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The OGA & UKCS EOR

David Puckett, Oil & Gas Authority

IEA Oil and Gas Technical Workshop Mature Fields
13th June 2016 (Imperial College)



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OGA and EOR in UKCS

Outline of Talk

- Introduction
- The OGA and MER UK
- Enhanced Oil Recovery
 - Low Salinity EOR
 - Miscible Gas EOR
 - Chemical EOR
- Impact of Low Oil Price
- The OGA EOR Vision and Strategy
- Questions ?



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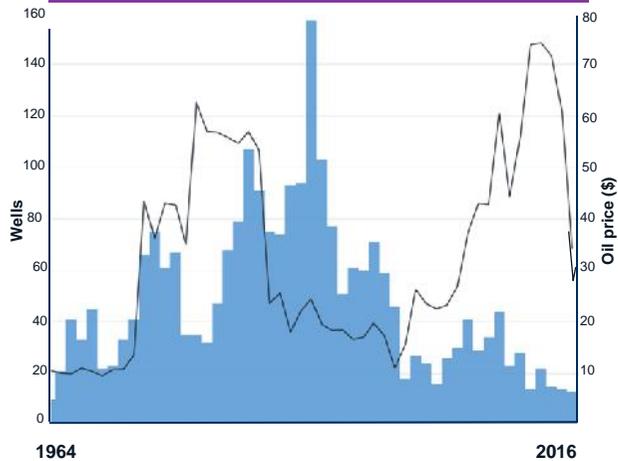
The OGA and MER UK



UKCS context

Exploration

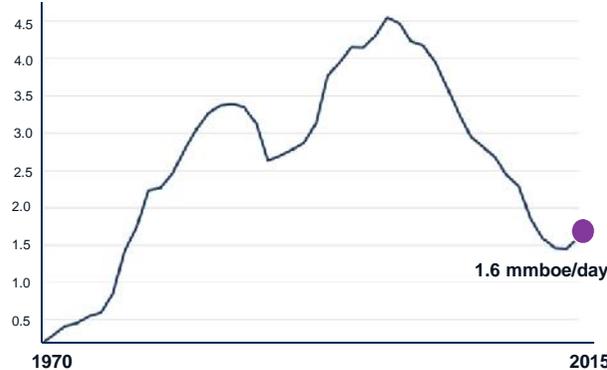
Exploration wells



Notable success 2015
 > 60% success with
 > 150 mmboe discovered

Production

Daily production

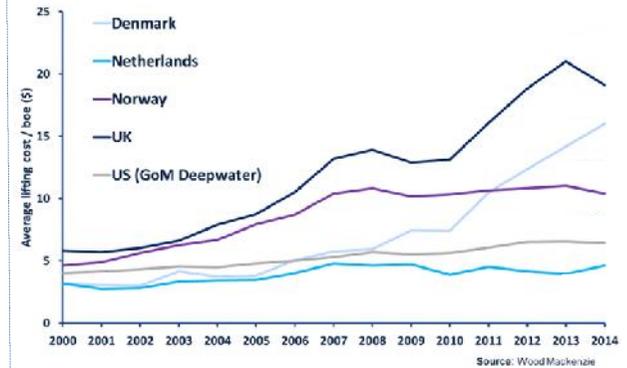


Production up by 9%
 with new fields & PE
 increase to nearly 70%

43bn barrels recovered
 Up to 20bn barrels remaining
 70% of UK's total primary energy

Costs

Average lifting cost per barrel (\$)

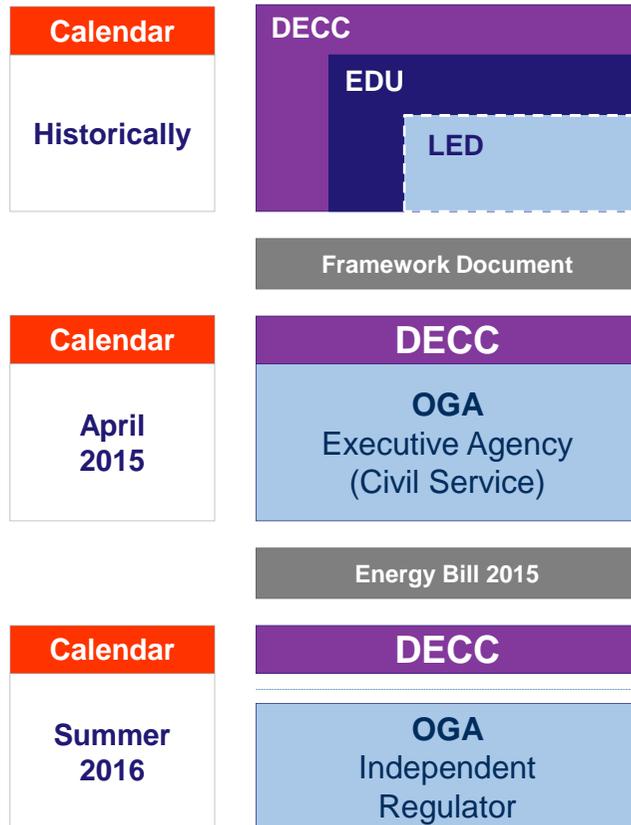


Operating efficiency
 improvements
 Sustainable transformation next

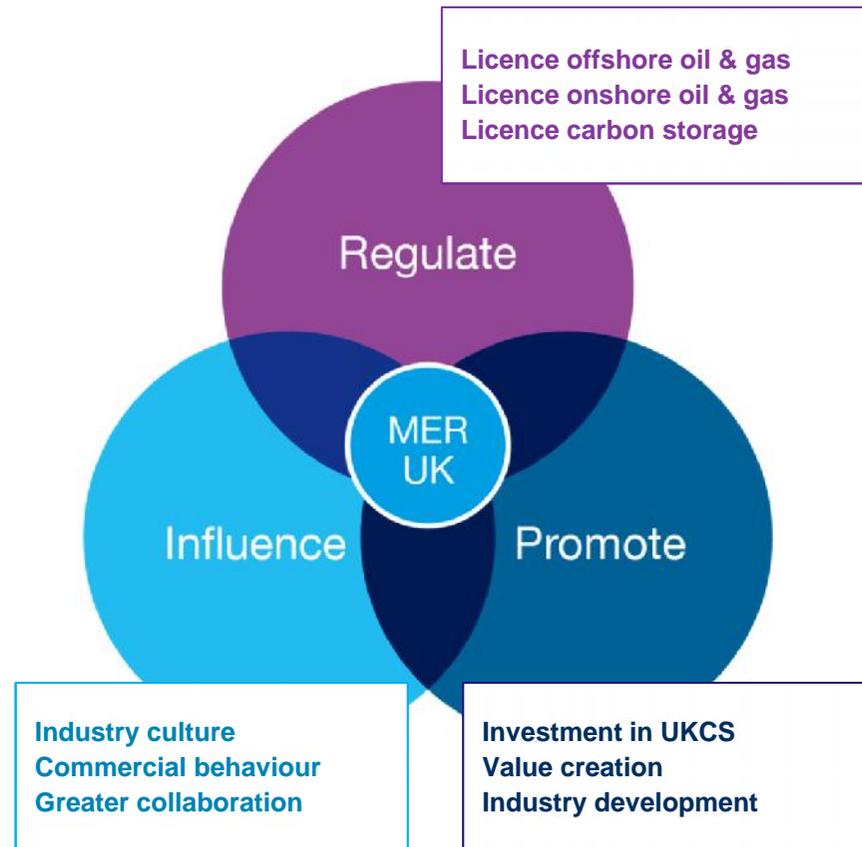
Difficult environment with low oil price but turnaround evident

