The Enhanced Oil Recovery strategy for the UK continental shelf

IEA EOR Symposium, Paris
September 2016

David Puckett
William Lindsay
## Outline of Presentation

1. OGA Context
2. EOR Background and Prize
3. EOR Ambition and Strategy
4. Way Forward – Delivery Programme
5. Q & A
Outline of Presentation

1. OGA Context
2. EOR Background and Prize
3. EOR Ambition and Strategy
4. Way Forward – Delivery Programme
5. Q & A

OGA Corporate Plan
2016–2021

OGA Corporate Plan
Difficult environment with prolonged low oil price but turnaround evident

**Production**
- Daily production

**Costs**
- Average lifting cost per barrel ($)

**Exploration**
- Exploration & appraisal wells

- >60% success rate & >200 mmboe discovered in 2015 but very low levels of activity

- Production up by 9% with new fields & PE increased to 71%

- Operating efficiency improvements - sustainable transformation needed
Our way forward

Why

Ambition
To be a world-leading authority setting the framework for a sustainable and competitive UK oil and gas industry

Purpose
To maximise the economic recovery of oil and gas

What

Role
- Licence and steward offshore oil and gas E&P
- Licence and steward onshore oil and gas E&P
- Licence carbon storage and gas offloading

Regulate
- Industry operating costs and efficiency
- Greater industry collaboration
- Industry culture and behaviours

Influence

Promote
- Investment in the UKCS
- Value creation in the UKCS and through exports
- Industry, supply chain and technology development

Priorities

Revitalise exploration
- Implementing a licensing regime that encourages high levels of exploration, using data, analysis and insights to proactively influence and help incentivise exploration on the UKCS and improve success rates

Improve asset stewardship
- Stewarding the development of UK oil and gas resources and working with industry to optimise efficiency while maintaining high standards of safety and environmental management

Drive regional development and protect critical infrastructure
- Seeing the big picture and maximising the sum of the parts, making sure that barriers to regional development are removed and that critical infrastructure and production hubs are protected

Improve decommissioning efficiency
- Achieving the maximum extension of field life and ensuring that decommissioning is executed in a safe, environmentally sound and cost-effective manner and that the UK gains a competitive industrial capability

Leverage technology and data
- Ensuring that existing technologies are deployed to their full effect, relevant new technologies are developed and that the collection, analysis and sharing of data is used to maximise economic recovery

Create the right conditions
- Engaging with industry, government and others to create an operating environment and supply chain that supports MER UK, sustaining high levels of skilled employment, economic value and energy security for the UK

Develop people, processes and systems
- Creating a diverse, high-performing team and a great place to work, where employees are supported to develop their capability, in an organisation with simple processes and systems

This means

How

Values
- Accountable
- Fair
- Robust
- Considerate

Behaviours
- One team – proactive, efficient, delivery-focused, respected and trusted – a catalyst for change
Oil & Gas MER UK Forum

Purpose

Drive tripartite action in support of MER UK and maximise UK value from the oil and gas industry as a whole.

Objectives

1. Promote dialogue between government, industry and OGA
2. Provide strategic direction, oversight and support
3. Drive alignment, accountability, action and delivery on key priorities

Core work areas

- Exploration
- Asset Stewardship
- Regional Development and infrastructure
- Cost and efficiency
- Technology
- Decommissioning
- Supply chain, Exports and skills

Strategy and Plans

Principles

1. Each core work area has executive-level leadership from industry and OGA, via a board
2. Each core work area has a five year plan via a board
3. Each core work area has a maximum of three key priorities each year
4. The Oil & Gas MER UK Forum will therefore drive no more than 21 key priorities each year
5. Each key priority completed before moving to next

Reporting

The Oil & Gas MER UK Forum will produce an annual progress report

Frequency

2 x 2-hour meetingspa

Secretariat

OGA external affairs team

Sector strategies strong foundation for Industrial Strategy
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**
- Planning early for decommissioning

