers and contractors to meet business needs, because we place high value on being the partner of choice and being able to foster local economic development.”

A key to the success of Alder has been the strong collaboration between the project team; ConocoPhillips, which operates the Britannia platform and is a coventurer in the development; and subject matter experts from across Chevron’s Energy Technology Company and Global Technology Centre in Aberdeen.

“The overall goal for the U.K. government is to maximize our economic recovery as well as drive more collaboration in the industry. I think the Alder project demonstrates that both of those can happen,” said Lydecker.

Richard Hinkley, CUE’s general manager of Projects and Future Growth, said, “The sophisticated subsea systems and technical learnings from this development, alongside the wider efforts of the industry to reduce costs within the mature basin, can help unlock the potential of future North Sea projects like Alder.” He added that the project demonstrates “commitment to the UK, commitment to the North Sea and a commitment of everybody here who has worked tirelessly to bring the project to first gas.” ◀



The Alder subsea manifold leaving its U.K. fabrication yard earlier this year. It houses a unique subsea cooling loop to reduce the temperature of production fluids before they enter the pipeline and a subsea High Integrity Pressure Protection System that manages the pressure between the reservoir and the receiving facilities.

Extending Britannia’s life

2016

1975

1998

1975

Alder is a satellite field to Britannia, which was the largest natural gas and condensate field in the North Sea when discovered, along with Alder, in 1975. Alder is the latest of several subsea developments to use Britannia’s infrastructure, extending the field’s productive life. The photo shows Alder facilities being installed at Britannia in 2015.



IMPROVED OIL RECOVERY IN THE DEEPER PART OF THE TOR FORMATION

The vision of the Danish Hydrocarbon Research and Technology Centre (DHRTC) is to demonstrate how the research can help increase the recovery of oil and gas in the Danish region of the North Sea. A number of research projects have been initialised to reach the goal and one of them being Advanced Water Flooding.

How is it possible to recover more oil from the chalk in the North Sea? This is the key question in DHRTC's research programme Advanced Water Flooding (AWF).

The Ekofisk and Tor chalk reservoirs have for many years played a central role for Danish oil recovery, as they still contain significant oil and gas volumes. The research programme Advanced Water Flooding is focused on developing new methods for recovering a larger share of oil. One of the challenges is to increase the sweep efficiency in the upper-most oil-bearing chalk stratum, the Ekofisk formation, to the same high level as in the underlying Tor formation. The challenges are due to the properties of the chalk. The porosity of the chalk in the Ekofisk formation is the same as that of the Tor formation, but it is less permeable. The reason for this is that the Ekofisk formation was formed by unicellular planktonic chalk algae, coccolithophores, approx. 60 million years ago, and these coccolithophores are smaller than the ones that built up the Tor formation approx. 70 million years ago.



Photo:
Mirhossein Taheriotagsara, DHRTC

In Ekofisk, the research focuses on:

- learning more about the properties of chalk
- the possibility of using fracturing – small cracks in the chalk to increase recovery
- new methods for forcing the oil out by injecting water, chemicals, or bacteria – Enhanced Oil Recovery.

In the Tor formation, the challenge is finding technological solutions that enable more oil to be recovered from deep, compact chalk strata. The research focuses on:

- the possibility of using hydraulic fracturing
- the development of new drilling and fracturing tools and new applications for existing tools

For both the Ekofisk and Tor formations, computer simulations and models are being developed and the most promising methods could be selected for testing in the North Sea. ◀

Read more about the research conducted in Danish Hydrocarbon Research and Technology Centre at www.oilgas.dtu.dk

●● ABSTRACT

Creating Value From Uncertainty and Flexibility

An increasing number of oil and gas companies use decision analytic methods to deal with complex and uncertain decisions, but they still yield consistent underperformance in typical business metrics (cost, production rates, time to start, etc.) leading to less value than expected, or, more perniciously, than possible. Uncertainty per se is not the culprit, rather a failure to make the best decisions under uncertainty—which are often non-intuitive. The real value-destroyers are bias and failing to plan for, and exploit, the different ways reality might evolve. If you underestimate the real uncertainty, you are likely to underinvest in managing its consequences. Making the best decisions requires an accurate assessment of uncertainty (unbiased, neither optimistic nor pessimistic) and an unbiased approach to managing its consequences — putting as much effort into capturing upside opportunities as into mitigating risks. The talk will illustrate and discuss how to create value from uncertainty and flexibility by applying an option-pricing methodology that explicitly focuses on upside possibilities.