Building the OGA

Evolution of the OGA



About the OGA



Low oil price environment creates difficulties and opportunities



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Recent Progress

Focused priorities

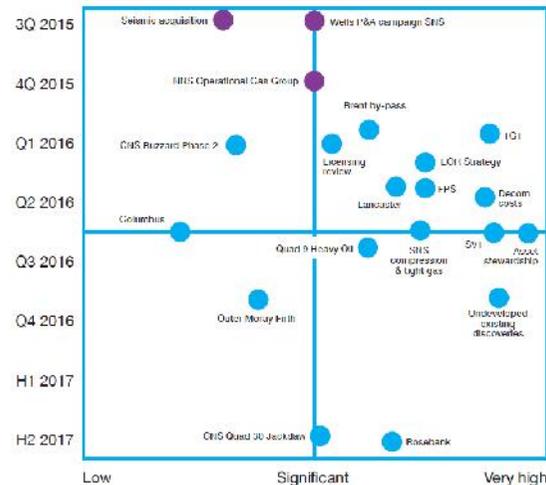


Now published

- OGA's priorities and plans
- Industry consultation & feedback
- Integrates Wood & Call to Action

Risks & opportunities

Opportunity Matrix



- 3-4 billion boe opportunity
- Creating alignment
- Strong industry engagement

Fiscal support

- Petroleum revenue tax - 50% to 0%
- Supplementary charge - 30% to 10%
- Basin-wide investment allowance
- £40 million for two geophysical surveys

- 1 Overall tax burden will need to fall as the basin matures in line with MER UK
- 2 HMG will consider wider economic benefits of oil and gas production
- 3 HMG will take account of the global competitiveness of the UKCS

Ongoing focus areas

Barriers to **exploration, infrastructure & asset transfers**

Government, OGA and industry working together

MER UK Forum and Boards

Purpose	Deliver tangible benefits in support of MER UK and maximise UK value from the oil and gas industry as a whole										
Objectives	<ol style="list-style-type: none"> 1. Develop a clear strategy, priorities and plans 2. Create leadership alignment and leverage tripartite action – forum for consultations 3. Deliver tangible and quantifiable results 										
MER UK Boards	<table border="1"> <tr> <td data-bbox="674 616 987 791"> <p>1</p> <p>Exploration</p> <p>Phil Kirk, Chrysaor</p> <p>Gunther Newcombe</p> </td> <td data-bbox="1003 616 1317 791"> <p>2</p> <p>Asset Stewardship</p> <p>Ray Riddoch, Nexen</p> <p>Gunther Newcombe</p> </td> <td data-bbox="1332 616 1646 791"> <p>3</p> <p>Regional development & infrastructure</p> <p>Paul Goodfellow, Shell</p> <p>Gunther Newcombe</p> </td> <td data-bbox="1662 616 1975 791"> <p>4</p> <p>Cost & Efficiency</p> <p>John Pearson, AMECFW</p> <p>Stephen Marcos-Jones</p> </td> </tr> <tr> <td data-bbox="674 815 987 890">Previously Exploration Task Force</td> <td data-bbox="1003 815 1317 890">Building on Production Efficiency Task Force</td> <td data-bbox="1332 815 1646 890">Newly created to build on rejuvenation groups</td> <td data-bbox="1662 815 1975 890">OGUK Efficiency Task Force</td> </tr> </table>			<p>1</p> <p>Exploration</p> <p>Phil Kirk, Chrysaor</p> <p>Gunther Newcombe</p>	<p>2</p> <p>Asset Stewardship</p> <p>Ray Riddoch, Nexen</p> <p>Gunther Newcombe</p>	<p>3</p> <p>Regional development & infrastructure</p> <p>Paul Goodfellow, Shell</p> <p>Gunther Newcombe</p>	<p>4</p> <p>Cost & Efficiency</p> <p>John Pearson, AMECFW</p> <p>Stephen Marcos-Jones</p>	Previously Exploration Task Force	Building on Production Efficiency Task Force	Newly created to build on rejuvenation groups	OGUK Efficiency Task Force
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Technology Leadership Board	Previously Decom Task Force	Previously in Oil & Gas Industry Council									
Frequency	Quarterly	Support	OGA / OGUK								

■ Industry lead □ Support lead

Prioritisation and focus essential

Energy Bill & MER UK Strategy

Energy Bill

- Energy Bill recently became law
- Royal Assent granted May 12th 2016

Striking the right balance

Sanctions

Licence Revocation

Fines up to £1m

Improvement
Notices

Rewards

Greater value via
cooperation

Transparency and
better data access

Timely, effective
decision making

MER UK
benefits all

MER UK Strategy

- Strategy in force since March 18th 2016
- Plans will be developed to assist collaboration - with input from industry
- Comprises - Central & Supporting obligations, Required Actions & Behaviours, Safeguards

Central obligation

*“Relevant persons must, in the exercise of their relevant functions, take the steps necessary to secure that the **maximum value of economically recoverable petroleum is recovered** from the strata beneath relevant UK waters.”*

Recognising best practices



Strong consultation and engagement with industry



Improve production efficiency

Enhanced stewardship strategy

- Senior leadership commitment from MDs
- Increased transparency on data and plans
- Stewardship across each lifecycle stage

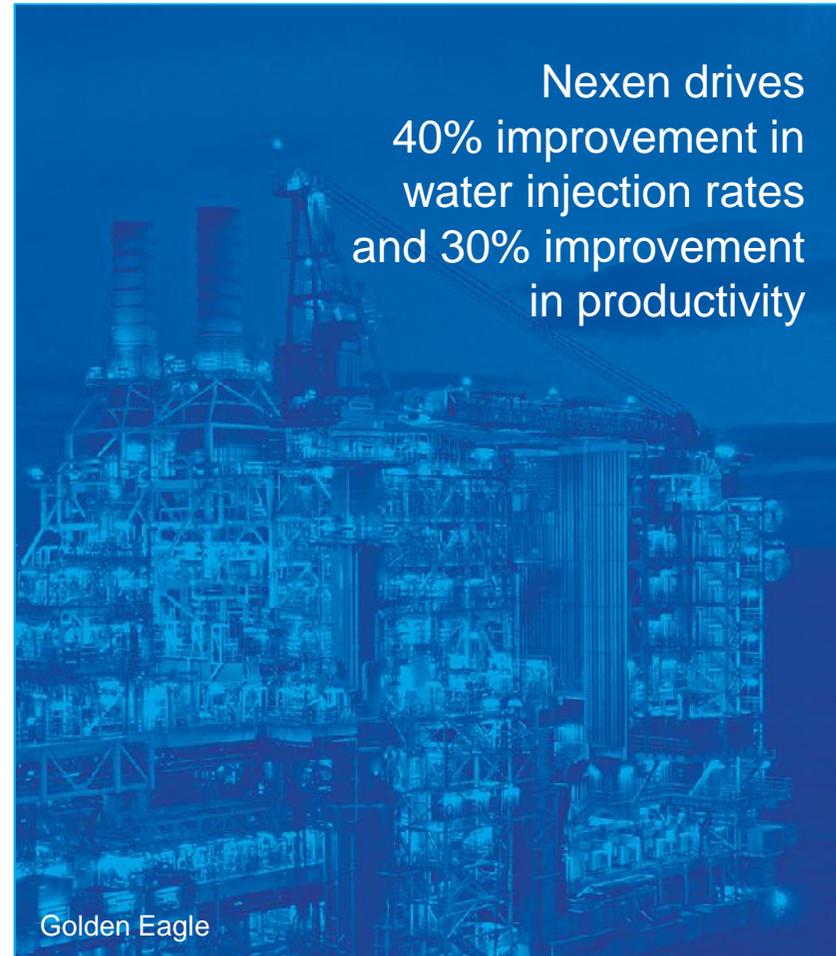
Data-driven approach

- Track and review 'company scorecards'
- Leading and lagging performance indicators
- Increase efficiency, value and accountability

Managing late-life assets

- MER UK approach upstream and midstream
- **OGA enhanced oil recovery strategy**
- Early planning for decommissioning

Nexen drives
40% improvement in
water injection rates
and 30% improvement
in productivity