Some great examples ....and still room for improvement
Government, OGA and industry working together

Focused priorities

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

Risks & opportunities

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

Opportunity Matrix

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

Ongoing focus areas

- Barriers to exploration, infrastructure & asset transfers

Fiscal support

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

Recent OGA Progress

OGA Corporate Plan 2016-2021
Enhanced Oil Recovery (EOR) Strategy

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

Opportunity Matrix
- High potential for economic benefits
- Strong industry engagement
Outline of Presentation

1. OGA Context

2. EOR Background and Prize

3. EOR Ambition and Strategy

4. Way Forward – Delivery Programme

5. Q & A
Where are we now and what’s the opportunity?

**UKCS is one of the most mature offshore basins in the world and achieving optimal recovery from the basin is demanding.**

- Average UKCS RF from oil fields projected to be approximately 46% at end of field life.
- Still a significant prize to be gained by increasing recovery from existing oil fields.
- EOR techniques are used to recover incremental oil beyond that which can be extracted from the more conventional depletion and water flood.

The key focus of EOR is to improve the recovery from the pore scale (for example, using low salinity EOR or miscible gas) and/or improve the sweep (for example, using polymer EOR).

But currently only 2 active EOR schemes:
- Magnus hydrocarbon miscible gas injection
- Captain Pilot Polymer EOR scheme.

Additional projects are now either in execution, such as Clair Ridge (the world’s first offshore low salinity EOR scheme) and Mariner Polymer EOR (Pre-investment), or are at pre-sanction stages of evaluation.
Wood Review “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

The principal barriers to implementing EOR projects are typically:

- Incomplete subsurface understanding (e.g. pore scale and sweep)
- Supply of secure, low-cost injectant, in particular for miscible gas EOR
- Cost of building EOR facilities or redevelopment of existing brownfield assets
- Concerns over EOR economics.

Potential EOR prize

PILOT EOR Work Group Report (April 2014)

“Maximising Enhanced Oil Recovery Opportunities in the UKCS through Collaboration” (SPE 172017, 2014).
The potential to expand the number of EOR schemes in the UK has been assessed by the PILOT work group and an analysis conducted to:

- Systematically screen fields for EOR potential
- Engage industry and look for synergies by geography/geology/EOR type and collaborative opportunities to progress EOR understanding, and
- Where possible, initiate EOR projects with operators and/or suppliers.

The estimate, validated by operators, was that the theoretical maximum (un-risked) total EOR potential of the UKCS is approximately 6,000 million stock tank barrels (mmstb) of oil (assuming the optimal EOR project will be carried out on each field where it is applicable).
EOR opportunities (risked)

- The PILOT EOR work group’s view was that the economic (or risked) EOR potential is between 10% to 20% of the maximum (un-risked) amount so in the range 600 to 1,200 mmboe.

- This represents a significant resource potential.

- For instance, the economic (achievable) EOR potential for the top 20 fields alone equated to 500 mmboe, which is comparable in size to the top 20 new projects that had their Field Development Plans (FDPs) approved over the six-year period from 1998 to 2013.

- Whilst there are a number of EOR techniques available, three have been prioritised based on their prize and a view on their suitability and applicability in the UK offshore environment. These are:
  - Polymer EOR
  - Low salinity water flooding
  - Miscible gas injection (either hydrocarbon or CO₂).
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.

Considerations

- 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
**Taking Stock**

- Little experience offshore, but growing
- High OPEX - expensive chemicals
- Chemical performance improved since UK fields developed
- Several new heavy/viscous oil developments in the UK.
- Good potential for polymer EOR application.
- Significant facilities and environmental challenges to overcome

**Considerations**

- Need improvements in chemical performance
- Offshore facilities challenges of handling produced EOR chemical are being address via Dolphin JIP
- Polymer EOR knowledge sharing is required
- New developments to be “chemical EOR ready” where appropriate
- Benefits of combining low salinity with chemical EOR
- Reduce polymer costs by scale and competition
Low Salinity EOR

Taking Stock
- Attractive as low cost
- Operators are comfortable with conventional sea water flooding.
- PILOT generated good cooperation, with industry leadership from BP
- Lack of clear understanding of how the Low Salinity Mechanism work in the reservoir has proved a significant issue
- Identified good options for implementation on North Sea platforms
- Best results if implemented from day 1; at sanction – Do EOR Early !!