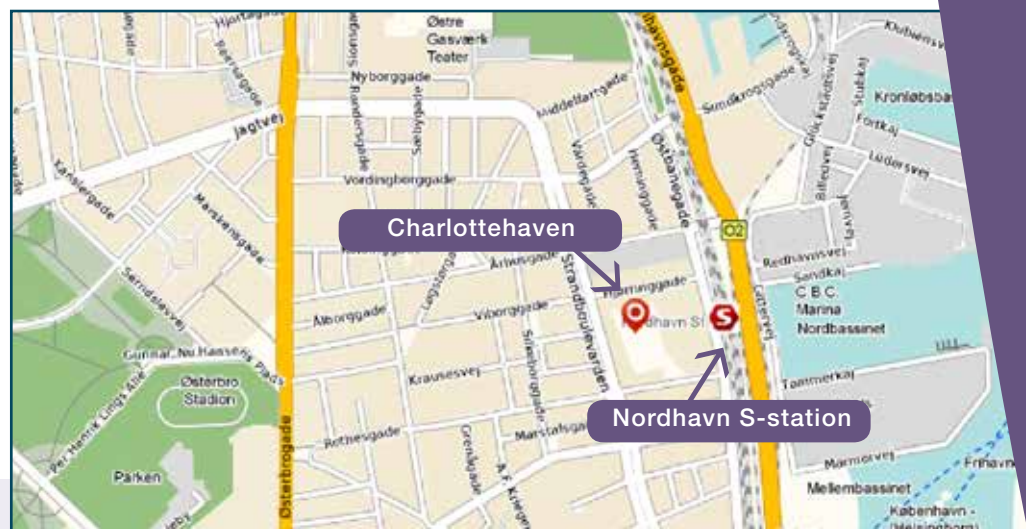
●● BIOGRAPHY



Reidar B. Bratvold, Professor of petroleum investment, University of Stavanger

Reidar B. Bratvold is professor of petroleum investment and decision analysis at the University of Stavanger. Before his career in academia, Bratvold spent 15 years in the industry in various technical and management roles. He is a coauthor of the SPE book Making Good Decisions. Bratvold has twice previously served as an SPE Distinguished Lecturer. He is the

2015 recipient of the North Sea Region SPE Management and Information Award and serves as the executive editor for the SPE Economics & Management Journal. Bratvold is a Fellow of the Society of Decision Professionals and a member of the Norwegian Academy of Technological Sciences. He holds a PhD in petroleum engineering and an MSc in mathematics, both from Stanford University, and has studied business and management science at INSEAD and Stanford. ◀



C O P E N H A G E N
M E E T I N G
T U E S D A Y 2 3 M A Y 2 0 1 7

MAY

PROGRAMME

17:00 - 18:00
DRINKS

18:00 - 19:00
PRESENTATION AND
ANNUAL GENERAL MEETING

19:00 - 21:00
DINNER

LOCATION
Charlottehaven
Hjørringgade 12C
2100 Copenhagen

SPEAKER

Reidar B. Bratvold (SPE DL)
University of Stavanger

TOPIC

Creating Value from Uncertainty and Flexibility

ENTRANCE FEE

None

REGISTRATION

Please indicate your attendance by Thursday 18 May by signing up on the internet www.spe-cph.dk

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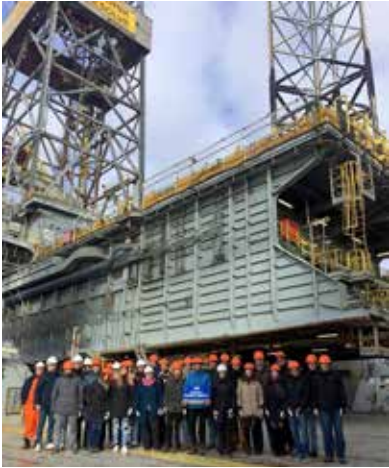
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SPE STUDENT NEWS

RIG VISIT

On the 1st of March SPE Student Chapter DTU in collaboration with Maersk Drilling organized a rig visit to Esbjerg Maersk Resolute. Maersk Resolute is the second in a series of four identical high efficiency jack-ups. During this visit the guests had the opportunity to explore several operational facilities of this 350 ft offshore rig. In addition, they were given the chance to familiarize with a large number of state-of-the-art components aimed to minimize non-productive time during operations in ultra-harsh environments. Simultaneously, a detailed presentation of each operational subsystem was conducted that provided the guests with a deeper insight of the purpose and function of each feature. Even though for many of us, this was the first time to step on a rig, the highly experienced and always available-to-help crew made it feel like home. ◀



WOMEN IN PETROLEUM

Traditionally, women have been a minority in the Petroleum Industry. However, in recent years, the number of women occupied in the oil and gas field has increased significantly. The “Women in the Petroleum Industry” event, organized by the DTU SPE Student Chapter, aimed to give the opportunity to female professionals of the petroleum industry to interact with successful Reservoir and Offshore Engineers. During this event the guests were given the opportunity to gain insight into the petroleum industry and learn from the experience of four successful female engineers; Christine Schjøttz, MLWD Field Engineer (Schlumberger), Pernille Silberg, Production Engineer (DONG), Birgit Biemans, Production Technologist (Maersk), and Mette Brødstrup, Geoscientist, (Schlumberger) talked about their course in the Petroleum Industry and their careers, while they also shared details on how they manage their work-life balance. At the end of the session, the guests had the opportunity to ask one-on-one questions and were given useful advice for their professional future. ◀



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SUMMER PARTY

Dear SPE Member,

You and your partner are invited to the 2017 SPE summer party on the 16th of June at Spisehuset 56° at 6PM.

Transport from 56° to Nyhavn will be available at 11.30PM.

Please register by email to Mette Brødstrup: Mhansen4@slb.com and pay 350 DKK to the SPE account at Nordea: 2274 – 5360 613 323 Please mark payment SPE-"your name"

Seats will be limited

Public transport to Spisehuset 56° :
Havnebus 992 from Nyhavn or Tolboden to Holmen Nord
(10 minutes) or Bus 9A towards the Opera House.

RSVP and payment 12th of May
Dress code: Suit or black tie