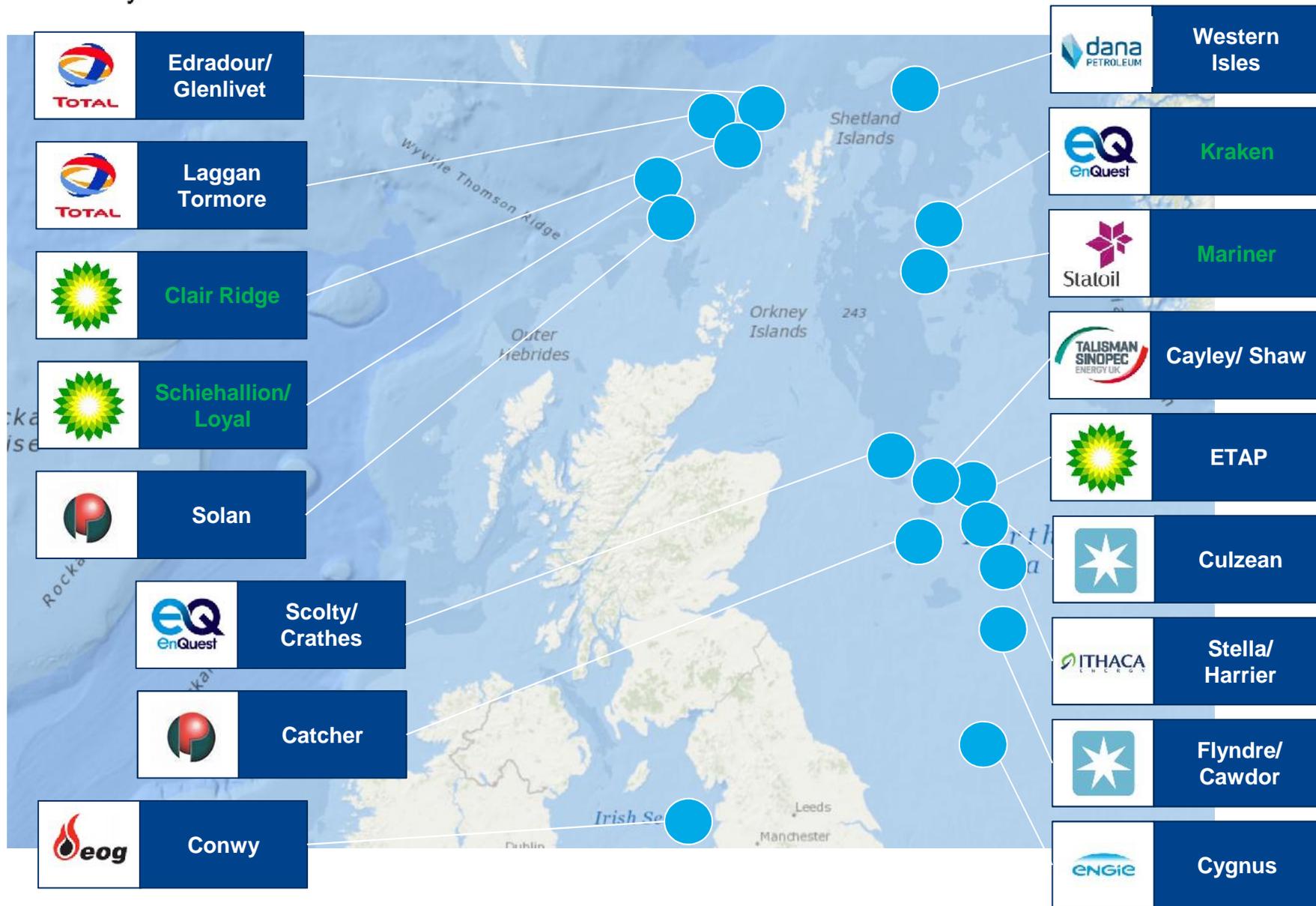
Golden Eagle

Some great examplesand still room for improvement



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Current developments





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Enhanced Oil Recovery



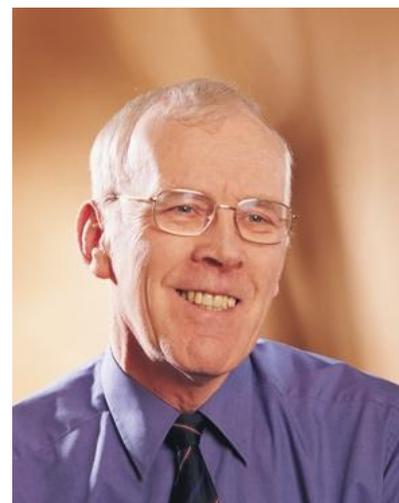
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EOR has a vital role

The “Wood Review” stressed the importance of EOR

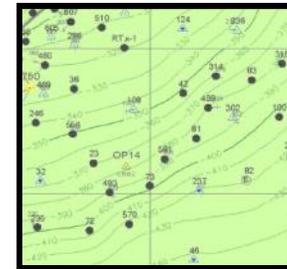
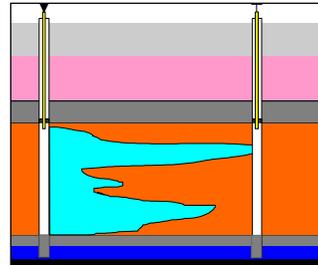
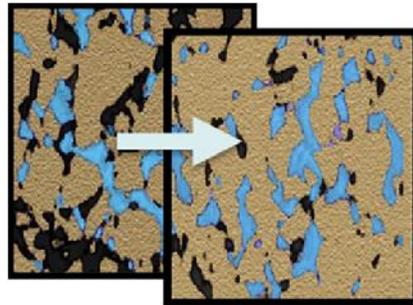
**“industry should be
encouraged more in EOR
schemes to avoid leaving
significant value behind”**

24 February 2014





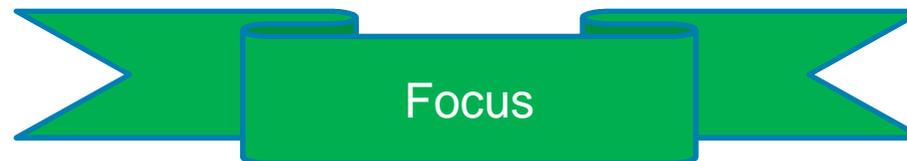
EOR focus



Recovery Factor = **Pore scale displacement** x **Sweep** x **Drainage** x **Time**

EOR
 Low Salinity Polymer

IOR
 Flood optimisation Infill Shut-off CoP date





Business Case EOR Workgroup - Defining the Prize

The economic (risked) EOR potential for the top 20 fields equates to 0.5 billion barrels.

The EOR workgroup defined the EOR Prize, and this was summarised in:

- PILOT EOR Work Group Report 2013
- Maximising EOR Opportunities in UKCS Through Collaboration (SPE 172017)

PILOT EOR Work Group
Report summarising 2012 - 2013 Activities

SPE 172017
Maximising Enhanced Oil Recovery Opportunities in UKCS Through Collaboration
M. J. McLomack, H. J. Exploration Operating Co.; J. M. Thomas, UK Department of Energy & Climate Change; K. Mackie, Industry Technology Facilitator

Abstract
The UK Continental Shelf (UKCS) is one of the most mature offshore basins in the world. Achieving optimal recovery from the basin is demanding, but as the anticipated ultimate recovery factor is 46%⁽¹⁾ of oil initially in place, there is still significant opportunity to optimise recovery from the existing oil fields. PILOT, a partnership between the UK Oil and Gas industry and the UK Government, has been re-focusing its efforts on maximising North Sea recovery.

There are currently only two Enhanced Oil Recovery (EOR) schemes operational within the UK North Sea. The principal barriers to implementing EOR projects are believed to be (1) incomplete subsurface understanding, (2) supply of secure, low cost injection, (3) the challenge of implementing EOR retrospectively on a brownfield site, (4) concerns over project economics.

The PILOT EOR Work Group was set up in 2012 to co-ordinate industry and government attempts to tackle these challenges. A three phase programme was identified to: (1) systematically screen the UKCS fields for EOR potential, (2) engage industry and look for synergies and collaborative opportunities to progress EOR understanding, (3) where possible, initiate new EOR projects with operators.