Considerations
- All new developments should be screened for low salinity EOR potential - don’t just assume seawater as default
- Still better understanding of mechanisms: such as impacts of clays; brine salinity and composition; oil composition and micro emulsion.
- Still need clearer guidelines on core screening methods.
- Solutions to offshore implementation, such as new membranes – (Imperial College) and Low weight and space desalination designs
- Further work needed on potential to combine EOR techniques: Polymer and Low Salinity
The oil price has declined significantly and this currently impacts EOR economics making the task of maximising economic recovery through EOR even more challenging.

5 EOR projects have Field Development Plans:

- **Magnus** hydrocarbon miscible gas EOR – in operation
- **Captain** phased polymer EOR pilot programme and then field-wide implementation – in front end design phase
- **Schiehallion/Loyal Quad 204** – in construction (pre-investment in tanks and pumps has been approved, ordering of polymer and deployment into the reservoir is still subject to partner sanction)
- **Mariner** polymer pilot scheme – in construction (pre-investment in tanks, pumps and infrastructure has been approved).
- **Clair Ridge** (world’s first offshore low salinity EOR scheme) – in construction
In addition other EOR Projects in pre-FDP (Field Development Plan) stage being assessed
<table>
<thead>
<tr>
<th>Outline of Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. OGA Context</td>
</tr>
<tr>
<td>2. EOR Background and Prize</td>
</tr>
<tr>
<td><strong>3. EOR Ambition and Strategy</strong></td>
</tr>
<tr>
<td>4. Way Forward – Delivery Programme</td>
</tr>
<tr>
<td>5. Q &amp; A</td>
</tr>
</tbody>
</table>

Enhanced Oil Recovery (EOR) Strategy

EOR Strategy published July 2016

https://www.gov.uk/government/publications/enhanced-oil-recovery-strategy
Impact of Low Oil Price on the EOR Strategy

Current low oil prices have resulted an EOR Strategy focused primarily on existing UK EOR projects and those future projects that will benefit from low-cost EOR technologies such as polymer EOR and low salinity EOR whilst screening new projects at Field Development Plan (FDP) review stage.

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 having capital investment squeezed such that EOR developments may not happen, even if economic.
- Operators are generally more risk-adverse
- OGA obligated to enforce MER UK and Energy Bill

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
- UK Government has reacted by reviewing and reducing tax burden in the recent March 2016 budget.
It is believed that polymer EOR presents the greatest opportunity for medium-term success in the UKCS and a number of heavy oil fields could have their recovery factor increased through polymer EOR.

**BUT NOT Forgetting:**

**Low salinity water flood and chemical EOR** experimental and simulation studies have been completed which have helped determine the potential prize of these chemical EOR technologies.

**Miscible hydrocarbon gas EOR** continues to be evaluated where spare gas is available. However there is limited hydrocarbon gas available in the UKCS and the current low oil price may reduce the possibility of maximising the full potential prize of this proven EOR technology for the time being.

**Miscible CO₂ EOR** is a future opportunity that could use CO₂ when it becomes available from Carbon Capture projects in sufficient quantities.

**Other EOR technologies/synergies** being developed on the back of lessons learned over the past decade when high oil prices led to a stimulus in EOR research and development.