The UKCS EOR screening exercise confirmed that there is still a significant realistically achievable EOR prize of up to 1 billion barrels of oil. The second phase of work focused on developing collaborative ways of working to tackle the technical and commercial challenges associated with EOR projects, with particular focus on offshore 'brownfield' environments. Three EOR techniques were progressed and high graded on the basis of their prize and durability in an offshore environment: (a) Low salinity Waterflood EOR, (b) Chemical EOR, (c) Miscible Gas Injection. Industry workshops were held for each EOR type and pilot and 'test' programmes were implemented via operator 'pilots', facilitated by the PILOT EOR Work Group. Examples of deliverables include: (i) adoption of a low salinity workflow protocol to ensure that laboratory studies are performed in a consistent manner; (ii) initiation of a Joint Industry Project and an industry call for proposed facilities solutions for implementing low salinity on brownfield platforms; (iii) identification of industry resource to support UKCS operators with planning of chemical EOR opportunities. Successful completion of these collaborative exercises will increase the chance of implementing further EOR schemes in the UKCS, unlocking the significant EOR prize.



Business Case EOR Workgroup - Defining the Prize

- For existing “producing” fields the **un-risked** incremental oil potential of EOR for oil fields in the UK Sector of the North Sea was evaluated.
- Identified viable projects to progress in the current low oil price cost era.

EOR Process	Estimated EOR Potential (mmstb)
Miscible Hydrocarbon flood	5400
Miscible CO2 Injection	5700
Surfactant/Polymer (Chemical EOR)	4800
Polymer (on its own)	2100
Low Salinity Waterflood	2000

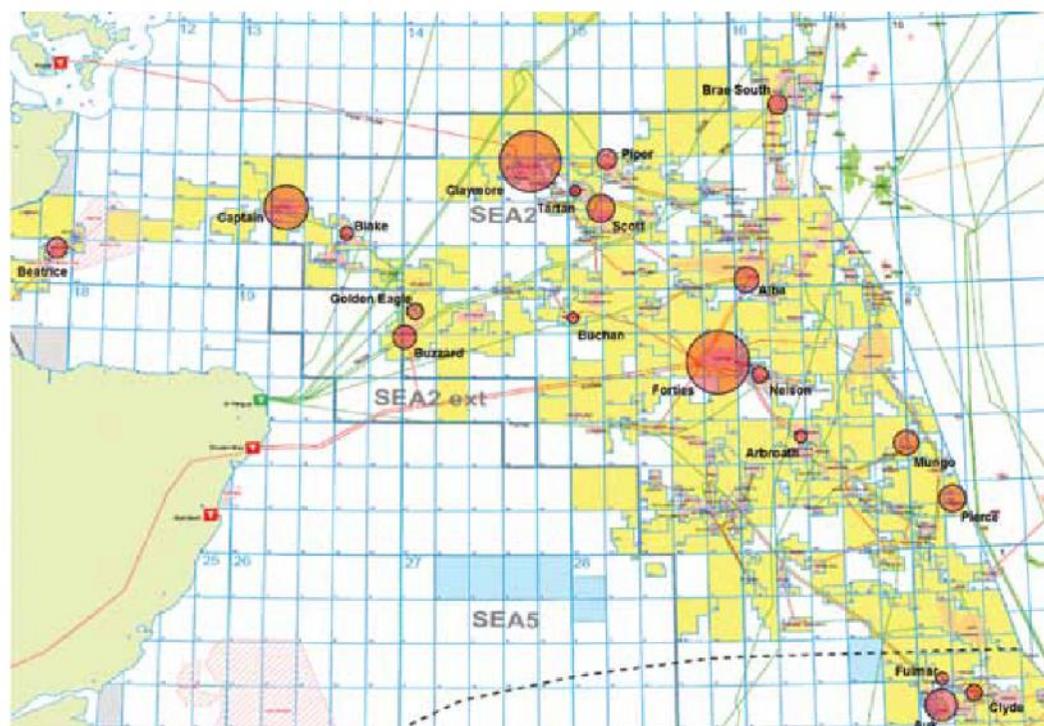


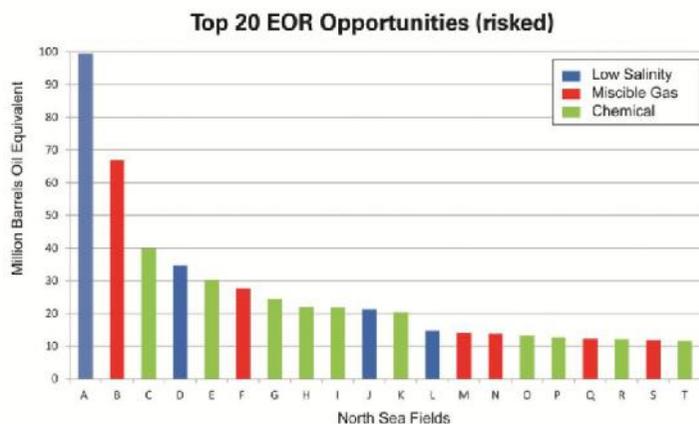
Figure 10: An example “Bubble-Map” of the Distribution of EOR Potential in the Central North Sea (the diameter of each circle is proportional to EOR potential)



Business Case

Top 20 UKCS EOR opportunities (Risked).

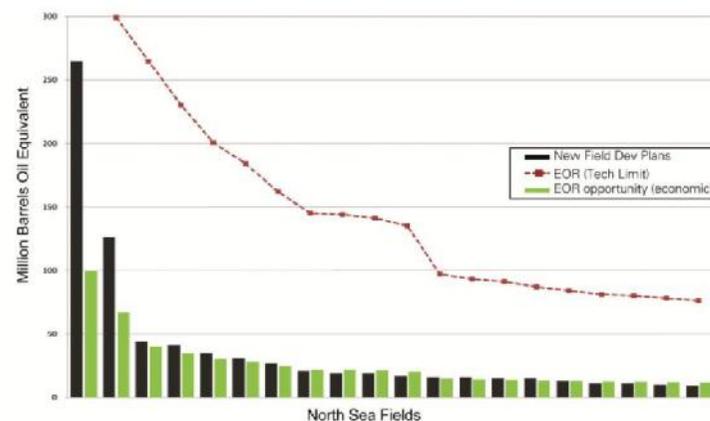
- The realistic economic (or risked) EOR potential in the UKCS is believed to be between 10 to 20% of the maximum figures.
- Which is in the range of **0.6 to 1.2 billion barrels oil**, which still equates to a very significant resource potential.
- For comparison, **the economic (risked) EOR potential for the top 20 fields alone equates to 0.5 billion barrels**, which is comparable in size to the top 20 new projects that had their FDPs approved over the 5 year period last (1998 – 2013).



Top 20 EOR opportunities in UKCS:

- Average prize – 26 mmbbls (risked)

Source: DECC SENEOR tool



New Field Developments approved by DECC over the last 5 years: Source: DECC

- Average field size - 26 mmbbls

Top 20 EOR opportunities in UKCS:

- 3.5 billion bbl prize (unrisked)
- Average prize – 26 mmbbls (economic estimate) Source: DECC SENEOR tool



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Low Salinity EOR



The official site of the British Prime Minister's Office

[Home](#) > [News](#) > PM gives go-ahead for £4.5bn UK oil and gas project

[News Stories](#)

[Press Briefings](#)

[Press Notices](#)

[Prime Minister's Questions](#)

[Speeches and Transcripts](#)

[Statements and Articles](#)

PM gives go-ahead for £4.5bn UK oil and gas project



Thursday 13 October 2011

Clair Ridge project will create hundreds of jobs over the next five years and produce a vital source of domestic oil until around 2050



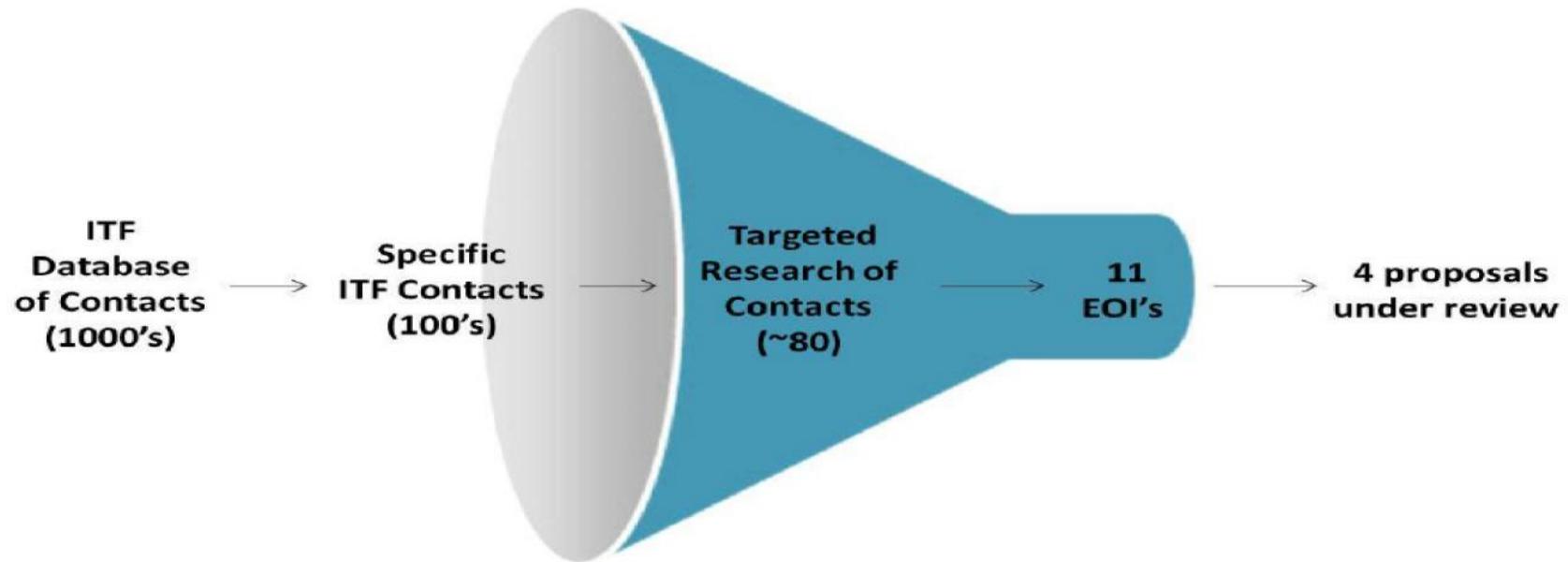


Low Salinity EOR – Current Position

- Attractive as relatively low cost and operators are comfortable with water flood
- PILOT has generated good cooperation, with industry leadership from BP
- Lack of clear understanding of how it works has proved a significant issue
- Identified good options for implementation on North Sea platforms
- Seems to be less effective on mature fields (most of UK fields are mature!)



Brownfield Facilities for Low Salinity EOR



Facilitate. Collaborate. Innovate

ITF is the internationally recognised champion for facilitating collaborative development of innovative technologies within oil & gas and related energy industries.



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For more detail see:



SPE 172017

Maximising Enhanced Oil Recovery Opportunities in UKCS Through Collaboration

M.P. McCormack, BP Exploration Operating Co.; J.M. Thomas, UK Department of Energy & Climate Change;
K. Mackie, Industry Technology Facilitator

Copyright 2014, Society of Petroleum Engineers



Low Salinity EOR – Looking Forward

- All new developments should be screened for low salinity EOR potential - don't just assume seawater as default
- Further work needed on potential to combine EOR techniques
 - e.g. Polymer and Low Salinity
- Solutions to offshore implementation need more support
 - Examples new membranes – Imperial College.
 - Low weight and space desalination designs
- Better understand screening work to date
 - Impacts of clays on recovery, mechanisms R&D
 - Low Salinity micro emulsion studies – Heriot Watt Studies
- Still need clearer guidelines on core screening methods

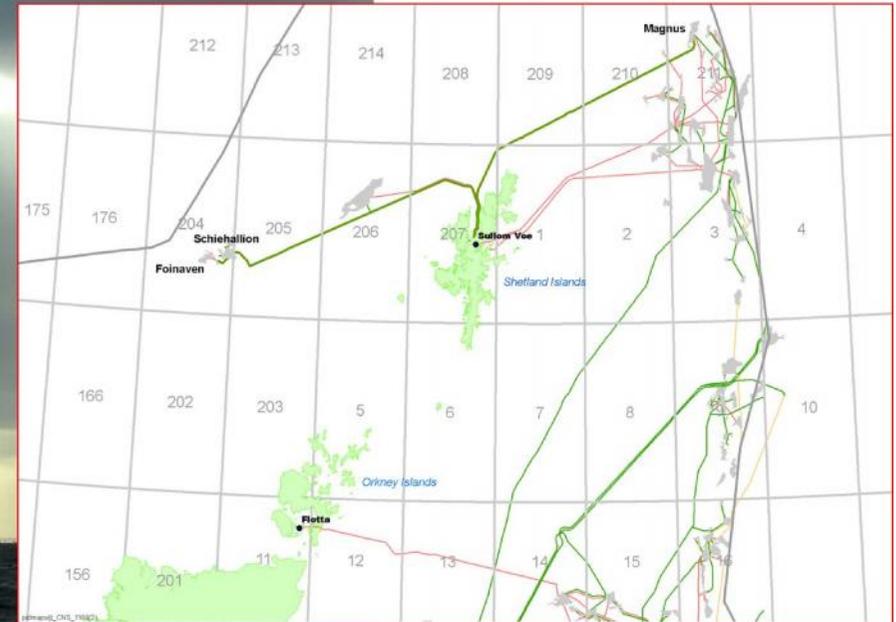
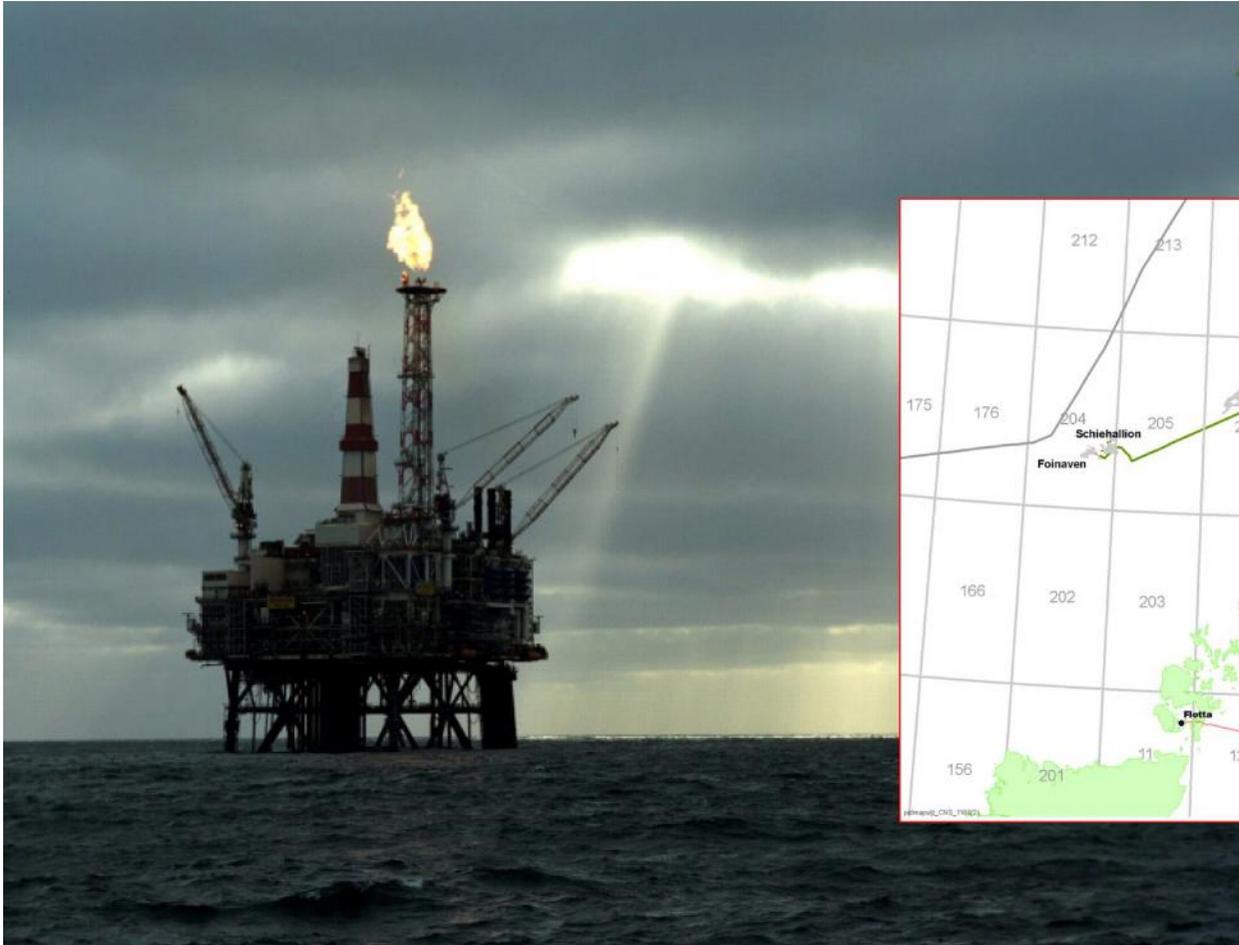