**Thermal EOR (steam flooding)** could be of interest for the more heavy oil reservoirs of the UKCS. However, this technique is energy intensive and potentially many years away from fruition.
The OGA’s ambition with regard to EOR can be described as follows:

- Drive economic development of 250 mmboe incremental reserves primarily through polymer EOR over the next decade. Work with operators and the supply chain to support existing projects to ensure readiness for future projects and drive risk reduction via technical and economic improvement.

- Demonstrate a proven offshore operation of low salinity EOR by 2021 and progress further opportunities by encouraging evaluations for all new developments.

- Advance the next tranche of EOR technologies and develop a framework for their economic implementation.
Creating the right conditions

In order to create the right conditions to meet this ambition, the following areas are crucial to advance polymer EOR development in both producing & new fields:

- **Cost reduction** – the creation of a competitive, robust supply chain is required to improve polymer EOR economics and reduce risk.
- **Collaboration** – where possible, share learnings to build EOR knowledge and competency in the UKCS and reduce barriers to EOR development at both producing and future fields.
- **Sustainability** – identify opportunities for standardisation of EOR-related technologies such as industry standards for testing base polymer.

**EOR Programme Elements**

1. Existing EOR Projects
2. MER for future EOR projects
3. Workgroups and industry partnerships
4. Technology development and deployment
5. Creating value – improving economics
6. Advance next EOR and support CO₂ storage
7. Knowledge management
8. Communication and stakeholder plans
## EOR Strategy - Programme

### Programme 1
**Existing EOR Projects**

To mitigate the risk that current polymer and low salinity EOR projects fail to be progressed in line with their FDPs:

- Support the Captain polymer EOR pilot and staged development project
- Support the implementation of Schiehallion/Loyal Quad 204 polymer scheme
- Support the Mariner polymer pilot programme
- Support Clair Ridge to implement the world’s first offshore low salinity EOR scheme

### Programme 2
**MER for future EOR projects**

To mitigate the risk that EOR opportunities are not identified early enough in field life cycle:

- Enforce early EOR screening for regulatory approval in draft FDPs
- Encourage operators to progress high-graded EOR resource opportunities
- Create a pipeline of opportunities to underpin business cases, track & communicate progress
- Plan and conduct specific OGA studies to evaluate future EOR opportunities
### Programme 3
**Workgroups and industry partnerships**

**To mitigate the risk that EOR technology lessons are not shared:**

- Proactively drive operator collaboration and partnerships via EOR workgroups
  - Polymer EOR
  - Low Salinity EOR
- Actively support industry partnerships and collaboration
- Engage in EOR Joint Industry Projects (JIPs)

### Programme 4
**Technology development and deployment**

**To mitigate the risk that EOR technologies are not developed or deployed:**

- Encourage technology providers and operators to develop and deploy low-cost EOR
- Drive operators to optimise polymer EOR technology
- Drive operators to develop further and trial low salinity EOR technology
- Actively support emerging technology and engage global knowhow
## EOR Strategy - Programme

### Programme 5  
**Creating value – improving economics**

To mitigate the risk that marginal EOR project economics stifle investment:

- Develop an improved economic understanding to facilitate informed discussions
- Develop a compelling business case for EOR technology; generic and specific cases
- Facilitate a competitive polymer supply chain and drive down costs

### Programme 6  
**Advance next EOR and support CO₂ storage**

To mitigate the risk that, while prioritising polymer and low salinity EOR, other EOR technologies are missed:

- Advance the next tranche of EOR, such as miscible gas/CO₂ injection and develop a framework for economic implementation
- Support miscible gas EOR opportunities in specific fields
- Develop a CO₂ EOR strategy and five-year plan
- For Carbon storage, continue to provide technical and regulatory support to the CCS agenda
### Programme 7
**Knowledge management**

**To mitigate the risks associated with poor EOR awareness and knowledge transfer:**

- Create and manage an OGA EOR library for EOR technologies
- Actively support international EOR conferences
- Actively co-operate with other governments and their technology centres