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Miscible Gas Injection EOR



Miscible Gas EOR— Magnus



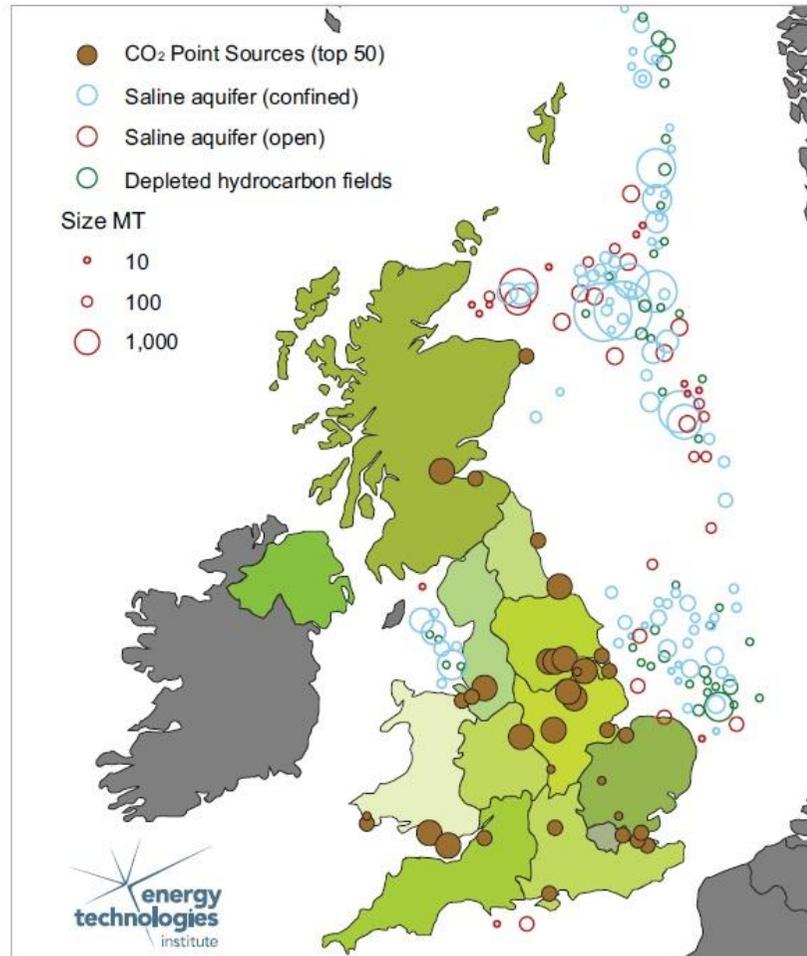


Miscible Gas EOR – Taking Stock

- Technology is fairly well understood
- Cheap & plentiful injection gas is key
- Looked at potential sources of hydrocarbon gas for EOR
- Looking to link the UK CCS Programme with CO₂-EOR opportunities in the Central North Sea.

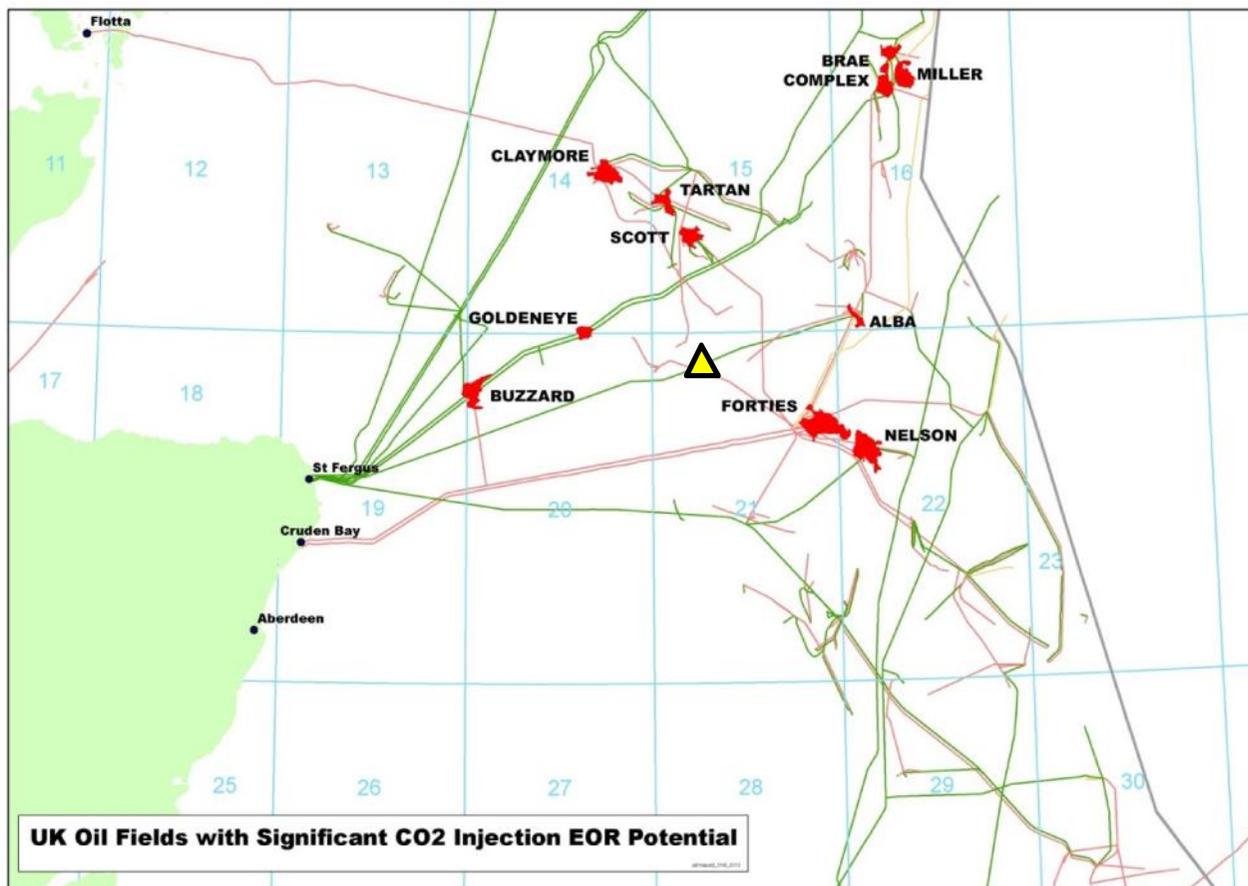


Need Joined-Up CCS Policy & CO₂-EOR





A Conceptual CO₂ EOR “Core Area”





Miscible Gas EOR – Looking Forward

- Keep a watch for new supplies of stranded hydrocarbon gas
- *Energy Research Partnership* study looked at strategic issues around joining up CCS & CO₂-EOR
- Economics of CO₂-EOR are not straightforward
- Need better handle on CO₂ impact on offshore facilities
- Limited “window-of-opportunity” – how do we accelerate?
- low oil prices are accelerating / advancing the end of existing field as they become uneconomic sooner



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Energy Research Partnership (ERP) Report PROSPECTS FOR CO₂-EOR IN THE UKCS

Recommendations:

1. Delivering CO₂-EOR in the NS requires coordinating the different sectors & industries for the extraction of oil and the development of CCS & a CO₂ transport network.
2. Policy decisions over next two years on CCS will determine CO₂-EOR outcomes.
3. Offshore tax regime needs to support the additional cost and higher risks of CO₂-EOR.
4. Establishing a CO₂ transport network company will reduce the risks and costs for emitters, storage developers and CO₂ users.



Steering Group chair:

Angus Gillespie, Shell International

Steering Group:

- Jonathan Thomas, EDU, DECC
- Tony Espie, BP
- Peter Emery, Drax Power Ltd
- Tassos Vlassopoulos, GE
- Paul Sullivan, National Grid
- Steven Fogg, Atkins
- Andy Leonard, Oil & Gas UK
- Ward Goldthorpe, Crown Estate
- Julien Hailstone, Nexen Petroleum UK
- David Rennie, Scottish Enterprise
- Will Lochhead, OCCS, DECC

<http://erpuk.org/project/co2-eor/>



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Chemical EOR



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Chemical EOR Projects



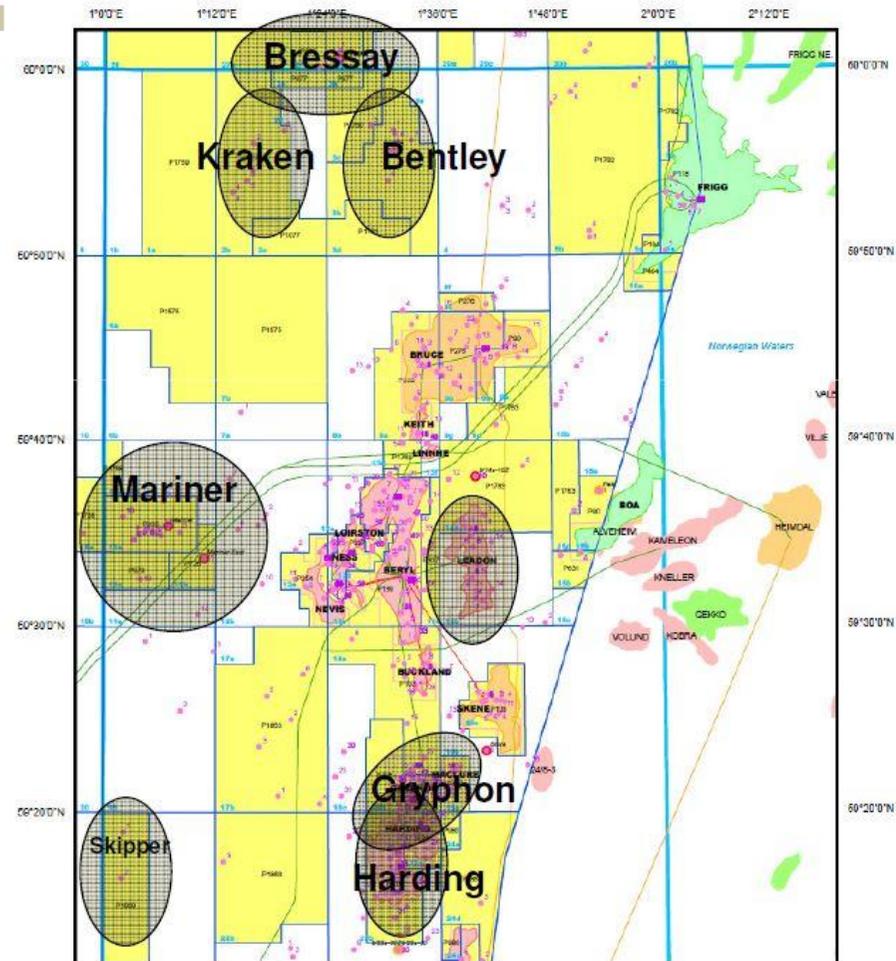
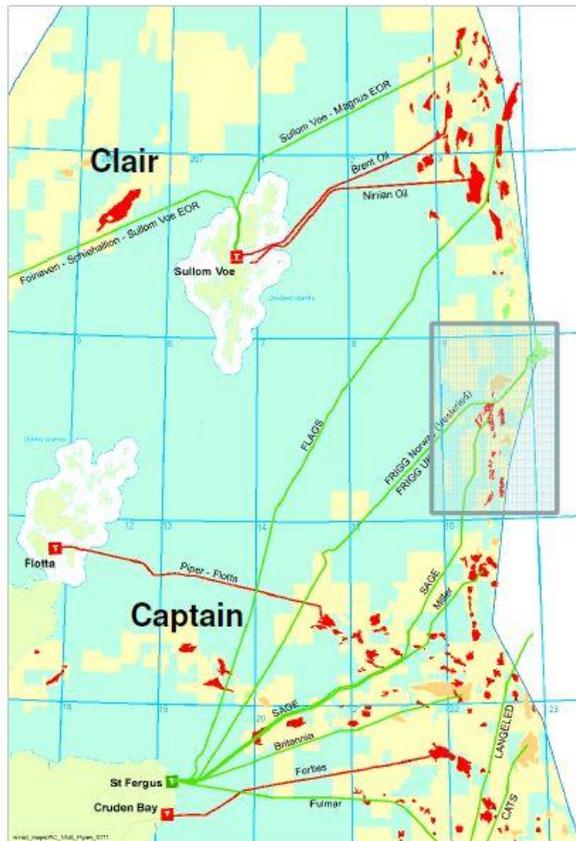


Chemical EOR – Taking Stock

- Little experience offshore, but growing
- High OPEX is a concern (expensive chemicals)
- Chemical performance has improved sharply since UK fields were developed
- Several new heavy/viscous oil developments in the UK.
- Good potential for polymer EOR application.
- The facilities and environmental challenges are very significant
 - Key here is the practicalities and scale of Polymer EOR.
 - It is important to recognise that the logistics offshore are much more complex, costly and (safety) risky than onshore.
 - Significant volumes (huge barge loads) are required to be shipped offshore each day, everyday for the Polymer flood to work.