### Programme 8
**Communication and stakeholder plans**

**To mitigate the risk that lack of senior industry leadership buy-in to the deployment of EOR technology limits investment in EOR projects:**

- Develop a clear stakeholder plan
- Develop and lead a powerful promotional campaign for EOR
<table>
<thead>
<tr>
<th></th>
<th>Outline of Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>OGA Context</td>
</tr>
<tr>
<td>2.</td>
<td>EOR Background and Prize</td>
</tr>
<tr>
<td>3.</td>
<td>EOR Strategy</td>
</tr>
<tr>
<td>4.</td>
<td><strong>Way Forward – Delivery Programme</strong></td>
</tr>
<tr>
<td>5.</td>
<td>Q &amp; A</td>
</tr>
</tbody>
</table>
Way forward – Delivery of Programme

Implementation programme

- The OGA will be the custodian of the EOR Strategy and any updates.
- A member of the MER UK Asset Stewardship Board appointed to be the industry lead.
- Strategies to be updated every 5 years, earlier by exception, with delivery programmes to be reviewed on an annual basis.
- Whilst EOR in the UKCS will largely be led by industry, the EOR delivery programme supporting this strategy will also detail how the OGA will ensure MER obligations are met.

Level 1 Plan developed
Consultation with stakeholders on-going
Asset Stewardship Board
Polymer EOR Workgroup
Publication expected in September 2016
## EOR Implementation: SPA & support role

<table>
<thead>
<tr>
<th>EOR Role</th>
<th>Key EOR responsibility</th>
<th>EOR Strategy</th>
<th>Progress of implementing EOR Strategy</th>
<th>Program 1: Existing EOR projects</th>
<th>Program 2: MER for future EOR projects</th>
<th>Program 3: Workgroups and industry partnerships</th>
<th>Program 4: Technology development and deployment</th>
<th>Program 5: Creating value-improving economics</th>
<th>Program 6: Advance next EOR and support CO2 storage</th>
<th>Program 7: Knowledge management</th>
<th>Program 8: Communication and stakeholder plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>OGA E&amp;P EOR Manager</td>
<td>Develop EOR Strategy and interactions on economics/cost improvements</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MER UK Asset Stewardship Board</td>
<td>Deliver tangible and quantifiable results, including senior leadership engagement on EOR</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OGA Technology Director</td>
<td>Linkage of EOR Strategy to technology</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OGA Senior Economist</td>
<td>Linkage of EOR Strategy to economics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OGA EOR Reservoir Specialist</td>
<td>Linkage of EOR Strategy to technology, workgroups, JIPs, technology development</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>OGA Area Managers</td>
<td>Existing EOR projects and engaging operators early to promote readiness for future CO2 EOR projects</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OGA Facilities Engineers</td>
<td>Existing EOR facilities and readiness for future CO2 EOR projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. SPA
2. KEY SUPPORT
1. OGA Context
2. EOR Background and Prize
3. EOR Strategy
4. Way Forward – Delivery Programme
5. Q & A

For further information, contact:

**David Puckett**
Senior Reservoir Engineer – EOR
The Oil and Gas Authority
London, UK
E: [David.Puckett@oga.gsi.gov.uk](mailto:David.Puckett@oga.gsi.gov.uk)

**William Lindsay**
EOR and CCS Project Manager
The Oil and Gas Authority
Aberdeen, UK
E: [William.Lindsay@oga.gsi.gov.uk](mailto:William.Lindsay@oga.gsi.gov.uk)
### References

1. [UKCS Maximising Recovery Review: Final Report - Sir Ian Wood](#)
2. [Maximising Enhanced Oil Recovery Opportunities in UKCS Through Collaboration - SPE 172017](#)
3. [Energy Research Partnership - Prospects for CO2- EOR in the UKCS – October 2015](#)
4. [OGA Corporate Plan 2016 - 2021 v2 – 4th March 2016](#)
5. [Enhanced Oil Recovery Strategy - 22nd July 2016](#)