Quad-9 Heavy Oil Fields





The Polymer Operating Envelope has greatly improved

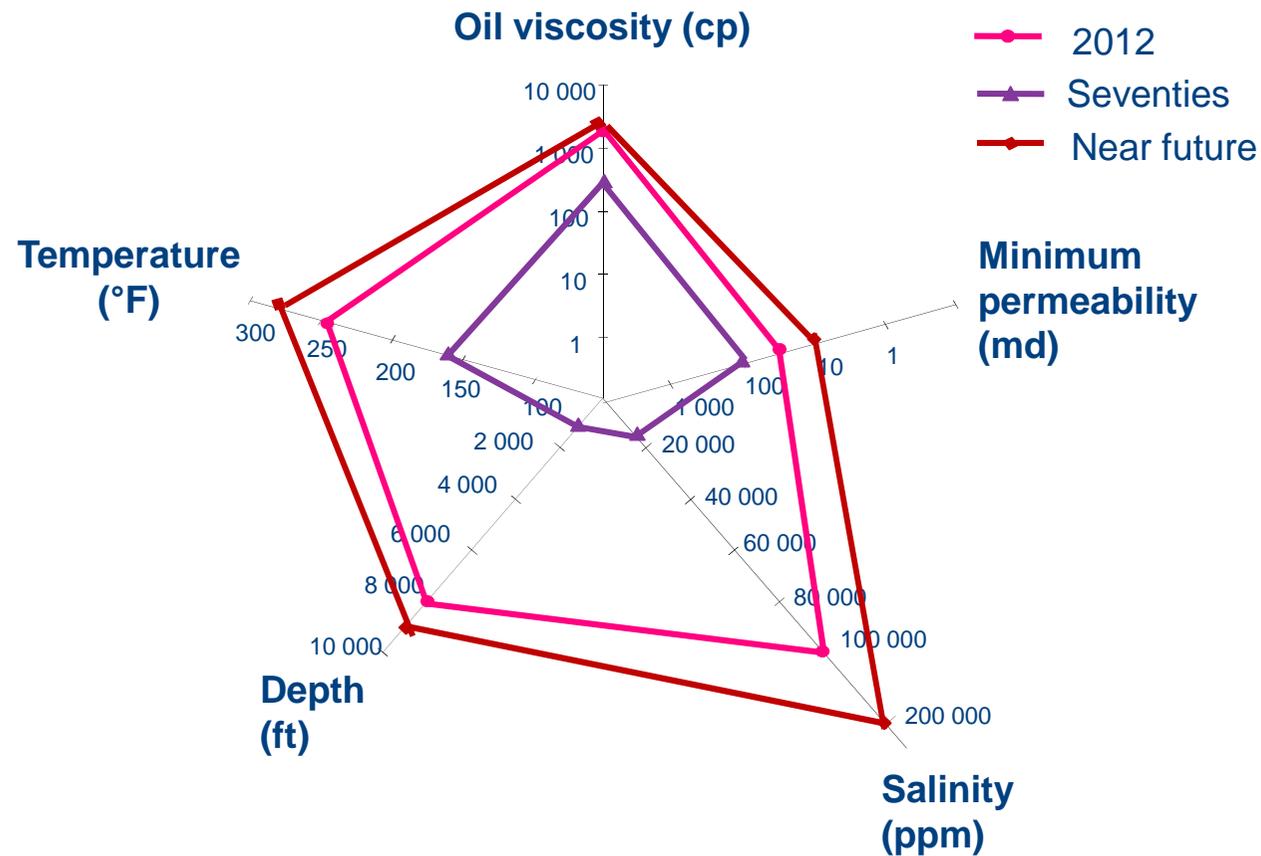


figure provided by SNF



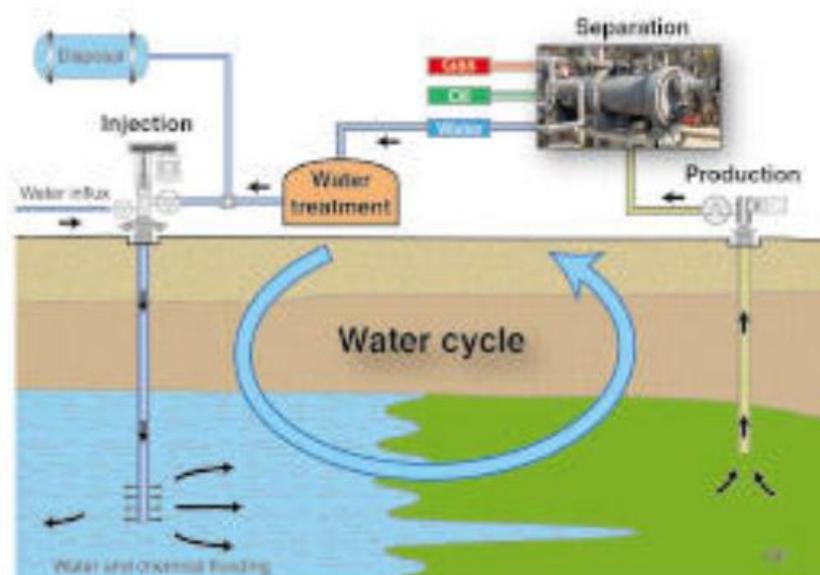
Chemical EOR - infrastructure issues

Press releases

- ➔ **Impact of chemical enhanced oil recovery on water management - IFPEN launches Dolphin™, an experimental research project with industry**

DOLPHIN

Impact of chemical EOR
on water management





Chemical EOR – Looking Forward

- Need to get better awareness of improvements in chemical performance
- Offshore facilities challenges of handling produced EOR chemical are being address via Dolphin JIP
- Polymer EOR “myth busting” and knowledge sharing is required
- Make sure new facilities are “Chemical EOR Ready” where appropriate
- Look at benefits of combining low salinity with chemical EOR



Impact of Low Oil Price

- Interest in EOR has dropped down the agenda
- EOR teams have been (or are being) reduced in size
- Many operators are currently losing money (or will be soon) so there is limited capital available to invest in EOR even if it was economic.
- Operators are generally more risk-adverse



Response to Low Oil Price

- Increase emphasis on larger new developments
- Ensure development plan commitments on EOR are honoured
- Closer engagement with operators to progress EOR options and tackle barriers to progression
- Strengthen OGA EOR capability and seek out new technological solutions
- The UK Government has reacted by reviewing and reducing tax burden in the recent March 2016 budget.



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The OGA EOR Vision and Strategy



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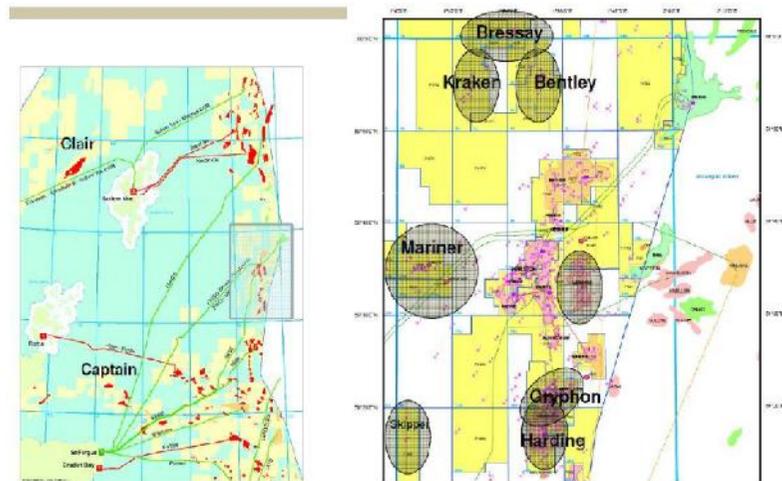
The Ambition

To drive economic development of 250 mmboe incremental reserves primarily through Polymer EOR over the next decade.

By working with operators and supply chain to support existing projects, to ensure readiness for future projects, and to drive risk reduction via technical and economic improvement.

To demonstrate a proven offshore operation of Low Salinity EOR by 2020 and progress further opportunities by encouraging evaluations for all new projects.

To advance the next tranche of EOR technologies and develop a framework for their economic implementation.





Summary of EOR Programme

1. Existing EOR Projects	<ul style="list-style-type: none">a) Pro-actively drive the sanction of Captain Polymer EOR field wide implementationb) Drive the implementation of Schiehallion / Loyal Quad 204 Polymer Schemec) Assist Clair Ridge to implement world's first offshore Low Salinity EOR scheme
2. MER for future EOR Projects	<ul style="list-style-type: none">a) Enforce EOR screening for regulatory approval in FDPsb) Encourage operators to progress high graded EOR resource opportunitiesc) Create a pipeline of opportunities to underpin business case and trackd) Plan and conduct specific OGA studies to evaluate EOR opportunities.
3. Workgroups and Industry Partnerships	<ul style="list-style-type: none">a) Pro-actively drive operator collaboration and partnerships by EOR workgroupsb) Actively support industry partnerships
4. Technology Development & Deployment	<ul style="list-style-type: none">a) Encourage EOR technology providers and operators to develop and deploy low cost EORb) Drive operators to optimise Polymer EOR technology.c) Drive operators to further develop and trial Low Salinity EOR technology.d) Actively support other IOR, EOR or use in regional schemes.
5. Creating Value – Improving Economics	<ul style="list-style-type: none">a) Develop an improved economic understanding to facilitate informed discussions.b) Develop a compelling business case for EOR technology – generic & specific cases.c) Facilitate UKCS Polymer supply chain and drive down costs.
6. Advance next EOR & CO2 Storage	<ul style="list-style-type: none">a) Advance the next tranche of EOR & develop framework for economic implementation.b) Support Miscible Gas EOR opportunities in specific fields.c) Develop a CO2 EOR Strategy and 5 Year Plan.d) For CO2 Storage, provide technical and regulatory support to the CCS agenda.
7. Knowledge Management / Oil & Gas Technology Centre	<ul style="list-style-type: none">a) Create & manage an OGA EOR library for all EOR Technologies.b) Actively support international EOR conferences.c) Actively co-operate with other governments and their IOR centres.d) Ensure that EOR technology is a key part of the new UK Oil and Gas Technology Centre.
8. Communication and Stakeholder Plans	<ul style="list-style-type: none">a) Develop a clear Stakeholder Plan.b) Develop and lead a powerful promotional campaign for EOR



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